FOOD BIOTECHNOLOGY IN ETHICAL PERSPECTIVE

SECOND EDITION

by

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This book is dedicated to my mother, Joan B. Thompson, with enduring respect for her appreciation of the influence of both genes and a character building life environment.

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As the second edition goes to press, the list of unnamed people to whom I owe a debt of appreciation has grown longer still. But a few additional ones do deserve mention. I would like to thank the US National Science Foundation again for support I received through award number SES-0403847, a project to explore links between the agrifood biotechnology debate and the emerging science of nanotechnology. I would also like to acknowledge Michigan State University and the WK Kellogg Foundation for the support extended through the WK Kellogg Chair in Agricultural, Food and Community Ethics. In addition, I would like to thank the Applied Philosophy group at Wageningen University in the Netherlands for the hospitality they extended to me during my sabbatical visit during 2004, when these revisions were originally begun. Bill Hannah has earned my gratitude for his assistance in compiling the index. Thanks also to Fritz Schmuhl at Springer for support and encouragement. Finally I would like to thank Julie Eckinger, without whom the final completion of the manuscript would have been impossible.

P.B.T.

INTRODUCTION

For nearly 25 years, word of changes in our food has percolated through the press, occupied untold bits of memory in computers on the Internet, and occasionally burst into the nightly television news broadcast. Tomatoes will be modified to ripen slowly and taste better, or perhaps they will be changed to resist frost. Plants will produce their own insecticides. Animals will take many new shapes, and familiar food animals may be used for organ transplants. The changes make their way from academic journal articles to scientific magazines to the science pages of major newspapers. From there the stories go to the front page and finally to editorial pages, as the struggle over regulation and approval takes place. Some of these changes seem miraculous and some seem threatening. Some seem threatening *because* they seem so miraculous. A public wizened to the false promises of chemical and nuclear technology may be less willing to greet these changes warmly.

From the standpoint of a working scientist, or of a policy maker in government or corporate organizations, these changes may not seem so sudden. Researchers who began scientific careers at the dawning of enthusiasm about recombinant DNA and its applicability to food and agriculture have progressed well into middle age. Some of the early leaders in the field are now enjoying retirement. To the scientists who did the work, public suspicion or reluctance to move faster with food biotechnology seems irrational, characteristic more of Ned Lud and of nineteenth century suspicion of Darwin than of any well-founded lessons from the unintended consequences of recent technological developments. Yet it was only within the last half of the last decade of the twentieth century that many products became available, and only the last years of that decade that they were tested in terms of consumer acceptance.

Whichever perspective one takes, there appears to be an ethical issue lurking here somewhere. Is it wise to take this course, and can those who will take it be trusted? Is it fair that decades of hard work should be subjected to the whims of an uninformed and superstitious public? Indeed there have been many calls for a review of ethical issues related to these new developments in human food systems, and many authors have included ethically based reflections among their treatments on food biotechnology. Yet such accounts typically make their philosophical points by implication and innuendo, and almost never lay out the foundations or framing assumptions that shape the key ethical claims. This book is an attempt to advance the quality of debate about the ethical implications of food biotechnology by sketching and evaluating arguments that have been or might be made in developing some of the frequent points on which opinion is divided. It is written for an audience that is already somewhat knowledgeable about agricultural biotechnology and the points that have been contested with respect to its use.

A secondary goal of the book relates to agricultural ethics and the philosophy of technology in general. Agricultural and food biotechnology serves as an extended and generalizable case study in the ethics of applied science and technology. Many of the topics discussed in this book would come up in connection with any technology that poses risk to human health and safety, to animals, to the environment or that has the capacity to induce important social changes in the way that people lead their lives. Since almost all agricultural and food technologies fit this description, this book can be read as a general work in the philosophy of technology, with the techniques of genetic engineering applied to farming and food technologies as an extended object lesson. Some of what follows will be relevant to engineering, energy and information technology. Much of it will be relevant for nanotechnology, which like biotechnology is a somewhat ill-defined cluster of techniques. Like biotechnology, nanotechnology will be very likely to emerge in the form of production technologies, rather than consumer products. Thus it will be "in" and "of" the products consumers buy without actually being something that they actually want. Like biotechnology, nanotechnology has already attracted a cadre of promoters and detractors. And of course, much of what goes here goes also for agricultural technologies of all kinds, including agri-nanotechnology. While other types of technology receive only occasional mention throughout the text, one would hope that a discerning reader will be able to generalize the lessons of biotechnology to the other relevant cases.

Most books on social and ethical issues relating to biotechnology either begin with an extended discussion of the science or confine themselves to biography, storytelling and human drama. Although this book will indeed discuss issues where science matters, the best way to get into the ethics of technology is just to get into it, rather than by engaging in extended preliminary discussion of scientific or philosophical ideas. Readers desiring the "short" version of the book are urged to skip the rest of the introduction, and go right to Chapter 1, then Chapter 11. Readers desiring a more leisurely or detailed tour will still find that they can pick up much of what they may not know about either science or philosophy by thinking about the issues, rather than enduring abstract and theoretical tutelage. A few preliminary points may ward off confusion, or help readers interpret what follows, and the next two sections of the introduction summarize those points. As noted, the general goal is to provide an analytic framework and introduction to the ethical issues that arise in connection with food biotechnology. This suggests two key questions for framing the discussion: (1) What is food biotechnology? (2) What is an ethical issue? Since debate over food biotechnology has been so contentious, it is useful to add a third and somewhat unconventional preliminary, namely a statement of the author's stake in readers' final conclusions on the issues reviewed. Finally, introductions usually summarize the organization of the book, and this one ends by explaining how this revised edition differs from the book that appeared with the same title in 1997.

WHAT IS AGRIFOOD BIOTECHNOLOGY?

The term "food biotechnology" that appears in the title is intended to indicate a number of recent technological innovations for producing and processing food. In fact, many of the technologies covered in this volume are used in agriculture. Agriculture is, of course, one of the key stages in food production. In some quarters agricultural and food technology are seen as discrete domains, but that is not the case in these pages. I will, in fact, use the somewhat awkward term "agrifood biotechnology" more frequently than "food biotechnology," in order to remind readers that the focus covers the entire food system. The technological innovations collectively referred to as biotechnology share an emphasis on cellular and subcellular manipulation of the organisms and commodities that make up the human food supply. Biotechnology involves the manipulation of plant, animals or microbial cells through physical, chemical or biological means. These cells are then either grown into whole plants or animals, or they are used in other ways to affect the production, processing and distribution of food. The implicit focus of this book is on relatively recent and controversial manipulations, especially genetic engineering and animal cloning.

There is no universally recognized definition for agrifood biotechnology. Some authors include tissue culture, the process of reproducing a whole plant from just a few cells by manipulating their chemical environment; others do not. By far the most controversial forms of food biotechnology apply recombinant DNA techniques in genetic engineering, inserting genes or other sequences of genetic code from one class of organisms into another. However, some techniques such as genomics and proteomics deploy rDNA techniques in projects that not only do not involve genetic engineering, but may not involve the creation of new organisms, at all. In these branches of biotechnology, the goal is to learn the location and function of genes, an activity that might be used to develop a new food product using genetic engineering, but might also be used in conjunction with more traditional techniques of plant or animal breeding. Most people include techniques for transferring and splitting animal embryos—cloning—as forms of biotechnology. Although cloning is one of the more controversial new biotechnologies, embryonic cloning does not necessarily involve the reorganization of genetic code that is usually associated with genetic engineering. At the risk of seeming indecisive, it is best to leave the definition of food biotechnology somewhat vague.

Biotechnology is thus a large class of techniques and agrifood biotechnology involves the use of these techniques in developing methods and products for the production, processing, distribution and perhaps one day even the preparation and consumption of food. The products of biotechnology include transgenic crops and animals, that is, crops that have been modified using genetic engineering to have genes with useful traits. The most common transgenic crops have been modified to resist damage by common herbicides (e.g. herbicide tolerant crops) or to produce the toxin *bacillus thuringiensis* which kills caterpillars. More discussion on specific products of biotechnology ensues in later chapters. Transgenic crops are often referred to popularly as "GM crops" or "GMOs" (where G = Genetic, M = Modified and O = Organism). Many scientists complain bitterly about this terminology, but I will use it occasionally, especially when the context is one in which consumer attitudes are important. In addition to transgenic crops and animals, some products of biotechnology are particular ingredients or substances (such as rennet, the enzyme that causes milk to turn into cheese) that can be produced by genetically engineered micro-organisms. The focus of the book is food and agricultural biotechnology, rather than medical or industrial biotechnology, but there are a number of products that challenge this boundary. Plants that have been transformed to produce non-food substances provide an example. Are these agricultural plants? They probably are, especially if they will be grown on large acreages, as maize plants transformed to be especially useful for fuel production probably will. But it may be quite important to keep these non-food plants out of the food system (especially if they have been transformed to produce pharmacologically active compounds), and some would object to even including discussion of them in a book on food biotechnology. Again, vagueness seems prudent here, for while the main focus is on food, it may be quite appropriate to discuss some agricultural crops (like cotton or tobacco, for example) that we do not normally think of as food.

This book has been written with a primary audience of scientists, policy makers and well-informed lay readers in mind. One of the challenges is to strike a balance between a vocabulary that is so technical that few lay readers will find it accessible and one that takes such extended detours to define terms that the primary audience begins to suffer from boredom. How much does one need to know about biotechnology, recombinant DNA and molecular biology to undertake an evaluation of the ethical issues that arise in conjunction with food biotechnology? Arguably not much. The opening paragraphs of this introduction provide a fair test of whether one's knowledge of biology is adequate to follow the arguments in the rest of the book. That means that when a phrase like "embryo transfer" appears, the reader should be comfortable with the word "embryo" and should be able to infer that moving embryos from one place to another is under discussion. This is far short of knowing what embryo transfer is, much less how or why it is done, but my suspicion is that more detailed knowledge will often be unnecessary, and will otherwise be available in context.

There may be lay readers who desire a bit more introduction, and in that vein, a few texts can be recommended. The introductory sections to Richard Sherlock and John Morrey's *Ethical Issues in Biotechnology* (2002) are concise, readable and up to date. Older books by David Suzuki and Peter Knudtson (1990) and by Colin Tudge (1993) include excellent (if short) discussions of ethical issues along with hundreds of pages on evolutionary biology, reproduction and molecular genetics. Two books by philosophers tilt the balance in the opposite direction. One is Bernard Rollin's *The Frankenstein Syndrome* (1995), which is discussed at some length in Chapter 4. The other is Michael Reiss and Roger Straughan's *Improving Nature?* (1996). Despite all that has happened in biotechnology over the last decade or more, some of the best introductory discussions were among the first to appear (see Fincham and Ravetz 1991; Gonick and Wheelis 1991; British

Medical Association 1992; Lee 1993). There are also a host of books that came out in connection with the early years of the Human Genome Project attempting to explain the science (see Bishop and Waldholz 1990; Wingerson 1990; Wills 1991), and another round that came out in the wake of debates over adult cell cloning (see National Bioethics Advisory Commission 1997; Kolata 1998). Sometime in the late 1990s, publications intended to inform the public about the basic science of biotechnology migrated to the web as their preferred outlet. Some company websites are quite informative on basic terms and methods. The Monsanto Co. maintains an extensive network of websites, and one developed for science teachers http://www.teachingscience.org/ is especially useful. On the other side of the debate, Genewatch UK http://www.genewatch.org/ is a venerable group that is often cited for the scientific quality of their information. In short, readers desiring a bit of biology are not lacking in opportunity.

Yet in my view these publications, especially those produced by official and semi-official scientific committees, appear to be based on some presumptuous beliefs about the level of biological knowledge needed to understand social and ethical issues. They assume (correctly) that less scientifically informed readers have gaps in their understanding of genes, their role in heredity and evolution, and natural order of living species and they presume that people are wont to fill in those gaps with speculation and misinformation. The uninformed, they worry, may draw on science fiction or Hollywood in constructing their own folk biology, resulting in unnecessary fears, and concerns on the one hand, or unreasonable expectations on the other. The implication is that ability to pass a comprehensive college biology examination is the admission ticket to participation in the social and ethical debate on biotechnology. The recent US debate over “intelligent design” and the teaching of evolution in pre-college classrooms has stoked the science community’s concern about public attitudes to new heights.

While one should not underestimate the public’s capacity for both unwarranted fear and unwarranted enthusiasm, it is questionable whether anything more than the most basic kind of science literacy is a prerequisite for beginning a discussion of ethical and policy issues in food biotechnology. One should know that scientists do not derive their theories by consulting oracles, of course, and one should have a vocabulary that makes sense of words like “cell,” and “molecule.” Beyond this high-school science, one should know a few very basic things about genes and genetics. One should know that every cell of every living thing contains a molecule of DNA. One should know that this molecule interacts with its cellular environment to do a lot of work for the organism in which it occurs. The interaction between DNA and environment determines the shape or form of the organism: Are its component molecules organized as a flower, a tree, a rhinoceros or you or me? The interaction regulates many of the organism’s life functions: when to grow, when to stop, when to reproduce. In sexually reproducing organisms parts of the DNA from each parent recombine to form a new molecule, which in turn interacts with its environment to form an organism with a unique mix of characteristics from each parent.

DNA itself is made up of four bases: guanine (G), adenine (A) thyanine (T) and cytosine (C). These bases connect with one another to form almost unimaginably long strands that fold and bend in the famous double helix shape. However, it will not be necessary to mention their names again. The sequence of bases in the DNA of any one individual of a given species is roughly similar to that of any other, but there are many small differences—differences that manifest themselves in the different size, shape and color of individual organisms. They explain why the individuals of any species (including humans) exhibit such diverse characteristics at the phenotypic level. The fact that differences at the level of an organism are related to differences in the DNA sequence is extremely important for agriculture because farmers, scientists and commercial companies have long sought plants and animals with certain desirable characteristics that are evident in the phenotype, that is, at the organismal level. They want plants that are well suited to a given climate (that don't bloom too early, or mature too late, for example), or that are especially tasty, or that are visually attractive, or that are easy to process or ship. The list of desirable characteristics is long, and many of these characteristics are related to DNA in complex ways that are not currently understood.

But scientists have learned that some of them are related to a specific sequence of bases within the DNA molecule, and I will refer to such specific sequences as genes. The scientific practice here has changed a bit over 25 years, and it is now more typical for scientific sources to use the word "gene" in a more restricted sense that distinguishes sequences that control or regulate other sequences from sequences that code for RNA and become involved in producing the proteins that carry out cellular functions. Like the names of the base pairs, this is a bit of biological detail that can create barriers between scientific and lay audiences. There may be cases where the distinction between coding and regulatory sequences becomes important, but my practice will be to use the term "gene" somewhat broadly and to specify more narrowly in those contexts where specificity makes a difference.

As has over 25 years become widely known, scientists have developed techniques that allow them to remove genes from plant or animal tissue, and to make many copies of the given sequence in a laboratory environment. They have also developed a variety of techniques for reinserting a gene into the DNA of an organism, and they have learned that they can insert genes derived from one species into the DNA of an organism of an entirely different species. In some instances the possibilities that result from such feats of genetic engineering are mind boggling. For example, fish that tolerate sub-freezing temperatures have a gene that can be copied, and when copies are inserted into plants, they too can tolerate sub-freezing temperature. The great enthusiasm among agricultural and food scientists that has accompanied early discoveries in molecular biology comes from a recognition that these laboratory techniques represent new means to accomplish the gradual alteration of agronomically valuable crops or food animals through plant and animal breeding.

Scientists will regard this as an utterly unexceptional account of what biotechnology is about. The ability to make sense of the above paragraphs presupposes more knowledge of biology than many may possess, but it is far less than what one needs to wade through many of the documents that have been developed to "inform the public." It is adequate to undertake all but the most metaphysical and theological of debates about the ethics of food biotechnology, as well. If there is a flaw in this account, it is that it makes biotechnology look too easy, like following a recipe or using Lego building blocks at the microscopic scale. It takes great skill, art, patience and some luck to succeed with the tools of biotechnology. Success in biotechnology requires extraordinary determination and attentiveness, and this alone would account for a lack of attention to ethical issues among those actually doing the laboratory-based work of biotechnology research and development.

THE NATURE OF ETHICAL INQUIRY

It is worth emphasizing that this is a book of philosophy, not science. In one sense, everyone employs philosophy in his or her most general attitudes about the nature of the world, their standards of rationality, and in their conceptions of right and wrong. Philosophy as a discipline is committed to more. At a minimum, philosophers are committed to an explicit statement of such general attitudes or presumptions about the world, rationality and morality. Rather than allowing these presumptive or implicit beliefs to lie dormant in cultural or religious practices, philosophy is an attempt to express them in spoken or written form. Once expressed, it is possible to examine these basic beliefs, and to apply many different standards of adequacy to them. Are they true? Are they well supported? Are they moral? Are they beautiful? Are they useful? Obviously, the attempt to evaluate basic beliefs often surfaces still more basic beliefs, beliefs that are implied by the standards of adequacy themselves. Readers having any familiarity with recent academic philosophy know that this process of self-reflection begetting self-reflection can continue to seemingly absurd levels of abstraction and distance from practical affairs.

However abstract the discussion may get, the branch of philosophy that is descended from Plato and Aristotle is committed to the principle that philosophy is a public activity. This means that any person's statement of presumptions, basic beliefs, etc. should be open to inspection and correction by anyone else. When someone objects to one's philosophizing, one has the obligation either to accept the objection and revise one's claim, or to rebut the objection by offering additional evidence or clarification. This process occurs subject to constraints of time and energy, of course, but in the ideal case it ends only when everyone agrees. In this respect, philosophy shares some important characteristics with science. It is organized around an ideal of convergence on the truth or adequacy of ideas within a community of inquirers. Anyone who shares this ideal and conducts his or her investigations according to it is a member of the community. Those whose interest in making or defending claims is inconsistent with that ideal are not.

Although science and philosophy share this general structure for inquiry, each has strengths and weaknesses that the other does not. In limiting (or at least focusing) deliberations on matters that are amenable to empirical test, scientists have a great advantage over philosophers in their ability to reach closure, and to more and more closely approximate the achievement of their ideal. Philosophy makes progress much more slowly, but does not foreclose the possibility of convergence on matters that are not amenable to logical demonstration or mathematical test. Philosophers risk the possibility that they are attempting convergence on matters where none is possible, but the matter of whether convergence is indeed impossible for a given set of questions is itself amenable to philosophical debate. Philosophy does make progress on its essential questions, however, and in both science and philosophy, even the most solidly established answers are always open to question, in principle, at least.

While these remarks on philosophy and philosophical method will not be controversial among academically trained philosophers, many academic philosophers adopt an approach to ethics that stresses the development of a general and comprehensive ethical theory that specifies procedures and criteria for ethical conduct and the justification of ethical judgments and claims. Questions such as those addressed in this book are then decided by applying this theory to the matter at hand. Those who take this approach apply the process of deliberation and debate to the development of ethical theory, but not to the immediate questions of human conduct or to the justification of specific claims about right and wrong action, duty, responsibility or virtue. Although this theoretical approach has generated great insight into the nature of ethics and ethical justification, the approach taken in this book is to presume that the questions arising in connection with the use and control of food biotechnology can be debated directly. Ideas and constructs from the history of philosophy and from ethical theory are introduced throughout the text, but not with the aim of shifting the discussion to a purely abstract and theoretical examination of ethical concepts or methods. Instead, ideas from ethical theory are offered as alternative ways of interpreting or understanding the ethical issues arising in connection with agricultural and food biotechnology. The point is to improve the discussion and debate of biotechnology by helping those who participate in the debate appreciate the logic and force of different ethical claims that might be made about it. As discussed at several junctures in the book, this approach to ethics is a reflection of a particular philosophical school of thought known both as "pragmatism" and as "discourse ethics."

Much of what is contested about food biotechnology can only be settled by science, if it can be settled at all. Whether genetically engineered plants pose any unique risks to the environment is a partly scientific, partly philosophical question. It is philosophical in so far as one might bring disparate concepts and values to bear upon one's interpretation of a "risk to the environment." Is *every* human impact upon ecological processes automatically detrimental? Are there processes of molecular or organismal evolution that must be protected, or should we think of "risk to the environment" more in terms of impact on the habitat of wild species? If it is the latter, then some aspects of "risk to the environment" are the intentional consequences of agricultural science, as when a new variety of soybean or a new vaccine permits new lands to be brought into production. Yet within differing philosophical conceptions of risk to the environment, there are a host of questions that only science can hope to answer. What is the probability of gene flow to wild or native species? What is the probability that such so-called errant genes would establish themselves in a population of native plants?

To say that only science can answer these questions is not to say that they lack a philosophical dimension. Probability itself is a deeply philosophical idea. Are subjective estimates of probability admissible when one is trying to determine whether a scenario is likely, or should only statistical methods based on observed data be used? Should uncertainty be handled so as to minimize the possibility of accepting a claim that is false, or to minimize the chance that one will neglect a claim that is true? Science is permeated by philosophy. Much of the convergence in science (take Darwin, for example) is philosophically based, even when it is corroborated by empirical results. Yet these facts do not entail that we can never know the answer to scientific questions. Indeed, both science and philosophy can produce levels of precision and confidence for knowledge that are more than adequate for the important practical decisions that must be made.

The purpose of this book is to examine *ethical* issues associated with food biotechnology. Excursions into epistemology and philosophy of science will be minimized. When debate over an issue turns clearly on whether or not specific claims of fact are true or false, the debate will be set aside for the purposes at hand. This means that readers will not find proclamations about whether food biotechnology is safe or not, for however one interprets "safe," some factual questions that are beyond the book's scope bear upon the claim. Instead the emphasis will be to analyze how the question of safety incorporates extra-scientific dimensions and values. The method of analysis that will be applied to philosophical questions involves research into the various contending claims that have been or plausibly might be made. The analysis is informed by more than twenty centuries of philosophical debate on practical ethics. Some of these issues have been discussed before, and the discipline of philosophy can provide both case studies and conceptual tools or theories that can greatly enhance the efficiency with which honest inquirers seek to understand the ethical issues associated with food biotechnology.

Ultimately the test is whether what is said here makes sense—seems correct or reasonable—to each individual reader, and whether readers can use what they find here to engage in productive discussion and debate with others. Neither the revelations of opinion polls, nor the end-points of the author's enquiry can controvert a reader's right to resist the analysis given here. However, in the spirit of honest philosophy resistance to the argument also demands that one attempt to articulate what is wrong, what is inadequate, and when possible to provide an alternative analysis. When enough well-meaning individuals participate in the debate over food-biotechnology on those grounds, it will be possible to make genuine progress in framing, understanding and finally addressing ethical issues associate with food biotechnology. Without that debate, self-regarding motives, advertising and strategic discourse will prevail. Under such conditions, cynicism is fully justified. The fate of our science and our society devolves into a contest of power and will. While some may embrace this turn of events, it seems deeply inconsistent with the spirit of scientific enquiry to do so. For this reason if no other, the analysis is presented with the presumption that readers will bring a scientific cast of mind to an enquiry that is unabashedly philosophical.

THE AUTHOR'S APOLOGY

Readers of Plato know that an apology is a defense of one's conduct. In *The Apology* Socrates defends himself against the charge of corrupting the youth of Athens less by denying the facts of the case than by challenging the moral authority of the Oligarchs. Although I intend nothing as high-minded as Socrates' famous oration, I need to defend my conduct in writing this book. In doing so, it is prudent to apprise readers of my attitudes and interests in a manner that is unusual for works of science or philosophy. Here I shift to a personal and autobiographical tone to summarize my opinions on food biotechnology. Readers are cautioned that what follows here is *not* a philosophically or scientifically grounded argument, but merely a recounting of my current opinions, and how I came to them. I offer this so that there will be less confusion on where I stand with respect to some of the most contentious issues. I distinguish these opinions, some of which would be readily overturned by convincing scientific studies or by events, from the philosophical analysis and argumentation that occupies the main part of this book. Since my scholarly values prevent me from reaching sharp and unqualified conclusions on many of those issues, it is only fair to readers that they have some sense of where I stand, however vague and qualified those opinions might be.

When the first edition of this book appeared in 1997, I described myself as a cautious optimist regarding the development food biotechnology. As I prepare the revised edition, I am more cautious and less optimistic than I was then, but I still think that employing the techniques of molecular biotechnology within agricultural science and agricultural industries will eventually improve the global food system. I am more cautious in part because I believe that the scientific community as a whole has become more cautious. As work on biotechnology has proceeded, a number of assumptions that underlay the confidence of biotechnology's proponents have been called into question, and some have been shown wrong. Some of my colleagues who were less welcoming of biotechnology's prospects a decade ago might regard this as vindication of their view. I also regard it as vindication of my own view. My cautious optimism has always been based on faith in the scientific community as a whole, and this faith has only been strengthened by the complexities that have complicated our collective view of biotechnology's prospects as a result of probing and questioning by skeptical scientists. I was a cautious optimist then because I believed that the scientific community could be relied upon to surface problems with agrifood biotechnology. That belief has been proven correct, and I am still a cautious optimist.

I arrived at cautious optimism as a result of highly impressionistic and personal experience, experience that has only become more impressionistic and personal since the earlier edition. I began my research on ethical dimensions of food biotechnology a full 20 years ago. When I did so, I turned my attention from several years of research on nuclear power, including my doctoral dissertation. My unvarnished opinion on nuclear technologies is relevant here. Nuclear power is inherently dangerous. Even biomedical applications of nuclear technology (morally compelling in themselves) cause difficult waste disposal problems. Second, nuclear technologies seem to concentrate power and decision making within large bureaucratic organizations, some governmental (such as the Nuclear Regulatory Commission), some commercial (such as the companies that build and operate reactors) and still others that are something in between (national laboratories or the Electric Power Research Institute, a private consortium supported by utility providers). What is more, the generally well-meaning and likable individuals who are professionally responsible for nuclear technology have a curious and disturbing blind spot with regard to ethics. They seem to think that if they keep their promises and tell the truth, their conduct will be beyond reproach. And they have never been particularly curious about how broader society understands promises or truth with respect to nuclear power. Even after decades of vigorous public criticism, they do not seem to have learned their lessons. As a result, nuclear technology seems to require eternal vigilance.

Although I was inclined to be suspicious when I first undertook my study of agricultural and food biotechnology, I concluded that food biotechnology is largely different from nuclear technology on each count. It is not intrinsically dangerous, though it can be put to very dangerous uses. Whether it is developed by large or small organizations seems to depend more on the socio-political environment than on the technology itself, so the links between technology and the concentration of power are less fixed. And although I have met plenty of jerks among the well-meaning in my encounters with molecular biologists, regulators and corporate types, even the jerks seem to have a broader and more comprehensive understanding of the ethical imperatives associated with their technology than did the nuclear engineers I interacted with in the 1970s and 1980s. The years that have passed between editions of this book have not led me to change these opinions. I have lifelong friends among nuclear engineers, but the food and agricultural biotechnology community seems better poised to respond critically to a complex set of scientific, social and ethical issues. Although I could speculate on why this might be the case (biotech depends more heavily on consumer acceptance, for example), I must confess that this is really just an impression based on hundreds of informal conversations and formal interactions over the course of my professional lifetime.

I have great respect for those who arrive at the opposing intellectual pole of cautious pessimism. We differ in our judgment on a host of matters, but we agree on many more. Indeed, those who stay with me until the end of Chapter 11 will notice that when I describe scientists in agrifood biotechnology as more prepared to engage ethical issues than nuclear engineers, I am *not* saying that these issues *have been* engaged to my satisfaction. The gap between this conclusion and cautious pessimism is not all that large. I have less regard for the reckless, whether they are optimists or pessimists. There are still too many reckless optimists running food biotechnology labs, and I concede that reckless optimists are more dangerous than reckless pessimists. We are in real trouble if biotechnology falls into the hands of the reckless. What will happen is a continuation of processes that characterized the years after World War II. Agriculture will continue to be at odds with environment. Food companies will continue to regard consumers as willing dupes. Animals will suffer needlessly, and the social transition that has undermined many of our healthiest communities and family institutions will continue unabated. Biotechnology can be part of a social and intellectual program that reverses all these trends, too. It is my view that we who envision something other than a thoroughly industrialized food system isolate potentially powerful allies when we dismiss biotechnology out of hand.

I wrote in 1997 that reckless criticism of biotechnology might be doing more to undermine the promise of food biotechnology than anything else. My greatest concern then and now is sense of frustration and resentment that I discern among the scientists who are developing and regulating biotechnology. Too many have reached the conclusion that their opponents are irrational. Unfortunately, this state of affairs may be having an impact on the prospects of biotechnology. To the extent that developers of biotechnology become cynical, my optimism will prove unwarranted. I originally decided to write this book in order to do what I can to forestall that turn of events. In both the original and the revised edition, I include extensive discussion of some of the negatives associated with biotechnology. My view is that these negatives entail constraints on biotechnology rather than reasons to oppose it unilaterally. It was and remains my belief that a scientific and industrial community committed to meeting its ethical responsibilities will permit agrifood biotechnology to be deployed in many useful and beneficial applications, while respecting the rights and personal autonomy of individual human beings, improving the well-being of animals, and preserving the beauty of nature and the integrity of ecosystem processes. I am still optimistic that the scientific and industrial community will endeavor to meet its responsibilities. Many of biotechnology's critics are not.

I am also more cautious and less optimistic today because the debate over biotechnology started to take a nasty turn just about the time that I was completing the original manuscript. As products started to appear on the market, biotechnology companies became very aggressive at pursuing all legal avenues for silencing and stifling their critics. It would not surprise me to learn that they pursued some extra-legal avenues, as well, but I am not aware that this is the case. At any rate, while I had personally experienced some heavy-handed tactics on the part of biotechnology's proponents even before the first edition came out, the industry's attempts to manipulate both policy and public opinion that have emerged in the last 8 years are clearly much more disturbing than anything I saw before. To cite only one example, the Monsanto company has admitted paying bribes to an Indonesian regulatory official who made a decision not to require testing of their transgenic cotton (BBC 2005). At the same time, new critics joined the fray, and some of them are clearly willing to misrepresent issues in order to manipulate the public, as well. There is less good will on all sides of this debate, and this creates a situation in which responsible development and application of the technology can fall prey to strategic ploys intended to manipulate public opinion. Yet the heightened level of public awareness about possible problems with biotechnology may also make its developers and regulators more careful.

I have been accused of having been co-opted by financial rewards, sometimes rather rudely, by those whose view on biotechnology is less favorable than my own. In a book on ethics, it is reasonable to go well beyond what would normally be required in disclosing my financial and professional interests with respect to food biotechnology, and so I ask my readers forbearance in recounting the gory details. I have no personal investments in biotechnology firms. In 1997 I wrote that my research on biotechnology was a relatively small part of my total research portfolio, though it represents a much larger percentage today. Research in philosophy is not expensive when compared to laboratory research, and the funding I have received to conduct studies of biotechnology over the last 20 years is not large when compared to most university scientists. I have received more grant support that most philosophy professors, but contrary to the natural and social sciences, where grants are necessary to pay for laboratories or data collection, grant support is not really necessary in philosophy. Research by philosophy professors is, in the vast majority of cases, done without grant support of any kind. It is possible to get a little more time to do research by getting grant funding that relieves one of the need to teach in the summers or occasionally releasing one from teaching responsibilities during the school year. It is also desirable to get funding for travel, for graduate students and to sponsor workshops and symposia at which one might pay small honoraria (between $200 and $2,000) to others who will prepare a paper on a specific topic.

A summary of the way that my research on agricultural biotechnology has been funded begins with approximately $150,000 I received from Texas A&M University's Institute for Biosciences and Technology (IBT) over a period of 8 years from 1990 to 1997. These funds operated the Center for Biotechnology Policy and Ethics (later renamed the Center for Science and Technology Policy and Ethics and now defunct). They covered the cost of operating an office (secretary, telephone, copy machine), purchasing research materials (computers and published materials, in my case) and travel to meetings and for bringing in speakers. They also paid for the publication of a bimonthly newsletter that reviewed topics of general relevance to bioethics and to science in society, not just food biotechnology. I did not draw salary from IBT funds.

The second major source of support is my basic academic salary, paid by Texas A&M from 1981 until the summer of 1997, and by Purdue University from 1997 to 2003. I am now employed by Michigan State University. Virtually all of the time I spent working on biotechnology was covered by my base salary, rather than grants or contracts. It has been what university researchers call "unfunded research". We are all expected to do some research whether we get grants or not, and I chose to do some of mine on biotechnology. I received a small grant from the US National Science Foundation (NSF) (Project SBR-9602968) in early 1997 when I was still working at Texas A&M University, but after the manuscript for the original book was largely completed. The total value of the grant was $49,787, major parts of which went to support the work of two colleagues at Texas A&M. I did derive some support from the grant for summer salary when I was editing the page proofs for the original book. These three sources, the IBT, Texas A&M and NSF, provided the support that I needed to do my research for the first edition of *Food Biotechnology in Ethical Perspective*. I have not received additional grant funds for biotechnology work since then. I have received external grants throughout my career for other work including grants for teaching related projects from the US Department of Agriculture (USDA), for work on environmental risk from the State of Texas, for work on ethics and development from the Rockefeller Foundation and for work various non-biotechnology projects from the NSF, including a large grant in 2004 for work on nanotechnology. In fact, my NSF biotechnology grant total of approximately $50,000 represents less than 2% of my career total for external grants on all projects (including nanotechnology).

At the time I wrote the first edition I reported that I had also been supported in the form of travel and small honoraria to deliver lectures on ethics and food biotechnology, mostly at other universities. At that time, I had spoken on biotechnology at many American universities, and in England, Jamaica, Israel, Egypt and Thailand, and I can add a few other countries to the list now. Then as now I addressed many meetings where I (or my own university) covered my expenses, but those who invited me to speak frequently covered my travel expenses. I reported in the first edition that I had received as much as $500 to make such presentations, above expenses, and had probably made somewhere in the neighborhood of five or six thousand dollars in total making those speeches over 10 years. In the interval since the book was published, I have received more opportunities to be remunerated for my work through similar kinds of contract arrangements. I was paid by the Canadian Biotechnology Advisory Committee, a quasi government group, to write a white paper that was the first draft of what now appears as Chapter 1 in the revised edition of the book. I serve on a number of advisory boards. Some, such as the Advisory Committee on Biotechnology of the Board of Agriculture and Natural Resources, National Research Council are unpaid, but I do advise two private firms, one of which is involved in biotechnology. The biotechnology company that I have advised is a start-up firm that paid me $2,000 for comments on the potential ethical pitfalls in a business plans they were drafting. I have signed a non-disclosure agreement with them and have not reported on any of their plans in this book or elsewhere, but it does not violate the terms of that agreement to say that as far as I know, they have not succeeded in bringing a product to market. I get Christmas cards from them, but otherwise have not heard from them a second time.

It would be difficult to make an accurate estimate of how much I have made on speaking, writing and other projects related to biotechnology since 1997, but it is certainly in excess of $20,000 and certainly less than $40,000. Because this subject is so sensitive to many readers, I will make an attempt to say more. The original Canadian paper I mentioned above paid something in the neighborhood of $1,500, and I have already listed my $2,000 windfall from a start-up firm. As the manuscript for this revised edition was under review I received my first invitation to consult with Monsanto, for which I was paid a flat fee of $1,000. This brings my career total of private biotechnology industry supported income to $3,000. I was also paid $2,000 by the Center for Ethics and Toxics to write a chapter for *Engineering the Farm*, a book that most would regard as hostile to agrifood biotechnology. By far the largest single source of income was a contract with the Commission on Environmental Cooperation, an inter-governmental agency for the United States, Canada and Mexico, which supports a number of research and consensus seeking activities involving the environment and trade. If memory does not fail me, I received $6,000 for my contributions to a report on Mexican maize contamination, a report that was leaked to the public by Greenpeace. The other significant source of income has been a series of relationships with genome research centers in Canada and with the Science and Industry Advisory Committee for Genome Canada. In total, I am sure that I have earned another $5,000 or more from this work over the last 10 years. The balance would come in the form of speaking and writing jobs that pay between $200 and $2,000. I would have to go back through my tax records to come up with a decent approximation of how much and from whom, but almost all of this has come from universities, professional societies or other non-profit organizations.

This could be considered a lot of speaking, a lot of travel (sometimes to attractive places), and a significant amount of money by many. Relatively few academic philosophers earn as much as $20,000 from philosophical employment beyond their teaching salaries over a professional lifetime, though leading figures in medical bioethics earn much more than this. I can only report the facts, and repeat what I wrote in 1997: if one were in it for the money, one would be wiser to take a critical stand. Certainly one's books would sell better if one did, of that I remain convinced. Others may dispute this judgment. Indeed an anonymous reviewer for this manuscript writes "My impression is that there is money to be made in being a proponent and not taking a critical stand," and notes that it may come in the form of travel and research contracts, rather than sales of books. I wrote in 1997 then that I would accept grants to do work on food biotechnology, and expected to do so in the future. (Indeed, as I indicate above, the grant from the NSF was being applied for as I wrote). I wrote that I would also accept both honoraria and contractual work from biotechnology companies if the request was consistent with my research interests, and if I was confident that they would not attempt to influence or stifle my results. In fact, as already noted, I have accepted two small consulting jobs from industry. I have turned down a handful of additional opportunities, usually because of schedule conflicts, but I have not been offered very many opportunities for work with biotechnology companies nor have they ever offered to support my research. All I can say in response to my anonymous reviewer is that if contracts are available for "not taking a critical stand," my cautious optimism is apparently too cautious to qualify as sufficiently uncritical.

Critics and industry alike have affected my reputation through what I feel to be unfair tactics. I have run afoul of biotechnology's critics more than once, and some of it can be found by anyone who takes a bit of time to troll the web. I was accused of trying to murder Mexican peasants in order to steal their land when I spoke in Oaxaca. Websites still exist where I am accused of advocating the blinding of chickens and of conspiring to promote the use of “Terminator” genes in the developing world. The latter accusation came about when a Purdue University staff writer posted a story that, from my perspective, was intended to discuss the possibility of using genetically induced seed sterility as a part of a strategy to limit the environmental risks from biotechnology (see Tally 2002). My experience with mainstream biotechnology companies is not, on the whole, positive, either. Prior to my involvement with them in 2005, Monsanto had placed another philosopher named Paul Thompson on its ethics advisory board, one who has not published any work that I am aware of on agriculture or biotechnology. The timing of this action coincided with my appointment to the US National Research Council committee that eventually produced the report *Environmental Effects of Transgenic Crops* (NRC 2002a), and resulted in an onslaught of attacks on my reputation from people who were accusing me of an industry connection that did not exist. People who were in a position to know have also told me that one biotechnology company or another had pressured Texas A&M to close my program, and I am sure that there were one or two administrators there who would like to have done so. Aside from one year when my annual budget was mysteriously cut from $40,000 to $2,000, I will say that Texas A&M stood firm in supporting my work.

I conclude this apology with a second apology, this time not a defense but a sincere act of contrition for dragging readers through these aspects of my personal and professional life. In recounting a few of the insults I have endured I feel like I have become self-pitying and boring. The life of an American college professor is an enviable one, and I feel very fortunate to have lived it. I have had a wonderful career and have been compensated better than the average philosophy professor for work that many would regard as being on the extreme margins of my discipline. But perhaps it is not such a bad idea for more of us to be more forthcoming than current practice would require in recounting what we have gained and not gained in pursuing a particular line of research.

THE PLAN OF THE REVISED EDITION

This book is a review of ethical issues associated with food biotechnology. Food biotechnology has been defined so as to include all uses of recombinant DNA gene transfer techniques, and to apply to all phases of food production, including agriculture, transport, processing, marketing, inspection and regulation. A review of ethical issues associated with food biotechnology so-defined takes on an extremely broad mandate. It encompasses the ethics of food safety and of food marketing. It includes the ethics of transforming the genetic characteristics of food animals, and the environmental ethics of producing transgenic crops, or using transgenic agents to control animal diseases. It must also touch upon genetic engineering’s affect upon the long transition from relatively small-scale extensive farming and ranching to relatively large and industrialized food production systems. An adequate review of the ethical issues in any one of these broad areas would constitute the life's work of several scholars, but the mandate for this book must be broader still. It must include some discussion of the transformation of property rules that has accompanied new techniques in molecular biology. It must include the religious, cultural and metaphysical questions that are frequently raised when any application of recombinant DNA technology is proposed. The law and philosophy that is relevant to these areas are driven more by medical biotechnology than by the food and agricultural applications that are the primary topic of this book. Yet no one should delude themselves into thinking that these issues are irrelevant to food biotechnology. Many of the human biotechnology arguments have direct implications for food biotechnology, and vice-versa. Furthermore, the fate of food biotechnology will be determined as much by the general cultural climate toward recombinant technologies as by the specific issues that may be associated with single products.

If it is important to understand, as best we can, the cultural climate for biotechnology, it is necessary to expand the mandate for this book even more broadly still. All new products must pass a market test: they are purchased and used or they languish and fade away. While there is an implicit ethic hidden in the factors that influence the market adoption or rejection of new technologies, it is evident that some technologies meet forms of resistance that differ from simple consumer disinterest. In the case of polluting industries, this resistance arose in response to unwanted environmental consequences that appeared long after the chemical and manufacturing technologies on which they were based had seemingly passed the market test. In the case of nuclear technologies such as power generation and food irradiation, resistance arose far earlier in their product history. Food biotechnology is such a contested technology. This means that food biotechnology must meet ethical burdens of proof that many other technologies escape. Whether they are in private companies or in public agencies (such as agricultural extension services), the people who promulgate new technologies employ strategies for developing products, for securing regulatory approval and for marketing new products. When the technology meets no opposition, it is reasonable to interpret these strategies as the legitimate means for subjecting a product to the market test. However, using these strategies to weaken or subvert opposition can compromise the ethical validity of market institutions themselves. The advocates of a contested technology thus bear a responsibility to develop and market their products in a manner that does not disenfranchise or inappropriately silence critics. Failure to do so weakens the general public's confidence in the procedures of democratic government and free-enterprise economics.

The fact that food biotechnology must bear this burden, while information technology and personal computers seemingly do not, is an enigma that cannot be adequately explained within the covers of the present treatment. Given the checkered history of both agricultural chemicals and applied genetics in the twentieth century, it should not be completely surprising that products that arise from the confluence of the two will be questioned. Yet the reasons why one set of technologies are subjected to scrutiny and criticism, while another is rapidly disseminated with little comment are more complex. Some may argue that characterizing food biotechnology as the heir to debates over pesticides and eugenics is unfair. Some would point out the fact that agrifood biotechnology has been very widely adopted on a worldwide basis, whatever critics might say. The point here is that fairly or unfairly, agrifood biotechnology has aroused opposition, and this fact (regrettable though some may take it to be) entails special ethical responsibilities. In 1997, I wrote that, "Perhaps some will question whether food biotechnology has been contested by critics and opponents." It seems incredible that anyone would question such an assertion now.

Much water has passed under the bridge with respect to debate over biotechnology since the first edition appeared. I have tried to update discussion of the debate to reflect more recent controversies in a few cases, but I have not tried to do so in anything like the detail (which was not intended to be exhaustive, in any case) in the original edition of the book. While the first edition made some attempt to document the popular, regulatory and intellectual debate over food biotechnology, any extended attempt to update this aspect of the original book would have resulted in a totally different book. In fact, the revised edition has eliminated a number of pages documenting the debate over biotechnology. In some cases, especially environmental risks, the debate has progressed to the point that some of the sources (dating back to the 1980s) discussed in the original edition no longer seem relevant. When the original manuscript was written, the most significant debate over food biotechnology had been in connection with recombinant bovine somatotropin (rBST), also called bovine growth hormone, a debate that is reviewed in Chapter 3. Although the debate over rBST raged for a decade and was just beginning to cool when I started working on the manuscript in 1996, rBST has now been virtually forgotten. On one hand, the account of rBST in Chapter 3 may be more revealing to readers now than it was in 1997, for some seem to think that food biotechnology did not become controversial until very recently. The rBST case provides a coherent study of a single technology, and serves to foreshadow the following chapters on food safety, animal welfare, environmental impact and social consequences. On the other hand, my own views have evolved considerably in ways that make some of the broad claims in the 1997 version of this chapter seem very problematic today. In the end, I've mostly left this chapter as it was in the interest of preserving its discussion of the rBST case in something that at least approximates its original form.

One might ask, given that your views have evolved and the debate over biotechnology has not been substantially updated in this edition, why produce a new edition at all? Part of the reason has to do with the publishing history of the first edition. The original publisher was Chapman and Hall, and the book was the first title in a series entitled "Techniques and Perspectives in Food Biotechnology," edited by Sue Hill for the International Food Information Service. Other catchy titles in the series include *Enzymes in Food Processing* and *Microorganisms in Foods: 5 Characteristics of Microbial Pathogens.* Unfortunately, Chapman and Hall disappeared from the publishing world in the interval between my sending in corrected page proofs and the actual appearance of the book in November 1997. Soon the book was lumped in with a package of rather technical titles in food science, sold back and forth through several publishers several times, and never came to the notice of many potential readers in agricultural science, molecular biology or philosophy. It was reviewed by only one scholarly journal, and I am amazed that any readers seem to have found it at all. For the most part, I am satisfied that most of the philosophy in the book is as relevant and applicable today as it was in 1997. As such, simply getting a new life and a fair hearing for the original book is a major part of my motivation for undertaking a revised edition.

Furthermore, aside from Chapters 3, 5 and 11 the book *is* significantly revised, both to address new issues and to make the entire book more useful and accessible. The original introduction was written hastily after the announcement of Dolly in February 1997 and after the rest of manuscript had been submitted for editing. It has been dropped and replaced with this introduction, which includes sections from the original Chapter 1 that were essentially introductory in nature. Chapter 1 is wholly new and is a recently updated version of the white paper I wrote for the Canadian Biotechnology Advisory Committee in 2000. It provides a synoptic overview of ethical issues associated with food and agricultural biotechnology and includes a summary, updating discussion of literature that has been published since 1997. As in the first edition, Chapter 2 is entitled "The Presumptive Case for Food Biotechnology". The idea here is that pending review of certain specific objections and concerns, ethical arguments weigh in favor of using food biotechnology, rather than against. This chapter reviews the basic argument in favor of food biotechnology and at the same time sets aside some spurious arguments that are sometimes offered by too zealous advocates. Organizing the argument this way places the burden of proof on biotechnology's critics. It is a burden that can be met in some specific instances, but seeing where requires a detailed look at the critical arguments. While this chapter maintains the structure and principle claims of the original, it has been revised sentence by sentence in light of developments since 1997.

As noted already, Chapter 3, the case study of rBST is virtually unchanged. As in 1997, it presents a philosophical framework for considering a number of issues relating to risk and unintended consequences. Most of the most serious issues regarding agrifood biotechnology are issues that arise in connection with the potential for unintended consequences. Other technologies have had unintended consequences, and nothing about the biological, genetic or molecular nature of food biotechnology makes it different from mechanical, chemical or information technologies in this respect. The heart of the ethical analysis consists in five chapters that review unintended consequences for human health, impact on non-human animals, impact on the environment and impact on society. Chapter 4 on food safety may have been the most successful chapter in the original, having been reprinted twice. The new version has many minor changes from the previous edition, which dealt with the ethics of food safety. Chapter 5 on animal welfare has a few new qualifications, but is otherwise unchanged. Chapter 6 on livestock cloning is entirely new and replaces the hasty discussion included in the introduction to the earlier edition. Chapter 7 on "Ethics and Environmental Impact" is substantially revised to reflect a change in the tenor and focus of debates over environmental risks associated with agricultural biotechnology, as well as the recent theme of addressing environmental issues from the perspective of the Precautionary Principle. Chapter 8 on social consequences is similarly updated, especially with respect to the discussion of impacts beyond the industrialized world.

The remaining three chapters of the book deal with issues that cannot be easily characterized as "unintended consequences". One is that recombinant DNA and the discovery of industrial processes and new products have sparked an extensive ethical debate over intellectual property and the ownership of life. Although debates over property rights are hardly unique to biotechnology, these issues do have an ethical character that differs from the usual kind of ethical issues that are associated with unintended consequences. Chapter 9 "Conceptions of Property and the Biotechnology Debate" has been edited heavily for style and readability, but has not undergone great changes in content. Another theme relates to the nature of life itself, the light that molecular biology sheds on this question, and the tension that is created between scientific and religious (or secular metaphysical) answers to this question. In truth, religious and metaphysical themes have implications that extend far beyond questions in food biotechnology. Chapter 10 on "Religious and Metaphysical Opposition to Biotechnology," has been substantially reworked, though large sections of the original text have been retained. The final chapter takes up directly problems of trust that surface throughout the other chapters. The fact that mistrust in science has grown so dramatically through the vehicle of debate over biotechnology cannot be ignored. Many authors have addressed this theme in the interval between the first edition of this book and the second. It was not possible to reflect this new literature on risk and trust without doing considerable violence to the flow of the original text. The new version of Chapter 11 "Communication, Education and the Problem of Trust" remains very similar to the first, though changes have been made to enhance style and readability.

CHAPTER 1

ETHICAL PERSPECTIVES ON AGRI-FOOD BIOTECHNOLOGY

The use of recombinant DNA to modify the genetic structure of plants, animals and microbes and the ability to clone adult cells from mammals jointly contributed to an international controversy that has several axes of contention. While theologians and philosophers have thus far focused primarily on applications in the field of human medical science, the broader public has arguably been equally (if not more) concerned with the use of these techniques in food and agriculture (see Einseidel et al. 2002; Lassen et al. 2002). This popular concern with biotechnology (as the techniques of gene modification and adult cell cloning will henceforth be called) is both prudential and moral. There are worries that the technology may have unknown and unacceptable risks, but there is also apprehension about the ethics of this seemingly new and radical activity (Frewer et al. 1997; Midden et al. 2002). Furthermore, risks can be readily converted into moral concerns (Thompson 1986; Beck 1992). As such, there is ample terrain for prima facie analysis of ethical issues associated with food and agricultural biotechnology.

Analysis of ethical issues might take any of several approaches. The goal throughout this book is to articulate the normative basis for alternate judgments about the acceptability, advisability and justifiability of using biotechnology in the production of agricultural plants and animals. A normative basis for action and judgment may stipulate ideals, values or standards that ought to be reflected in human conduct, and is distinguished from matters of fact that may also form a component of the basis for action or judgment in a particular case. On the one hand, ethics deals with almost universally recognized norms that are both implicit within everyday social interaction and explicitly articulated in public sources such as legal or professional codes of practice, religious texts, folktales, literature and philosophy. On the other hand, the ethical dimension of conduct and reflection is often characterized as inherently personal, introspective and inherently unsuited to public discourse. Given this range of interpretation, ethical concerns associated with food and agricultural biotechnology can be expected to comprise highly idiosyncratic personal reactions of individuals, identifiable traditions and values of particular social groups, and broadly shared social norms.

One approach is to present the debate in terms of opposing pro and con arguments, as several studies by philosophers have done. Gregory Pence (2002) for example, emphasizes the way in which proponents of biotechnology emphasize humanitarian goals of ending hunger, while opponents see biotechnology as unnatural, a "mutant harvest." Pence's focus on the issue of whether biotechnology is natural was also the main organizing principle for an earlier study by Michael Reiss and Roger Straughan (1996) that included medical as well as agricultural biotechnology. Gary Comstock (2000) also takes up the possibility that biotechnology might be unnatural, but emphasizes how he himself came to see the humanitarian rationale for biotechnology as overriding his own concerns about the social and environmental risks associated with transgenic crops and genetically engineered animal drugs. Interestingly, all these authors wind up on the "pro" side of the debate. This way of framing the debate in terms of benefit from increasing agricultural productivity, on the one hand, and risky technology, on the other, has also been the subject of a lengthy and careful study by Hugh Lacey (2005), who is less inclined toward the "pro" point of view. Lacey believes that the pro-biotech perspective is rooted in an ethical perspective that valorizes processes of control and predictability, while the anti-biotech perspective can be traced to scepticism about the viability and desirability of control.

My approach to the debate interprets controversy over agricultural biotechnology as an episode in several ongoing and overlapping social, political and ethical struggles over the appropriate guidance (the ethics, that is) of food and food production. These struggles range over disputes about food safety, where the normative dimension (avoidance of mortality and morbidity) is virtually uncontested, to the accommodation of culturally or religiously based norms that define what is and is not considered to be food, irrespective of nutritive or health-related concerns. Because food consumption is both rich in symbolic or cultural significance and biologically necessary for human life, any technology for producing or preparing food has ethical ramifications of one kind or another. These include the way that the technology affects safety and access to food, as well as other questions of fairness and equity associated with the broad system for producing and distributing food. One should expect that any novel food technology such as biotechnology will raise such ethical issues, and these will be referred to below as issues of *general technological ethics*. Nevertheless, any superficial survey of the global controversy over food and agricultural biotechnology reveals that this technology has been subject to far more public debate and criticism than has been typical of food production, processing or marketing technologies in recent years. As will become clear below, much of the debate involves ethical matters that could be raised for any food technology. Yet there are characteristics of biotechnology that create forms of ethical apprehension that do not arise in connection with chemical, mechanical and other food technologies. These can be referred to simply as *special concerns*, though some of them (as Reiss and Straughan suggest) overlap with questions in biomedical applications of genetic technology. Following these two discussions on ethical concerns, there is a discussion of philosophical schools of thought or *decision frameworks* on how the array of concerns should be addressed. Finally, the concluding section of the chapter will note some *institutional concerns* that relate to the nature of technical expertise, its use social decision-making and governance, and concomitant issues associated with public trust in science.

Must one, as the approach of Pence Comstock and (to a lesser degree) Lacey implies, be "for" or "against" agricultural biotechnology? The analysis that follows situates agricultural biotechnology within broader ethical debates, and interprets pro and con arguments about agricultural biotechnology as being motivated by philosophical positions that the parties to these arguments have adopted with respect to these broader debates. The reader is thus invited to understand the controversy as, in fact, a conglomeration of multiple controversies, each having a history and logic of its own, and in some cases operating in spheres of social and political concern that might have been thought to have little relation to one another. While advocates of positions within any of these multiple controversies might have hoped to enroll allies in their respective fights by portraying agricultural biotechnology in stark pro and con terms, it is not clear that such a portrayal leads to a philosophically sophisticated, much less philosophically honest, understanding of the issues involved. As such, the analysis that follows proceeds along organizational principles that break the debate up into the three broad categories listed above, each of which can be subsequently broken into sub-categories of its own.

GENERAL TECHNOLOGICAL ETHICS

The twentieth century was a time of unsurpassed technological progress, but it was also a time in which humanity learned that technological changes bring unintended social and environmental consequences. The German philosopher Hans Jonas is generally credited with first recognizing the need for a systematic method of anticipating and evaluating technology in ethical terms. Jonas (1984) understood that this would depart from traditional ethics in that technology has impacts that extend indefinitely in space and time. Jonas argued that technological ethics must integrate science-based attempts to understand the systematic and temporally distant effects of technology with ethical concepts attuned to the fact that many of the people who will be affected by technology will not be known to those who plan and execute a technological practice. Jonas called for what he called a principle of responsibility (*Prinzip verantwortung*) as a response to this situation.

Jonas represents a break from the dominant conceptualization of ethics in science and engineering, which is confined to scientific integrity and the responsibilities that arise in connection with human subjects. Jonas called for an ethical inquiry into the purposes and general trajectory of technology. He noted that it would be necessary to re-conceptualize the impact of human projects on the natural world in moral terms, and he noted special concern for technological developments (such as atomic weapons) having the potential to extinguish "autonomous reason" from the universe. Yet in one respect Jonas's approach was not radical. The implicit logic of the principle of responsibility accepts the basic legitimacy of technological innovation, and does not challenge the presumptive norms that support the discovery and implementation of new technical methods and products. These norms draw on two of the most venerable philosophical traditions of the industrial age: utilitarianism and libertarianism.

The implicit logic of technology is utilitarian in that new technologies are presumed to offer new opportunities, new possibilities of action, to human beings.

These new opportunities present alternatives to the status quo, and are evaluated according to whether the outcome of utilizing a new technology is expected to be an improvement on the current situation. Utilitarianism mandates that an actor should always choose the course of action that produces the best outcome. The specification of what counts as an improvement is left open in this unexceptional description of technology, and in practice, technological innovations have typically been evaluated in terms of workplace standards already in play at the time and place in which an innovation is made. These standards often reflect workplace needs to economize on scarce or expensive inputs in the production process, resulting in spare time, more production or, what has been most important under capitalism, an ability to sell the product for a lower price. Alternative "ways of making or doing" that do not economize in this way are simply not taken up, with the result that technological innovation comes to be closely, perhaps even inherently, associated with increasing efficiency in the production process. Translating localized workplace efficiencies into global, social efficiencies requires a process for ensuring that efficiencies have not been achieved simply by "externalizing" costs, that is, by imposing costs on other parties. But "all things considered" (and under utilitarian ethics all things truly must be considered), increases in efficiency are always a good thing (see Schmid 2004, for a concise review of economic analyses of technological innovation).

The implicit logic of technology is libertarian in that new technical methods enable particular modes of human activity. The libertarian ethic holds that human beings should be maximally free of constraint, subject to the condition that their actions should not harm or constrain others. Innovators should be free to innovate and to use their innovations, subject, of course, to the limitation that they are not free to harm others. Although the specification of harm or constraint is left open here, the libertarian view establishes a key burden of proof for technological innovation. If no one complains, there is no basis for constraining innovation. Importantly, there is no reason why the innovator has to have an argument in favor of the innovation. It is those who would constrain the innovator who are placed in the position of showing how they are or would be harmed. Now, Jonas is essentially saying that innovators must take this burden of proof upon themselves. The *Prinzip verantwortung* calls for scientists and engineers to make an active attempt to anticipate possible forms of harm. But if they do this and find no harm, they are liberty to proceed with their technological application. And the expectation that technological innovations will improve workplace efficiencies provides a global argument that further supports them doing so. There is, in short, no real need for a "pro" argument for biotechnology or any other technology, at least not at the outset. There is only the need for a responsible effort to ascertain the unintended consequences of technical change.

Risk analysis is one of the main social responses to Jonas's call for a *Prinzip verantwortung*. Risk analysis is often characterized as a multi-stage process comprising risk identification, risk measurement, risk evaluation and risk management. The last two stages have always been understood to incorporate value judgments. The most obvious type of value judgment concerns the attribution of value to any predicted outcome. Financial gains and losses are easily expressed in terms of monetary values, but the comparative measurement of injury, loss of life and psychological harm are more difficult. When impacts borne by future generations, by society as a whole, by non-human animals or even by inanimate entities such as natural ecosystems are thrown into the mix, the philosophical and methodological problems of placing a value on predicted outcomes becomes both complex and contentious. From the standpoint of risk management, ethics weighs in on whether people must be informed and their consent obtained before they can become bearers of risk, and on how trade-offs between risk and benefit are to be evaluated.

In some of the early approaches to technological risk analysis, the stages of risk identification and risk measurement are characterized as wholly objective. On this model, ethics comes in only when it is time to compare the risks and benefits of different technological options, or to accept or reject a technological practice based on its predicted risk (see Rowe 1977; Lewis 1990). However it is now generally recognized that value judgments are implicit in any attempt to identify or decide which consequences are relevant, or to determine which of the myriad of actual possible courses of action should be selected as the "options" that will be subjected to modeling and analysis. Furthermore, it is recognized that measurement of risk requires value judgments about how to treat uncertainties in data and modeling, and how to derive and integrate statistical and subjective probabilities. As such, it is possible to see all phases of risk analysis as involving ethical issues (see Brunk et al. 1991; Shrader-Frechette 1991; Caruso 2002).

Even this short synopsis suggests that there are many ethical issues that can be raised in connection with risk analysis, and most of them arise to some degree in applying this general framework to food and agricultural biotechnology. Some of the most difficult problems arise simply in organizing the issues. In the literature that has already been generated on agricultural biotechnology, there are five general categories in which the products and processes of rDNA have been alleged to have impact: (1) impact on human health (i.e. food safety); (2) impact on the environment; (3) impact on non-human animals; (4) impact on farming communities in the developed and developing world; and (5) shifting power relations (e.g. the rising importance of commercial interests and multinationals). It will prove helpful to review the philosophical basis for seeing each of these categories of impact in ethical terms before moving on to a discussion of special concerns that have been associated with genetic engineering, and then to a review of how different policy or decision frameworks can be proposed to manage the risks of agricultural biotechnology.

Food Safety

Critics of food and agricultural biotechnology may link the need for ethics with a concern for food safety. This is, on the one hand, quite understandable, since if one already believes that eating so-called GMOs—the acronym is short for "genetically modified organisms," or the products of food and agricultural biotechnology—could be dangerous, one is also very likely to believe that it is unethical to put people in a position where they might eat them, especially without their knowledge. On the other hand, those who advocate on behalf of agricultural biotechnology take great offence at this characterization of ethics, since it implies that they are exposing the unwitting public to grave dangers without their knowledge. In fact, what is at issue between critics and advocates of biotechnology is not really a question of ethics. Both would agree that it would be very unethical to expose people to food borne hazards without their knowledge. The source of their disagreement is whether there *are* hazards associated with the human consumption GMOs, or if harms are theoretically possible, the likelihood that any potential hazards will actually manifest themselves in the form of an injury to human health.

One ethical issue concerns the question of what a company or government food safety regulator should do when there are disagreements of the sort just mentioned. One possible answer is that the decision should be based on the best available science. The ethical rationale for this approach presumes that GMOs have benefits of some sort, if only the potential to increase the cost-efficiency of crop production and build wealth for farmers and seed companies. If so, it would be ethically wrong to prohibit GMOs without some sort of evidence that they pose a hazard to human health. If one allowed baseless concerns to stifle innovation, the result would be technological and economic stultification that is not in the public interest. This approach does require criteria for deciding when an alleged hazard is baseless, and "the best available science" is supposed to provide a risk-based approach (discussed below) to this problem (Miller 2000).

Even under the best circumstances of strong scientific consensus on hazards, this approach to food safety suffers from some of the problems often associated with the utilitarian or consequentialist form of ethical reasoning with which it is closely allied (Saner 2000). Any approach to ethics that rationalizes some chance of a hazardous outcome in terms of benefit to the general public will be vulnerable to criticisms that stress individual rights. The widely discussed risk of allergenicity associated with GMOs is an instance of this problem. Since genes make proteins and proteins are potential allergens, one cannot exclude the possibility that genetic engineering of foods may introduce proteins into foods that will cause sensitivities and allergic reactions in some portion of the population. Since food allergies are not well understood, and since they may affect very small percentages of the population, it may not be practical to anticipate or characterize the likelihood of allergic reactions before GMOs are released for public consumption. Thus, there may be a few people who would be harmed by eating a GMO, and the approach to food safety described above seems to rationalize a small probability of serious health affects on these few in terms of economic benefits to the many. Here, the utilitarian and libertarian foundations of technological ethics come into conflict with one another.

One may be inclined to think that individuals have an inviolable right not to be harmed by inadvertently consuming a protein that they could not have known they were allergic to, and even that this right is violated even when the risk is purely hypothetical. One way to characterize this type of thinking is to say the rights of the few outweigh less vital interests of the many. Some opponents of biotechnology may wish to take this position. The most obvious alternative is to place each individual in a position to look after their own interests where food safety is concerned. This approach follows the ethical logic of informed consent: people should be free to take whatever risks they choose, but they should not be put in a position of risk without adequate notification and an opportunity to choose otherwise (Jackson 2000; Streiffer and Rubel 2004). This sort of reasoning has led many to demand labels for GMOs, a response that will be discussed in more detail below.

However, the informed consent approach to food safety has drawbacks, as well. Gary Comstock (2002), for example, discusses empirical research showing how apparently detailed food information can distort personal decision making. It may be impossible to provide the information that allows one person to make an informed choice without simultaneously putting another person in a position where they will make an uninformed choice. As such, some argue that governments should be judicious and sparing in the information that they require to be supplied to consumers, and this argument effectively brings us back to the "best scientific evidence" perspective described already.

Ethical Significance of the Environment

Environmental risks present a key category for social and political controversy in industrialized societies. Unlike food safety risks, which are born by individuals and which can be addressed conceptually in terms of individual choices and individual rights, environmental risks cannot typically be addressed through policies that allow individuals to apply their own values as to whether a risk is acceptable or not. Environmental risks necessarily involve political decisions. Complex and well-developed constituencies contest a wide array of issues along environmental lines, and sociological perspectives on environmentalism and environmental movements suggest a number of ways in which environmental concerns might be interpreted with respect to political values and interest group politics (Edelman 2001) While there are many ways in which environmental responsibilities might be interpreted, one central and abiding ethical question unifies a host of approaches with the hazard identification phase of mainstream risk assessment: What counts as an ethically significant environmental impact?

One useful way to simplify the range of issues arising in connection with environmental impact is to note that answers to this question can raise three different kinds of ethical concern. First are human health effects accruing from environmental exposure, such as air or water borne pathogens (as opposed to ingestion through food). Second are catastrophic impacts that would disrupt ecosystem processes in ways that threaten to destabilize human society. This includes dwindling energy supplies, human population growth and global warming. Finally there are effects that are felt less by humans than by the broader environment. These may be classified as eco-centric (or non-anthropocentric) impacts. Interpreting each of these three types of environmental impact as having ethical significance calls involves distinct ethical concepts and values, some widely endorsed and others less so.

Environmental impacts in the first category manifest themselves as human injury or disease. They include cancer induced by chemical pollution, emphysema and lung diseases from air pollution, poisonings and non-fatal diseases such as allergies and reduced fertility speculatively associated with hormone disrupting chemicals in the environment. Although the scientific and legal issues that arise in establishing the connection between cause and effect are tortuous, the ethical imperative to limit these risks is very clear. Ethical and quasi-ethical issues arise because it is not clear how to resolve uncertainties that arise in assigning a probability to the unwanted impact, and because there are different ways to think about the social acceptability of environmental exposure to human health risks. Although it is certainly possible that food and agricultural biotechnology could pose such risks, products currently under development for use as food have not been linked to any known human diseases that would be contracted by environmental exposure. Critics of biotechnology have noted that transgenic crops are also being developed to produce drugs and industrial products, and that these products must be contained in order to limit environmental exposure to human health hazards (Andow et al. 2004). No one has contested the claim that hazards to human health through environmental exposure are ethically undesirable. One ethical issue that arises with respect to the possible realization of this hazard is uncertainty: what is the chance that environmental exposure to transgenic plants and animals will cause human injury or disease? This uncertainty is associated with virtually every kind of consequence discussed throughout this section. What responsibilities follow from the possibility that there is something we have not thought of? A second ethical issue (also ubiquitous) concerns the acceptability of this risk: should the risk be run?

For many years, the environmental risks associated with agricultural biotechnology were thought to fall primarily in the middle category of potentially catastrophic ecological consequences. In contrast to environmental exposures that might lead to human health hazards, the science that would be used to predict and measure the likelihood of ecological catastrophe is less well developed. Ecologists raised the possibility of widespread disruption of atmospheric processes associated with ice-nucleating bacteria early in the development of agricultural biotechnology (see Thompson 1987 for an overview). The speculation that biotechnology would contribute to a narrowing of the genetic diversity in major food crops was also an early concern (see Doyle 1985). During the 1990s the potential environmental impacts foreseen were less sweeping. Particular attention has been given to the potential for escape of herbicide tolerant genes into weedy relatives of crop plants, and to the possibility that insect pests will acquire resistance to *Bacillus thuringiensis* (Bt) (Krimsky and Wrubel 1996; Rissler and Mellon 1996). Though such events are not in themselves catastrophic, their ethical significance derives from interpreting them as contributing to a broad destabilization of the global food system. Early on, environmental philosophers noted two general categories for ethical debate: duties to posterity and so-called eco-centric ethical values, or duties to nature (Hanson 1986).

The potential for ecological catastrophe relates to the first of these concerns. Again, there are two ethical questions: What if there is a scenario leading to ecological catastrophe that has not been thought of, and are the risks acceptable? Here, these questions are complicated by the possibility that the impact of today's choices may be felt by future generations.

North American philosophers writing on environmental ethics have laid greater stress on duties to nature than on duties to posterity, suggesting that the third of category, of eco-centric or non-anthropocentric effects might be of particular ethical significance. Although questions of uncertainty and risk acceptability might also arise in connection with impacts on wildlife or ecosystems, here there is more debate over why such impacts might be thought to have ethical significance. Preservation of wilderness and endangered species has been of particular importance in Canada and the United States. In part, this emphasis derives from the fact that environmentalists in Canada and the US have sought persuasive rationales for setting aside the relatively large tracts of undeveloped land that exist in these countries. Industrial, scenic and recreational uses provide a baseline for valuing wild ecosystems in economic terms. The main philosophical tasks have been understood in terms of developing a rationale for valuing and preserving wild ecosystems, including keystone species, irrespective of their economic value. Given this orientation, one would expect that products such as transgenic salmon, which could affect wild salmon populations, would be among the most contentious applications of biotechnology from the perspective of eco-centric environmental ethics.

In addition, agriculture is sometimes viewed as antithetical to environmental values in the North American context. Agricultural technologies are potential polluters, contributing to human health risks, and agricultural land use competes with wilderness preservation. For example, Canadian environmental ethicist Laura Westra argues that farmlands cannot possess "ecological integrity". She sees farming as environmentally valuable only as a buffer that protects wild areas from the impact of human civilization (Westra 1997). Given this orientation, one might think that agricultural biotechnology would not be of interest to on eco-centric environmental grounds. A contrasting view, which may be more prevalent in northern Europe, implicitly sees preservation of nature as preservation of farmland. Preservationist goals are articulated in terms of keeping land in fairly traditional forms of farming, and farming is seen as wholly compatible with preservation of habitat.

Prior to 1999, crop biotechnology was not widely associated with environmental impacts on wilderness or endangered species. In that year news reports that Bt-crops could affect monarch butterflies enlivened the prospect of unintended impact on nontarget species for the first time. This has awakened public recognition of the way that agricultural biotechnology could have an impact on wild species, and provides an example of how eco-centric environmental impacts could be brought about by genetic agricultural technologies. In Canada, genetically engineered canola could outcross with wild rape. Research on genetically engineered fish has long been associated with the potential for negative impact on wild populations. There are also less well known products, such as recombinant vaccines, that could also have negative impact on wild habitat. As experience and experimental studies accumulate, the list of possible hazards is expanding, and scientists' ability to quantify the likelihood that such hazards will materialize is increasing (Wolfenbarger and Phifer 2000).

An additional type of environmental impact requires one to see a farmer's field as having a kind of ecological standing or integrity of its own. Critics may see biotechnology as threatening in virtue of the possibility that transgenic plants may appear in a field in which a non-transgenic crop is growing, either by pollen drift, contamination of the seed supply or when volunteer transgenics survive over the winter to reappear in a field sown to non-transgenics in the succeeding year (Bruce 2003; Mellon and Rissler 2004). The key philosophical question is: Why does this matter? Some answers to this question are economic. A farmer may lose the ability to gain a price premium for a non-transgenic crop, or in the worst case lose the ability to sell the crop in some international markets altogether. Here, an ecological or environmental mechanism contributes to an impact that is better classified as "socioeconomic" than "environmental." Other answers relate to consumer preferences of the sort discussed in connection to food safety (above). Still other answers may foreshadow the discussion of purity and unnaturalness that is taken up in the section on special concerns.

Ironically, public opinion surveys suggest that Canadians and Americans have not historically associated ecological risks of agricultural biotechnology with ethical concern, though there may be a greater tendency to do so in recent years (Einseidel 2000; Priest 2000). Ecological impacts of agricultural biotechnology elicit more ethical concern globally than in North America (see Durant et al. 1998; Gaskell and Bauer 2001). Attentiveness to potentially catastrophic risk and to preservation of farmland has created a groundswell of environmentally based concern about agricultural biotechnology in Europe. The difference between North American and European attitudes may reflect cultural and philosophical norms about the place of agriculture within nature, with Europeans seeing agriculture as part of nature and North Americans associating nature with wild or unmanaged ecosystems. Alternatively, it may reflect different ways in which environmental issues are capable of mobilizing individuals into effective forms of political action, a difference that may be rooted in respective national histories or in the structures of political organization (Gaskell et al. 2002).

Moral Status of Animals

Like impact on ecosystems or ecosystem processes and unlike impact on human health, the impact of human action on non-human animals is controversial because some people deny that animals can be harmed at all. The belief that animals are non-sentient machines who feel no pain is often attributed to René Descartes (1596–1650), and has without question been influential in the use of animal experimentation within the medical sciences (Rudacille 2000). Immanuel, Kant (1724–1894) believed that animals could not be harmed because they lacked reason, and argued that the moral wrong associated with animal abuse owed not to any harm suffered by the animal, but solely to the harm that a perpetrator inflicts upon himself in acquiring a habit of poor character (Kant 1963, pp. 239–241). Long before these pivotal figures in European philosophy, philosophers of the ancient world such as Aristotle had defended the view that animals lack the mental faculties that would make human conduct toward them morally significant (Sorabji 1993), and Thomas Aquinas had written that if the Bible appears to forbid cruelty to animals it is only to guard against the possibility that "through being cruel to animals, one become cruel to human beings; or because injury to an animal leads to the temporal hurt of man," (Aquinas, excerpted in Regan and Singer 1989, p. 9)

The philosophers Peter Singer and Tom Regan have jointly campaigned against the belief that animals do not count morally, arguing that these philosophical attitudes are causally responsible for untold amounts of animal suffering in medical research, product testing and animal agriculture. Singer and Regan oppose one another, however, in offering accounts of why animal suffering is morally significant. Singer places his argument within the tradition of utilitarian philosophy, often quoting the venerable founder of this tradition, Jeremy Bentham (1748–1832), who wrote, "[T]he question is not, Can they *reason*? nor, Can they *talk*? but, Can they *suffer*? (Bentham, excerpted in Regan and Singer, p. 26). Here, the ethical basis for concern about the impact of human activity on non-human animals follows from the utilitarian mandate to act in ways that maximize the ratio between pleasure or satisfaction and pain or suffering. If animals experience pain (and Singer produces prodigious amounts of scientific data and argumentation to support the common sense belief that they do), then we are morally obligated to take their pain into account when evaluating our actions in ethical terms (Singer 1975).

Regan presents his argument in favor of animal rights by arguing first against the general utilitarian framework that Singer accepts. Instead, Regan believes that the only philosophically defensible approach in moral philosophy is to observe rights that protect the interests of moral subjects. In Regan's view, the key philosophical burden of proof involves whether or not animals possess the interests characteristic of moral subjectivity. These involve having a sense of oneself, a continuous form of conscious experience capable of supporting a minimal experience of personal identity. Regan defends the view that vertebrate animals, at least, do indeed possess such interests, and that they are, in his terminology, "subjects-of-a-life," or bearers of a cognitive identity commanding our moral respect (Regan 1983, 2003). Sociologists James Jasper and Dorothy Nelkin (1992) give Singer, Regan and other philosophers great credit for initiating the worldwide social movement for reform in a number of domains in which animals are used by human beings.

The philosophical movement for animal welfare (Singer's view) and animal rights (Regan's view) has broad implications for agriculture and for biotechnology. Both Singer and Regan advocate vegetarianism, for example, though Singer's commitment to vegetarianism might wane were it possible to institutionalize more humane forms of animal production. Furthermore, both seem to believe that problems in contemporary livestock production owe to the philosophical errors catalogued above. It is, however, questionable to assert that abuses associated with industrialized animal production can be laid at the feet of Descartes and Kant (see Thompson 2004), and Singer and Regan's valorization of the Western philosophical canon neglects the complex way in which animals have been conceptualized in non-Western philosophy and religion. However, an even cursory discussion of animal ethics as they apply within contemporary animal production settings would take the present discussion far afield. It must suffice to note that public interest groups advocating humane treatment of animals monitor developments in animal agriculture closely. They also take a keen interest in biotechnology, though here much of the debate has focused on transgenic mice developed for biomedical research (Mepham et al. 1998). The balance of the discussion in this book will narrow these broad concerns to the topic of biotechnology applied to food animals.

Genetic transformation and cloning of livestock is currently in the experimental stage (NRC 2002b). Nevertheless, survey research indicates that animal biotechnology is strongly associated with ethical concern among members of the public (Sparks et al. 1995; Frewer et al. 1997; Einseidel et al. 2002). There are also a number of authors associated with social movements to protect animals who have decried food and agricultural biotechnology (see Fox 1990, 1992a, 1999; Linzey 1995; Ryder 1995). However, other authors who have argued strongly for recognition of animal interests have not found gene technology to be especially problematic (see Rollin 1995, 1996; Varner 2000). Clearly some of those who find animal genetic engineering problematic are among those who see gene technology as intrinsically wrong, and this topic is treated as a special concern discussed below. Gene technology applied to animals raises two additional issues that might also be applied to animal breeding and that thus belong in the category of general technological ethics. The first is that gene technologies have the potential to produce suffering in animals. The second is whether or not it is acceptable to reduce an animal's capacity to suffer as a means to reduce suffering.

Some of the first genetically engineered animals were very dysfunctional (see Rollin 1995), and there continue to be questions about the health of cloned animals (though the evidence currently suggests that they do not have abnormal health problems). As already noted, animals have not always and everywhere been thought to have moral standing that would make their suffering a matter of ethical concern. Nevertheless, few in Western industrial democracies would deny that animals are capable of feeling pain, and few would deny that humans have a responsibility to ensure that animals do not suffer gratuitously. The ethical issue here is thus whether the purposes to which animals are being put justifies any pain and suffering they experience. Although this is an ethical issue of general interest and importance, its bearing on the ethical acceptability of animal biotechnology should not be overstated. No genetic transformation that would result in genetically engineered or cloned animals enduring greater suffering than ordinary livestock is being proposed. Rollin (1995) has argued for an ethical principle that would proscribe any such application of biotechnology. To the extent that existing practices within livestock production are ethically acceptable with respect to their impact on farm animals, practices associated with food and agricultural biotechnology should also be acceptable.

Of course, existing practices are the subject of intense criticism by animal advocates, and arguments that follow the principle stated in the preceding paragraph have already been controversial. For example, recombinant bovine somatotropin (rBST), a product of genetically engineered bacteria that stimulates dairy production, has been controversial because cows with higher rates of milk production are also at a higher risk for health problems. The US Food and Drug Administration chose to interpret the animal health risk from use of rBST as consistent with that of existing practices, since there are other legal ways for boosting milk production. Critics chose to interpret the same data as evidence that rBST increases the risk of health problems in animals on which it is used (see Powell and Leiss [1997] for a discussion of the Canadian debate on rBST). There is thus a real prospect that animal advocates will interpret the animal health risks associated with gene technology as having greater ethical significance than that of existing technology.

The second set of ethical issues associated with animal biotechnology were first clearly stated when Rollin suggested that genetic engineering should be used to render animals being used in medical experiments "decerebrate"—physically incapable of experiencing pain (1995). This general approach could be applied in a less drastic fashion to livestock. Gene technology could be used to produce animals that are more tolerant of the crowding and confinement that create welfare problems in existing animal production systems. It is, in fact, possible to do this through conventional animal breeding, so this consequence that should be seen as uniquely associated with recombinant gene transformations (Sandøe et al. 1999). If animal suffering is the predominant ethical concern, it would seem that there is a compelling ethical argument for using breeding and biotechnology to reduce suffering. Many animal advocates find this to be an abhorrent suggestion, though it has proved difficult to articulate reasons that do not revert back to the claim that animals have a form of *telos*, or intended design. This notion of *telos* has been cited by a number of critics who find genetic engineering of animals to be intrinsically wrong, and these arguments are discussed below as a form of concern special to biotechnology

Socio-Economic Impact and Social Justice

As noted above, part of the implied social logic of technological innovation is that increasing the efficiency of production practices is generally, if not inherently, beneficial to society. Nevertheless, technology is a concern for social justice when specific products affect the distribution of economic rewards (and penalties) throughout society, or when less tangible social goods such as social cohesion or social legitimacy are damaged. Such impacts have been widely associated with agricultural biotechnology, and the focus here will be to discuss a sample of these criticisms with an eye toward understanding the norms and principles at work in these arguments. Those who have raised issues of social justice have based their concerns on many different ethical claims. Some of the arguments have a history that extends back to the origins of the industrial revolution; others exemplify social concerns uniquely characteristic of the late twentieth century. Here it will be useful to divide socio-economic impact into two sub-categories and to offer an extended discussion of each. First, there has been a longstanding debate over the effect and justifiability of yield enhancing agricultural technology, in one sense, a focused rejection of the utilitarian argument for technological innovation discussed at the beginning of the chapter, as least as it applies to agriculture. From one perspective, biotechnology is just the latest example of a general technological approach that has been the focus of debate in agriculture for a long, long time. Second, there is a related but nonetheless distinct debate that associates biotechnology with relatively recent trends in shifting power relations, globalization, the rise of international corporations and the transformation of national sovereignties. Because so few people are now intimately associated with or knowledgeable about agricultural industries, it is easy to mistake the old debate for the new one. In the interest of disentangling these threads here, they are treated as more distinct than they probably are in fact.

Impacts on Farms and Farm Communities

Agricultural production technology affects economies of scale in farming or food distribution, and the control that different persons or groups maintain with respect to the overall food system. Certainly any technology has these effects, including not only such obviously agricultural technologies as plant breeding or chemical pesticides, but also information technologies such as the internet and basic infrastructure such as roads and transport. How do technological changes pose challenges of social justice with respect to farming communities? Perhaps more than any of the other ethical concerns discussed in this paper, food and agricultural biotechnology represent nothing more than a case study for this general question.

In assessing long-running historical arguments, it will be useful to trace the way that agricultural technologies have played a key role throughout history. It is plausible to see late twentieth-century themes that link opposition to science and technology and movements of social liberation as building on these long running historical arguments, but in considering food and agricultural biotechnology it is important to have a firm grasp of the agrarian context in which these arguments originated. Some of the foundational arguments for contemporary discussions of social justice achieved some of the most influential formulations during seventeenth and eighteenth century debates over agricultural land reform. Developments in transport technology and infrastructure made it feasible for farmers and landowners to seek competitive prices for grain. This practice sparked additional innovations (such as enclosure and increased use of draft animals) that increased yields. It also disrupted the system of tithes and shares that had been the foundation of feudal and village economies. On one side of the political dispute that emerged from this technological change were those who developed the two-stranded argument summarized at the outset of the chapter:

(a) *The Libertarian Premise*: People who invest labor in the production of goods have the right to seek the most favorable price for their goods; and
(b) *The Utilitarian Premise*: The increased efficiency of technological innovation serves everyone in the long run—technological innovations promote the greatest good for the greatest number.

On the other side were those who argued that these transformations destroyed the integrity of village communities. They argued that the older system of exchange, in which every person in the village was entitled to a share of the local crop, better satisfied the ethical demands of social justice (see Thompson 1971; Montmarquet 1987; Smith 2003).

The ethical issues associated with early transformation of rural areas in Europe were generalized and evolved into general views on social justice during the nineteenth and twentieth centuries. Arguments that favored agricultural technology eventual took shape as the neo-liberal principles endorsing the social efficiency of unregulated markets, on the one hand, and the sanctity of private property, on the other. Arguments opposing technological improvement of agricultural production and rural infrastructure evolved into socialist and communitarian conceptions of social justice. The anti-technology dimension of these arguments was gradually muted, particularly in strong leftist and Marxist interpretations of social justice. Karl Marx (1818–1883) believed strongly in the power of technological development as a force of liberation. There is thus a sense in which some of the broadest concepts of social justice have their roots in disputes over agricultural technology. Disputes over agriculture and rural development continued throughout the twentieth century, but participants in these debates were not particularly mindful of their historical origins. It is useful to isolate two themes.

First, new agricultural technology had its greatest effect on rural communities in industrial societies during the twentieth century and especially after World War II. This created a century long debate over the ethical and political wisdom of allowing industrial principles to shape agricultural production, vs. policies and technological investments that would strengthen family ownership structures and rural communities (see Kirkendall 1984). The ethical dimension of the debate consists in the claim on one side that technological innovations adopted by profit seeking farmers, processors and food retailers reduce overall food costs, resulting in consumer benefits that outweigh the financial and psychological costs of those who suffer economic reverses. On the other side it is claimed that the economic opportunity represented by family farms and the small businesses that arise to support them is the essential component of social justice. Furthermore it is claimed that small-scale rural communities promote participatory local governance and are therefore most consistent with the ethical principle that social justice depends upon consent of the governed. It was virtually inevitable that any new agricultural technology developed in the last quarter of the twentieth century would be subsumed by this debate. Some of the first social science publications on food and agricultural biotechnology framed it in precisely the terms of the century long debate over the structure of agriculture and the ethical importance of the family farm (Kloppenburg 1984; Kalter 1985; Schor 1994).

A second strand of ethical concern over social justice examined the impact of food and agricultural biotechnology in developing countries. Here, too, there was an ongoing debate over the "Green Revolution" agricultural development policies being pursued by organizations such as the World Bank, FAO, the Consultative Group on International Agricultural Research, the Rockefeller Foundation and the international development agencies of industrialized nations. Like the first strand of debate, critics of the Green Revolution have argued that increases in agricultural productivity have been gained at the expense of rural ways of life, a repeat of failures and tragedies that have faded from the memory of people in the industrialized world. Here, too, it was inevitable that biotechnology would be subsumed by the existing debate (Nuffield Council on Bioethics 1999, 2003). On the part of those who support the actions of the official development organizations, it is argued that developing countries must follow the lead of the developed world in adopting yield enhancing agricultural technology. As above it is argued that the benefits of increased food production outweigh any short run reverses suffered by individual farmers. Indeed, given the threat of famine, it is argued that the social demand for more food production is compelling (Persley 1990; Robinson 1999; Borlaug 2001; Wambugu 2002).

Those holding an opposing view raise factual questions about the success of the Green Revolution. The ethical dimension of their viewpoint notes that the infusion of technology and capital into peasant economies and traditional agricultural production systems causes an upheaval in existing social relations. In addition to claiming that this upheaval destroys the culture and way of life in traditional societies, critics of Green Revolution-style development note that the poorest of the poor are the most vulnerable group when such massive transformations of social structure occur. They counter the argument that food needs in the developing world override concern for cultural integrity with an argument that appeals to the basic rights of individuals whose lands, jobs and way of life are destroyed in the wake of development projects (Dahlberg 1979). These general criticisms have been extended to biotechnology in a series of critical discussions dating back to the mid-1980s (Kloppenburg 1984, 1988; Buttel and Barker 1985; Kenney and Buttel 1985; Buttel 1995; Peritore and Galve-Peritore 1995).

Shifting Power Relations and Intellectual Property

In addition to the above noted affects on farming communities, there have been several other concerns that have been associated with the dominance of hierarchical decision making styles and linked to the growing power of multinational companies. Critics of food and agricultural biotechnology claim that policy making has been dominated by men who exhibit a decision making style that has been the target of the feminist social movement. They note the prevalence of a viewpoint that characterizes critical attitudes as emotional or irrational, and equates rational decision-making with an emphasis on economics and cost-benefit style comparison of decision options. They also believe that decision-makers see nature as an object of human domination. Consistent with much of the literature in feminism, they see the domination of nature and the domination of women as themes with a common historical, intellectual and cultural origin. Hence they argue that opposition to biotechnology and the overthrow of the existing decision-making elite for biotechnology follows from an ethical commitment to feminist philosophies of social justice. Vandana Shiva (1993a, 1995b, 1997, 2000) is particularly known for linking feminist ethics to the critique of the Green Revolution noted above. The argument has been made as a more general postmodern critique of both agricultural and medical biotechnology by social critics such as Brian Tokar (2001), Chaia Heller (2001) and Finn Bowring (2003).

A more general set of concerns have been raised in connection with industry's impact on publicly funded science. *Biotechnology's Bitter Harvest* (Goldberg et al. 1990) was one of the most influential publications to make a forceful ethical critique of food and biotechnology in a clear way. Although the report included a critique of biotechnology on environmental grounds, its primary argument was that US agricultural universities were abandoning an ethical commitment to serve farmers, turning instead to the development of technology that would primarily benefit agribusiness and agricultural input firms. This argument can be seen as a direct outgrowth of the issues concerning farming communities discussed above. Yet in directing the brunt of its criticism at the planning and conduct of publicly funded agricultural research, the authors of this report made claims with a substantially different ethical importance. Their argument connects with that of social critics who have been expressing concerns that commercial interests were having a growing influence on the conduct of science (see Busch et al. 1991; Krimsky 1991; Press and Washburn 2000; Busch et al. 2004).

A third strain of argument focuses again on issues relating to international development. Much of world's most valuable plant genetic resources lie in the territory of developing countries and much of it is found in land-races. Land races are crop varieties that have been grown by indigenous farmers who have selected for valuable traits by a process of trial and error. Developed country plant breeders have made many advances by extracting these valuable traits from the seeds of land races. In the past, neither the indigenous farmers who grow land races nor the governments of their countries have been compensated for the use of these genetic resources. Critics have claimed that a double form of injustice occurs when these genetic resources are first taken without compensation, and then sold back to developed countries in the form of seeds protected by patents or under plant breeders' rights (Shand 2001; Magnus 2002). This argument is also tied to the concern that biotechnology might hurt small farmers, but here the injury being done to them is in the form of property rights, and arguably quite different from the traditional critique of social impacts due to the increasing size of farms and their industrial organization.

Ethical concerns about smallholder control over seeds predate the debate over biotechnology. Social critics have noted this issue with respect to the collection of germ plasm for conventional plant breeding (Juma 1988; Fowler and Mooney 1990). Biotechnology has brought this set of concerns to the forefront of public attention in conjunction with legal debates over the patentability of genes and genetic sequences (Lechtenberg and Schmid 1991) and over the status of patents and other forms of intellectual property in the TRIPS Agreement, which established basic principles for adjudicating intellectual property disputes in the World Trade Organization (WTO 1994). Defining and defending any given configuration of property rights is an inherently moral and philosophical exercise, hence these technically complex legal debates generally presume some sort of ethical framework in which arguments about what should and should not be recognized as property are mounted (de Beer 2005). Broadly, the case for recognizing the patentability of genes and gene sequence is a derivative of the case for intellectual property in general, and it is couched in utilitarian terms: In a setting of competitive markets, innovators benefit from their inventions only if they are kept secret and no competitors are able to use them. But the public benefits if the inventions are made public and everyone can use them. So inventions (intellectual property) should be made public, but if they are made public too soon, inventors lose all incentive to innovate. Hence, the rationale for intellectual property rights, including patents and copyrights, is to give inventers an exclusive right to use or license the use of their invention, but only for a limited time, after which this right ceases to exist, thus maximising public benefit (Brody 1989).

This basic argument has been challenged on many fronts. Some critics accept the basic utilitarian rationale for patents, but question whether patents in biotechnology are really beneficial (Hettinger 1995). Others see the utilitarian view of patents simply as a subterfuge to allow the growth of capitalist social relations and corporate power (Hobbelink 1991; Burrows 2001). Still others stress the view (noted above) that indigenous people who discover uses for plants and who develop germ plasm through generations of trial and error have a prior claim that vitiates this utilitarian rationale (Tauli-Corpuz 2001). These anti-utilitarian arguments are linked with concerns about intellectual property rights in the domain of human medicine, where patenting of genes and gene processes are sometime said to violate human dignity (Bowring 2003). The ETC Group, a non-governmental organization that has been active in opposing biotechnology, often links their criticisms of gene patents to the so-called Terminator gene, a biologically based means of protecting intellectual property by rendering seed infertile. Although intellectual property arguments can involve exacting technical detail when considered in a legal setting, it has proved relatively easy for critics of biotechnology to link the spread of intellectual property rights in biotechnology with the worst aspects of globalization.

These ethical issues associated with the shifting balance of power in society should be seen as distinct from concerns about the impact of technical change on farming communities. Someone who holds values that generally favor pursuit of food and agricultural biotechnology (in the belief that it will help address world hunger, perhaps) could still find fault with the way that the science agenda is being established in the era of biotechnology. One concern expressed at the grossest level is that pursuit of profit or receipt of funding from industry might influence the results of research intended to review the safety of products. More, broadly these seemingly seismic shifts in the role and nature of science, in the structure of international institutions and in traditional ways of understanding ownership feed a pervasive concern about the general drift of social relations. Critics such as Shiva, Bowring or Tokar unify a broad array of medical, food-related and legal trends to create a picture of biotechnology as a monolith that must be met with widespread popular resistance. At this point, concerns emerging out of a fairly straightforward need to anticipate unwanted consequences of biotechnology seem to blend together. Perhaps at this point, they take the shape of an intrinsic evil to be opposed simply for its own sake.

SPECIAL ARGUMENTS PERTAINING TO THE USE OF rDNA TECHNOLOGY

The most sweeping ethical argument against biotechnology would be one that finds the manipulation of genes or cells to be either categorically forbidden or presumptively wrong, so that compelling arguments would need to be adduced in its favor. Fable and myth provide a basis for the idea that certain forms of knowledge or technology may be subjected to such proscription (see Shattuck 1997). It is not clear whether members of the lay public who express ethical reservations about gene technology have such a view in mind, but it is reasonable to presume that some do. There are many ways in which such a claim might be stated. Empirical research indicates that many members of the lay public who find food or agricultural biotechnology ethically objectionable base their judgment on the view that it is *unnatural* (Gaskell and Bauer 2001; Wagner et al. 2002). Philosophers have called these objections to biotechnology "intrinsic objections," meaning that it is the activity of genetic manipulation itself that is wrong, not its consequences (Saner 2001; Streiffer and Hedemann 2005).

Statements to the effect that biotechnology is unnatural convey a judgment of disapproval, but do little to articulate the basis for that judgment. In one sense, all of agriculture is an unnatural activity, but we should not infer that all of agriculture is therefore of ethical concern. How would one spell out the belief that biotechnology is unnatural in a way that would form the basis for an argument against its use to develop agricultural crops or animals? How would one articulate an intrinsic objection to gene transfer that would cover its use in plants and animals, as well as human beings? A few strategies that have been attempted in the literature can be summarized.

1. *Genes and essences*. Since antiquity, people have thought of living things as having "essences" that constitute their essential being. Nelkin and Lindee (1995) note a general cultural tendency to interpret genes as bearers of the traditional notions of essence and purpose that would achieve moral significance in some teleological conceptions of nature. One view of biotechnology may see it as "tampering" with these "essences" (Bockmühl 2001). Criticisms voiced by Rifkin (1985, 1995)

suggest such a judgment, and it is particularly associated with those who have suggested that genetic engineering violates a species' *telos*. (See Fox 1990, 1992b, 1999; Verhoog 1992, 1993). The term "telos" is derived from the philosophy of Aristotle, where it was used to indicate a thing's guiding or final purpose, realized in the case of living organisms through the processes of growth, development and reproduction that are characteristic of their species. It is associated with *teleology*, a philosophy of nature that seeks to explain biological processes in terms of function, purpose and design. Although teleology does not necessarily prescribe particular ethical norms, versions of teleology that find a predetermined design in nature, often the work of a supernatural intelligence, move quickly to the ethical judgment that humans deviate from the preordained purposes of this plan at their physical and spiritual peril.

2. *Species boundaries and natural kinds.* Human cultures display a remarkable constancy with respect to the way that species boundaries are taken to reflect a kind of natural order, reflected in the linguistic tendency to build the system of meanings around natural kinds. Plants and animals visible to human senses and important for human purposes are described as kinds, rather than as particular things not amenable to classification. Although different cultures parse the world around them in different ways, human languages tend to have equivalent kind-terms for "dog" "cat" "tree" or "flower". Verhoog (1993) suggests that this tendency is evidence for an underlying system of purposes such as those discussed immediately above. He also makes the separate argument that biologists lack any special authority to redefine these terms to more faithfully reflect the scientific construal of kinds as interbreeding populations. The force of this second argument is that modern biology is challenging the most basic way in which human beings have made sense of the world since antiquity—and so much the worse for modern biology.

3. *Emotional repugnance.* Genetic modification of foods causes an immediate reaction of repugnance among many. The most sophisticated philosophical statement of the ethical significance that should be associated with that reaction was made in brief article by Kass (1997), commenting on the announcement of Dolly, the sheep cloned by the Roslyn Institute in 1997. Kass's central argument is that mammalian cloning elicits a repulsive reaction from many, and that this repugnance is sufficient ground to regard cloning as intrinsically wrong. In making this case, Kass relies on a conservative tradition in ethics that harks back to the philosophical writings of David Hume, Adam Smith and Edmund Burke. These philosophers believed that morality was based on sentiments of sympathy with others, and that emotional attachments were a key component in any moral judgment. Although they lived and wrote in a pre-Darwinian culture, they also believed that emotional reactions like repugnance reflect a deep-seated and culturally ingrained wisdom. Societal stability is the result of respecting these emotional reactions, and departure from them entails the risk of upheaval and dissolution. Kass's argument has since formed the basis for a similar argument against applications of recombinant technology to foods (Chadwick 2000; Midgley 2000).

4. *Religious arguments*. Many people clearly attach religious significance to species boundaries and question the wisdom of genetic engineering. Furthermore, many of the world's religions endorse specific injunctions against crossing species boundaries, interfering in reproductive processes, and consuming proscribed foods. As noted already, some of the most plausible ways of understanding the view that biotechnology is unnatural or that it tampers with the natural order against the demands of morality involve appeals to divine authority. Furthermore, worldviews that construe nature as bearing specific forms of moral significance may also be considered as resting on religious foundations, especially when they involve beliefs that are not amenable to scientific characterization and measurement. Chapter 10 examines some of these possibilities in greater detail.

Evaluating Special Arguments

For the most part, professional philosophers have not been kind to the objection that biotechnology is unnatural. Roger Straughan (1999) and Gary Comstock (1998) review a series of ways to extend the claim that gene technology is unnatural into a more substantive ethical argument for regulating or restricting crop biotechnology. In each case, they find either that the substantive issues do not pertain specifically to the use of rDNA techniques for gene transfer, or that the characterization of naturalness is too vague and fails to exclude many well-accepted uses of technology. Bernard Rollin (1995) offers a similar analysis, and characterizes arguments that appeal to the unnaturalness of gene transfer as "bad ethics." Mark Sagoff (2001) has replied to the suggestion that biotechnology is unnatural by reviewing the four ways in which John Stuart Mill found that something could be said to be natural, arguing that for the most part, no judgment against biotechnology can be maintained without also tarnishing ordinary plant breeding, if not agriculture itself.

Philosopher Fred Gifford (2000) has shown how conceptions of the gene as a carrier of human essence fail to correspond with the conception of genes that is operative in contemporary molecular biology. Scientific authors do not characterize the processes of cloning or genetic transformation in terms that would support the judgment that essences and *telos* are being affected. As such, there is a gap between the ethical understanding of nature implicit in philosophies that attribute essential or teleological significance to genes or gene processes, and the dominant scientific interpretation of the practices that constitute food and agricultural biotechnology. It is not clear who bears the burden of proof with respect to further development of this line of ethical concern. On the one hand, those who believe that genes have the ethical status of essence or *telos* have not shown how the idea of genes as sequences of DNA can be made compatible with traditional notions of essence or *telos*. One might argue that this line of criticism has reached a dead end until such an argument is forthcoming (Rollin 1996). On the other hand, one might argue that until scientists and practitioners of biotechnology bear the burden of defending biology against traditional notions of purpose and essence that may still be very active in the worldview of non-scientists, it is entirely appropriate to oppose biotechnology on the ground that it is intrinsically wrong (Streiffer and Hedemann 2005).

The argument from natural kinds does not have widespread appeal, though it is one way of making sense out of the claims made by some of biotechnology's most vehement opponents. It deserves consideration if only as a possible way of explaining why biotechnology and molecular biology seem to cause such a profound sense of anxiety. Jason Robert and François Baylis (2003) have made a version of this argument, but applied strictly to biomedical technologies that muddy the boundary between human beings and other species. It is not clear whether the next move should be a stronger statement of the reason why the need to preserve the basic categories of human language (and perhaps, by extension, of humanity's collective intelligence) entails any specific proscriptions or norms with respect to food and agricultural biotechnology. Alternatively, a need for better public education in biology might follow, on the assumption that the real problem is the underlying anxiety and disorder associated with shifting worldviews. Better ethical discourse on biotechnology might even be a means to resolving the tension felt by those who feel that modern molecular biology threatens the most basic categories that human beings use to make sense of the world.

Mark Sagoff's evaluation of the "naturalness" of biotechnology is relevant to repugnance arguments offered by Kass, Midgeley and Chadwick. Sagoff writes that Mill in fact offers us one sense of what it means to be natural that allows us to sort GM crops and animals into the unnatural basket while leaving traditional foods in the natural one. This is that things can be "unnatural" in the sense of being inauthentic, not true to themselves. Here, Sagoff admits that we (meaning our culture) might find biotechnology to be unnatural in the sense of being inconsistent with our aesthetic sensibilities. He argues that we should allow ourselves free reign to indulge our aesthetic tastes, but only under the condition that we recognize the full implications of doing so. Sagoff's view on this point is that the human and environmental costs of rejecting biotechnology would be significant. Nevertheless, if a public informed about the technology and its likely benefits still found it repugnant, such a result it would strengthen the repugnance argument, and presumably Sagoff would be forced to concede that biotechnology is "out" on aesthetic grounds. Streiffer and Hedemann (2005) suggest that opinion research supporting the demand for labeling suggests that a majority of people have already found biotechnology to be intrinsically unacceptable, and on this basis argue that political decision makers can no longer reject this sentiment in good conscience.

The ethical significance of religious views can be pursued in two ways. First, one may examine the theological or doctrinal basis for this judgment, given the sacred texts, sectarian juridical processes and doctrinal traditions of specific religions. Clearly, religious deliberations represent an important source of insight with respect to the application of cloning, genetic engineering and other forms of gene technology to human beings (see Nelson 1994; Peters 1997). Second, one may simply acknowledge that the principle of religious tolerance affords people with wide latitude for deriving faith-based opinions on food and agricultural biotechnology, and inquire how these intrinsically personal ethical judgments entail social norms. Worldviews and normative beliefs about nature and natural order must be regarded as protected by principles of religious tolerance even if they do not derive from recognized religious traditions, churches or theological traditions, and even if they do not involve belief in a supernatural power.

Arguably, the second approach converts the significance of religious beliefs about gene technology into a problem of consumer and social policy. The norms that guide action are based on a secular principle of religious tolerance, rather than (or in addition to) norms that make specific appeal to religious inspiration or doctrine. Tolerance implies that religious believers should be able to act on their beliefs. If those who find biotechnology unnatural are working from conceptions of nature that are so inconsistent with those of contemporary biology that we must regard them as "faith-based" (even if they make no specific appeal to God or recognized religion), then one of the main implications of calling these views faith-based is that the individuals who hold these views are regarded as having a right to hold and act on these views irrespective of modern science. But this line of reasoning may convert the argument from a "special concern" to an ordinary principle of technological ethics. The fact that people have faith-based views prohibiting a practice does not ordinarily provide a public basis for constraining or regulating that practice. Rather this fact establishes a prima facie obligation [1] to respect these beliefs and to accommodate a believer's desire to act on faith-based beliefs in their daily life. Any form of technology that compromised people's ability to hold and act on faith-based beliefs would raise ethical concern, so the ethical issue that is raised here is a general concern of technological ethics, rather than a special concern associated with gene technology. Streiffer and Hedemann (2005) resist this turn in the argument, suggesting that if a sufficient number of people hold faith-based beliefs, it becomes appropriate to take whatever public action such beliefs dictate, subject to the qualification that the full range of political values must be taken into consideration when doing. On this ground, they argue that, at a minimum, intrinsic arguments provide a powerful argument for segregating and labeling products of biotechnology, and could conceivably provide an argument for banning them altogether.

RESPONDING TO THE CHALLENGES OF AGRICULTURAL AND FOOD BIOTECHNOLOGY

The issues discussed so far under the heading of general technological ethics (environmental impact, food safety, animal welfare, impact on farming communities and shifts in power) plus special concerns that arise uniquely in connection with

[1] A prima facie right or obligation is one that we should recognize as having moral force, and as binding when countervailing considerations are not present. But prima facie claims may be overridden by other considerations that are regarded as more compelling in particular cases.

genetic engineering and mammalian cloning have been addressed in terms of ethical value: Why do these things matter ethically? There is also the further ethical issue of what to do about them, given the values identified. In the parlance of risk analysis, this is the "risk management" phase of decision making. This section will review several competing philosophical approaches to the articulation of broad principles for risk management, for converting a review of values and concerns into a prescription for action or policy. To simplify a complex and sometimes seemingly incoherent debate, three approaches will be described. First, there is what might be called *mainstream thinking*, the approach being advocated by a number of leading scientific organizations and endorsed by regulatory agencies in countries where transgenic crops are currently grown or where animal biotechnology is approaching the stage of regulatory approval. Mainstream thinking has been countered by calls to implement the precautionary principle or a corresponding *precautionary approach* and to require *labeling* of products of biotechnology. Clearly, many advocates of precaution think of themselves as occupying the mainstream and many would see labeling as a component of precaution. Furthermore, many elements of what will be characterized as a precautionary approach are incorporated into government and international regulatory decision making. Readers are thus cautioned to note that this tripartite division is somewhat artificial and has been adopted only to simplify exposition.

The Mainstream Approach

Products of biotechnology were first introduced in the United States and Canada, and the regulatory agencies and administrative law of these two countries have established a general philosophy of risk management largely through the accumulation of precedents established through a series of specific decisions made by respective regulatory agencies. The principles of this philosophy have been articulated in a few early conceptual papers on the risks of agricultural biotechnology (Alexander 1985; Brill 1985), a series of US National Research Council Reports (NRC 1983, 1989, 2002a), and in documents prepared by the Food and Agricultural Organization of the United Nations (FAO Undated 1996) and the Organization for Economic Cooperation and Development (OECD 1993). Advocacy for this approach has often adopted rhetoric characterizing it as "risk-based," or "science-based," implying that alternative perspectives lack scientific grounding (Huttner 1993; Miller and Conko 2001). But as noted already the terminology can be confusing and inconsistent. For example, Indur Goklany provides a clear overview of the mainstream approach in a 2000 white paper for the Center for the Study of American Business under the title "Applying the Precautionary Principle to Genetically Modified Crops." His philosophy has little or nothing to do with the precautionary alternative to mainstream risk management, but perhaps this simply testifies to the fact that what is "precautionary" may be open to philosophical interpretation.

The mainstream approach is a fairly straightforward adaptation of utilitarian philosophy as described throughout the book. A decision maker attempts to characterize the likely consequences of a given course of action, and compares the expected value of the opportunities available. The correct action is the one having the best (or optimal) overall yield of expected benefit, happiness or satisfaction over expected cost, dissatisfaction or harmful outcome. Three key values specify how this utilitarian framework has been applied in evaluating agricultural biotechnology. The mainstream approach is *outcome oriented*, *data driven* and *comparative.* Arguably it is the last of these values that is most decisive for the relative strengths and weaknesses of the mainstream approach.

The mainstream approach is outcome oriented in that it evaluates agricultural biotechnology strictly in terms of the expected costs and benefits of its use. This has the effect of excluding most of the issues described above as "special concerns" from the decision making process altogether. If the wrong done in genetic engineering consists in simply doing it, rather than in some effect that it has on humans, animals or the environment, the outcome-orientation of classical utilitarian thinking has no way to incorporate this wrong into its general framework. The mainstream approach is data-driven in that strong preference is given to empirical studies that have measured risks, as compared to conceptual models or speculative arguments that hypothesize risk. Two articles by philosophers, one by David Magnus and Arthur Caplan (2002b) and another by Robert Streiffer and Thomas Hedemann (2005) argue that defenders of mainstream approaches seem to regard outcome oriented and data-driven decision making as self-evidently equivalent to rationality. Rationales or defences for these values are almost never forthcoming. Hugh Lacey (2005) argues that prediction of outcomes and presentation of empirical data are key values that shape the overall coherence of the "pro-biotech" position and that lead advocates of the mainstream approach to think of it as "based on science."

Emphasis on outcomes and data may be somewhat misleading, however, for it is the insistence on a comparison of risk/benefit ratios that may account for the most important values in the mainstream approach. The risk-based approach is comparative in that the same principles and methods for evaluating risks and benefits should be applied to each of the main options, for example to transgenic and conventionally bred crops. Many of the hazards and uncertainties that critics associate with biotechnology are (or may be) equally associated with conventional forms of plant and animal breeding. In fact, little data has ever been collected on human, animal and environmental impacts from conventionally bred crops and animals. The general presumption that traditional practices are "safe" is, on the one hand, fully justified in light of the fact that humankind has relied upon them for some time. On the other hand, the experiences and lore of the agricultural sciences are filled with examples of misbegotten efforts in traditional breeding, experiments that were abandoned after going awry in every conceivable manner, from dysfunctional animals to weedy grasses and toxic potatoes. There is little or no published data on this lore because the norms of the agricultural sciences were not attuned to the accumulation of data on risk and because scientists were perhaps understandably not interested in advertising their failures. If these traditional breeding practices are safe, it is not because they are intrinsically free of risk. Rather it is because the professional ethic of agricultural scientists has, for the most part, been successful in preventing damage worthy of widespread recognition or public debate (Thompson 2002).

When known and suspected health and environmental damage associated with chemical-intensive agriculture is figured into the risk of conventionally bred crops, the comparative risks of transgenic crops may seem attractive. When food deficits associated with low yields from traditional land races are calculated as part of their risk, the comparative risks of transgenic crops may seem attractive even in settings where chemicals and industrial production methods are little used (Chrispeels 2000). In the absence of a comparative framework, however, it might seem silly to accept the risks that are increasingly being documented for transgenic crops (Weaver and Morris 2005). Arguably, it is the insistence on applying roughly consistent standards of comparison both to transgenic and to traditional breeding, chemical and mechanical agricultural production methods that yields the strongest argument favoring biotechnology.

But the comparative framework is also a source of weakness in the mainstream approach. Considerable gaps exist in the regulatory framework that has evolved for anticipating and managing the risks of traditional agricultural technology. If the same framework is applied to transgenics (as emphasis on fair comparison to non-transgenics insists) there may be a number places where key risks are simply not addressed (Mandel 2004; Taylor et al. 2004). From an ethics perspective, the fact that socio-economic consequences associated with agricultural technology have not been taken into account in government regulatory decision making may be the greatest omission. The risk management approach here has been to leave everything to market forces. This has arguably led to a skewed set of outcomes, even from the ethical perspective of utilitarian optimization, persistent resentment over the influence of economically powerful actors, and a decline in confidence that outcomes from the introduction of agricultural biotechnology will be appropriately steered (Thompson 1997b). It is also the case that this approach provides little basis for thinking that the applications of biotechnology that are most needed in the developing world are very likely to materialize. There is little opportunity for profit with many of these applications, and the costs (including infrastructure and liability risk) for introducing transgenic crops in non-industrialized economies lacking effective regulatory oversight may be prohibitive (Tripp 2001). If capitalist markets are the only mechanism for managing socio-economic risks associated with biotechnology, as the mainstream approach continues to insist, there are clearly large gaps.

Uncertainty and the Precautionary Principle

The Precautionary Principle is, perhaps, the most visible alternative to the mainstream approach in evaluating agricultural biotechnology. The definitive statement is taken from the United Nations' Rio Declaration on Environment and Development:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (UNEP 1992)

As this language implies, precaution is less a single principle or decision rule than a general philosophy which dictates a conservative or risk-averse response when uncertainty is present. The Precautionary Principle is also often used as a reason to reject practices that have consequences that would be impossible or difficult to reverse or mitigate.

Some authors describe the Precautionary Principle simply as a preference for statistical and evidential burdens of proof that favor public and environmental health interests over commercial and industrial interests in cases where there is little scientific consensus on the levels of risk associated with a practice (Cranor 1999; Ozonoff 1999). Yet is also clear that precaution with respect to agricultural biotechnology often involves eschewing the technology at least until uncertainties in current estimates of risk have been substantially reduced (Cranor 2003). Other authors identify precaution with the integration of ethical concerns into regulatory decision making (see O'Riordan and Jordan 1995; Bernstein 1999). Following this line of thinking, others argue that a precautionary approach to uncertainty requires broader public participation in regulatory decision making (Carr and Levidow 2000). The Royal Society of Canada (2001) report *Elements of Precaution* interprets precaution to explicitly endorse the inclusion of intrinsic objections to biotechnology within any consideration of its pubic acceptability.

Critics of the Precautionary Principle portray it as a decision rule that allows perception of hazard to override documented evidence for hazard in regulation and enforcement of international agreements (Gray 1993). This theme has been especially prominent in connection with biotechnology. Critics have described the precautionary approach as "unprincipled" (Miller and Conko 2001), and as mandating contradictory advice concerning transgenic crops (Comstock 2002). Philosopher Henk van den Belt (2003) has written a detailed overview of the debate over the precautionary principle in which he concludes that there is no basis on which any technology, including transgenic technology, could have met the burdens of proof being advanced under the banner of the precautionary approach. van den Belt's analysis suggests that a distinctive feature of the precautionary approach is that it does not apply comparative or uniform standards in the evaluation of technological alternatives.

There are a number of ethical concerns that are interwoven in debates over the precautionary approach. One is the claim that there is a need to anticipate harm to persons and the environment in advance, and to take action that will forestall this harm. This is a theme that recurs frequently in statements of the Precautionary Principle, but it is not, in fact, a view that would be contested by advocates of the opposing "risk based" approach. The risk-based approach can be strongly committed to anticipatory action when the evidence warrants. A second concern notes that powerful commercial and industrial interests can influence the assumptions that are deployed in conducting scientific risk assessments. This, too, is a concern that has been voiced repeatedly by those who call not for an abandonment of risk assessment, but for a more objective implementation of risk based decision making (see Graham et al. 1988; Brunk et al. 1991; Mayo 1991). It is thus likely that at least some of the alleged incompatibility between a "risk based" and a "precautionary" approach is terminological and rhetorical. This is not to minimize the importance of these two ethical concerns; indeed, the fact that they have long been a part of the attempt to develop an adequate approach to technological risk assessment only underscores their importance. Discussions of the Precautionary Principle arise at several junctures in the chapters that follow, but especially interwoven with the review of environmental impact in Chapter 7.

Nevertheless, there are several points on which it is fairly clear that mainstream and precautionary approaches diverge. For one, precautionary approaches do not uniformly, at least, appear to be limited to the outcome-oriented assumptions of mainstream risk analysis. The recognition of intrinsic objections and calls for participation in decision making suggest that non-consequential norms have a clear place in precautionary decision making. This aspect of a precautionary approach makes it more similar to themes that I have analyzed in connection with participation and consent. Again, Chapter 7 will revisit this point in more detail. Another difference, noted by van den Belt, is that many who advocate a precautionary approach do not consider the comparative risks of transgenic and non-transgenic technology. They treat risks from transgenic technology as if conventional agricultural production methods were risk free. However, some statements of a precautionary approach also suggest that the mainstream approach itself has not sufficiently applied a comparative norm, arguing that the acceptability of risks from transgenic technology as compared to industrial agriculture begins to fade when the full range of organic and agro-ecology methods that are available for agricultural production are included in the mix (Kirschenmann 1999; Lacey 2005). Either way, advocates of a precautionary approach are framing the entire question of agricultural technology differently from those in the mainstream.

Consent, Labels and Consumer Choice

One of the key points of dispute over GMOs involves the appropriate role of labeling and consumer choice. The issue of choice is broader than safety, however, since consumers may desire an alternative to GMOs for reasons that derive from repugnance or religious views, or to express their moral views about animals, ecology, globalization or family farms. Some argue that individual consumers must not be put in a position where they are unable to apply their own values in choosing whether to eat the products of biotechnology. Others argue that the matter of whether genetic transformation has been used is immaterial to the underlying values (especially safety and healthfulness) that are the basis of consumer choice. They argue that the very act of informing consumers about GMO foods would mislead consumers into making choices that are not consistent with the underlying purposes that are sought through the purchase and consumption of food.

This is an ethical issue rather than a simple dispute over facts about the safety of food and agricultural biotechnology because one viewpoint presumes that individual autonomy and consent are the key ethical norms, while the other stresses an ethic of rational optimization. The tension between these two ways of stating the most basic norms of decision making has been endemic to some of the most protracted ethical debates of the last 200 years, and one that pits the twin pillars of technological ethics against one another. The utilitarian school of philosophical ethics has argued that a choice that produces the best consequences is always the best one, while libertarians and followers of Kant have argued that rational conduct requires respect for the autonomy of others, even when this may not lead to the best consequences, all things considered. While it is not plausible to suggest that ordinary people make systematic commitments to either utilitarian or autonomy-based ethical theory, paying attention to these two competing philosophies can usefully illuminate the issues of consumer choice. The ethical issues here are also probably some of the least well understood by scientists and key decision makers responsible for biotechnology policy. The persistent misinterpretation of the ethical issues involved with consumer consent is arguably the source of some the most difficult lingering problems associated with food and agricultural biotechnology. The Parliamentary Office of Science and Technology (1998) report, the US Congressional Research Service Report (Vogt 1999) and the Nuffield Council on Bioethics Report (1999) are examples of documents that discuss choice issues, but fail to make a clear statement of the argument from autonomy.

The problem is that those who are implicitly committed to the ethics of rational optimization (or utilitarianism) interpret consumer choice in a manner that distorts the basic ethical position of those who stress autonomy and consent. According to utilitarian ethical theory, rational individuals seek to maximize personal satisfaction through choice by selecting the course of action that has the best chance of producing an outcome consistent with their personal preferences. The preferences that might lead consumers to prefer GMO-free foods include non-rational emotional reactions, as well as aversion to hazards associated with the potential for allergens or unresolved questions of food safety. However, it is important for individuals to have the options (e.g. choices) that allow them to act on their preferences, whatever their origin. If some individuals would prefer so-called GMO-free products (products free of ingredients in which food and agricultural biotechnology have been used), a food system in which this option is available will better serve consumer preferences than one in which this choice is unavailable (see Sherlock and Kawar 1990; Nestle 1998).

This analysis of consumer choice provides a rationale for labeling that would permit consumers who want GMO-free foods to express their preferences, but it also puts this preference on an equal footing with other consumer preferences, such as the desire for inexpensive or tasty foods. Indeed, it is possible to argue on these grounds that a food system that did not allow those who wanted to eat GMO foods to act on this preference would be as problematic from an ethics perspective as one that denies the choice of GMO free. It is also possible that the confusion that would be produced by a complex system of labels and consumer information would substantially reduce consumers' ability to satisfy their preferences. Furthermore, if labels that described a product as GMO-free tended to be interpreted as conveying a safety warning, this, too, might lead consumers to make less rational choices than they would if no label were present. Thus, the utilitarian approach to the issue of choice and labeling requires a complex weighing of the costs and benefits that would be associated with labeling.

This is a distorted picture of the ethical issues from the perspective of autonomy and consumer consent. Here, the underlying issue is that people should not be placed in a position where they are unable to act on basic values that are central to their personal identity and worldview. It is crucial to this position that beliefs about the appropriateness or naturalness of food are a component of individual belief systems that are protected by principles of religious tolerance (see the discussion in Chapter 4). A system of choice that constrained a person's ability to act on the basis of religious or metaphysical beliefs would compromise the principle of autonomy in way that a system that denied opportunities for inexpensive or tasty food choices presumably would not.

The analysis of choice from the perspective of autonomy and consent demands an argument demonstrating that food choices do indeed represent values that are of deep importance to individuals—importance rising to the level of a value that is protected by liberties of conscience. Given the prevalence of food beliefs throughout religion and culture, this is not a difficult argument to make. Of course individuals often deviate from religious or culturally determined food beliefs. A utilitarian might interpret this behavior as evidence that these are weak preferences. The opposing view is that individuals must be free to follow or deviate from values fundamental to their personal and cultural identity. It is one thing for individuals to freely violate such beliefs and something entirely different for society to develop a system of practices that forces them to do so (see Chadwick 2000; Rippe 2000; Zwart 2000; Streiffer and Rubel 2004).

It is of course a matter of contention as to which of these two philosophical approaches—utilitarian rational optimizing or respect for autonomy and consent—ought to have the upper hand with respect to issues of market structure, labeling and consumer choice. However, the fact that autonomy and consent issues continue to be misrepresented even by those who are attempting to provide a balanced overview of social and ethical issues associated with agricultural biotechnology suggests a further concern. An unreflective (and probably unintentional) tendency to frame issues in utilitarian terms may itself be a source of ethical concern with respect to food and agricultural biotechnology. If this is the case, it would suggest that not only issues involving consumer consent, but also issues associated with social justice, environment and even animal ethics are being addressed with a utilitarian bias to frame ethical issues solely in terms of utilitarian, cost-benefit kind of thinking. If so, there is a kind of unfairness or perhaps ethical blindness that pervades thinking on biotechnology. The possibility of such a problem leads into the problem of trust.

CONCLUSION (WITH A NOTE ON INSTITUTIONAL CONCERNS)

This chapter has offered an initial framework for understanding the range of ethical concerns and for appreciating the value judgments that underlie conflicting opinions on the ethical responsibilities associated with food biotechnology. Hopefully, readers can appreciate the multiple bases of ethical concern as well as the extensive range of debate that has already occurred over the ethics of agricultural and food biotechnology. Although this summary discussion has continued at what to some readers must seem to be an unreasonable length, it represents but a fraction of the opinion and analysis that is currently available. The goal here has been to sketch the types of argument that would be deployed in interpreting and developing each area of concern more fully. Two broad types of concern have been distinguished so far. First, it is possible that the use of gene technology is itself the basis of concern, a special argument that there is something about the manipulation of living matter at the genetic level that is ethically troubling. Second, it is possible that gene technology is of ethical concern because it poses risks to animal, environmental and human interests, including not only individual health and safety, but also economic and social considerations. One would expect that concerns in the first category would not arise in connection with conventional chemical, mechanical and breeding technologies used in food science and crop production, while concerns arising in the second category would be generally applicable (e.g. general technological ethics). Finally, there are some remaining ethical concerns that relate less to the products or processes of animal and crop biotechnology than to the social institutions that develop, promote and regulate these technologies.

Since 1989, the National Agricultural Biotechnology Council, a consortium of Canadian and US non-profit institutions conducting research on food and agricultural biotechnology, have conducted annual meetings on the issues needing attention. Every report from those meetings has noted a need for building public confidence in the technology. The reports have stressed better communication with the public and educational programs in the recognition that those with a poor understanding of biotechnology would have every reason to be suspicious about its introduction into the food system. Indeed, many authors have noted that public attitudes and distrust of biotechnology or of science in general is the greatest single obstacle to its market acceptance and commercial success (see Boulter 1997; Rubial-Mendieta and Lints 1998; von Wartburg and Liew 1999).

The social science literature on public trust in science builds upon points that have been discussed throughout the earlier sections of this white paper—environmental impact, uncertainty, animal issues, social justice and consumer consent. It suggests that the public does not trust the actors that promote food and agricultural biotechnology because they have exhibited ethical failings with respect to one or more of the issues noted (see Frewer et al. 1997; Brom 2000). Commercial influence on the conduct of science, discussed above under the heading of "shifting power relations" is also tied to this decline in public trust (Martin 2000). Social science research also indicates high variability in the confidence accorded to the messages of activist groups. Non-governmental organizations or NGOs are among the most trusted sources of information for certain sub-populations, but totally untrusted by others (Durant et al. 1998).

Is there an ethics issue here? Philosophers such as Ronald Sandler (2004) as well as myself (Thompson 1997a) have argued that the promoters of biotechnology have displayed an ethics deficit with respect to the virtue of trustworthiness. Trustworthy people display thoughtfulness of purpose and a clear capacity to be mindful of the interests of those by whom they are trusted. We do not trust people who seem to be making reference to their own immediate goals and self-interest at every moment (Baier 1994). If these criteria are extended to actors responsible for the development of food and agricultural biotechnology, those who always seem to be engaged in strategic promotion of biotechnology and never in serious practical discussion are not trustworthy. This is not a judgment that necessarily reflects on the moral character of the individuals involved. People who are virtuous in their own right and in their private lives may well be involved in groups or associations that are untrustworthy in virtue of the fact that serious discourse about ethical issues occurs infrequently.

This suggests that strategic behavior on the part of those who speak on behalf of science is ethically more problematic than strategic behavior by activist and industry groups. Industry groups have an obvious interest in promoting their products, and there is a growing recognition that activist groups depend upon media visibility for their causes (and membership). There is thus a general expectation that activist groups and industry interests will offer communications that portray issues in the most favorable light, that they are prone to exaggeration, and that their communications should be regarded with skepticism. If activist and industry groups are expected to address issues strategically, scientific and governmental forums should be the locus for open, public discourse focused not only on factual issues associated with environmental and public health risk, but also value judgments. As discussed throughout this chapter, value judgments are intrinsic to the definition of key options, the treatment of uncertainty, the relative ranking of outcomes (including non-human animal and social consequences) and to the development of risk management strategies. It is impossible to exclude discussion of value judgments without also introducing strategic elements (elements that suggest a point of view without arguing for it) into the discussion of risk.

Concerns about the one-sidedness and utilitarian bias of claims that have been produced to defend or promote biotechnology also arise in this connection. Even those committed to the belief that issues should be addressed from the perspective of weighing the trade-offs between risk and benefit that are associated with biotechnology should recognize that an alternative approach to risk issues exists (Magnus and Caplan 2002b). An ethical perspective that sees the issues in terms of securing individual consent, negotiating social consensus, and curtailing the power of elite groups (including scientists) to shape culture and policy represents a neglected alternative to the utilitarian framework (von Schomberg 1995b; Brom 2000; Mepham 2000). Failure to acknowledge the full range of ethical perspectives can create the impression that one is promoting a utilitarian trade-off approach to ethical decision making. This impression does not serve the goal of a fair and open hearing for all ethically motivated points of view. This book, overall, is an effort to contribute to such a fair and open hearing. In resisting the "pro" and "con" summarizing approach, I have tried to suggest that agricultural biotechnology has become caught up in several longstanding moral and political debates, as well as having introduced a few new wrinkles on its own. More detailed and careful philosophical discussions of key points follow in the succeeding chapters, as does a more straightforward statement and defense of my own views.

CHAPTER 2

THE PRESUMPTIVE CASE FOR FOOD BIOTECHNOLOGY

The case for using the tools of recombinant DNA and the expanding bodies of scientific knowledge in molecular biology to develop new products and processes for agriculture and the food industry is simple and direct. The tools and science we know as food biotechnology can be employed to increase agricultural productivity, reduce negative environmental impacts, and to insure and improve food safety. The record of products already on the market is mixed, but a strong defense of their ability to deliver on these criteria can certainly be mounted. More products are currently under development that would do all of these things, and there are undoubtedly many more applications that are as yet undeveloped, unresearched and even unimagined. What is more, these ethically important results are multiplied by indirect benefits of both a social and environmental nature. Increases in productivity can (they don't always) benefit farmers, ranchers and vegetable growers, but they also benefit food consumers when they translate into lower food prices or greater availability of foods. Since food purchases take up a much larger part of the personal budget for the poor than for the rich, lower food prices are of greater value to those in society who are relatively worse off than to the better off. Increasing agricultural productivity thus satisfies egalitarian moral principles that recommend a reduction of the level of inequality in society. Some products of biotechnology will mitigate the environmental harms associated with industrial agriculture. Products that successfully allow plants to produce their own insect toxins, such as those that incorporate a gene for producing *Bacillus thuringiensis* (Bt) into corn or cotton, as well as herbicide tolerant crops, have resulted in a measurable reduction in the use of chemical insecticides (Carpenter et al. 2002). Other work is underway to provide plants with greater ability to resist insects and plant diseases through genetic engineering, and to help farmers utilize more sustainable production practices.

The first product of food biotechnology to appear on the market place was a form of rennet—the enzyme essential to cheese making—that was produced by a genetically engineered microorganism. These engineered organisms produce rennet (or chymosin) in the same way that living organisms have produced alcohol in the brewing process for centuries. Prior to the creation of these organisms in the early 1990s, all rennet was harvested from the entrails of recently slaughtered calves. Bacteria have been transformed using genetic engineering to produce rennet under conditions resembling traditional industrial fermentation. The new form of rennet has a triple advantage from an ethical standpoint. It is cost effective, allowing profits for cheesemakers with the prospect of lower prices to consumers. It is pure, offering a benefit in the form of food aesthetics, if not food safety. The development of recombinant rennet led to a variety of cheeses deemed to meet the standards for kosher certification. Finally, recombinant rennet has an indirect benefit to animal welfare, eliminating the need to slaughter calves in order to make cheese. Recombinant rennet thus serves egalitarian values in lowering food prices, aesthetic and religious values in its service to purity, and animal welfare values in offering an alternative mode of production that does not involve the slaughter of calves.

This is *not* to claim that any of these products or others yet to come represent an unalloyed panacea for social, environmental, health or animal welfare problems. For example, the same study showing a reduction in the use of pesticides associated with Bt cotton showed little reduction of pesticide use in the case of Bt corn, and virtually no change in the total use of herbicides (Carpenter et al. 2002). This confusing result can be partially explained by noting that corn producers had no effective means to combat the European corn borer prior to Bt varieties (there were thus no pesticides whose use could be reduced), and by noting that as crops tolerant to glyphosate herbicides became commonplace, not only did the use of these herbicides increase, but prices of competing herbicides came down, providing farmers with additional economic incentives to increase their use of them, as well. Any evaluation of the net effect of an agricultural technology will, as this example illustrates, be complex, so perhaps some skepticism of claimed benefits for biotechnology is warranted. Subsequent chapters will take up some of the trade-offs and unwanted consequences that even very desirable products can have. Yet the simple statements and examples cited in the first two paragraphs show that there is a strong presumptive case in favor of food biotechnology. The possibility of producing desirable and beneficial environmental outcomes and improvements in human and animal well-being provides the basis of an argument for developing and deploying specific products of biotechnology. That such beneficial products exist and can be conceived provides an argument for developing the tools and techniques of biotechnology within society. These arguments do not prove that biotechnology should be developed any more than they prove that any of these beneficial products should be released, marketed or utilized by farmers, consumers or the food industry. Rather, they provide straightforward and direct reasons for framing a more detailed discussion of biotechnology in terms of the question, “Why not?” To structure the argument this way does not mean that one should ignore unfavorable outcomes that might accompany these presumptive benefits. It does not imply that one should decide to use the technology and its products indiscriminately or in every case. The most favorable evaluation that follows from the presumptive argument is this: if the broad set of tools and knowledge known as food biotechnology can be deployed for good, the ethical responsibility is to support the development and training in the tools of biotechnology *in general*, and to make assessments of *specific* products or applications when there are good reasons to suspect that there may be problems, or that costs and unwanted consequences outweigh benefits in a particular case.

In one sense, my goal in summarizing the presumptive case for biotechnology is less to provide an argument *for* agricultural biotechnology that would persuade a neutral or doubtful reader than it is to provide those readers who are already favorably disposed toward biotechnology with an orientation to the broad ethical argument that is developed in the balance of the book. The main point of the book is to help those involved in developing and promoting biotechnology gain a sophisticated appreciation of their ethical responsibilities. As such, the presumptive case for biotechnology is summarized in order to characterize the ethical platform from which the development and promotion of biotechnology proceeds. In starting with the presumptive case for biotechnology, I do not mean to imply that cynical attitudes and deep concerns are unworthy of consideration or respect; my goal is, in fact, quite the opposite. Such attitudes and concern will in fact be treated respectfully throughout the balance of the book. As the problematic prediction of reduced pesticide use shows, it is not unreasonable to react to simple statements like those made in this chapter with skepticism. Although the book is not intended to be a detailed response to skeptical arguments, skeptical readers should test their reaction to the *overall* case for biotechnology by examining whether other chapters provide answers to their doubts and protests, and *not* by the presumptive case being elaborated here.

THE LOGIC OF THE PRESUMPTIVE CASE

To say that there is a presumptive case in favor of food biotechnology means that the burden of proof falls on the side of providing reasons to restrict, control, limit, regulate or moderate the use of the technology, rather than the reverse. Why establish the burden of proof in terms that favor biotechnology? Logic permits only three options here. In addition to the presumption for biotechnology, there is its opposite, a presumption against it demanding argument to justify its pursuit, and a third choice that demands case by case evaluation for every proposed use of technology. While this third choice may seem appealing at first blush, it becomes surprisingly difficult to apply in practice. The idea that there should be case-by-case evaluation of each new utilization of biotechnology sounds in fact a lot like the position that advocates of biotechnology have taken, that is, the "product not process" view: evaluate the safety, efficacy and environmental impact of each product, rather than evaluating the process of using recombinant DNA to modify plant or animal traits. But opponents of biotechnology have argued against the "product not process" view by suggesting that it presupposes a basis for going forward with biotechnology unless some specific problem tied to a given product provides a reason not to do so. This argument suggests that the neutrality of the case-by-case alternative is illusory. One must either assume a presumptive case *for* biotechnology, and then examines each product for reasons not to go forward, or one must presume *against* biotechnology, and then see if any given product provides a basis for overcoming that presumption. One way of understanding the latter alternative is to interpret it as decision making in conformity to the precautionary principle, a view that deserves notice and is in fact discussed more thoroughly in Chapter 7. But note that the allegedly neutral third way has now dissolved into competing presumptive cases. As such, the presumptive case *for* must be stated in order to proceed, eventually, to an examination of the presumptive case *against*.

What is more, allegedly neutral case-by-case evaluation of technology (like any proposal for case-by-case evaluation of alternatives) actually imposes intolerable costs on our decision making. There is no area of life in which we weigh every possible option on a case by case basis, and we would clearly spend all our time weighing and deliberating if we did. Instead we rely on "filters" to determine which cases demand more careful scrutiny and deliberation. Such filters often take the form of biases that implicitly structure the burdens of proof that we impose on others and ourselves. Although we can certainly review and rethink when faced with any given case, the idea that we will thoroughly consider every possibility is not really a viable one. The question can thus be limited to two cases: should our cognitive filters be set for or against biotechnology?

I have already indicated that an argument intended to reset the filters of those who bring a bias against biotechnology would have a different shape from the one that I am trying to develop in this book. Nevertheless, it is useful for everyone to admit that bias exists, that it is not all bad, and that having one's cognitive filters set in a particular direction does establish an ethical responsibility to test one's bias from time to time. Having a bias in this sense means that we are predisposed to regard situations and proposals in a given way. People tend to assume that unless some contradictory evidence is presented, or unless reasons for thinking otherwise are apparent, a habitual practice or a standard operating procedure (SOP) is adequate. Being predisposed this way does not mean that there are no considerations that can overturn our inclinations, but it does mean that our evaluation of situations and proposals has an implicit logical structure: *unless* there is evidence or reason to behave differently, we are inclined to act in the manner in which we are predisposed. Acting ethically requires that we give due consideration to the evidence and reasons that could contravene our inclinations.

Many people have biases or cognitive filters that favor the status quo. Indeed, favoring *some* understanding of the status quo (or SOP) may be characteristic of all predispositions or biases, but one person's status quo may be another person's big change. New technologies can seem like radical departure from SOP but in fact new technologies are being created and applied constantly. Much of the controversy over biotechnology in agriculture arguably derives from people who see the status quo or SOP in radically different ways, and because of this their cognitive filters are at odds. Some see biotechnology as a radical departure from the status quo. Their cognitive filters have been tripped, and they want a justification for what seems to be a radically new and possibly dangerous trend. When the first edition of *Food Biotechnology in Ethical Perspective* was published in 1997, this was far less the case than it seems to be ten years later. A book intended to help agricultural scientists, administrators and regulators through the ethical issues associated with an emerging technology in 1997 did not need to devote much energy to convincing that audience of the presumptive case for biotechnology. *Their* cognitive filters were, for the most part, set in that direction before they opened the book. In 1997, it thus seemed reasonable to simply state the reasons for setting one's bias in favor of agricultural biotechnology, then going on to consider some objections and concerns.

Jeffrey Burkhardt has described scientists' bias toward the promotion of biotechnology in a somewhat similar way. He bemoans the way in which "the scientific attitude" makes those who are developing biotechnologies totally insensitive to a broad range of ethical concerns. While calling for large scale cultural change within the sciences, he expresses pessimism about the possibility that scientists will seriously entertain reasons *not* to go forward with applications of biotechnology any time soon (Burkhardt 1997). Weed scientist Robert Zimdahl has supplemented Burkhardt's pessimism with a book-length study of how and why agricultural scientists fail to consider ethical arguments, as well as alternative technological approaches. Zimdahl attributes much of the problem to an unexamined positivist philosophy in the agricultural sciences. Like Burkhardt, he calls for reform, but expresses doubt that reform is at hand (Zimdahl 2006). Hugh Lacey's detailed analysis of agricultural biotechnology as a case study in the intersection of values and objectivity (Lacey 2005) and an empirical study of attitudes among molecular biologists by three University of Reading social scientists (Cook et al. 2004) provide further support for Burkhardt's and Zimdahl's analysis. Although I find many points of agreement with this characterization of scientists' attitudes and beliefs (see Thompson 2004), my strategy of argument here is different. Rather than taking readers through a tour of philosophy of science and its role in the scientific attitude, my approach is more hopeful. By articulating some principles on which, I assert, we can (or should) agree that there are good reasons to view biotechnology favorably at the outset, we can see that there actually are ethical values underlying the optimistic biases that many scientists bring to their work. Once these values are made explicit, it then becomes possible to develop a more sophisticated and critically sensitive approach to biotechnology.

A broad set of philosophical considerations in support of a presumption favoring any new technology can be derived from the confluence of utilitarian and libertarian rationales described in Chapter 1. A succinct summary of that rationale goes as follows. If we are inclined to favor freedom on libertarian grounds, we should allow technology developers to exercise their freedom to develop technology. The history of technologies that have increased the efficiency of our ability get things we want in exchange for a given expenditure of resources and effort suggests that the utilitarian maxim to promote the greatest good for the greatest number would also support technological innovation. As already noted in Chapter 1, both libertarian and utilitarian rationales come with qualifications and possible concerns but nonetheless, we begin with a broad philosophical mandate for viewing technological innovation favorably.

This broad mandate can be further strengthened with respect to agricultural and food biotechnology because the uncritical cognitive filters bemoaned by Burkhardt and Zimdahl are to a considerable degree counteracted by social and governmental filters (i.e., institutions) that weed out a lot of bad ideas without our having to pay much attention to them. A scientist who has a "great idea" for genetically engineered rutabagas except for that unfortunate side-effect (people who eat them break out in an uncomfortable rash) will not get far in the real world of food and agriculture.

The mere fact that most products won't be developed unless there is a chance of making money from them weeds out lots of bad ideas (and unfortunately, as will be discussed below, some good ones). The market is a filter. Environmental protection and food safety agencies within government provide additional filters. The threat of a liability lawsuit may be the ultimate filter for many individuals and firms that contemplate introducing new technology. An awful lot of the bad ideas in food biotechnology will be eliminated from consideration whether working scientists *or* ordinary citizens adopt an ethical predisposition against food biotechnology, or not. These economic, regulatory and tort-based legal filters are a part of the SOP for new agricultural technologies. Of course it is possible that these institutions have gone awry, so noting them is *not* to say that they are working perfectly. Nevertheless, the belief that our society is institutionally oriented to the promotion of certain technologies rather than others must be tempered by the recognition that any technology faces a significant set of hurdles as a matter of course.

Given the range of potential beneficial applications for food biotechnology, one would expect that many cases will be presented for our consideration. Given the economic and regulatory filters that are already in play, many applications will never see the light of day as practical agricultural or food technologies. It is thus reasonable to expect that food biotechnologies able to work their way through the economic and legal filters described above will be favorable more frequently than they are unfavorable. There is thus a purely *methodological* reason to adopt a presumptive view favoring biotechnology: our cognitive filters should be on the alert for bad outcomes and products, rather than the reverse. As a result, most of this book is dedicated to biotechnology's possible problems. This reasoning may sound contrary to technology boosters and latter-day Luddites alike. If he's *for* biotechnology, why is he spending all this time on problems? Or contrarily, if we are concerned about problems, why do we adopt an outlook presuming that biotechnology will be good? The answers to these two questions (like the questions themselves) may seem to run at cross purposes.

Conducting a due and careful ethical evaluation of any given technological product or group of technological means requires weighing the good and the bad, as all proponents and opponents of the technology must admit. A truly *neutral* view of technologies, I have argued, is a seductive illusion. If we presume *against,* we demand that advocates *for* overcome our bias by presenting arguments in favor of a specific application. What we would get is an endless, repetitious and ultimately numbing recital of benefits, much on the order of those listed in the first two paragraphs of this chapter. It is thus *methodologically* much more effective to simply assume that there will be benefits, and to give due consideration and review to the possible problems or objections, whether one is proponent or not. Proponents of technology spend a lot of time in the public arena extolling its benefits and combating its critics. It is thus, perhaps, natural for them to see a philosopher who proposes to devote an entire book to the ethical problems with biotechnology as an ally of the critics, so it is reasonable and appropriate for said philosopher to begin the discussion by not only taking the likelihood of benefits as a methodological starting point, but also by making an explicit and detailed statement of the way that likely benefits provide a presumptive bias for favoring agricultural and food biotechnologies. This is, of course, what this chapter is all about.

An answer to the neo-Luddites, also notes that review of negatives is logically and conceptually more effective when done against the background of presumed benefits. Perhaps I should have expected that the first edition of *Food Biotechnology in Ethical Perspective* would attract a number of readers who find a presumption in favor of *any* technology troubling, and one apparently favoring a genetically based extension of the industrial food system especially so. Such readers have little sympathy with the very idea of a presumptive case for biotechnology and suspect that I have biased the argument right from the start. To them I repeat again that a book engaging the extensive philosophical and social criticism of technology that has taken place over the last 200 years would have a very different structure and approach than this one. My presumptive case for biotechnology is not intended to address or respond to that literature, and I must certainly admit that it does not do so. Nevertheless, while expressing some sympathy for the line of criticism that has produced sophisticated critiques of technology such as those by Albert Borgmann (1983, 1999) or Andrew Feenberg (1991, 1999), I must insist that the *methodological* reasons for developing an ethical review of any particular technological domain by taking the likely beneficial outcomes of developing that domain for granted are sound. As such, while skeptics of biotechnology will undoubtedly find fault with my analysis, it is, I submit, in subsequent chapters rather in than my commitment to a presumptive bias in favor of biotechnology that fault must ultimately be found.

Finally, it is a social fact that a strong presumptive case in favor of technology still exists within industrialized and industrializing economies. Late twentieth century culture is organized such that people expect change, and even if they do not expect it to be as uniformly beneficial as they once did, the traditional, static social structures, with their rigid social hierarchies and their lack of social mobility, are a thing of the distant past. This social fact may imply that most individuals in late twentieth-century society are inclined to favor technological change, but even if it does not, it shows that establishing a moral presumptive case *against* any broad form of technology will be very costly. It will be the life's work many dedicated people, and they will have to be very persuasive. Furthermore, it will compete with other large social issues such as opposition to racism and gender bias, as well as environmentalism and world peace. As such, the case *against* food biotechnology needs to be pretty compelling to justify a social movement to reverse the status quo. If the case against this new technology is, in other respects, a close call (and the list of potential benefits already cited is a reason to think that it is), the sheer costliness of campaigning against it tips the deck in its favor. Elsewhere I *have* argued that the campaign against agricultural biotechnology has been too costly for environmentalists and supporters of social justice (Thompson 2003a). The people who have dedicated themselves to opposing agricultural biotechnology would have better expended their time and energy elsewhere. This, however, is not the place to pursue that theme.

These reasons do not preclude the possibility of an objection to food biotechnology that is so sweeping and so compelling that we would reverse the presumptive judgment in its favor. All that is claimed here is that *until* such an objection is brought forward, a presumptive bias favoring food biotechnology is a philosophically reasonable platform from which to proceed. The balance of this book will consider a host of potential objections and qualifications, and by the last chapter the case for biotechnology will be much more qualified than at present. The case will still favor food biotechnology, but the favorable judgment will be conditional, dependent on key responsibilities being discharged by industry, by science and by government regulators. The final argument will be far from an unqualified pedal-to-the-metal green light for anything, anywhere, anyhow. Although the book has not been written for them, even those readers who have questions and qualms about food biotechnology are thus urged to hear out the argument.

One would expect that biotechnology's boosters will be pleased with this starting point, but the logic of the presumptive case for food biotechnology does have implications that are the frequent subject of complaint from that quarter. Both boosters and more neutral or objective scientists have been heard to complain that talk of "ethics" is too frequently critical of biotechnology and molecular biology. Why isn't there an ethical argument for biotechnology, they say? Well, they have a point, of course, and one purpose of this chapter is to acknowledge it. Yet one point bears repeating: if one presumes in favor of biotechnology, then most of work in conducting an ethical analysis will consist in entertaining the objections to that premise. This means that most of what one says in a book on the ethics of food biotechnology is a review of reasons to oppose, qualify or constrain the technology. Ironically, it is the strong presumptive case for biotechnology that has led ethicists to concentrate their first round of analysis on negatives, on reasons to resist and oppose. In many instances, the presumption for biotechnology survives attack unscathed. In a few cases, it must be modified or constrained. The best case for biotechnology is the one that takes the reasons against it most seriously. That is the thesis of this book.

MAKING THE CASE FOR BIOTECHNOLOGY BADLY

Unfortunately, many of the attempts to recite a case *for* biotechnology are unconvincing even to mildly critical ears. Sometimes the problem is simply a lack of sophistication or a poor choice of words. During the first half of the 1980s, scientists, venture capitalists and university fund-raisers became highly practiced at making the case for both food and medical biotechnology in economic terms. They convinced funding agencies, administrators, state governments and private investors to place large sums of money at their disposal on promises of impressive financial returns and great wealth for all (see Teitelman 1989). Some of the ethical fallout from those promises is discussed in Chapter 10/11, but what is significant here is that biotechnology's boosters became habituated to making their case in terms of economic gain. Biotechnology was good because it was going to make everyone (or everyone who got on board soon enough) very rich. Needless to say, this is not a compelling ethical argument for biotechnology. Although the importance of economic returns and benefits should not be underestimated in ethical assessments, too much of the "case for biotechnology" consisted only in economic boosterism and whining about the negativism of the critics.

Biotechnology's boosters have done even more serious damage to their own case by offering several singularly bad arguments. The balance of this chapter will take on four bad arguments that seem to have many proponents among the scientists and decision makers who will ultimately determine the fate of food biotechnology. The first of these appeals to an outdated and naive notion of technological progress, and will be called the Modernist Fallacy. The second fallacy assumes an inappropriate reference group for making comparisons about the relative risks of genetic engineering. It is a version of the Naturalistic Fallacy, the common moral mistake of claiming that because something is natural, it is therefore good. The third fallacy also addresses risks of genetic engineering and is an instance of the Argument from Ignorance. The final argument emphasizing world hunger is dealt with at substantially greater length.

The first three bad arguments are examples of fallacious reasoning that one hears repeatedly at scientific meetings, both from the podium and over coffee. Anyone who has been present at such meetings has heard them, and it serves no positive purpose to single out any particular individual for attribution. Casual conversation is not a propitious setting for the production of an informed and rigorous ethical argument; however it is quite likely that most of the people offering these arguments actually believe that what they are saying is establishing an important point about the ethics of food biotechnology. The following criticisms are offered in the spirit of improving the quality of debate, rather than embarrassing individuals who hold these views.

THE MODERNIST FALLACY

One easy way to dismiss any and all ethical concerns that might be raised about virtually anything is the reply "That's progress." Advocates of food biotechnology have not resisted the temptation to deploy this reasoning, if it can actually be called reasoning by any decent standard. The universal applicability of this strategy is a good reason for giving it a harder look. Other similarly universal replies to criticism ("That's politics," or "That's life.") signal one's reluctance to discuss the matter further without also conveying one's moral approval of the state of affairs. "That's progress," implies that whatever ethical concerns or consequences have just been brought forward, they are the price that must be paid for progressive social change.

Now, it may be correct to conclude that some social, animal, environmental or even human costs are a price that must be paid for ethically compelling reasons. If so, it is important to state those reasons and to justify the need to accept certain costs in order to achieve them. If a new rice or potato variety really does end hunger in a region of resource poor farmers, that result may indeed be worth some loss of local cultural institutions. If a new procedure for inspecting meat really does decrease the risk of food borne disease significantly, it may indeed justify changes in the configuration of meatpacking or inspection that costs some jobs. There may also be ways to mitigate some of these costs, so the matter does not end here. Nevertheless, there *are* circumstances where it is appropriate to rebut an ethical critique by pointing out the compelling reasons for accepting certain costs in exchange for progress on other fronts.

The Modernist Fallacy consists in presuming that science, technology, capitalism, or maybe just history is inherently progressive, so that any change brought about by these forces is always good. Alternatively, one may believe that any resistance to science, technology, etc., is a form of traditionalism or irrationalism that must be overcome. A strong, (often justified) faith in the power of science to alleviate harms, encourage democracy and promote social justice characterized the period in philosophy and economic history that is now known as Modernism. It had a good run, beginning with the philosophical writings of Francis Bacon and Rene Descartes, and becoming socially effective during the industrial revolution. During this period, the open and skeptical pattern of scientific inquiry was indeed both a force and a model for the democratization of hierarchical societies, and the technologies of the industrial revolution led to the expansion of European civilization across the expanse of the globe.

People will be debating whether Modernism was a good thing for some time to come. Certainly it was less good from the perspective of conquered peoples than it seemed to Europeans who wrote much of the history for the period, but perhaps it is too much to lay the blame for colonial oppression at the feet of science and technology. The point here is that surely no one can take such an attitude of unalloyed optimism toward science and technology today. If the scientific and technological achievements of the last five centuries are *on balance* good, they can still be made much better by attending to environmental consequences, human health consequences, and social consequences that are the unintended accompaniment of science-based technical change. While only a few intellectuals challenged the philosophical basis for modernism until recently, much of the twentieth century consisted in discovering the health and environmental consequences of the old smokestack industries and of chemical technologies. These discoveries were accompanied by social movements and intellectual developments that undercut the supreme self-confidence of European culture, the culture in which the scientific attitude was historically grounded (Harvey 1989; Beck 1992). While science and the scientific attitude are capable of thriving without the social and cultural background of European expansion and colonialism, it is not surprising that scientific and technological achievements of the past have been tarred by some of the less savory aspects of the social and intellectual milieu from which they emerged.

The modernist fallacy is particularly important because many critics of biotechnology make rejection of modernist philosophy an important component of their argument. Jeremy Rifkin includes a popularized diatribe against Bacon and Descartes in his books *Algeny* and *Declaration of a Heretic*, as does Andrew

Kimbrell in *The Human Body Shop.* More scholarly versions of the same argument can be found in books by Maria Mies (1993), Vandana Shiva (1993b) and Ruth McNally and Peter Wheale (1995). The argument has not gone away since the first edition of *Food Biotechnology in Ethical Perspective.* It is echoed in the more biologically oriented critique of Mae Wan Ho (2000). Finn Bowring (2003) has produced another book-length version of it that interprets developments in medical and agricultural biotechnology as part of a grand pattern in the history of science. To reply to such criticisms with "That's progress," is to beg the question, to commit the logical fallacy of assuming precisely the point that needs to be proven. The late twentieth century *may* have been a period of overreaction, and biotechnology may even be unfairly falling victim to an obsessive fear of science and technology. Yet even if one believes that, one should not blithely maintain the sort of faith in the progressive nature of science and technology that would permit one to simply dismiss concerns about unwanted consequences without giving them their due. The presumptive case for food biotechnology that is given above is about as far as one can go. A less critical faith in progress is indeed blind faith, and the sort of faith that has been the enemy of science in the past. How ironic that some scientists become the least scientific in their willingness to dismiss concerns and objections to biotechnology! The Modernist Fallacy is a truly bad argument, and one that should be expunged from even coffee table conversation.

THE NATURALISTIC FALLACY

Philosopher G.E. Moore described the Naturalistic Fallacy in his 1903 book *Principia Ethica.* It has since entered the philosophical lexicon as the logical mistake of concluding that something is good merely from the fact that it exists, that it is part of nature, of SOP or the status quo. The fallacy is likely to be committed by certain types of conservatives as well as by those who detest change. It is given a religious backing by those who believe that the world as it is embodies God's design, but scientists are capable of the Naturalistic Fallacy, too. The instances of the Naturalistic Fallacy that occur in debates over biotechnology are subtle and a defensible argument can be made for key claims if one cares to do it. They involve making comparisons between natural phenomena and the behavior of transgenic organisms. Such comparisons are not in themselves problematic, but if the point of the comparison is to argue that the behavior of transgenic organisms is unproblematic or in some sense "acceptable," because the behavior of non-transgenic (or natural) organisms is similar, then the natural phenomena are being invested with normative significance. Such arguments often involve claims about risk. Here are two arguments that exemplify the problem.

1. The kind of alterations that molecular biologists are making in plants and animals are just like those that occur as a result of natural mutation. They are, therefore, an acceptable risk.
2. Modern biotechnology is just like plant or animal breeding. Since the risks of plant and animal breeding have been acceptable, the risks of biotechnology are acceptable.

The first version seems to state that because risks of biotechnology are consistent with risks from natural mutation, they are ethically acceptable. The second version states that because they are consistent with historical risks of plant and animal breeding, they are acceptable.

The first argument is a clear instance of the Naturalistic Fallacy. Moore's discussion has given this logical mistake its name (though his analysis was both more subtle and more philosophically ambitious than the account given here), but John Stuart Mill called attention to this logical mistake some years before Moore. Mill's essay *Nature* noted that we can derive nothing of ethical significance by comparing intentional actions performed by human beings to acts of nature. "In sober truth," he wrote, "nearly all the things which men are hanged or imprisoned for doing to one another are nature's everyday performances" (1874, p. 20). The mere fact that humans must live with the risks of mutation tells us nothing about whether it is ethically acceptable for some to act in such a way as to intentionally bring about such risks. The second instance at least compares like and like. Plant and animal breeding are intentional actions. However, it is not clear that society at large has ever undertaken an informed debate on whether these risks are acceptable, either. Indeed, stories of mistakes in planned introductions—Chinese carp and killer bees— are a commonplace theme in literature that raises concern about the environmental risks of genetic engineering for plants and animals. More informed critics note that plant and animal breeding are often associated with increases in fertilizer or pesticide use, creating risk through an indirect mechanism. It is likely that any well-publicized change in food and agricultural technology like biotechnology would have brought on a new debate over risk. German theorist Ulrich Beck has argued that many social issues once debated in terms of class conflict are now debated as issues of risk (Beck 1992). Given the dramatic changes in technology and social organization that have occurred since World War II, simply assuming that historical trends on risk levels provide evidence for contemporary criteria of risk acceptability is unwarranted.

It is possible that what people who offer arguments like (1) and (2) above are trying to say is that the probability of harm from food biotechnology is quite low. This is not an ethical claim. It is an attempt to infer the probability of harm from food biotechnology by analogy to a distinct but relevantly similar sample population for which experience provides good (if not statistically quantified) information about the probability of harmful environmental or food safety consequences. There is nothing fallacious in this general pattern of inference, though inference by analogy can be tricky when examined case by case. Some of the philosophical problems that have arisen in plant scientists' attempts to use this pattern of inference are discussed in Thompson (2003b), though they have largely been omitted from the subsequent treatment of environmental issues in this book. If one is careful in stating the point, however, there can be no objection to using such analogies in estimating risks from transgenic crops. But low probability is not *in itself* enough to prove that a risk is acceptable. When consequences are sufficiently high, when risks are unnecessary, or when people are needlessly prevented from participating in a decision process, even very low probability risks can be socially unacceptable.

THE ARGUMENT FROM IGNORANCE

Philosopher Kristin Shrader-Frechette is well known for her studies of faulty arguments used in developing the case for nuclear power, for geological disposal of nuclear waste, and for radiation technology in general. She notes that a persistent and disturbing fallacy in that literature that “occurs when one assumes that because one does not know of a way for repository failure or radionuclide migration to occur, none will occur. Such inferences are examples of the appeal to ignorance,” (Shrader-Frechette 1993, p. 105). Technical disparities between radiation issues and biotechnology limit the lessons that one can learn from Shrader-Frechette’s work on nuclear waste, but virtually anyone with knowledge of the arguments that boosters of biotechnology have brought forward (especially in informal settings) will find the similarities disturbing. A significant component of booster confidence appears to be based on the appeal to ignorance applied to risks that might ensue from food biotechnology. Because they cannot imagine how bad things can happen, they infer that bad things cannot happen.

Another and more dishonorable version of the fallacy occurs when boosters of biotechnology report that there is “no evidence of harm (or risk)” associated with field experiments or farmer plantings of transgenic crops when in fact there is no evidence of any kind because no one has bothered to look. Some types of harm (such as rare allergic reactions) would be very difficult to detect, so the fact that none have been reported needs to be placed in proper context. Failing to do this is apt to be misleading. The fact that the argument from ignorance can be used to mislead links its use to the public’s lack of receptivity toward biotechnology. Here is how that link gets made: Replete with assurances about the safety of chemical technology and nuclear power, boosters of those technologies forged ahead. Many of their beliefs about the probability of an accident may have been well founded, but the public has become suspicious of such assurances in the wake of accidents at Bhopal at Chernobyl. While biotechnology may differ from chemical and nuclear technology in many ways, the conduct of the science community is, from an outsider’s perspective, distressingly similar. The appeal to ignorance has failed before; perhaps it will fail again.

As in the naturalistic fallacy, there are valid inferences that can be drawn from the fact that one cannot imagine how a harmful consequence could materialize. Risk assessment is a process that begins with a systematic attempt to imagine the scenarios and mechanisms that can end in harm. It is inevitable that the scenario no one thinks of will be omitted from the estimate of risk that such exercises produce. Nevertheless, when scientists work diligently to anticipate the full complement of risks, it is reasonable to conclude that unanticipated scenarios are either unlikely or at least not a proper basis on which to reject the technology as a matter of public policy. When researchers have diligently looked for evidence of environmental or health impact it is unreasonable to neglect that work in public decision making. It is not reasonable to think (and no judicious scientist would claim) that the unanticipated scenario does not exist, though this is what the appeal to ignorance effectively does claim. Complacency arises easily when appeals to ignorance go unchallenged, and complacency can result in the exercise of risk analysis being pursued less diligently than it should be. If biotechnology is to be pursued in an ethical manner, the appeal to ignorance must be expunged from both daily practice and the public defense of biotechnology.

THE ARGUMENT FROM HUNGER

While modernist, naturalist and ignorance fallacies circulate over coffee whenever scientists congregate, a more complex and insidious bad argument for biotechnology has become firmly entrenched in public discourse. This is the claim that agricultural biotechnology is the solution to world hunger, generally accompanied by the claim that those who oppose it are themselves ethically irresponsible in virtue of the misery from disease and starvation that their opposition is alleged to cause. Hopefully no one will take issue with the three fallacies discussed above, but many clearly do think that agricultural biotechnology holds such great hope for world's poor and dispossessed that opposing it is morally wrong. As such, it is important to devote a bit more attention to making the case for viewing the claim that biotechnology is needed to feed the world as a form of making the case for biotechnology badly.

Tracing the history of the argument from hunger would itself be a substantial task, even if one were to confine the topic to its use as an argument for biotechnology. There has always been some hope among agricultural scientists that rDNA techniques would be useful in developing new crop varieties for the developing world. This hope started to emerge as an explicitly developed argument for biotechnology as developed country Bt and herbicide tolerant crops began to encounter serious opposition in the 1990s. Advocates of biotechnology began to look for a "poster child": a biotechnology that was so appealing it could be used to silence the critics. One candidate was Charles Arntzen's plan to develop a banana capable of delivering vaccines as a means of fighting tropical disease. The one that eventually achieved public notoriety was Ingo Potrykus's "Golden Rice," the vitamin-A enhanced rice variety intended as a partial response to a widespread nutritional deficiency. Potrykus appeared on the cover of *Time Magazine* in July 2000 and the accompanying story touted his work as an important advance in the battle against the ills of poverty (Nash 2000). The story precipitated a continuing series of exchanges between boosters and knockers debating the value of Golden Rice for meeting nutritional needs. Michael Ruse and David Castle have collected articles representing both sides of this exchange in their book *Genetically Modified Foods: Debating Biotechnology* (2002).

The argument from hunger has been articulated in more general terms by several distinguished agricultural scientists. Per Pinstrup-Andersen, a Danish economist with long experience in international development, has directed this argument directly to a European audience that he holds accountable for the reluctance of developing countries to adopt products of agricultural biotechnology due to either concerns about their ability to export into European or markets or more straightforward fears based on Europeans' reluctance to accept GM crops.

(Pinstrup-Andersen and Schiøler 2000). Norman Borlaug, who won the Nobel Peace Prize for his work on green revolution crops, has stressed biotechnology's capacity to aid the poor and hungry people of the world in a number of fora, calling opponents of biotechnology "anti-science zealots" (Borlaug 2000, 2001, 2002). Pinstrup-Andersen and Borlaug both make a number of claims. One is that opponents of biotechnology are immoral in virtue of the harm that they are doing to needy people. This more extravagant claim builds upon the basic argument from hunger, which holds that ethical objections to biotechnology (such as those reviewed in the balance of this book) are mute/moot in virtue of biotechnology's capacity to address world hunger.

The argument from hunger surfaced again in the summer of 2002 when several African countries refused US food aid because it was not certified as "GM free." The story received substantial play in the US media, where it was generally portrayed as a case of moral insensitivity on the part of African and European leaders, allowing people to starve for fear that future export markets would be lost. While there is little doubt that African rejection of even milled cornmeal (maize) broached the level of paranoia, these stories failed to note that the US routinely takes pains to satisfy purely aesthetic preferences in the delivery of food aid (e.g. delivering white rather than yellow maize), and that since large maize producing regions in the US *do not* grow GM varieties, it would have been fairly easy for the Food for Peace program to have satisfied a preference for non-GM food aid, as well. If anyone was actually starving while all the dawdling was going on, US officials could be blamed for it as surely as African leaders. In May of 2003, the food aid episode became the centerpiece in a US trade action against the European Union's continuing reluctance to accept GM crops. The argument from hunger has been imbedded in cynical and strategic manipulations from the outset, and it is tempting to write it off entirely as a particularly odious form of deceit perpetrated to defame honest critics and dismiss legitimate concerns.

Nevertheless, the argument from hunger is complex because for the first time in the history of agricultural science, the developing world *is* broadly positioned to make substantial use of cutting edge techniques. Not surprisingly, the greatest capacity for using science to develop new agricultural technology resides in Western Europe, North America and a few industrially developed countries such as Japan, Australia and New Zealand. It has been this way since the dawn of agricultural science in the nineteenth century laboratories of Justus von Leibig (1803–1873) and Luther Burbank (1849–1926). The much-maligned Green Revolution was largely an attempt to adapt agricultural technologies from the sphere of European influence to growing conditions in Africa, Asia and Latin America. For a variety of reasons, scientists in these areas have a much greater capacity to use biotechnology in response to their own problems than has been the case for agricultural technologies that depend heavily on traditional chemical, mechanical and even breeding expertise, though they continue to work closely with developed country science through institutions such as the World Bank, the Rockefeller Foundation, and the Consultative Group on International Agricultural Research (CGIAR) which coordinates the activities of national and non-profit development agencies. As such, it is really true that agricultural biotechnology might well be deployed in response to some genuine problems faced by poor and hungry people in the developing world (see Rosegrant et al. 2001; Nuffield Council 1999, 2003).

The irony is that just as the developing world has achieved this capability, other forces have conspired to frustrate its exploitation. For one thing, critics of the Green Revolution, which did in fact achieve impressive gains in agricultural yields at the occasional expense of environmental costs and the displacement of poor farmers and landless labor, have been gaining steam for three decades. There is now organized opposition to new agricultural technology in the developing world. For another thing, opposition to agricultural biotechnology in the developed world, especially Europe, has created a climate of suspicion and doubt about this technology that is slowing its adoption in developing countries. This has particularly been the case in countries that export agricultural commodities to places that have imposed a ban on GM foods, and the food aid episode of 2002 is indeed evidence of this problem. While there is a strong case for using biotechnology in the developing world, events have transpired to create hurdles for deploying it, hurdles that did not exist 30 years ago when the capacity for indigenous scientific work was considerably less.

It is, however, a rather large leap in logic to move from this carefully stated claim to the claims that biotechnology holds the solution to hunger, or that opposition to biotechnology is morally irresponsible, much less the even stronger claim that opponents of biotechnology are committing acts tantamount to the murder of starving people. Yet all these immoderate claims are heard in defense of agricultural biotechnology. Biotechnology cannot be said to hold the solution to world hunger because as Amartya Sen demonstrated in the path breaking book *Poverty and Famines: An Essay on Entitlement and Deprivation* (1981), the misery and suffering of the poor is never due simply to a lack of food. While the techniques now in the hands of developing country scientists might increase yields and will almost certainly help developing country farmers reduce losses from disease and insect pests, solving hunger involves a reform of social institutions that deprive poor people of secure economic and political resources. Lacking these, there will still be hunger, even when there is plenty of food. In fact, some portion of the opposition to biotechnology comes from people who are arguing that social reforms must accompany technical change in developing countries. This claim is at the root of Vandana Shiva's argument against biotechnology (Shiva 2000) and is stated repeatedly in grass roots literature coming out of India. While it is certainly true that some opposition to biotechnology has little to do with a concern for social inequality, other forms of opposition are deeply committed to addressing issues of social inequality, especially by insisting that new technologies be accompanied by needed social reforms. To tar biotechnology's critics broadly as being unconcerned about the poor is either ignorant or cynical in the extreme.

The argument from hunger is also insidious because even those who reject it often do so with an equally fallacious and irresponsible reply: the problem is not a lack of food, but a matter of distribution. Like the argument from hunger itself, this comeback has a grain of truth. Sen's analysis supports the claim that hunger is a problem of distributive justice, but to say this is not to say that the problem would be solved by redistributing food, as if what we need are more boats and trucks. To think that hunger will be solved by exporting surplus production from industrialized countries to the developing world is just as naïve as thinking that a new potato or rice variety is the answer. Many critics of biotechnology underestimate the need to maintain and continuously improve humankind's capacity for biologicallybased responses to problems in agriculture. The productivity of industrial agriculture cannot be regarded as a permanent achievement. Not only does it involve levels of water and energy use and forms of pollution that are themselves creating problems, but diseases and pests are constantly evolving and will eventually become resistant to technologies that hold them in check. It may be unnecessary to state such obvious points in a text written for scientists and leaders in agriculture, but it is critical that the case for biotechnology be built upon this more subtle and valid foundation, rather than on a simplistic and ultimately misleading portrayal of its ability to feed the world.

The argument from hunger is a bad argument not because there is no truth in claiming that rDNA techniques will be an important part of the toolkit for agricultural scientists who work to improve food production in the developing world. Nor is it false to suggest that the current climate of opposition to biotechnology is slowing the progress of work that is currently underway. But agricultural scientists' desire to have things the way they were 30 years ago is probably not a defensible position. It might not be a bad thing to have technical change go a little more slowly and more deliberately in the developing world, especially if the slowness is because people in vulnerable positions have attained a modicum of power. Once one has witnessed starvation, the imperative for change becomes paramount and impatience starts to look like a virtue. Nevertheless, the main thrust of the argument to come in the balance of the book is that meeting the concerns and criticisms of opponents is among the ethical responsibilities that agricultural scientists and decision makers must accept. Telling people to buzz off because we are busy helping the poor simply will not do. While it is certainly possible to take a different view of how far scientists, government officials and industry leaders need to go in meeting the views of critics, it is something else again to promote a simplistic view of poverty and deprivation in order to bring about better public acceptance of biotechnologies that are being used in industrial agriculture today. The argument from hunger is a bad argument because it has been deployed shamelessly and cynically in a manner that promotes continued misunderstanding of the problems of global hunger and of agricultural science's role in addressing them.

CONCLUSION

The presumptive case for food biotechnology is strong. In part it issues out of the presumptive case that must be assumed for all technology at this point in history. Technology has always been with humanity, of course, but in the post industrial age it has taken on a systematic character reflected in the organizations—corporations, government agencies and universities—that have been built to develop it and in the agencies—regulatory bodies, legal systems and financial institutions—that create our social filters for picking and choosing which technologies ultimately succeed. The existence of these social filters creates an expectation (at least among those who work with and develop technology) that the applications of rDNA techniques in food and agriculture that run this gauntlet are more likely to be beneficial than harmful. All of which may simply be to say that at present, agricultural biotechnology is a social fact. The organizations that support and govern the food system have deployed people with expertise in gene technology throughout. Such people (the intended audience for this book) are poised to use biotechnology and any attempt to consider the ethics of biotechnology in agriculture and the food system must begin with this fact.

This is not to say that technology is always or automatically good, for one can maintain a presumptive bias in favor of technology only under the condition that scientists, government officials and the private sector make faithful attempts to evaluate technology, and to correct or mitigate its unwanted consequences. Technology must be monitored, but responding to the problems created by yesterday's technical fix will, as often as not, require more technology, not less. The larger aim of this book is to work through the conditions that have been proposed to limit the presumptive case for biotechnology, discarding some, endorsing others. This means that much of the discussion will be focused on criticisms and negatives. Yet the ethics of food and agricultural biotechnology is not simply a matter of limits and constraints, for the promise of biotechnology is real, substantial and should not be ignored.

CHAPTER 3

BIOTECHNOLOGY POLICY AND THE PROBLEM OF UNINTENDED CONSEQUENCES

Philosopher Hans Jonas published the German edition of *The Imperative of Responsibility: In Search of Ethics for the Technological Age*, in 1979. As noted in Chapter 1, Jonas called for an ethic of responsibility that would neither demonize nor sanctify science and technology, but that would use science and technology as aggressively as possible in a systematic inquiry into the unintended and unwanted impacts of technological change (Jonas 1984). The book seemed unexceptional in many respects at the time of its publication. In retrospect, Jonas's analysis was wiser than we knew. While a bald statement of the ethic of responsibility seems trivial, in calling for a view of science and technology that steers between the rocks of over enthusiasm and the shoals of Luddism, Jonas was challenging science and society to recognize the fallacy of modernism, and to find a new way to cope with technology's inevitable unwanted consequences. Jonas recognized that this would unavoidably involve new forms of interaction between science and government, and he devoted considerable space in *The Imperative of Responsibility* to a comparison between capitalism and socialism.

Jeffrey Burkhardt built upon Jonas's ethic of responsibility in his important article on the ethical significance of recombinant bovine somatotropin (rBST), one of the first and most widely debated products of food biotechnology. Burkhardt divided Jonas's ethic into five components. First, there are ethical questions that must be raised with respect to any individual's use of a tool or technique. Second, ethical principles should govern the decisions that groups (or society as a whole) make to adopt techniques. Third, there are ethical issues that must be raised about how the choice to adopt or reject a technology is framed. An advocate of technology who presents technical change (or "progress") as inevitable has not made a fair presentation of alternatives. The fourth area arises with respect to decisions to research and develop specific technologies, not just to adopt or reject them. Finally, the broadest dimension concerns "the technological ethos," or society's disposition toward science and technology expressed as a form of culture (Burkhardt 1992, 226–231). Technical changes raise ethical questions at each of these levels, yet it seems likely that naïve readers of Jonas were thinking primarily of Burkhardt's first or second level, at best.

The unintended consequences of technical change permeate culture, and eventually include even the religious questions raised in Chapter 10. Yet, as Burkhardt himself notes, it is the near term health, environmental and social impacts of biotechnology that are the immediate focus of debate and concern

(Burkhardt 1988, 53). The larger cultural issues are mainly issues of how we cope with these narrower concerns within our political institutions. Arguably, biotechnology has done a better job of coping than some technologies, but as Chapters 4 through 8 attest, these are complex issues. The difficulty of formulating an ethic of responsibility with respect to near term consequences of biotechnology raises the stakes for debates about property rights, religion and public trust, raised in Chapters 9 through 11. This chapter offers a synoptic treatment of the ethics of food biotechnology, confined to the case that Burkhardt discussed in 1992. While the debate over rBST may seem like ancient history to the agricultural and food scientists who are the intended audience for this book, there are four good reasons for taking the time to look more closely at this debate.

First, a tight and short focus on one case provides a roadmap for thinking ethically about other new applications of biotechnology. From this standpoint, one case is as good as any other, and although rBST differs in important respects from other biotech products that have been or will be developed and proposed for commercial use, this is a defect that is shared by every possible case study that might be proposed. Second, although rBST has disappeared from headlines, there is an important sense in which this case is far from "over." As the succeeding discussion shows, rBST was approved in the US in 1993, but more than a decade later few industrialized countries have followed suit. The issues thus remain potentially open, as regulatory and other bodies—the social filters alluded to in the preceding chapter—have handled this case in a very uneven fashion. The third reason may be more relevant to scholars of science, technology and society than to the scientists who make up the primary audience of this book, but the rBST controversy has some intrinsic value as an object of analysis for those who study science, risk and political power. In addition to Burkhardt's original paper and other studies discussed below, the rBST case has been the focus of a paper by Fred Buttel (2000) and an important book length study by Nicholas Guehlstorf (2004). A comparative discussion of Buttel's or Guehlstorf's theoretical approach and the more traditional framework applied below would take the present chapter too far afield. Yet it seems likely that future studies will find it useful to touch upon the rBST debate for some time to come.

Finally, the rBST case was intensely and vociferously debated in the United States. It was in some respects a key test case for US opposition to biotechnology. It is important for readers who may not have been paying attention between 1984 and 1994 to recognize that opposition to biotechnology was not invented by Europeans in 1998. Although on the one hand, the international controversy over rBST provides an excellent case study for evaluating public policy problems for agrifood biotechnology, on the other hand, rBST is an animal drug. The genetic engineering that made rBST possible was performed on a microbe, which in turn produces rBST for use on dairy cattle. Although regulatory issues for genetically engineered food and research animals certainly differ from issues associated with genetically engineered animal drugs, the *politics* of the rBST case nevertheless prove a useful object lesson in thinking through the unintended consequences of food biotechnology more generally.

BIOTECHNOLOGY POLICY AND PHILOSOPHY

Perhaps the seminal philosophical article on the ethics of recombinant DNA controversies was published in 1978 by Stephen Stich. Stich's article was written in the wake of the 1976 conference at Asilomar where leading scientists debated the risks inherent in genetic engineering. Stich reviewed "bad arguments" that surfaced in both scientific and lay debates. He defended an approach that took the ethical responsibilities of scientists seriously, but that interpreted those responsibilities largely in terms of anticipating and mitigating risks (Stich 1978). Writing specifically on genetic engineering of animals, Bernard Rollin echoed Stich's message a few years later stressing that the lesson to learn from Frankenstein metaphors was not that some things should never be done, but that scientists must avoid the fictional Dr. Frankenstein's, "failure to foresee the dangerous consequences of his actions or even to consider the possibility of such consequences and take steps and precautions to limit them" (Rollin 1986). Both Stich and Rollin were following in Hans Jonas's footsteps in issuing such a call.

Stich and Rollin devote considerable attention to the argument establishing scientists' responsibility to consider risks or unwanted outcomes very seriously before pursuing their research. Stich and Rollin classify these risks and unwanted outcomes into categories that reflect a demarcation first between fact and value, and then amongst different kinds of value. Their approach organizes a vague and contentious thicket of issues by analyzing how distinct burdens of proof might be applied to different components of the controversy. Both Stich and Rollin dismiss the possibility that genetic engineering could be intrinsically wrong. Movement of genetic materials is permissible, subject to consideration of the consequences. Moreover, the types of consequence that count are familiar: human health, animal welfare, environmental quality, and distributive justice. While genetic engineering allows humanity to do things that have never been done before, Stich and Rollin define the ethical issues raised by molecular biology as familiar problems of technological risk.

Although biotechnology has progressed to the point that the conservatism of these early papers by Stich and Rollin might be questioned, it is still crucial to examine the ethical issues associated with the risk of unwanted consequences. Significantly, Stich and Rollin do not agree on how to address the problem of unwanted consequences. Stich seems far more comfortable with *consequentialist* or optimizing solutions to the problem of technological risk. The classical characterization of the consequentialist approach dictates that potential outcomes be predicted and then assessed or subjected to a process of valuation. This value, whether positive or negative, is then discounted by the probability that the outcome will actually occur. In combining the value of outcomes with the probability that the outcomes will occur, the consequentialist approach treats ethical decision making as an exercise of weighing the *expected value* of outcomes. When costs and benefits of an activity have been thusly assessed, they may be summed. Each option available for choice can be analyzed similarly. A decision maker must choose the option that is expected to produce the optimal ratio of benefit to cost, or the greatest net expected value.

Stich is at most committed to the spirit rather than the letter of this approach, but he nonetheless seems comfortable with an assessment of biotechnology that compares its costs and benefits.

Rollin agrees that the ethics of animal biotechnology demand a prediction of its likely consequences. He differs from Stich in that for him there are at least some potential consequences that should not be subjected to an evaluation of cost and benefit trade-offs. Rollin notes a class of possible outcomes whose ethical significance is sufficient to determine the correct course of action irrespective other costs or benefits. His 1986 article is primarily concerned with impacts on animals. He describes the potential for creating dysfunctional animals, condemned to lives of physical pain or cognitive suffering. Rollin states that when such animals are inadvertently produced, scientists have an obligation to terminate the experiment, ending the animal's suffering. When there is knowledge that dysfunctional animals are likely to be produced, the experiment should not be done. However, Rollin goes on to describe the potential for using genetic engineering to change an animal's nature, so that, for example, pain cannot be sensed, or cognition does not occur. Such modifications are not only permissible in Rollin's view, but also might be obligatory for scientists who wish to develop transgenic models for certain types of disease. In none of these discussions does Rollin endorse a cost-benefit type of accounting or a calculation of offsetting costs or benefits that could override the judgment that these singular outcomes determine whether or under what conditions an experiment ought to proceed. Although biotechnology raises ethical issues in virtue of its unwanted consequences, Rollin shows that it is possible to bring non-consequentialist patterns of ethical reasoning to bear on the problem of unwanted consequences.

The international public controversy over the approval and adoption of rBST, the hormone that increases productivity of dairy cows, can serve as a model for analyzing ethical issues related to animal biotechnology. With but few additions, the categories of unintended consequence in the Stich/Rollin theory of scientists' ethical responsibility are well represented. The next section shows how a Stich/Rollin assessment might be applied to rBST. Following sections in the chapter elaborate each of the four areas of unwanted consequence. Two claims are argued in the balance of the chapter. First, although the philosophical dimensions of unwanted consequences are likely to remain controversial, the existence of a reasonably well functioning political forum for human health, animal welfare and environmental impact constitutes a political solution to these problems. Second, the lack of a political forum for debating social consequences is a serious political deficiency in biotechnology policy.

rBST: ASSESSING UNWANTED CONSEQUENCES

Somatotropin or growth hormone is produced naturally in mammals and regulates not only growth but also other functions, notably lactation. When somatotropins are administered under carefully managed conditions, milk production can be increased, and the lactation cycle can be extended. Bovine somatotropin can, therefore, be administered to cows under a herd management regime that results in significant increases in milk production. It is not economical, however, to use bovine somatotropin harvested from cows because of the high production cost of the hormone. Genetic modification of bacteria for production of somatotropins was one of the first successful applications of recombinant DNA technology, and genetically engineered organisms are now used routinely to produce human growth hormone for medical applications. Several animal drug companies including Monsanto, Eli Lilly and Upjohn succeeded in developing a recombinantly produced bovine somatotropin during the 1980s, and the Monsanto version, trade-named Posilac™, was approved for use in the United States in the Fall of 1993. The story in other countries with well-developed regulatory systems (and significant levels of dairy production) differs in that Canada has never approved rBST, and the substance has been banned in Europe (Brinckman 2000).

The social history of rBST in the United States deserves a more extended treatment than is warranted in the present context, and readers wishing to follow it more closely should consult Guehlstorf's (2004) book. Here it must suffice to say that a complex network of interested parties opposed the technology. Most specific objections to rBST can be classified into the categories of animal welfare, food safety and social consequences. These represent three of the four areas noted for our study, so a discussion of environmental quality is added to round out the issues. In the rBST case, food safety became deeply contested. Concerns about the integrity of the food industry, the regulatory process, and agricultural research organizations were expressed as uncertainties about the safety of rBST milk, but scientists and regulators were adamant about excluding these concerns from risk assessment. This difference of opinion, crucial to the ethical analysis of agrifood biotechnology in general, is represented below by introducing a distinction between safety and anxiety, a distinction that many social critics would contest. Although safety became the eventual focal point, social consequences associated with restructuring in the dairy industry precipitated the entire debate. Social impacts were the most politically contentious of the rBST debate. In this respect, controversy over rBST is a particularly apt model for considering food biotechnology.

FOOD SAFETY

Food safety is perhaps the most obvious area of potential impact from genetic engineering as it affects agrifood products. For purposes of this chapter, *food safety* will be defined as a function of the probability that consumption of a food will produce injury or debilitating disease, or that substitution of a food for reasonable alternative foods will adversely affect a person's health through nutritional deficiencies. Food safety policy represents a classic risk issue. Consequentialists treat risk in the manner described above: measure probabilities and expected values, then choose the course of action that optimizes the production of good over bad. An alternative view stresses rights. When dealing with risks to human beings, the rights approach emphasizes informed consent on the part of the person exposed to any risk, no matter how small or uncertain. The consequentialist position translates into public policy as a judgment that key decisions should be made by experts who can assemble and interpret information on risk. Informed consent requires mechanisms where individuals are exposed to food borne risk only under circumstances of their own choice.

At present, the consensus standard is that foods produced using biotechnology must be at least as safe as conventional foods, and procedures for assessment of food products from biotechnology in all industrialized nations virtually assures that far more will be known about the probability of injury or disease from recombinantly produced foods than from foods of more conventional origin. There is, as a result, the possibility that ethics might weigh in on the side of *less* attention to food safety in virtue of disproportionate expenditure of resources on the assessment and mitigation of quantitatively minimal risks (Johnson and Thompson 1992). Of all potential impacts from rBST, food safety has received the greatest technical specification. It is also the one on which there is the greatest unanimity: rBST does not pose a measurable probability of harm to human beings who consume milk from rBST treated cows (see Munro and Hall 1991). Anyone even remotely inclined to take a consequentialist position on food safety risk would deem rBST a non-issue.

Despite this circumstance, food safety emerged as one of the most prominent public points of controversy in the rBST case. Samuel Epstein, a biomedical researcher at the University of Illinois expressed early concerns about potential health impacts (1990), and a group of UK researchers documented increased incidence of insulin-like growth factor in the milk and mammary tissue of goats treated with growth hormone (Prosser et al. 1991). These concerns were rebutted in the scientific literature. A second 1990 article in *Science* gave special consideration to concerns relating to children and reported no human health consequences associated with consumption of rBST. The article reports that rBST is biologically indistinguishable from BST that occurs naturally in cow milk (Juskevich and Guyer 1990). Manfred Kroger reiterated these findings in a review of literature on human food safety in 1992.

Even critics of rBST found little technical basis for complaint with respect to consuming the product itself. In 1991, Michael Hansen of Consumers Union produced an essay on consumer concerns with rBST that was clearly hostile to the product, yet Hansen cites only public opinion research documenting non-scientists' concern about safety. He questioned whether rBST is healthy for the dairy cows on which it is used, but raised no human health concerns associated with human ingestion of rBST. Krimsky and Wrubel (1996) devote an eight page section of their book to food safety impacts of rBST. They report that "Unusually strong, although not universal, consensus among diverse members of the medical, veterinary, and nutritional community indicates that rBST use on cows does not pose a health risk to humans." (p. 173) Critics raise food safety questions about rBST by linking it with collateral production practices that may indeed pose risks, a theme discussed in Chapter 4. Hansen, for example, emphasized the possibility that mastitis associated with elevated levels of milk production might create human health hazards (Hansen 1991). These were sufficient to spark a significant amount of public resistance to rBST in the United States. The Pure Food Campaign under the leadership of Jeremy Rifkin organized chefs on both coasts to protest what they termed adulteration of milk by addition of rBST. However, with the exception of the few sources cited here, the vast majority of criticisms associated with food purity are addressed at factors that do not bear in any direct way on the probability of injury or other deleterious human health impacts. With respect to these broader factors, rBST has been questioned repeatedly.

Anecdotal evidence suggests that a significant number of people do not want milk from cows treated with rBST. There are several reasons why this might be the case. First, reasonable people may wish to dissociate themselves from foods produced using recombinant DNA technology on religious or aesthetic grounds. Nothing is more human than to adopt beliefs about the purity and authenticity of foods that would be difficult or impossible to support on scientific grounds. Is New York State Champagne an oxymoron? The French certainly think so. Avoiding impure or inauthentic foods may not be a safety issue in the narrow sense, but it can be extremely important to those who hold the relevant beliefs. Second, people routinely make consumer choices to express solidarity with other groups or political causes. This type of consideration overlaps with aesthetics to some extent, as the injunction to "Buy American" echoes the French desire for authentic champagne. In the rBST case, however, solidarity may have more to with loyalty to small dairy producers or animal welfare concerns. In either case, it may be important for some consumers to choose so-called non-BST milk.

Neither of these concerns relate to the probability of disease or injury that associated with drinking rBST milk. They could be described as elements of *food anxiety*, rather than safety in a narrow sense. Ironically, controversy itself creates anxiety. As questions are raised about the technology, people naturally wonder whom to believe. They may ultimately resolve this question by considering the costs of being fooled. If the critics of rBST are wrong, a consumer is losing several cents per gallon of milk purchased. Although this may add up to significant social costs, even a family purchasing a hundred or more gallons of milk every year may find the three or four dollars a year cost a reasonable price to pay for avoiding the anxiety of a new and unfamiliar form of milk. If the scientists are wrong, after all, the cost would be measured in ill health, especially to children who drink more milk than adults. Even if one thinks it far more likely that the scientists are right, it may be rational to forego the marginal consumer price benefit in exchange for the familiarity of ordinary milk.

In sum, given the Stich/Rollin framework, we must conclude that the food safety critics of rBST never produced reasons to ban the product. What they produced were reasons why individual milk consumers might want an alternative. The issue, thus, is one of consent. Those who want the price savings, or who are confident in the product's safety should have access to the product. Those who do not want it, for any reason, should have some mechanism for avoiding it. The mechanism is almost certainly a label that would allow those who want "ordinary," milk to get it, though the actual social history of attempts to label rBST played out in complex and unexpected ways (Buttel 2000). A more detailed analysis of the ethics of labeling follows in Chapter 4. Here it must suffice to say that the most philosophically promising mechanism for milk and for other foods using biotechnology is a negative label, one that certifies the absence of any use of recombinant DNA technology in producing the food. Although negative labels are far from perfect in assuring consent, they represent a reasonable compromise between enabling consent for those who care about biotechnology in their food, and not stigmatizing a safe, beneficial technology for those who do not (see Thompson 2002).

ANIMAL WELFARE

Although impact on animals may be a marginal category in some areas of science politics, it has always been prominent in discussions of animal biotechnology, and for obvious reasons. Rollin's 1986 and 1992 papers on animal biotechnology stress the possibility that genetic engineering may produce situations that contribute to animal suffering. Certainly this potential has been one of the most controversial topics with respect to rBST. Gary Comstock raised the issue of animal welfare impacts associated with rBST in a 1988 paper, noting stress associated with the administration and with the pharmacological effects of rBST. Concern over the linkage of rBST to enhanced milk production (and in turn to increased incidence of mastitis) has been the subject of considerable review and worry ever since (see the discussion in Chapter 5). However, the concern for animal welfare noted by Rollin and Comstock is unlikely to be defined as a compromise to animal health, given current approaches that are standard in the animal sciences. Rollin introduces the concept of *telos* to describe the genetically encoded set of physical and psychological needs that determine "the fundamental interests central to [animals'] existences, whose thwarting or infringement matters to them" (Rollin 1990[1985], p. 305). He suggests that any experimental or production practice which compromises an animals' *telos* is morally wrong, and specifically notes that a farmer's profitability (or a consumer's price reduction) does not provide a sufficient justification for practices that violate the package of rights an animal must be accorded in virtue of its *telos*.

For both Rollin and Comstock, these rights cash out in terms of practices that produce pain or suffering to individual animals, or that frustrate animals' ability to behave according to their genetic endowment or "nature". Current regulatory approaches to animal welfare vary dramatically around the globe. In the United States, *ex ante* assessment of animal technology is limited to animal health. It is carried out by the Food and Drug Administration (FDA) as a component of certifying the safety and efficacy of animal drugs. Anti-cruelty statutes provide an opportunity for animal advocates to bring charges on behalf of abused animals, and provide a basis for *ex post* regulation. In practice, however, anti-cruelty statutes are rarely successful in overturning an agricultural production practice, though they have been applied to generate reforms in transport of animals. It is nevertheless easy to see how the anticipation of impacts described by Rollin and Comstock fits under the general heading of responsibilities noted by Stich, once the pain and suffering of non-human animals is recognized as morally significant. Extensive physiological, behavioral and cognitive approaches to the assessment of impact on animals have progressed dramatically since the evaluation of rBST. There can now be no ethical excuse for failing to apply them in the study of animal welfare.

Assessment of transgenic animals, animals whose genomes have been altered through manipulation of recombinant DNA, will be more difficult, as discussed in Chapter 5. It may be impossible to anticipate the impact of a genetic modification on an animal's needs. Domestication and even conventional breeding rely on selection in a way that allows us to predict a rough fit between an animal's physiological, behavioral and psychological needs and the environment in which it will live and reproduce. It is less clear that the animals produced through recombinant techniques will have behaviors, interests and needs adapted to the environments in which they will live. Although this introduces uncertainty into our collective ability to anticipate impacts on animal welfare, it does not alter the conceptual basis of the scientists' responsibility to consider and assess such impacts.

ENVIRONMENTAL IMPACT

Agricultural technologies are routinely assessed with respect to environmental impact, though requirements to assess such impacts have arguably been less stringently applied to agriculture than to manufacturing and energy sectors of the economy (Thompson et al. 1994). While the technical requirements of environmental assessment are becoming relatively well defined, the ethical significance of environmental assessment is extremely complex. There are, for example, environmental impacts that impinge on human health, but assessments also model technology's impact on broader ecosystem processes. Impacts on these processes may be considered adverse only when they affect human life, but they may also be considered significant simply because they challenge the stability or equilibrium of an ecological zone. A growing literature in environmental ethics in agriculture provides the basis for minimizing such challenges (see Aiken 1984; Norton 1991).

The rBST case is a relatively poor model for illustrating ethical issues associated with environmental impacts of biotechnology. The consensus of opinion on rBST was to regard environmental impact as one of the least serious of consequences of potential impacts associated with the technology. This consensus appears to have been based on the assumption that rBST would reduce the number of dairy cows, and since fecal wastes are regarded as the most serious environmental contaminant associated with dairying, the reduced number of cows was projected to produce a corresponding reduction in the total volume of waste. As such, the environmental impact of rBST was judged to be positive (Executive Office of the President 1994).

Yet there were critics who opposed rBST on grounds of ecological sustainability. The social consequences of restructuring the dairy industry (discussed below) were projected to have secondary environmental impact because nutrients are cycled differently on traditional pasture-based dairies than in the intensive, concentrated dairies thought at the time to be most likely users of rBST (Lanyon and Beegle 1989). Perhaps the key document in this critique was a collection of papers published under the title *The Dairy Debate* in 1993. Articles on possible health issues and consumer concerns that might arise in connection with using milk produced using rBST (Feenstra 1993) were included alongside studies demonstrating that an aggressive program of rotational grazing could provide a meaningful alternative for dairymen (Liebhardt 1993). The line of argument put forward in that volume held that risks *to* the environment (understood in terms of unwanted environmental consequences) may provide an insufficiently developed picture of sustainability. Only when a technology such as rBST is considered in comparison with alternative approaches does a clear picture of the environmental dimension emerge.

For purposes of illustration, more direct or easily understood types of environmental risk are more readily seen as having ethical significance. For example, a recombinantly engineered rabies vaccine was tested in the wild in Belgium (Brochier et al. 1991). Critics of this action represented both sides of a classic divide in environmental ethics. Although the issue was characterized as "environmental," the greatest volume of criticism stressed the potential for risks to human health. These critics feared the introduction of a potential pathogen into the environment. The ethical concern was "human-centered," or anthropocentric. A quieter voice raised questions about the impact of releasing the virus on the wild populations themselves, and by implication, the ecosystem in general. (Anonymous 1991) The politics of the issue were not good for environmentalist complaints. It is difficult to argue that unconstrained spread of rabies should be permitted as part of natural ecosystem checks and balances. Nevertheless, the principle behind this concern reflects the type of eco-centric, holistic and non-anthropocentric thinking that characterizes the opponents of anthropocentrism in environmental ethics.

One can certainly imagine applications of biotechnology where the divide between human benefits and ecological interests would create significant difference of opinion. A different type of recombinant vaccine may provide the first example. Researchers in Nairobi may be close to developing a recombinant vaccine for sleeping sickness. This disease has long been the bane of cattle herders in Eastern and Central Africa. At the same time, however, the prevalence of the disease and its vector, the tsetse fly, has effectively protected large areas of habitat from human exploitation. The tsetse fly limits the limits the success of both poor subsistence herders and large commercial operators in much of Africa. Where these human uses are excluded, African wildlife may thrive. Given the enormous pressure on habitat in Africa, eco-centric environmentalists will certainly regard the environmental consequences of this new vaccine with apprehension. Given the food needs of resource poor African pastoralists, there will be compelling human-centered reasons to use it aggressively. Of course, environmental issues have proved to be particularly important elements of controversy over genetically engineered crops in light of the United Nations Convention on Biological Diversity signed at the 1992 Rio Earth Summit (Rossignol and Rossignol 1998). These issues are discussed in Chapter 7.

SOCIAL CONSEQUENCES

Social consequences are associated with all agricultural technologies. Some consequences, such as the elimination of hand labor jobs, may be intentional. Some technologies are too costly for poor producers, but can give large or wealthy farmers significant advantages over the poor. The economic structure of agriculture in both developed and developing countries means that aggressive early adopting farmers derive short-term benefits from production enhancing technology, but that the ultimate beneficiaries are food consumers. Although animal biotechnologies may be less susceptible to a farm size bias than are mechanical and chemical technologies, it is reasonable to think that many poor producers will be unable to compete with richer competitors as a direct result of biotechnology.

Robert Kalter's (1985) study of economic impacts from rBST predicted that relatively small-scale dairy producers might be disadvantaged when rBST became available. The basic idea is that the "size-distribution" of farms, that is the proportion small and large farms, is skewed to fewer and larger farms by technologies (such as rBST) that increase the productive efficiency of farming. This prediction is itself somewhat complex, and a substantial literature on it is summarized by Loren Tauer (1992), who has followed up with empirical analyses of the social consequences that rBST actually had (Tauer and Knoblauch 1996). For the purposes of this discussion, the economic issues that arise in predicting or measuring a technology's effect on the size-distribution of farms and the make-up of rural communities are less relevant than the general question of why alleged impacts on small vs. large farms might be thought ethically significant.

There are at least two strategies for approaching this issue. One begins with the assumption that those adversely affected by new technology are harmed in some way analogous to impacts described above. They may be deprived of income they would have received without the technology, and may also be harmed in more subtle psychological and social ways. These impacts must be weighed against benefits not only to other producers, but also to food consumers (Thompson et al. 1994, pp. 242–245). A second strategy begins with the observation that those who make decisions about whether to develop and market a technology occupy a position of power over the small farmers who will be affected. On this more populist view, what is ethically significant is the distribution of power, not the distribution of risks and benefits. The remedies associated with this way of framing the issue enhance affected parties' ability influence decisions that will have dramatic effect on their future livelihood and way of life. In this respect, it is crucial to note that in the United States no agency of government has the authority to monitor or regulate technology based upon social consequences. Lacking an outlet for their frustrations, groups seeking remediation of social consequences will politicize the regulatory process for environmental, animal welfare and human health consequences (Thompson 1992a).

RESOLVING ETHICAL DISPUTES THROUGH CONSENSUS POLITICS

In the best of circumstances, most of the problems described in the Stich/Rollin adaptation of Jonas's original model are amenable to political solutions. This is not to say that the philosophical problems are solved politically. Philosophers will continue to debate whether non-human species or ecosystems themselves are morally considerable. Furthermore, I am not suggesting that solution to a political problem results in dissolution of the competing political or moral interests that may have led to a problem in the first place. However, close attention to the standard regulatory politics of new technology reveals that these continuing philosophical and political differences can often be blunted, if not finessed altogether. The rabies controversy in Belgium provides illustrates the point. Here both human-oriented and nature-oriented critics of the vaccine tests were up in arms because procedures for anticipating environmental risk and for informing the public were ignored. Close adherence to fairly common procedures of environmental impact assessment and public notification would have likely mitigated the uproar. The ethical problem, thus, was less a problem of conflicting interpretations of environmental goals and responsibilities than it was a problem of failing to follow procedures that are philosophically non-controversial.

Returning to rBST, the problems of animal welfare and of food safety are similar. Animal rights activists clearly seek radical changes in society's practice, and these changes might well eliminate many practices in animal agriculture. On this point, animal activists might take a "rights" view that challenges the consequentialist perspective of those who think that a compromise to animal health, welfare or needs fulfillment can be offset by benefits to human beings. Many technologies are being introduced in animal agriculture all the time, however. Focusing on technologies derived from recombinant DNA techniques will not necessarily fix the animal activist's attention on the most problematic technologies. The case of recombinant rennin (or chymosin) illustrates this point. Rennin is an enzyme essential to cheese making. Traditionally it is harvested from rennet, the inner lining of the fourth stomach of calves and other young ruminants, which must be slaughtered to obtain it. A bacterium has been engineered that produces a purified version of the enzyme under industrial conditions. While not strictly an "animal biotechnology," recombinant chymosin met absolutely no resistance on either food safety or animal welfare grounds. In the latter case it is easy to see why. It is a technology that affects animal agriculture for the better from an animal welfare or animal rights perspective.

The Stich/Rollin approach suggests that evaluation of biotechnology's unwanted effects must be done on a product-by-product basis. If new biotechnologies do create dramatic risks to animal healthor welfare, the radical activists' concern will certainly be matched by that of philosophically far more conservative animal protectionists. While there is, indeed, a philosophical difference of opinion on animal use (and presumably a corresponding political difference), there is little reason to think that this difference will surface predominantly or even especially in considering specific products of animal biotechnology. There is likely to be consensus on the worst cases. Advocates of reform in human relationships with animals will have little to gain by raising concerns about relatively less significant products and technologies, simply because they happen to be associated with biotechnology.

The issue is only slightly more complex for food safety. As already discussed, negative labels represent a compromise solution that allows those who wish to avoid rDNA products to do so. Developed nations have mobilized the scientific community to assess substantive risks associated with food additives and with residues of chemical technology. While these mechanisms for risk assessment are not perfect, it seems far more likely that problems will be associated with the continuing use of chemical technology than with biotechnology. Many of the new applications of plant biotechnology, for example, will reduce the application of pesticides and fertilizers, if they perform as promised by their developers. As such, consumer advocates should be generally supportive of biotechnology, especially if the problems of consent can be resolved. Lacking positive evidence that there are food safety problems, it is silly to object to a technology that will reduce food borne risks solely on the ground that it involves biotechnology. The sheer novelty of recombinant DNA techniques and products presents reason for caution and for explicit assessment of risk, to be sure. As the experience base builds, however, the same principles that mandate caution over biotechnology may well shift toward favoring biotechnology over its chemical or mechanical alternatives. Whether this happens is not a philosophical question. Only time will tell.

There are, thus, political solutions to the unwanted health, animal welfare, and environmental impacts of animal biotechnology. To say that there is a political solution is not to say that philosophical problems are settled by a show of hands. Political solutions redirect philosophical disagreements away from regulatory decisions about animal biotechnology. In some cases they redirect those disputes to broader, more comprehensive debates over public policy. In some cases, the dispute is moved out of the political realm entirely. In purely philosophical terms, the dispute between human-oriented environmental concern and nature-oriented environmental concern may be more fundamental than the other two. The tension between habitat preservation and wise use of resources creates seemingly irresolvable rifts in land use policy. The lesson may be that it will be wise for developers of agrifood biotechnology to concentrate on products that are consistent with more environmentally benign forms of agriculture. Biotechnology may be useful in mitigating pollution from animal waste, for example. Technologies that would extend animal agriculture to new places, to new ecosystems, will be more problematic. The fact that scientists and technology planners can choose biotechnologies to avoid some of the most serious conflicts, not only in environment but in food safety and animal welfare as well is further reason to regard these areas as amenable to a political solution.

SOCIAL CONSEQUENCES REDUX

Good policies represent political solutions to philosophical problems when they appeal to the overlapping consensus that exists in most industrialized democracies. In an uncharacteristically pragmatic moment, John Rawls argued that political philosophy must seek to identify the common principles and policies that would be endorsed even by persons having very different life philosophies. (Rawls 1987) Rawls was hopeful that the main elements of a just society could be identified by emphasizing these areas of consensus, rather than the dissent that often underlies them at the level of fundamental beliefs. Food safety, animal welfare and environmental impact represent three areas of policy where Rawls' hopes seem to have some chance of being fulfilled. The unwanted, unintended social consequences of animal biotechnology are less amenable to a hopeful solution. Ironically, it is in the area of distributive justice that Rawls' appeal to the overlapping consensus seems least promising.

Social consequences must be analyzed at multiple levels (see Berlan 1991). New technologies routinely jeopardize some forms of employment, and ruin businesses that are wedded to obsolete technologies. The first level of analysis draws our attention to the individuals that are left without jobs and income during such transitions. Social welfare programs in most developed countries moderate the effect of these transitions, offering temporary benefits and retraining to affected parties. The second level of analysis takes up the loss of these jobs to the communities in which the relevant industries are located. Job loss in one sector translates into failed businesses, schools and hospitals across the board. Public policies for coping with community transition are unevenly distributed across developed countries. The United States arguably does a poorer job of moderating transitions at this level than do most countries. Nevertheless it is reasonable to claim that some policies and mechanisms exist for coping with the impoverishment and psychological harm that are associated with these aspects of technological change.

Another level of analysis is reached when we consider the impact of technological transitions on entire regions. With respect to transitions in mining and manufacturing, as well as agriculture, entire regions of the world have been effectively depopulated. When people leave the countryside in this way, it is not only individuals and community institutions that are lost. Entire ways of life, and networks of kinship and mutual affection are dissolved. There is really no way to compensate the losers for these transitions, for the basic values that define what is a profit and what is a loss have been stripped away from them. They will, to be sure, land someplace else, but mere survival aside, the systems of meaning that determine value will have to be reconstructed entirely. When they are, new values, new friendships, new senses of possibility will be in place, but to compare the new with old is no more meaningful than comparing the life of contemporary suburbanite with that of seventeenth century aristocrat. Who is better off? Is it clear that one would trade places with the other? The texture of these lives is so different that such questions are ridiculous.

It is thus reasonable to say that when technological transitions have such systematic effects, a loss occurs that cannot be compensated. Whether such losses should be permitted, or whether they should be resisted is complex. Clearly the dispute over the social consequences of rBST centers on just such a question. The dairy farmers who have opposed this technology are acutely aware that a delicate balance of subsidy and productivity keeps them in business. If productivity increases, there will be more milk at a lower price. Small-scale producers cannot recoup losses from a reduced margin of profit by increasing volume. Furthermore, increases in volume will put political pressure on policies that keep prices at current levels—a circumstance especially crucial for dairymen in Europe and Canada. The classic dairy, with 50–100 or 200 cows, is at risk. What will go with it are the businesses, schools and hospitals of a hundred counties, but what is worse is that a form of life that is thought particularly characteristic of agriculture will disappear from the landscape. It will be replaced by industrial plants servicing 2,000, 4,000, even 10,000 cows in a single location, trucking the feed in and the milk and manure out (Lanyon 1994).

Canada and Europe have been more willing to take social consequences seriously than has the United States, but it is at least arguable that the US exercises hegemonic influence over world policy on the matter of social consequences. Trade agreements and the sheer pressure of international competition make governments reluctant to place their own producers into an economically disadvantageous position relative to US producers. The lack (or weakness) of regulatory procedures for social consequences represents a form of international assurance problem. If every government would regulate on the basis of social impact, the rules of international competition would be fair. However, as long as one government does not, any government wishing to regulate technology on the basis of social impact risks losing its ability to compete in the relevant sector altogether. When the one actor is as large and dominant as the United States, the absence of political solutions to the social consequence issue is a foregone conclusion.

CONCLUSION

There are, therefore, four ethical problems associated with rBST, but only three political solutions. The significance of this fact is both political and philosophical. Politically, the lack of a policy framework for even raising, much less resolving, problems associated with social consequence introduces a high degree of uncertainty into the politics of food biotechnology. Again, the rBST case illustrates this point. Why did rBST become an issue at the Food and Drug Administration (FDA) where questions of human and animal health were to be assessed? Why, especially when there was such unanimity among the science community that food safety risks were minimal, does it continue to raise public concern? Some of the answers have been discussed above, but the political contentiousness of rBST at FDA must have arisen partly because those interested in social consequences had nowhere else to go. The absence of a forum for debate and regulation of social consequences in either administrative or judicial branches of government leaves no alternative but the translation of these issues into trumped up and ultimately false concerns about human and animal health, or environmental consequences.

The political implications of the missing forum for social consequences are particularly significant for those interested in the animal welfare implications of biotechnology. On the one hand, those who oppose all forms of animal biotechnology (on animal rights or species integrity grounds, for example) will typically find willing allies among those who are concerned about agricultural technology's impact on small or resource poor farmers, and on rural communities. Working together, these groups can slow the approval process for biotechnology products, and might even succeed in making regulatory approval for animal biotechnology so expensive that the entire industry becomes economically unattractive. On the other hand, if more radical animal activists are busy fighting the battle against *all* forms of animal biotechnology, it will more difficult to act on the available consensus to regulate animal biotechnology on welfare grounds. As argued above, it should be possible for researchers and industry to agree with animal protectionists on many parameters for animal genetic engineering and for the approval of animal drugs. Policy based on this consensus is, I would argue, the course of action that is truly in the interests of non-human animals. Yet acting on *any* political consensus becomes difficult when social interests intervene.

The philosophical implication is that our notions of distributive justice need to be more carefully integrated with research ethics. Is it reasonable for scientists to think that if the responsibilities described by Stich and Rollin are addressed systematically, they have discharged their responsibilities as researchers? The Stich/Rollin approach leaves many philosophical questions unanswered, but it implies that if scientists are honest and diligent in conforming to the requirements of the regulatory process, they have done everything that we may reasonably require of them. Conformity with the regulatory process means that scientists are acting within the framework of an overlapping consensus on how human health, animal and environmental impact should be addressed. That consensus will change, of course, as well it should when subjected to ethical scrutiny, but the political apparatus for each of the three covered areas provides a procedure for dealing with unwanted consequences in a way that shares the burdens with the scientific conscience.

But scientists cannot be as sanguine about social consequences as this view of research ethics suggests. As noted in Chapter 2, the pattern has been to see technological change as inevitable, and to see the problem as one of distributing its benefits and costs. It was this image of technological change that led Jonas to write *The Imperative of Responsibility.* Technology is not an act of God, like a hurricane or an earthquake. It is something for which human beings and human organizations can be held responsible. The model proposed by Stich and Rollin recognizes the importance of agency in producing technology, and implies that social consequences are as deserving of our attention as are risks to human health, animal welfare and environmental quality. The implication, however, is not followed out in public policy. Though molecular biologists, aided by the evolution of public policy, are in a good position to discharge some of the responsibilities noted by Stich and Rollin, the matter of social consequence is not included in this list.

Perhaps it is not mainly scientists' fault that there is a crisis of trust in science, for even if scientists were more inclined to adopt an ethic of responsibility than they appear to be, political structure would constrain them. Nevertheless, change in this political structure is a battle that must be fought by everyone, not the least those who are in a position of privileged knowledge about the likely technological future of humanity. With that in mind, it is time to revisit each area of unwanted or unintended consequence with greater attention to the ethical dimensions of contested issues, and a broader look at food biotechnology's potential consequences.

CHAPTER 4

FOOD SAFETY AND THE ETHICS OF CONSENT

Foods developed through biotechnology must be safe. No one disputes this, though it is certainly possible to disagree about what safety means and about whether the use of biotechnology introduces unacceptable risk. While in many areas there are extended technical and political disputes about the appropriate level of acceptable risk, the standard in food safety is *de minimus*, or the lowest feasible level of risk. Food safety is disputed on scientific grounds when the mechanisms of food borne illness are not understood or when there are disagreements about the probability of harm. Food safety raises philosophical issues because society must choose between public policies that minimize the probability of food borne illness and those which protect individual consent.

This chapter approaches the questions surrounding the safety of eating products of agrifood biotechnology by sandwiching a fairly straightforward discussion of the scientific consensus on food safety risks from genetically engineered foods in between two more philosophically oriented sets of ideas. The first and more concise of these philosophical ruminations sets up the entire chapter by making the case for seeing food safety as an ethical responsibility in the first place. This means showing that food safety involves something more than simply following advice about what is good for you, that it involves interpersonal and social duties that people owe to one another. The second discussion makes up almost half the chapter, beginning with a general *philosophy* of food safety that was, as far as I know, the first of its kind when it was originally published in 1997. The more straightforward discussion on whether agrifood biotechnology is actually dangerous to eat and of the ethical issues arising in connection with non-controversial industry and government responsibilities to ensure that it is safe comes in between. This section of the chapter largely takes a scientific consensus that agrifood biotechnology is as safe as any existing food technology for granted. In doing so the analysis neglects an opportunity to take up some interesting and important philosophical issues associated with food safety risk assessment. My impatience to get along with what I take to be the really interesting and ethically important issues leads me to devote less attention to topics that naturally fall into the middle of the sandwich, what many would take to be the “meat” of food safety. Many of food biotechnology’s skeptics will be impatient with my impatience. Nevertheless, the main argument from the last half of the chapter holds that even if a private citizen or rump scientist rejects that consensus, the most important legal and political basis for challenging dominant approaches to food safety does not demand a challenge that consensus on scientific grounds. No one should be placed in the position of having to produce a scientific risk assessment in order to justify eating a diet based on whatever conception of food safety, purity or wholesomeness they wish to adopt.

FOOD SAFETY: A PRUDENTIAL OR ETHICAL RESPONSIBILITY?

Prior to the industrialization of the food system, food safety would have been thought to be a purely prudential norm. Norms of prudence stipulate what any reasonable and competent person should do in order to accomplish a given goal; they are norms of self-interest and self-preservation. Farmers and food preparers who fail to undertake the precautions necessary to ensure the safety of their own food would be thought foolish rather than immoral. When others rely on their precautions, failing to perform them without advising or seeking permission from the affected parties is likely to be seen as a moral infraction. There have thus always been some fiduciary responsibilities associated with the food system, but the extent and scope of these duties has expanded as the system of producing, harvest, processing, distributing and serving food has become socially and technologically complex. Thus what was once largely a prudential domain has increasingly become an ethical one.

Many of the ethical issues associated with contemporary food and agriculture have this character. Today's food system depends on an implicit social ethic that makes the exercise of prudential duties on behalf of others a moral duty. It was not always this way. The norm of *caveat emptor* makes the buyer of a good fully responsible for all risks associated with the use or ownership of the good. When *caveat emptor* prevails in the food system, the person who accepts food through purchase or as fulfillment of an entitlement agrees to hold the seller blameless. It then becomes a prudential norm for buyers to exercise due caution in accepting food, whether as a raw commodity or as a prepared meal. When the implied social ethic is for buyers to beware, the entire series of activities involved in producing, processing and preparing food fall into the sphere of prudence, and moral questions do not arise at all.

The food system of past centuries placed many individuals in direct control of the production and preparation of their food. Those who purchased raw goods or prepared food could recognize many signs of poor quality. The kinds of interdependence that existed in the past emphasized personal relationships among individuals who were well known to one another. This kind of food system produces a "moral economy" in which duties to handle food properly become intertwined with complex expectations and non-market entitlements. Peasants in pre-industrial English villages, for example, felt that the grain growing in farmers' fields was community property. When wagons and better roads made it possible to transport a harvest in search of better prices, riots occurred in protest (E.P. Thompson 1991). Producer and processor responsibilities for food safety mean something quite specific in a food system where selling meat or grain known to be unsafe would tarnish an individual's reputation permanently in the community. The interactions between neighbors who will interact with one another over the course of multiple generations creates a setting where these responsibilities become matters of shared self-interest and community self-preservation. It is not at all unreasonable to think of them as prudential rather than ethical norms.

Today, food consumers cannot reasonably be expected to make the assessment of risks needed to make fully informed choices. For at least a century the food industry has expanded by winning consumers' trust, and when this effort has been found wanting, consumers have called upon government agencies to intervene. Through their collective efforts to win the confidence of food consumers, food producers and the food industry have accepted responsibility to exercise duties of prudence on behalf of others (Burkhardt 1994). Some (but not all) of these moral duties have legal force, and government agencies enforce laws and regulations to ensure food safety. The tension between prudence and morality, like the tension between safety and consent, might not arise in a food system where producers, preparers and consumers of food are all in the same household, and where the exceptions to this pattern accept a social ethic of buyer beware. But that is not the food system that exists in developed countries, and philosophical tensions do indeed arise.

Although these observations have an obvious quality, there has been surprisingly little work done on the ethics of food safety. Philosophers, in particular, have neglected this topic almost entirely, though a few papers have appeared since the first edition of this book. The Dutch philosopher Michel Korthals has, in particular, taken up this theme in a series of papers that frame some of the issues discussed in this chapter in terms of the difference between citizen and consumer perspectives, on the one hand, and technical vs. common sense attitudes, on the other (Korthals 2001, 2004). Jeffrey Burkhardt (2001) continues to address the topic with the larger context of probing the way that the scientific attitude (discussed in Chapter 3) influences the direction of biotechnology. Karsten Klint Jensen and Peter Sandøe (2002) have explored attitudes toward food safety within the framework of rational attitudes toward risk. For their part, food scientists have tended to treat food safety as a largely technical issue lacking any particular ethical dimension. This view may have been consistent with a perspective which sees food safety purely as a prudential norm, yet the obvious change in social circumstances noted above has clearly created fiduciary responsibilities, elements of trust and frameworks of ethical responsibility that simply did not exist in the past. As Ralph Early has argued (2002), it is clearly time for industry to consider ethics within its decision making frameworks. Nevertheless, the relatively more technical orientation to food safety may be an appropriate place to continue the discussion of biotechnology.

SAFETY CRITERIA FOR FOOD BIOTECHNOLOGY

Most scientifically trained professionals working in food safety understand safety in terms of relative risk, and they understand risk as a function of the probability of harmful events. There is a tendency for them to think of food safety in purely technical terms, but the specification of the risk function requires a series of subtle pragmatic judgments. Do we assume a given dose (amount of consumption) and calculate the probability of injury? And if so for whom—adult males, females, children, the wealthy, the nutritionally weak? Or should we specify risk as a dose response curve? These approaches suggest that risks can be calculated as simple conditional probabilities, but perhaps they should be modeled as increases in mortality or morbidity relative to the total population, or perhaps it would be more meaningful as a comparative ranking of available dietary options? The precise specification of the risk function can make a great deal of difference to the evaluation of risk acceptability. For example, disputes over the shape of the dose-response curve have been very important in the debate over the risks associated with pesticide residues in food (Cranor 2003). But all of the approaches discussed above share the assumption that the facts about food safety are facts about the probability of illness or injury as a result of ingesting a food or food constituent, whether an additive, a residue or a natural chemical component of food.

Given this starting point, the pivotal question is whether there are any facts about the safety of biotechnology in the production, processing or preservation of a food that are cause for special notice, concern or alarm. Advocates of biotechnology have argued persistently that the new techniques for modifying and domesticating plants and animals are not fundamentally different from traditional food technologies (see Brill 1985; Miller and Conko 2001). This claim about the fundamental similarity of transgenic and traditional technologies has been revisited many times in the past quarter century, and will resurface at a number of points in this book. It is thus important to take some pains to clarify what is and is not being claimed. With respect to food safety risk, the claim can have several interpretations, but the key issue is whether regulatory approaches developed for previous types of agricultural and food technology are adequate for protecting the public against food safety risks associated with transgenic plants and animals. When boosters of biotechnology claim that biotechnology is not fundamentally different from traditional technology, they are claiming that there is no need for markedly different regulatory approaches.

Ordinary plant and animal breeding are capable of introducing novel food safety risks and the risks of chemicals and additives can be considerable. Indeed, debates over food safety risks of chemicals added to foods are among the issues that originally gave rise to food safety laws. Anticipating and avoiding food safety problems has been (and should be) part and parcel of developing any new food or agricultural technology. Approvals for new chemical or pharmaceutical technologies are quite rigorous and it is this system of approvals that is being applied to the evaluation of food safety for biotechnology. Two points must be made in tandem. First, it is quite possible for biotechnologists to create foods and food technologies that pose hazards to food consumers. This is not a fail-safe technology. Second, diligent efforts are made to protect food consumers from potentially hazardous technology. The "pro-biotechnology" position on food safety is that *products* of food and agricultural biotechnology can pose risks, and as such should be subjected to the same approval process as would be applied to other substances entering the food supply for the first time. However, boosters have argued that the *process* of transformation through genetic engineering and the other tools of biotechnology does *not* signal any basis for thinking that the probability of human illness or injury will be higher than for conventional forms of plant and animal breeding.

The "anti-biotechnology" position on food safety is in fact not a single position at all. Long before any genetically engineered foods had actually appeared on grocery shelves, citizen-scientist activists have argued that there are major gaps in the regulatory systems for food safety. In some cases, the alleged gaps reflect a lack of clarity about which regulatory office will be responsible for approving a product of biotechnology, or what methods and data they will utilize in making their assessment. While these may be substantively important criticisms from a regulatory standpoint, it is questionable as to whether they should be regarded as philosophically substantive objections to the "pro-biotechnology" view that the regulatory system is adequate for addressing transgenic crops and animals. To some extent, every new product represents a different case, and there is always a need for regulators to work out the specific approach that will be taken. Totally new types of scientific expertise may need to be brought into the regulatory process. What is more, the standard give and take between the advocates of technology, citizen-scientist opponents and the government agencies can be regarded as part and parcel of the regulatory process, especially in the United States where many of these debates have taken place. Adjustments to regulatory methods that can be made within the existing administrative and legal structure of regulation should not be thought of as philosophically significant evidence against the boosters' view.

ETHICAL GAPS IN THE REGULATORY SYSTEM

More substantive objections from the knockers' camp relate to the uncertainties associated with any attempt to assess food safety risk from biotechnology, or involve the claim that there is something about biotechnology that makes it very different from traditional food and agricultural technologies when it comes to the overall approach to food safety. As noted in the previous chapter, the Stich/Rollin model for evaluating ethical issues associated with rDNA technology finds no basis for objecting to genetic engineering in principle, but both Stich and Rollin find the scientific community generally insensitive to risks and unintended consequences. The insensitivity can be narrow or broad. Narrowly, scientists, regulators and advocates of biotechnology can overlook or underestimate the significance of factors that bear on the probability of disease or illness. A broader type of insensitivity is associated with the general philosophical framework for conceptualizing issues in food safety, one that can be inconsiderate with respect to reasonable concerns voiced by the general public, as well as the demand for informed consent. These broad issues make up the main thrust in the second half of this chapter, but three issues of clear significance do not seem to be covered by existing regulatory systems: the problem of "bad actors," the collateral effects of biotechnology and the problem of social uncertainty.

Bad Actors

The film *I Love Trouble* (June 1994, Touchstone Pictures) featured a fictional genetically engineered hormone that an unscrupulous company was trying to bring to market despite some unfavorable research trials. During the course of the film, company thugs manufacture data and misrepresent the findings of studies designed to demonstrate the fictional product's safety, along with displaying a willingness to engage in more pedestrian crimes and even murder, all in the name of corporate greed. This kind of behavior violates the most obvious norms of ethics, and no one needs a philosophy book to tell them why. Do such unscrupulous companies—bad actors—increase the risk of consuming foods produced using biotechnology? Most assuredly they do. Government and the responsible parties within the food industry must police such behavior. Are films like *I Love Trouble* remotely realistic? There have been instances where rogue scientists have violated both the letter and spirit of institutional policies (but not laws) in pursuing biotechnological research, and rumors of repressed rBST data have circulated among critics for years. No credible evidence of unethical activity that could have exposed human food consumers to risk ever became public, however. Genetic engineering continues to figure as a plot device in science fiction, but in the decade since *I Love Trouble,* no film has done to biotechnology what *The China Syndrome* and *Silkwood* did to nuclear power.

More disturbing cases of bad actors have occurred, however. One concerned a Japanese company that introduced a new method of manufacturing the dietary supplement tryptophan using genetically engineered microorganisms. This incident figures prominently in Gary Comstock's book *Vexing Nature?* (2000). Several deaths occurred in connection with impurities in the product, and opponents of genetic engineering continue to cite it as an example of the dangers of biotechnology. It is more likely that other manufacturing irregularities caused the problem, and the tryptophan incident was a case of an industrial bad actor. In the end, Comstock concludes that that the tryptophan episode provides an object lesson in the need for regulatory oversight, but does not provide a compelling ethics argument against any and all applications of biotechnology to food.

Another incident occurred in connection with field tests for a new pharmacologically active type of maize (corn) plant conducted by the Prodigene Company in 2002. The company did not take adequate steps to ensure that this grain, never intended for use as human food, was kept out of the food supply, and was heavily fined for its failure by the US Department of Agriculture (USDA) (Thayer 2002). More generally the Biotechnology Regulatory Services at the Animal and Plant Health Inspection Service (APHIS) at USDA conducted a review of compliance with its procedures, finding that 2% of authorized field tests involved potential compliance infractions.

> Between 1990 and 2001, after a thorough investigation of each potential compliance infraction, APHIS found that 76 percent of all potential compliance infractions were actual compliance infractions, and of those, 12 percent were referred to APHIS' Investigative and Enforcement Services (IES) unit and were deemed violations. (APHIS 2006)

The potential for unethical conduct exists everywhere in human life, and biotechnology is no exception. Bad actors exist, but what significance should one make of this fact?

One does not need to read a philosophy book to see what is wrong with bad actors who wear their lack of ethics on their sleeve. The subject of bad actors bears mention and further discussion for three reasons. First, although catching crooks is the responsibility of the police, creating a working environment in which unethical behavior is not acceptable is the responsibility of everyone. If the ethical issues that are the primary topic of this book are taken seriously, the climate will be less hospitable for gross violations of ethical conduct. Second, some scientists may think that some of the conduct, which is so obviously unethical in the incidents cited or the film *I Love Trouble* would be acceptable (or at least forgivable) if the products pose no threat to human health (as we may presume the APHIS environmental compliance violations between 1990 and 2001 did not). They are unlikely to try and justify this kind of conduct, but they might well argue that such incidents should not be brought up in a discussion of the food safety risks from crop biotechnologies (such as herbicide tolerant and Bt crops), that do not pose threats to human health. One could say that lying or using intimidation to bring a safe product to market has no affect on biochemical properties that are the basis for objective assessments of risk to health, and it may just be part of the business environment for big agricultural input companies. But this form of reasoning takes an indefensibly narrow approach to the problem of risk. We quite rationally bring evidence concerning the conduct of people we must trust to bear on our assessment of the risk we take in trusting them. Rogue scientists, repressed data and non-compliance with environmental regulations are a serious matter, even when they do not cause a threat to health.

Third, bad actors are more likely to affect food safety in countries where poverty, illiteracy and a weak or corrupt regulatory system create opportunities for abuse. Other agricultural technologies have been abused in this way. A US Senate review of agricultural chemical use in developing countries has documented frequent instances of hazardous and improper use, causing harm to workers and food consumers alike (US Senate 1991). As yet, no comparable document details abuses from products of biotechnology, though the activist critic Vandana Shiva makes allegations of unethical conduct on the part of employees from biotechnology companies (as well as the United States Government) in India (Shiva 2003, 2005). These alleged activities range from theft of intellectual property to extortion and bullying. Although these allegations, if true, are obvious cases of ethical impropriety, there is an ethical dilemma for biotechnology companies, for public sector biotechnology researchers and for the governments of the industrialized world alike. On the one hand, there seems to be a responsibility to ensure that products and research discoveries made in industrialized countries do not cause harm to innocent workers and food consumers in the non-industrialized world. On the other hand, it is clear that any effort to restrict, regulate or control the use and development of technology in another country becomes paternalistic and indefensible at some point.

This dilemma notwithstanding, it is past time for the potential for bad actors to receive more attention in the literature and debate over biotechnology than it has. There has been virtually no attention to the potential risks from deliberate abuse of food biotechnology in either the industrialized or developing world. Although it might be unlikely that anyone has suffered harm from such abuse so far, there are products on the market that could easily be abused, and this possibility will increase as non-food forms of transgenic crop come on the market. An existing product, transgenic maize producing aviden for industrial purposes provides a case in point. Aviden, a useful biological agent, is toxic to a broad spectrum of animals, including arthropods, birds and mammals (though as a natural ingredient in chicken eggs, not exceedingly so). The maize plants that have been transformed for commercial production of aviden have been shown to exhibit levels of aviden sufficient to make it an effective post harvest pesticide, though it is doubtful that it could receive regulatory approval for this use. There is thus every incentive for bad actors to plant aviden-producing transgenic maize (if they could get access to it), and to distribute this production into the food supply (NRC 2002a, pp. 180–181). There is no reason to think this has or will happen, but the possibility for this kind of risk illustrates why continued inattention to the potential for unethical conduct on the part of biotechnology companies, their employees, farm supply dealers and also farmers themselves is inexcusable.

Collateral Consequences

The most troublesome food safety issues associated with rBST did not involve human ingestion of rBST itself, but rBST's potential for impact on other aspects of milk production. Sheldon Krimsky and Roger Wrubel summarize the debate over alleged links between use of rBST and mastitis, a disease of the udder that is normally treatable with antibiotics. Mastitis is clearly an animal health problem and could cause a food safety problem if antibiotic residue is allowed to contaminate milk. Wherever milk production is industrialized, however, antibiotics are carefully regulated. Krimsky and Wrubel also cite Hansen's claim that use of rBST might increase the risk of bovine spongiform encephalopathy (BSE) as a result of the need to feed treated cows with a more energy intensive ration (Krimsky and Wrubel 1996, pp. 176–179), but as for antibiotic residues, procedures that protect the public from exposure to BSE exist independently of the rBST issue. While mastitis and BSE are serious problems in their own right, critics are reaching too far when they use these arguments to raise food safety concerns with respect to rBST.

Nevertheless, these unconvincing criticisms of rBST are instances of a general problem that deserves far more consideration than it typically receives. The effects of technology are systemic. Using a novel technology alters the way that many other things are done, sometimes in subtle and unpredictable ways (Tenner 1996).

As discussed in Chapter 7, herbicide tolerant crops have been criticized by those who believe that they will encourage farmers to use more herbicides. Although this is generally thought of as an environmental hazard, rather than a threat to food safety, it is yet another example of how biotechnology that is benign in itself might have collateral consequences that affect food safety. It is relevant and important to consider the way that one technology will have an impact on the use of others (or on non-technological practices) when considering risks to health. The unpredictability of collateral consequences is sometimes cited as an excuse for failing to consider them. While it is true that the complexity of collateral consequences makes it unlikely that we will ever be able to predict all of them, there is no excuse for indolence. There is little research on the systemic nature of food and agricultural technology, and virtually none on the collateral consequences of specific products of biotechnology. When collateral consequences are anticipated, it is because someone (frequently a critic) serendipitously happens to think of them, not because there has been an organized effort to anticipate the systemic impact of a new food or agricultural technology. It would appear that the public deserves a more sustained effort to understand collateral consequences than it has thus far received.

Ethical Issues Associated with Social Uncertainty

Public debates over food and agricultural technology often bring deep scientific disputes to the surface, but the terms in which the public debate is conducted often fail to characterize the questions accurately from a scientific perspective. Agricultural pesticides have been debated for four decades, for example. The debate was precipitated by the publication of Rachael Carson's book *Silent Spring* in 1962. Carson was a distinguished science writer, rather than a scientist herself. She interviewed a number of scientists and worked through the scientific literature on ecological and health effects of pesticides, which included a few studies on the bioaccumulation of toxins used against insects and the attended effects on other animals, especially birds. This work was presented to the public as a polemic against pesticides in general and DDT in particular, predicting the precipitous decline of songbirds—a silent spring. Among scientists, the overarching debate was and continues to be composed of many smaller and more focused controversies over the toxic and chronic effects of many different chemical substances, over the appropriateness of animal vs. clinical studies, and over the relative risks of alternatives to chemical control. Carson focused the controversy over the failure to act in the face of uncertain evidence that pesticides were having a deleterious effect on wildlife.

From the perspective of science, that is, from the perspective that sees the issue in terms of focused controversies, interpretation of data and methodological debates, the term "uncertainty" implies a set of standard problems well known to anyone trained in scientific procedures. Such issues are not without ethical significance, and the extensive discussion of uncertainties associated with environmental risk that appears in Chapter 7 is also relevant to food safety. For now, it is important simply to note a less technical phenomenon that might be referred to as *social* *uncertainty.* Social uncertainty is the indecision, hesitation and skepticism that often attends scientific controversy and that prevents policy makers and ordinary citizens from feeling confident about what they ought to do. Because scientific concepts, data and even experimental studies are open to multiple interpretations, it is often possible to make almost contradictory statements about what is and what is not known about a controversial phenomenon on the basis of scientific studies. Because many different scientific disciplines are involved in estimating technological risk, virtually no one is in a position to command all the information and expertise relevant to decision making. Even highly educated and interested members of the public and government officials, in particular, must thus rely on expert testimony for their interpretation of technological risks. This situation of unequal access to expertise and knowledge creates a form of uncertainty about risks that is seldom discussed in scientific studies.

The debate over agricultural pesticides provides a classic case study for this phenomenon, and several useful studies of the debate have been made. Thomas Dunlap (1981) has written a historical study that details the way that political interests squared off in the debate over DDT, while John Perkins (1982) has contributed a study that examines how competing claims of scientific expertise racked the discipline of entomology for 20 years. Christopher Bosso (1987) has offered a useful political study of the controversy as an example of the politics inherent in regulatory policy making. All three of these books indicate how political and economic interests can exploit ambiguity and disagreements over data and the interpretation of its significance. In 1996, the general debate over pesticides took a new turn with the publication of a book entitled *Our Stolen Future* by Theo Colburn, John Peterson Myers and Diane Dumanoski (1996) The book was remarkably like *Silent Spring* in that it adopted the style of popular science writing, rather than refereed science. The three authors argued that one class of pesticides might be linked to several chronic health effects, including male sterility, in virtue of their ability to mimic the action of hormones in effecting the endocrine system of many animals, including human beings. Colburn's conclusions were described as speculative by Ronald Bailey (1996), a professional critic of critics who has frequently come to the defense of new technology, including biotechnology. Colburn's work has been endorsed in a book-length study of the endocrine disrupter hypothesis by Sheldon Krimsky (2000), who has also been a frequent critic of biotechnology. For present purposes, the observations of Lorenz Rhomberg (1996) of the Harvard Center for Risk Analysis are apt: "The wide span of opinion on xenoestrogen issue is typical of the early stages of an emerging scientific question, where possibilities of great concern are raised, but existing information (and, perhaps more importantly, scientific consensus about the meaning of that information) is insufficient to resolve whether or not emerging fears are well grounded.

The pesticide controversy and the endocrine disrupter dispute have nothing directly to do with food safety risks from biotechnology, but they may have disposed some observers on the sidelines of the biotechnology debate to take a more skeptical attitude toward what scientists were telling them. In effect, anyone who has not actually collected data and conducted risk analysis is in a position such that their assessment of food biotechnology's safety reflects two factors: the content of the risk estimate being offered by experts, and one's confidence in the competence, neutrality and reliability of the experts themselves. Confidence derives from the social relationship between any given individual and the expert group conducts the risk analysis. In situations where confidence in the group doing the analysis is very low, statements to the effect that risks are acceptable can actually increase a person's estimate of the risk associated with the activity in question. Social sources of uncertainty cannot be eliminated by conducting more scientific studies.

One of the most significant sources of social uncertainty is grounded in the difference between local knowledge and more conventional scientific techniques. Brian Wynne (1992) conducted a series of studies on attempts to quantify and manage risk in the wake of the Chernobyl accident which revealed that scientifically trained risk managers made a number of errors in mitigating radiation contamination risks among sheep farmers because they did not understand local conditions and practices. Farmers lost confidence in the scientists when it became clear that they did not understand a number of relationships crucial to the economic viability of sheep farmers. This loss of confidence exacerbated public health risks when communications between public officials and farmers became mired in misunderstanding and distrust. If it becomes clear that scientists do not know or appreciate things that are well known by affected parties, trouble ensues, especially when the affected parties are in a position of social vulnerability to actions they know to be ill-informed or narrow in perspective.

There is little doubt that food and agricultural biotechnology has been plagued by problems of social uncertainty, beginning with the debate over environmental risks associated with genetically engineered ice-nucleating bacteria in the 1980s (see Thompson 1986). However, it is remarkable that social uncertainties relating to food safety have not played a more prominent role than they have. This may, in part, be due to the relative lack of disagreement among scientists about the safety of consuming transgenic crops and the other products of food biotechnology. As Chapter 3 discusses in some detail, food safety concerns were raised in connection with recombinant bovine somatotropin (rBST) during the late 1980s, yet what little genuine scientific uncertainty existed about the food safety characteristics of rBST itself had been resolved well before the rise of public controversy. The classic form of scientific uncertainty that has given rise to controversy over nuclear power (Thompson 1984) and pesticides is remarkably absent with respect to the food safety impact of biotechnology.

This is not to say that the safety of consuming food from biotechnology will escape the problems of scientific uncertainty forever. Rollin worries about genetic engineering of food animals that involves manipulations of genetic constructs, "without a full understanding of the mechanisms involved in phenotypic expression of the traits, with resulting disaster" (Rollin 1996). There has been a persistent murmur of uncertainty about food allergies and sensitivities. Will people who are allergic to fish or peanut butter become allergic to any food in which a fish or a peanut gene has been inserted? Food sensitivities, or sub-allergic reactions (sometimes difficult to document medically) are even more problematic, if less dangerous. There is relatively little regulatory debate about what to do while this uncertainty is resolved. Products involving insertion of genes from food known to have allergenic properties have been abandoned and would be subjected an exhaustive safety review. The best way to approach the allergenicity question continues to be debated (see Taylor 2002).

Perhaps uncertainty with respect to food safety is controlled in part because product liability laws make the food industry rather conservative about introducing a novel product in the absence of strong scientific evidence documenting its safety for human consumption. When there is any question of future product liability actions, companies typically submit products for government approval, a process that triggers an approval process designed to resolve safety concerns. Scientific uncertainty is more likely to create social uncertainty with respect to products (such as chemical pesticides) that are being profitably sold and utilized. In such cases people are actually being exposed to risks, while prior to use the risks are hypothetical. The economic interest of those who benefit from using the product (and of those who might be found liable for damages) creates a situation in which the eventual resolution of scientific uncertainties can pose ruinous economic risk as well as health concern. If such uncertainty should come to pervade the assessment of food safety for biotechnology in the future, the ethical dilemmas discussed in this chapter will take on considerably more complexity than they have thus far.

Yet even if food safety has not been the focus, social uncertainty has arguably been at the root of much controversy over the acceptability of foods from transgenic crops outside the United States. Such foods were introduced into Europe at a time when confidence in the competence of risk assessment and regulatory decision making was quite low. Highly publicized public health disasters, from Chernobyl to mad cow disease, had rocked confidence in scientific risk assessment. Harmonization of regulatory regimes among European nations created a situation in which incompatible standards and the economic interests served by any given risk standard were at the forefront. US corporations and the US government were perceived as promoting an interest-based view on global agricultural trade, and the social relationships amongst European regulators and the European public, on the one hand, and the biotechnology industry and the US government, on the other, created a situation in which each of these groups took a rather jaundiced view of the risk estimates for biotechnology that were being put forward by the others. In particular, European suspicions about the motives, competence and willingness of Americans with respect to health and especially environmental risk provided a setting in which scientific uncertainties were amplified by distrust. The result was a collective judgment on the part of many Europeans that biotechnology is quite risky.

What is the ethical response to social uncertainty? To some extent, this question must await further analysis, for it is often the interplay amongst food safety, animal welfare, environmental and social issues that creates competing interests and places people into positions where they are unlikely to place confidence in expert views of risk. The difficult mangle of issues that intersect when all these interests are in play is the subject for the final chapter of the book. The succinct answer is to advise against the creation of situations in which great inequalities in power and access to information exist. But it must be admitted that some such inequalities are unavoidable. Beyond that, a tired aphorism may be the best that can be offered: Honesty is the best policy. This will not forestall social uncertainty, and may be singularly ineffective in dealing with it once it arises. But to think that one can outfox the public with strategically constructed messages full of nuance and rhetoric is precisely the sort of attitude that gives rise to social uncertainty in the first place.

ETHICS AND FOOD SAFETY CRITERIA: SOME INTERIM CONCLUSIONS

In summary, while the products of food biotechnology will need to be subjected to safety review whenever substances with unknown risks are introduced into human foods, the use of biotechnology as a process for introducing such substances into food should not, *in itself*, trigger additional review of food products. Within developed countries, the food industry works with government to assess and regulate the safety of food. The rest of the world relies heavily on the regulatory apparatus of the industrialized nations. Uncertainty, bad actors and collateral consequences require specific normative responses from industry and government and at present these requirements are met imperfectly at best. Yet while ethics demands greater diligence, there is little reason to think that uncertainty, bad actors or collateral consequences represent serious ethically based challenges to the safety of foods produced using genetic engineering or the other tools of biotechnology. That is, these are areas where the mainstream approach to food safety should be strengthened; they do no constitute ethical objections to that approach, nor do they state ethical reasons to oppose agrifood biotechnology on food safety grounds.

Considerations such as those that have been cited in connection with bad actors, collateral consequences and social uncertainty are often met with the objection, "What about the benefits of biotechnology?" In truth, food biotechnology *is* being applied in ways that enhance our ability to monitor the safety of foods, and the first edition of *Food Biotechnology in Ethical Perspective* included a discussion of DNA probes used to test for the presence of *Listeria monocytegenes* and *Camphylobacter*, as well as future products that may deploy genetically engineered organisms to destroy food borne pathogens (Cross 1992; Thompson 1997a). When the first edition of *Food Biotechnology in Ethical Perspective* was prepared, animal scientists were investigating the potential for producing low-fat meat through a variety of methods, most particularly through the use of animal drugs called repartitioning agents. Although some success was noted with respect to a class of repartitioning agents called β-agonists, and great enthusiasm was expressed over the potential for protein hormone repartitioning agents (of which rBST is an example) (Guyer and Miller 1994; Rexroad and Pursel 1994), these animal biotechnologies have not been proven a decade later. In the years since the first edition, enthusiasms have shifted to products that, while not directed to making food safer, might make it healthier. Golden rice is, of course, the primary example (see Potrykus 2001).

However, a more appropriate response to the objection that benefits are being overlooked is a reminder of the logic implied by the presumptive case for biotechnology. Benefits, somewhere and of some kind, are assumed, lest we would not be undertaking the exercise in the first place. They might not always be benefits taking the form of improved health and safety, but the argument is long enough as it is. Persistent repetition and recounting of off-setting benefits whenever any risk is mentioned becomes tedious. There are other problems with this objection, however, and they involve the apparent assumption that the questions of food safety are always and of necessity to be resolved by weighing benefit against risk. Weighing risks and benefits is one way to look at the issue, but there are others. This brings us to the general topic of a philosophy for food safety, which is the really interesting part of this chapter.

THE PHILOSOPHY OF FOOD SAFETY

Once risk-based tests are passed, why would the safety of food biotechnology raise any serious ethical questions at all? The established booster answer to this question is that there *are* no more ethical questions. Critics of biotechnology are hysterical or liars (or both), and the public is ill informed, easily misled and otherwise fairly apathetic about the safety of food biotechnology. But the established booster answer is wrong. Risk, defined as probability of food borne illness or injury, is too narrow to encompass the full range of issues that are traditionally associated with food safety. Socially based management of food risks has undergone three broad phases. For most of human history the problem has been one of classification. Is it food or not? When medical scientists began to appreciate the importance of germs and other contaminants as a cause of disease, a more subtle approach arose which stressed the elimination of impurities. Only recently have scientists begun to appreciate the complexity of whole foods, recognizing that many components of foods may have toxic properties under certain circumstances, and that toxicants themselves may be responsible for benefits that offset the disease risk associated with their presence in food. This has introduced a tendency to think of food safety as an optimization problem that gives rise to the risk-based approach described above, and supports it with impressive scientific credentials.

My own view is that the optimization approach is correct when safety is conceived narrowly, but that alternative views are entirely reasonable. For those food safety decisions we must make collectively (and given the complexity of our food system, that is most of them), norms of democracy demand an accommodation for all reasonable points of view. This is not to say that everyone gets whatever they want, but it does entail that collective or political decisions must be made in a manner that does not foreclose the possibility of reasonable disagreement and that when divergent viewpoints can be accommodated without imposing unreasonable costs or inconveniences on others, they should be. The case for applying these general norms of democracy to the issue of food safety and biotechnology begins by considering each of the three historical approaches to food safety in more detail, and by gaining an appreciation of the concomitant values that complicate food safety decisions. Given the diversity and complexity of these values, norms of democracy weigh heavily in favor of a policy that preserves key elements of consumer sovereignty and consent. Labeling is one means of supplying consumers with information and protecting the autonomy of their decision making with respect to diet.

Classification

Human beings recognized the existence of poisonous foods in prehistory. By the time of the Greeks, such knowledge served as the basis for Socrates' famous meditations on death and duty prior to drinking hemlock. The ability to distinguish foods with toxic constituents from microbial toxins would have confounded early efforts to manage the risk of ingesting poisons through a dietary regimen, but trial and error would have eventually ruled out acutely poisonous plants and animals. It is less sure but seems likely that humans came early to the knowledge that eating the wrong thing could have delayed effects and increase chronic health risks. Clearly, early beliefs about food safety were a mix of superstition, speculation and hard-won experience. The Pythagorean cult of which Plato was a member proscribed the eating of beans, though it is unclear whether the deadly effect of castor beans, metaphysical beliefs about the germinative power of seeds, or simply the problem of flatulence was the occasion for this food rule. Generally such rules classify plants and animals into food and non-food groups and in some cases specify finer distinctions for preparation or serving foods. Whatever else might be said about these culturally transmitted food rules, in every known case following them results in food consumption that is safer than a diet of randomly sampled plants and animals. This is an unexceptional fact; a food culture that included acutely toxic elements would disappear rather quickly.

Dietary rules that distinguish food from non-food, as well as stipulating which foods may be consumed together are a part of every culture. In some cases these rules are relatively weak prescriptions of taste: one does not mix ice cream and onions, and croutons with red wine is not a breakfast dish. In some cultures dietary rules take on religious significance and become a serious matter indeed. Semitic rules against the eating of pork are among the best known food taboos. Food safety is thus but one function of a cultural dietary regimen. While adherents of a given system of food classification may associate violation of the rules with sickness, injury or death, they may also associate it with religious, spiritual and social forms of risk. Religious, ethnic and regional food rules persist today because they are constitutive of social, cultural and personal identity, because they reinforce feelings of well-being and order, and because people love them, find them pleasing, satisfying and take gratification in following them.

Purification

Anthropologist Mary Douglas (1966) has used the term "purity" to describe a traditional society's adherence to a system of social practices including food rules such as described above. What I have in mind here is a way of looking at food safety that begins with the advent of the germ theory of disease in the nineteenth century. The germ theory held that disease was the result of invisible infectious agents or germs, and that strategies of purification could control disease before it starts. The germ theory gave rise to a strategy for food safety that deployed technical means for preventing the entry of infectious agents into human food, for destroying them once they are there, and eventually for treating those afflicted by germs. Refrigeration, sterilization, irradiation and temperature monitored cooking are all weapons in the arsenal of purification.

Belief in the efficacy of purification spawned legislation that regulated the food industry and created governmental agencies for enforcing the first food safety laws. It was the beginning of the modern conception of food safety. Sinclair Lewis's *The Jungle* created an uproar with its description of unsavory practices in the Chicago packing plants, among them an episode in which a hapless immigrant worker is literally ground into sausage as the line rolls on without missing a beat. In a ghoulish way, this episode from *The Jungle* is indicative of the way that food safety regulation based on a strategy of purification carries water for cultural foodways, just as Mary Douglas would predict. If we set prion diseases that were unknown to the readers of *The Jungle* to the side, grinding up a human being along with the sausage introduces little additional health risk for consumers. *The Jungle* was effective because however little regard middle class Americans may have had for immigrant workers, they were queasy about consuming parts of them in their hot dogs. The food safety regulations that came on line in most industrialized countries prior to World War II used the phrase "safe and wholesome." They prohibited the use of dogs, cats and rodents in meat products despite the fact that all these animals are used for food in some non-European cultures. Purification introduced science, technology and government into the pursuit of food safety, but retained many cultural norms in defining when a food is pure.

Purification was still the model when a new class of food safety problems began to be discussed in the 1950s. The US Delaney Clause, for example, appears to be a model of the purification approach. The law requires the US Food and Drug Administration to ban any additive found to cause cancer in humans. The law is accompanied by a list of traditional food ingredients deemed "Generally Recognized As Safe" (GRAS). It is imminently plausible to think that many of the legislators who voted for this law, if not Congressman Delaney himself, were thinking that foods (including the GRAS list) are non-risky, and that hazards are associated with contaminants. They may well have thought of themselves as instructing the regulators to seek out the contaminants and ban them. As eminently plausible as this thinking may seem, it is utterly incompatible with the new thinking on food safety that is represented by the optimization paradigm.

Optimization

Quite recently scientists and regulators have adopted the risk-based view of food safety. The conceptual distinction between purity and risk-based approaches to food choice hangs on one's interpretation of "no risk," the criterion applied to food additives under the Delaney clause. A thorough purificationist (if such ever existed) believes that whole foods consumed since time immemorial bear no risk. This cannot mean that one will never come to harm from eating them, since food pathogens and unexplained poisonings and reactions have been around for time immemorial, too. "No risk," must mean no human caused risk, no risk introduced into the food system as a result of intentionally introducing additives into whole foods. What counts as "intentional introduction"? If you put something not on the GRAS list into food, it is an intentional introduction, and you must prove it harmless.

Few (if any) scientists or regulators think of risk in these terms. For them, "no risk" means zero risk, a quantity that can be reached only when the probability of harm associated with an action or choice is zero. This is an assumption that makes the Delaney Clause intellectually incoherent. At best, epidemiological studies and animal trials will reveal no statistical evidence of carcinogenicity, but "no statistical evidence" is far short of *proving* zero chance of harm. More detailed studies and better tests can always overturn this result, and that has indeed been the case. In addition, the purificationist interpretation of the Delaney Clause clearly admits circumstances in which GRAS substances with risks known or strongly suspected to be higher than those of banned additives are allowed, clearly a sub-optimal situation.

What is worse, the risk-based approach has begun to surface evidence that many common foods fail the zero-risk test. The work of Bruce Ames (1979) is typical of this new view, though it was clearly on the horizon well before Ames became an advocate of it. Ames' biochemistry work has shown that virtually all foods contain mutagens—substances that increase a the statistical rate of "errors" or minor changes in the order of DNA base pairs as a cell duplicates itself. Mutagens are thought to precipitate cancerous cell growth, though their very ubiquity shows that any link between mutagenicity and carcinogenesis is complex. Cancer would be everywhere if mutagens caused cancer, *tout court*. In a series of influential publications, however, Ames has promulgated the view that since naturally occurring mutagens far outnumber those associated with chemical additives and pesticide residue, it is unlikely that the rate of chronic diseases in the human population will be significantly reduced by strategies that target food additives or chemical residues (Ames 1979; Ames et al. 1987; Ames and Gold 1998).

Identification and Purification vs. Risk-Based Optimization

Since mutagens are everywhere in human foods, the new view eliminates the importance of the food/non-food distinction. Foods (tomatoes, beets, beef) are at least as likely to introduce the fatal mutagen into the body as are additive or pesticidal non-foods. People do not get cancer all the time because somehow these mutagens are kept in check, either by the body's defense mechanisms, or perhaps even by each other. The risks of chronic diseases such as cancer cannot be controlled by purifying foods, for the foods themselves are not benign. Instead we must seek a balance point, not yet well understood, in which the mutagenicity of what we eat is held in check (as much as possible) by all the other factors (good nutrition, exercise, cognitive stimulation) that create health.

This way of conceptualizing food health risks fits hand in glove with the risk/benefit trade-off thinking that had already begun to emerge in the wake of attempts to regulate agricultural insecticides, herbicides and other chemically based pest control technologies. Some such technologies, notably rodenticides and insecticides used to control pest infestations of harvested grain, had been introduced in order to prevent contamination—a clear application of the purification philosophy. It was evident that when adequate substitutes were unavailable a ban on these technologies would be followed by a resurgence of pest infestations and attendant health problems. In such cases trade-offs are inevitable, and the trade-off involves food safety, not merely economic losses. Sometimes the interests of human health will be better served by accepting the risks associated with the technology, sometimes it will be better to accept the pests.

Both Ames' work and the trade-off logic of chemical technology support a reconceptualization of food safety along the lines of risk optimization. Risk comes to be seen as pervasive and the presumptions of purification (that risk is due to impurities only) come to be seen as naïve. We must accept some risk, and the norm that we should apply to the problem of food safety is to define an optimum, a balance point, and to regulate food production and processing so as to approximate the optimum as closely as possible. Optimization is clearly a tricky business; it is not simply a matter of minimizing risk. It requires one to answer questions such as "How should we compare a statistically high level of risk to a few agricultural field laborers, to a very low probability of harm that may fall on food consumers?" Optimization strategies for food safety demand a high level of philosophical and ethical sophistication in their treatment of risk, but the point here is simply to note how dramatically the optimization approach differs from that of either classification or purification.

Seen as strategies bound by the limited knowledge of their respective moments in history, classification and purification can be interpreted as worthy attempts at risk optimization that have become obsolete. This amounts to the claim that ethnic or religious foodways and the purification technologies that followed were conceived and adopted with an end in view of striking the proper balance between risk and benefit for food safety. I do not think that this claim is plausible, though I know of no historical or anthropological research that could disprove it. What seems more likely is that the normative philosophy of optimization evolved at the same time as the relatively recent scientific theories and political problems to which it is so admirably suited. If that is right, then the values and experience of previous generations and of many in the present day do not provide adequate support for a strategy of optimization, and if this is true, then reasonable, intelligent people are likely to conceptualize food safety more along the lines of classification and purification than as an optimization problem.

FOOD SAFETY AND ETHICS

The most obvious way to move from risk-based optimization to an ethical philosophy for food safety is to interpret it as an extremely sophisticated extension of utilitarianism. The main problem with risk-based optimization is a traditional problem of utilitarianism: too little attention to consent. The consent based approach harks back to a system of *caveat emptor* Individuals accept risks to which they have given informed consent, but coercion or concealment of relevant information is morally unacceptable. Critics of consumers' right to know argue that this ethic is unrealistically demanding for a modern food system, but the justifiable demands of such rights are less onerous than is sometimes thought. The existing food system in most parts of the world is surprisingly close to what the rights view would hold as ideal.

The ethics of food safety is framed by the dialectical opposition between risk-based optimization, on the one hand, and an alternative ethical system that emphasizes consumer choice, citizen autonomy and consent, on the other. I regard this as a genuine dialectical dilemma in which there are compelling points to be argued on each side. But the dialectic is complicated. First, few specialists in food safety appear to recognize that there is a dilemma at all. Indeed, they write and speak as if risk-based optimization is pure science, rather than being shot through with (often defensible) philosophical assumptions. As such, it may be necessary to overstate the case for autonomy and consent. Second, there is slippery intellectual turf separating the two poles of this dialectic. Given certain plausible views on uncertainty, the authority of science and the individual's right to believe what they want, it is possible to slide from optimization right over to consent without noticing it. However, to launch this dialectical exercise, it is useful to articulate the links between risk-based optimization and utilitarian ethics more explicitly.

Utilitarianism and Risk-Based Optimization

Utilitarianism is the system of ethics that evaluates an action, rule or public policy in light of its consequences for all affected parties. Traditional English utilitarians such as Jeremy Bentham or J.S. Mill assumed that the total value of all consequences, beneficial or harmful, could be summed, and proposed the decision rule of "promote the greatest good for the greatest number" (Mill 1861). The emphasis on optimization, rather than maximization, signifies an appreciation of (if not a solution to) the complexity of quantifying and consistently ranking the myriad of goods and evils that bear on food choice. One strength of the utilitarian approach is that in emphasizing the likely consequences of a given action or policy, it represents the most obvious way to bring predictive science to bear on ethical decision making. Indeed, many scientists gravitate so easily to the view that public policy should apply the best science to predict the consequences of several policy options, then choose the option with the best outcomes, they fail to notice that they are applying a philosophical framework at all.

Frequently we are happy to have people in decision making positions decide on our behalf, for when they can be trusted to look after our interests, it saves us the time and expense of staying fully informed about what the latest science has to say about this or that. The modern food system has evolved under circumstances in which the public was generally happy to have many decisions about the ingredients or composition of food left to the experts (Knorr and Clancy 1984). A utilitarian would interpret this state of affairs as ethically justified because the cost of staying informed far outweighs any benefits the information would bring to the mass of people. But although the cost of staying informed clearly plays a key role the public's willingness to entrust the safety of food to experts, it is not necessary to adopt a utilitarian analysis of this fact. It is equally plausible to assert that in view of these costs, consumers consented to a set of social arrangements in which trustees were responsible to decide on the basis of the public interest. Furthermore they did so under circumstances in which they were frequently capable of choosing otherwise, as alternatives to processed foods and foods produced using agricultural chemicals were generally available. The fact that many people did not choose these alternatives makes no difference; what guarantees consent is that they could have opted otherwise, had they wanted to. This is a horse of a different moral color, as the logical force of the moral judgment now rests on giving consent, whereas for the utilitarian it rests in selecting the most attractive ratio of benefit and cost, irrespective of consent.

Science-Based Policy and its Discontents

The best argument for optimization does not lie in its alliance with utilitarian ethics, but with the fact that this approach best synthesizes current scientific thinking with respect to the probability of food borne illness and injury. Nevertheless, the problems with a too narrow emphasis on risk management and trade-offs are also generally the problems of utilitarian approaches. Utilitarianism has always been criticized because it appears to make short work of rights in too many instances, depriving people of the opportunity to make their own choices in the name of doing what is good for them. In the case of food safety policy, the claim that policy should be risk-based, or simply science-based neglects the fact that science provides little insight into many of the dimensions that influence individual food choices. None of these dimensions provide reason to ban or regulate food biotechnology, but any of them might well provide an individual with defensible reasons for preferring not to eat these new foods.

Is "food safety," a purely scientific concept, to be defined and controlled exclusively by food scientists, or is "food safety," a term of ordinary language? If it is the latter, then it becomes relevant to see what non-scientists mean when they use the concept of safe food. Food journalist Robin Mather puts in this way in writing for a popular audience:

> Because food is so important to us on so many levels, we must generally trust blindly in government's promises of a safe food supply and in the safe practices of those who produce the foods we buy. We wade doggedly through complicated, confusing and often contradictory information about the foods we eat. The reason is that most of us realize on a fundamental level that food choice is one of the last arenas in which we have some measure of control. (Mather 1995, p. 5)

Here Mather characterizes "control" as a primary dimension of food safety. Most of her book discusses the social organization of agricultural production (see Chapter 8), but she links the social impact of biotechnology to this paragraph on food safety by noting how difficult it is for food consumers to "track where our food comes from" (p. 5).

Building on Mather's comment, the problem with the risk-based approach is not that it is wrong as far as it goes, but that it does not go far enough, ignoring the "many levels" on which food is important to us. Mather's complaint with government regulation of food safety is that it is being used to undermine "one of the last arenas in which we have some measure of control." Of course, the Department of Transportation may be "undermining our control" when they mandate air bags or speed limits. In one sense, every public policy affects individuals' control over their lives. This is not in itself a powerful argument. What must be shown is that food consumers have rationally defensible ends in view in wanting alternatives to biotechnology-derived foods. There are at least four such ends.

1. *Religious and ethnic beliefs*. As already noted, the cultural history of food beliefs has produced a rich array of religious and ethnically based beliefs about what is and is not food. These beliefs are imperfectly correlated with scientific probabilities concerning illness or injury, at best. Yet no one challenges the right of religious and ethnic minorities to stipulate food rules that are far more restrictive than those stipulated in legal codes. Jewish and Muslim practices, among the most widespread, demand both dietary restrictions and special procedures for slaughter and preparation. These rules remain under the constant supervision of each groups' ecclesiastical authorities. Clearly it is up to these authorities whether the use of genetic engineering or other forms of biotechnology are consistent with their traditional dietary rules. Any intentional or *de facto* attempt to decide this question on their behalf would violate minority rights that are well established throughout the industrialized world and covered by the International Declaration on Human Rights.

2. *Latent purificationism*. Few lay persons and even many scientifically trained individuals can make ready sense of the risk-based optimization approach that is *de rigour* among toxicologists, epidemiologists, biochemists and food regulators. The purification model that has been around for a century is more consistent with educated common sense. The idea that crossing genes is a violation of purity rules comes readily to many people, and they are at least psychologically justified in feeling somewhat queasy about genetically engineered food.

Do the queasy need more justification than that? Historically, simply *preferring* to pass up on a food innovation has been sufficient justification for being allowed to do so. Though we find it hard to believe today, resistance to pasteurized milk was once ran deep. However, resistors who resented the fact that their product of choice was not available on the local grocery shelf had (admittedly expensive and inconvenient) alternatives and they were never placed in the position of having to guess whether the milk on the grocery shelf was pasteurized or not. Fluoridation of public water supplies also made tempers flair, but bottled water was generally available, and again no one had to wonder. Queasiness and latent purificationism regarding food biotechnology are clearly present among members of the lay public, and they are all the reason some people need to avoid genetically engineered food.

3. *Distrust of science*. A subset of the queasy are angry, too. Many of them purchase organic foods, often at great inconvenience to themselves, and they write angry letters to activist magazines, complaining about "Franken-foods." Some may combine resistance to science with religious faith. Some, like the Unibomber, may press their anger beyond rationality. But in a world that has given us disasters like Bhopal and Love Canal, where the safety of chemical and then nuclear technologies was badly oversold, and where scientists performed experiments on humans without informed consent not only in Nazi death camps but in Tuskegee Alabama, is it really so surprising that some people are a little reluctant to accept scientific assurances about the safety of biotechnology? For some, skepticism about science is learned from science itself.

Clearly it is impossible to isolate oneself completely from science and its impact on our world. Claiming a right to do that would be preposterous. But as already argued, people have never been forced to choose between total reliance on science or subsistence agriculture. Food choices and alternatives have been the norm, if not a right, and people are justifiably resentful (and suspicious!) of the forces that threaten this valued status quo.

4. *Solidarity*. As will be discussed in Chapter 8, some of the most potent arguments against agricultural biotechnology have to do with its social consequences. Critics argue that family farms will be lost, and that farmers will lose control of their operations, becoming little more than "serfs," as one Ontario farmer put it at the 1996 meeting of the National Agricultural Biotechnology Council in New Brunswick, NJ. Whether this is true or not, those who believe it may wish to avoid foods from agricultural biotechnology as a form of protest. Just as consumers boycotted grapes to show solidarity with field workers or meat products to show solidarity with packers, some consumers may wish to boycott biotechnology as a way to show solidarity with traditional or small farmers. This appears to Mather's (1995) primary reason for opposing biotechnology, for example. The last chapter of her book is entitled "Voting With Your Buck," and it details how consumers can make foods that support small-scale, sustainable agriculture, rather than "bioengineered foods."

If consumers have a right to "vote" with their food purchases, it is certainly less secure than the previous three. It is far from clear that producers of a targeted good are obligated to help their opponents identify it on supermarket shelves. Yet food consumers who were willing to put themselves to a bit of inconvenience have generally been able to express their politics through their pocketbooks in the past, and it is not unreasonable for those who accept animal welfare, environmental or social criticisms of biotechnology will want to do so in the future. Like religious or ethnic beliefs or simple queasiness and distrust of science, solidarity motives do not constitute irrational objections to biotechnology. Furthermore, because the solidarity motive converts food choice into a form of political speech, it is especially significant as an ethically protected domain of citizen action.

FOOD LABELS AND CONSENT

Many of the things that people want to know about food have nothing to do with science and are only marginally related to safety (as conceived as the probability of illness or injury). But people want to feel good about their food choices and if this means knowing that their Champagne comes from France rather than California, or that their hot sauce is made in Texas, NOT New York City, then having the ability to discriminate on the basis of such information contributes to their feelings of well-being and satisfaction. To the extent that "safety" connotes a feeling of security and well-being, such information contributes to food safety. Perhaps its better not to stretch the word "safety" this way, but what *is* clear is that people will feel suspicious of and at-risk from individuals or groups who try to deprive them of information they deem valuable.

The point of food safety policy is not merely to make foods safe, but to provide the public with reasonable *assurances* of food safety. Ironically, it may not be possible to accomplish this latter objective without providing information that has little bearing on the probability of harm from consuming the food in question. Thus there are calls for mandatory labeling that would identify foods derived from biotechnology. As will be shown presently, this is a policy approach that has problems of its own. First it is crucial to be absolutely clear about the ethical argument.

Bad Arguments for Mandatory Food Labels

Most of the arguments that have actually been proffered for labeling genetically engineered foods do not stand up to close examination. It will be useful to review several of them.

Biotechnology is unsafe. The most straightforward argument for requiring labels proclaiming the use of biotechnology would be if there are demonstrated health risks associated with consumption of products derived from biotechnology, as there are for alcohol and tobacco products. Such labels would warn consumers of such risk. Clearly from what has gone before in this chapter, no evidence exists for health risks, so this argument relies on a false premise.

Biotechnology is unnatural. The argument here is that since biotechnology may have been used to produce a whole food, meats or grains, products that are not readily recognizable as processed may be confused with natural foods, meats or grains. Consumers who want a certain kind of product (e.g. one in which biotechnology has not been used in any way) have no reliable way to recognize such products are indeed deprived of any right they have to satisfy that preference by unlabeled produce, meats and grains. Yet, while religion, queasiness or solidarity are clearly relevant it is difficult to see how "naturalness" comes into play in establishing this right. On this point, Michael J. Reiss and Roger Straughan (1996) are right: The abuse of natural/artificial distinctions is extensive enough that we ought not to encourage more of them.

People want genetically engineered foods labeled. Data on public opinion demonstrate an abiding interest in labeling of genetically engineered foods in virtually every population surveyed (Hoban and Kendall 1993; Frewer et al. 1997; Pew Initiative 2001–2005). While such surveys might constitute a sufficient political argument for mandatory labels if there were no countervailing concerns, they do not establish ethical reasons for requiring that the producers of biotechnological foods label their products. There is a fallacy in applying any kind of survey data to reach such a conclusion. Given the question, "Would you like more information (or labels) on X?" many people are likely to respond affirmatively, without regard to what X is, or whether they have any legitimate interest in having the information. At a minimum, this argument needs supplementation with an account of why consumers might have reasonable preferences which they would exercise if the information were available.

Biotechnology is irreligious, impure or harms animals, the environment and small farmers. The previous section provided an account of the religious, the queasy, the skeptical and the politically active which demonstrates the legitimacy of their concerns. Perhaps if that account were added to the survey data documenting a desire for labels, the argument would hold up. It is *reasonable* for people to believe any or all of these things about biotechnology (though I do not), and people do have a right that protects the exercise of these beliefs from interference by others. But arguments intended to convince others that biotechnology is irreligious, impure or bad for animals, the environment or small farmers do not in themselves provide a sufficient ground for mandatory labels. At most, they entail that the food system must not be manipulated through conspiracy or public policy in a manner that effectively forces them to buy and eat genetically engineered foods. Such manipulation would stifle political speech on behalf of religion, animals, the environment or small farmers. It is political liberty – freedom of speech – this is ethically important in justifying choice, and not the punitive harm to affected parties. Mandatory genetic engineering labels would be necessary only if they were the sole means to protect the food system from such manipulation, but they are not.

Alternatives to Mandatory Labels

The ability to avoid genetically engineered foods is what matters most. Those who wish to avoid processed foods do so by choosing and preparing whole foods. Those who wish to avoid fluoridated water do so by buying bottle water that is labeled as free of fluoride. Those who wish to avoid pesticide residue do so by purchasing food that is labeled as "organic," "green" or otherwise free of pesticides. In each of these cases, the principle of informed consent is protected, but in none of them are the offensive products the object of mandatory labeling laws. Indeed they are not labeled at all.

The principle of consent is protected in each of these cases by the availability of alternatives. These alternative foods give food consumers the right of *exit* from a system of food transactions that they find objectionable (see Hirschman 1970 for a discussion of exit). If there are identifiable alternatives to the products of biotechnology, then consumer sovereignty and the principles of consent are protected. There are several ways in which the principle of exit can be protected, and the most obvious of them all involve labels that identify a product as "biotech free."

Voluntary negative labels. The most straightforward approach is a *voluntary* label that may be placed on products where no biotechnology has been used. The label would be negative in that it would proclaim the absence of biotechnology, rather than its presence. If a sufficient number of products begin to use negative or "no biotech" labels, then those who wish to avoid biotechnology can do so. The development of negative labels would require standards stipulating what "no" means. Such standards give rise to a further set of philosophical questions about the compatibility of a GMO-free sector and the presence of GMOs in the commodity chain. Thus, agreement on a "no biotech" label does not settle the controversy.

Organic or "Green" labels. Another approach is to specify that "green" or "organic" products may not utilize biotechnology, so that the concerned may opt out of the soon-to-be-biotechnologicallydominated mainline food system by shifting over to a segment that already exists. This is the solution that appeared most likely in 1997 and that eventually became United States policy a few years later. It does not involve the start-up costs of establishing a new market niche, and it appears that many of those who initially wish to avoid biotechnology are quite willing to segment themselves into the green section of the supermarket. Yet this solution is far from ideal. Some of the most attractive products from agricultural biotechnology are those that promise virus or disease resistance, or that permit the elimination of chemical pesticides. The green and organic buyers should be the most enthusiastic buyers of these environmentally friendly products, and the move to a "Green equals biotech free," policy both stigmatizes these products and undercuts their potential market.

MANDATORY LABELS: FOR AND AGAINST

Here it may be useful to pause and take stock. The philosophical argument thus far is that exit, the ability to avoid eating GM foods, is ethically important. It is this principle that is worth protecting, and labels should be regarded as providing a means to do this. In contrast, risk-based thinking on food safety tended to make regulators look at this issue somewhat differently, using a more utilitarian orientation that sees the issue as one of encouraging people to eat healthily and spend their money wisely. From the perspective of anyone who takes the scientific consensus on the safety of agrifood biotechnology seriously and who also sees labels in these utilitarian terms, *any* kind of label seems like a bad idea. Against this view, the argument thus far has attempted to show that an ordinary citizen's view of food safety (informed as it may be by tradition or purity norms) should be treated much the same way as a religious, political or purely aesthetic preference.

In saying this, I do not mean to minimize the importance or validity of either these preferences or the average non-scientists view. Rather, my point is that the question of whether labels are justified should not revolve around the conflict between the ordinary citizen's view of food safety and the scientific view. From that perspective, any responsible policymaker would have to base decisions on the scientific view. Rather, this question should be evaluated in terms of how labels facilitate or frustrate the average citizen's right of exit, their ability to opt out of eating genetically engineered food. From this perspective, it does not matter whether the reason for opting out is focused on food safety or religious beliefs. Indeed, it does not even really matter whether people want to opt out of food biotechnology at all. There are many cases where people take great pains to protect a right that they have no intention of actually exercising in any economic transaction.

The 1997 edition of *Food Biotechnology in Ethical Perspective* was interpreted by some readers as implying that science trumps the consumer's right to choose (see Jackson 2000; Streiffer and Rubel 2004). That was certainly not the intent, and I have since published a more extended discussion of ethics, labeling and the right of exit (see Thompson 2002). Nevertheless, I continue to believe that mandatory labels declaring a product to contain GMO's, to be products of biotechnology, or whatever are, in fact, not the best response to the ethical problems that have been outlined here.

The argument thus far has shown that alternatives to mandatory labels exist, and they are capable of resolving the most potent ethical problems, that is, those that preclude consumer exit. Yet an advocate of mandatory labels might protest that if negative labels provide exit, so do mandatory "positive" labels (e.g. labels that identify a food as being produced through biotechnology). They do so directly, and there is less chance that people will be confused or misled into thinking that they are avoiding genetically engineered foods when they are not. What is more, the cost falls on the biotechnology industry, rather than those who want to avoid it.

The most serious ethical objection to mandatory labels is that they would stigmatize products of biotechnology unjustly. Although there are reasonable concerns that may lead some to avoid genetically engineered foods, it is at least as reasonable to accept them as beneficial. This is, of course, especially the case for foods engineered to boost nutritional value, but even crops primarily of value to farmers can be beneficial additions to human diets. If a GM crop allows farmers to utilize fewer pesticides (as at least some Bt crops apparently do), adding these crops to the human diet would be beneficial. Furthermore, as economists have argued at some length, consumers are the *primary* beneficiaries of technology that increases the efficiency of agricultural production. Farmers enjoy at most temporary benefits for efficiency-enhancing seeds or other farm inputs, because market adjustments return them to previous (or lower) levels of income after the innovations have been widely adopted. Price adjustments for consumers, however, are permanent and result in lower food costs (Cochrane 1993). What is more, these benefits are returned differentially in favor of the poor, who spend a greater portion of their income on food (Tweeten 1991). Given these economic results, a policy that would groundlessly sway people who are neither religious, queasy, untrusting nor politically active in the manner described is more than questionable. Barring a very persuasive philosophical counterargument, it is ethically unjustifiable.

Stigmatization of agrifood biotechnology would also groundlessly reduce the commercial viability of genetically engineered foods, and this could plausibly be interpreted as interference in the rights of the food industry, its investors, and non-profit biotechnology researchers. Robert Streiffer and Alan Rubel criticize this last point in two papers by noting that no one has a right to any level of guaranteed economic return on a transaction or investment (Streiffer and Rubel 2004; Rubel and Streiffer 2005). It is certainly true that economic returns are not protected by rights. However, those who offer products for sale to the public do have the right to fair conditions of competition. Suppose a country (call it Govingia) passes a law requiring that all imported beer bear a large label with a skull and crossbones, then indicates somewhere on the Govingian Ministry of Trade's website that the skull and crossbones is not intended imply any defect or hazard but is simply the symbol adopted to indicate an import product. We would not be inclined to call this fair. It is not at all implausible to diagnose this unfairness as a violation of the importing company's right to fair conditions of competition.

Now I am not deeply invested in the language of rights, here, and would be happy to shift the debate over to some other philosophical formulation that addresses questions of fairness. The point here is that mandatory labels can unfairly stigmatize a product, and victims of unfairness in this case are, at a minimum, the food industry and their investors. It seems evident that something very much like this has actually happened in Europe since the original publication of *Food Biotechnology in Ethical Perspective* in 1997 (see Bates 2003). Furthermore, Streiffer and Rubel do not address the possibility that there might be unfairness to non-profit biotechnology researchers, people who have invested a life's work in a set of technologies and who may have no personal financial stake in their success. Clearly, they are no more entitled to success by right than are private sector scientists, but are not they, too, entitled to have their work evaluated under fair conditions? Ingo Potyrkus has complained bitterly about what he takes to be the lack of fairness with which his work on Golden Rice has been received (Potrykus 2001). So although Streiffer and Rubel are certainly correct to note that no one is entitled to success, economic or personal, I reiterate that the stigmatization mandatory labels might create for agrifood biotechnology could in fact be ethically problematic in being unfair to the people who develop this technology.

The 1997 edition suggested that mandatory labels for genetically engineered foods would be very difficult to enforce because at that time no test existed that could reliably detect whether genetic engineering had been used. That is a situation that changed fairly soon after the book was published, and it is now clear that technical monitoring issues present little barrier to segregation or sourcing of GM from non-GM products. Nevertheless, testing and segregation issues do continue to play a role in where the burdens fall. A voluntary non-GM label would almost certainly sell at a higher price than commodity grade “may contain” GM foods. Part of these price premiums would certainly go toward the costs of segregating and labeling the non-GM product. The cost burdens for any kind of mandatory label will be more broadly distributed across the food system, probably raising the costs of all foods slightly. These cost increases may be very slight indeed when widely distributed, but it is nonetheless the case that increased costs for food fall most heavily on the poor, for the same reason that lower costs benefit them more. Economic arguments such as these have made Per Pinstrup-Andersen and Ebbe Schiøler critics of current European policies on labeling for GM (Pinstrup-Andersen and Schiøler 2000).

If the labeling debate was purely a philosophical problem, however, it must be admitted that the case for mandatory labels is very nearly as strong as the case against them. Other circumstances, such as strong demonstrated political demand for mandatory labels, might plausibly be advanced to tip the balance in favor of the mandatory alternative. This might especially be the case for societies where a majority or large plurality of religious believers decide against biotechnology, or, indeed, for European countries where protests have (in conjunction with mandatory labeling policies) virtually driven products of agrifood biotechnology from the shelves. As such, I conclude by noting that while I remain convinced that voluntary negative labels represent the better ethical response, my opposition to mandatory labels as a practical policy solution is not hard and fast. Indeed, the tenuous state of consumer rights of exit in the United States at the time of this writing suggests that the food industry is far from ready to utilize the opportunity to offer voluntary negative labels that currently exists under US law. Whether this represents a lack of moral commitment and character in the food industry or alternatively a flaw in the way that the FDA crafted its approach to voluntary labeling is not entirely clear. Perhaps all that can be concluded is that far from achieving any consensus policy solution, the labeling debate has matured into one of the more philosophically active areas in the ethics of food biotechnology.

CONCLUSION

Regulators and scientists generally approach food safety as a problem of optimizing the trade-offs between the nutritional, aesthetic and economic benefits that we get from food, and the probability that consuming any given food or diet of foods will result in illness, injury or other detriment to health. Given the seriousness of food borne health hazards, and the power of food science to anticipate and manage these hazards, this is an eminently defensible approach from both an ethical and a scientific standpoint. However, in one of the supreme ironies of science and public policy, the more aggressively regulators and scientists promote the wisdom of the risk-based approach, the less effective it becomes (Thompson 1995b, 1999).

One reason it is ineffective is that regulators and scientists become entrapped in an indefensible political position when they follow the logic of risk-based or science based food safety policy too literally. Some industry scientists and sympathetic regulators promote the view that scientifically assessed probabilities of injury are the sole criterion on which food choice should be made (or what is the same thing, that such risk information is the only information that consumers have the right to demand). A moment's reflection reveals the absurdity of this view, but what is worse than its absurdity is the way that it inculcates suspicions in the public mind: What are they trying to hide?

When viewed from the risk-based perspective on food safety, biotechnology scores well. Scientists and regulators must not abandon the view that their primary responsibility is to ensure that biotechnology does not endanger public health, but there are ways to do this without coercive manipulation of the food system. Consumer concern about food biotechnology is not irrational. As long as it is possible to accommodate the desire for alternative choices without unduly stigmatizing the products of biotechnology, we should do so. The ethical basis for this prescription resides in the importance of minority rights, consumer sovereignty and the principles of informed consent.

CHAPTER 5

ANIMAL HEALTH AND WELFARE

Like any animal production technology, drugs or feeds derived from biotechnology can have adverse effects on animal health. Whether achieved through breeding or through transgenic methods, genetic modification of animals can also result in dysfunctions severe enough to constitute cruelty (Broom 1995). In one of the first attempts to apply genetic engineering to an agricultural animal, researchers at the US Agricultural Research Service's (ARS) Beltsville, Maryland station inserted the gene for human growth hormone into pig embryos in one of the early experiments to apply biotechnology to food animals. The animals experienced a painful arthritic condition that ultimately led researchers to terminate the experiment and to euthanize the pigs. Critics of food biotechnology were quick to seize upon these experiments as evidence for the unacceptability of genetic engineering in animals. (Fox 1992a; Kimbrell 1993) Bernard Rollin, the leading philosophical analyst of animal biotechnology, writes, "opponents of genetic engineering of animals are right to fear that such engineering will proliferate animal suffering, though they are wrong in thinking that it must do so" (Rollin 1995, p. 181)

As in previous chapters, it is helpful to distinguish root issues from procedural questions. In this instance the root issues concern the basis of our moral concern for animals, and the nature of our obligations to them. These deep and important philosophical issues are intertwined with some of the most complex, pervasive and enduring philosophical matters: the nature of morality itself; the nature of consciousness; and the relationship between human spirituality and the material world. It is important to inquire into these matters, but it is unreasonable to think the basis of our moral concern for animals or the nature of our obligations to them can be settled either to the general satisfaction of interested inquirers, or even, perhaps, with respect to our own conscience. The procedural issues concern methods for coping with the potential for uncertainty and contentiousness that attends any human use of non-human animals. In this chapter, it is root issues that receive the bulk of our attention, though one important procedural point is noted early on. Procedural issues are more prominent in the succeeding chapter on animal cloning. The division of intellectual labor between this chapter and the next is thus to focus on basic animal ethics and genetic engineering here, and to defer both the discussion of cloning and the ethics of animal biotechnology policymaking to Chapter 6.

Rollin's describes his view of the root issues as "the consensus social ethic for animals," and doubtless there is wide agreement that "the plight of the animal," to use Rollin's phrase, must be part of any ethical evaluation of the genetic engineering of food animals. The effects of genetic engineering on animal health were extremely controversial during early phases of public debate on biotechnology, in part because rBST raised a constellation of problems that included social consequences, labeling and food safety, as well as animal health. By the time that products from crop biotechnology appeared on grocery shelves in the late 1990s, public controversy over genetic engineering had subsided and all the attention was being given to cloning. By the time that Dolly, the first mammalian clone announced in 1997 died in February of 2003, animal biotechnology had come to be regarded largely as a medical technology. Despite many efforts, neither gene transfer nor cloning have emerged as important technologies in the food system. The principal exception is genetically transformed fish, which were introduced for sale to the novelty aquarium market in 2004 and may yet appear as food products by 2010. As the Beltsville pigs fade from memory, Rollin's concern for "the plight of the creature," may never become a major issue in food biotechnology. Still, it would be remiss to neglect the possibility, and for this reason the genetic manipulation of animals raises some of the most challenging ethical issues in agrifood biotechnology.

ANIMAL BIOTECHNOLOGY AND FOOD

Animal biotechnology is the application of recombinant DNA techniques to animals. For purposes of this book, the two leading forms of animal biotechnology are genetic engineering and cloning. As with plants, genetic engineering involves the introduction of transgenes into the DNA of an animal, and as with plants, the potential for such introductions does not appear in principle to be limited by the source (e.g. the species) of the transgene. For cloning, there is no direct analog with plants because asexual reproduction of plant tissue is a fairly routine process, practiced by home gardeners who work with plant cuttings. During the early 1990s animal cloning was discussed frequently alongside genetic engineering as a promising application for agriculture, but the technique being discussed was the physical separation or splitting of at the blastocyst stage. Both halves of a split embryo (indeed more splits can be made up to a limit of about six) have the potential to develop into genetically identical animals, or clones. Animal cloning took on a different meaning and attained great significance in the public mind after the 1997 announcement that researchers at the Roslyn Institute had produced the sheep "Dolly". The ethical issues associated with embryonic and adult cell mammalian cloning of animals are taken up in the succeeding chapter.

Both genetic engineering and cloning can, in principle, be applied to animals of virtually any species, and for a wide array of reasons. Most of the past interest in animal biotechnology has focused on vertebrate species, though a number of ideas are currently being developed to transform arthropods. Among vertebrate species, much of, if not most of, the genetic engineering and cloning research has been done on rodents. This research aims either to achieve basic advances in genetics and genetic manipulation, or to further applications of relevance to human medicine and public health, and can, for convenience, be referred to as medical biotechnology.

Rollin's discussion of animal biotechnology in *The Frankenstein Syndrome* was focused equally on medical and agricultural applications.

Even when mouse biotechnology is excluded, it is likely that many of the most contentious applications of genetic engineering to animals are medical and fall outside the parameters of food and agriculture. This fact simplifies the task in this chapter enormously. By limiting the scope of discussion to genetic engineering of animals intended for food and fiber production, we bypass the issue that Rollin identified as the most difficult ethical dilemma in animal biotechnology. Rollin, for example, discusses the possibility that medical researchers might transform animals so that they exhibit the symptoms of painful genetic disease in order to search for possible cures. On the one hand, the modification of an animal with the express purpose of making it suffer seems ethically wrong. On the other, the purpose of relieving human suffering may override this harm. Although this problem will be discussed in more detail below, the question of whether this kind of research is ethically acceptable (or perhaps even ethically required) falls beyond the scope of agricultural ethics. No one in agriculture is proposing genetic transformations that will intentionally cause animals to suffer.

Before moving beyond the discussion of medical applications entirely, it is important to consider the distinction between agricultural and medical biotechnology a bit more closely. Authors who discuss animal biotechnology often recite a list of applications that include "gene pharming," or genetically engineering animals so that they will produce pharmaceutical products in their milk, the genetic modification of animals to serve as models for research on human disease, and xenografts, animals that are genetically engineered to be human organ donors. All three of these applications (and especially gene pharming and xenografts) are likely to be performed on classic agricultural species such as sheep, cows, goats and pigs. Through the mid-1990s there both proponents and critics tended to include these applications as examples of agricultural biotechnology. Yet all of three of these applications might more readily be characterized as medical biotechnology. Opponents of biotechnology in agriculture have an obvious incentive to include more sensational applications simply as a tactic to incite public outrage. Proponents also had tactical motives for doing so, though they are less evident. During the decade beginning in 1985, researchers specializing in the reproduction of sheep, cows, goats and pigs were mostly employed by agricultural research agencies (such as state or federal agricultural experiment stations). As medical research opportunities began to blossom, they found such themselves undertaking research intended to assist these new applications and obtained funding from public and private sources (such as the US National Institutes of Health) more typically associate with medicine than agriculture. However, they continued to report to agricultural research administrators, and to interact with farm groups. Partly from habit, perhaps, but also because farm groups think of themselves as the constituency and primary support base for research at agricultural institutions, researchers have an incentive to describe their projects as if they will benefit animal producers by providing new or higher value added products.

Yet the production of pharm animals, research models and transgenics will be minuscule in terms of animal numbers when compared to traditional food animal production, and will almost certainly be done under highly controlled conditions. It is likely that all of these animals will be owned by drug and medical supply companies, who may hire a handful of people for ordinary husbandry work. Promoting such developments as "good for agriculture," is thus ethically questionable, if not mendacious. Clearly they are good for the scientists who work or are trained in agricultural institutes and veterinary colleges, but it is unlikely that any of these applications will benefit many individuals or firms involved in agriculture. This kind of strategic behavior does not harm any animals, to be sure. As such it is a procedural rather than a root issue. The wrong here concerns the way that science is interacting with the public, rather than what they are doing in the lab.

Nevertheless, gene pharming, disease models and xenografts are not agrifood biotechnologies. As we turn to root issues, we note that the root issues of agricultural and medical biotechnology differ in important respects. Whatever we think about our moral relationship with animals, the root issues of gene pharming, research models and xenografts are shaped by the compelling human needs that these applications address. Agricultural biotechnology may help the hungry by lowering the price of food, or by increasing food production in ecologically marginal places, but this is a compelling need of a very different kind. For one thing, it is difficult to imagine any *animal* biotechnology that will be so compelling. The needs of starving people are met by crops, not animal production. For another, it is impossible to point to a particular famine victim and say that this individual can be saved from starvation, if only a certain amount of animal suffering is permitted. Yet it is tragically easy it is to find such compelling cases of individualized human need for a particular drug, research on a devastating disease, or an organ transplant. Biomedical uses of transgenic animals present cases for which animal suffering might be thought justified; food uses do not.

The overwhelming majority of people see no ethical problems with using animals for food, but as Rollin notes, people in industrialized countries are becoming increasingly less tolerant of animal production practices that subject animals to pain, suffering, fear and stress. Early public opinion studies that attempted to rank the degree of ethical concern associated with various forms of biotechnology reported a result that surprised many: a greater percentage of respondents reported ethical concerns in connection with animal genetic engineering than with respect to genetic engineering of human beings (Hoban and Kendall 1993). Although subsequent polling has not replicated the methods of this early study in a manner that would permit direct comparison, high levels of public concern with both genetic engineering and animal cloning have continued to be supported by more recent polls (Pew Initiative 2005). It is reasonable to surmise that part of the reason people found animal biotechnology morally problematic in the early poll was associated with current and future biomedical uses of animals. However, more recent studies provide ample evidence for the suggestion that people wonder whether the genetic transformation of food animals has the potential to create new or exacerbate current food animal production practices that are ethically questionable, if not clearly unacceptable. The plight of the food animal is at least one of the main bases for this concern.

ANIMAL BIOTECHNOLOGY AND "THE PLIGHT OF THE CREATURE"

Before addressing the root issues, it is useful to survey some of the ways that genetic technologies might affect animal welfare. Biotechnology can affect how animals fare or, as Rollin has it, their plight in two distinctive ways. First, animal drugs (such as rBST) and possible feeds and feed additives can be produced using biotechnology. Like drugs or feeds produced through conventional means, these products have the potential to affect animal health and nutrition. Second, genetic engineering and other forms of biotechnology can be used to affect the genetic constitution of food animals themselves. This form of biotechnology is capable of making significant changes in animal phenotypes, hence it is not surprising that such changes can have attendant effects upon animal welfare. Each of these modes demands more detailed scrutiny.

Drugs and Animal Feeds from Biotechnology

Pharmaceuticals represent one of the largest and most lucrative uses for biotechnology to date. Yet there are important differences between the way that drugs and feeds are used on animals and the way that we think of human drug therapies or foods. Here the case of rBST continues to be a very relevant and illustrative example. rBST generated a great deal of reaction from advocates of animal welfare. Their criticism took a sophisticated philosophical form quite early in the debate and continued long past 1992 when rBST was approved in the United States. Gary Comstock published a detailed description of animal welfare impacts both from the topical administration of rBST and from increased susceptibility to stress-related bovine diseases such as mastitis (Comstock 1988). Sheldon Krimsky and Roger Wrubel summarized the controversy over rBST and animal health in their 1996 book, giving prominence to the opinions of David Kronfeld, who cites a litany of pathologic changes in cows associated with the use of rBST (pp. 176–179; see also Kronfeld 1993). If such allegations are true, how is it that rBST was approved for use in the United States? The answer to this question lies in partly in the technical literature on rBST and animal health and partly in the way that US regulators chose to interpret their legal mandate at the time that rBST was reviewed. Dale Moore and Lawrence Hutchinson summarize a large technical literature on rBST and animal health with the conclusion, "When animal-health effects have been documented in BST studies, they have generally been shown to be secondary to increased milk production, indicating the importance of excellent nutrition and management if BST is used to enhance production," (Moore and Hutchinson 1992, p. 122)

The boosters who defended rBST argued that rBST increases milk production, and that increasing milk production is linked to detrimental impact on animal health. That is, high producing animals tend to have health problems, though these problems can be minimized with "excellent nutrition and management." Administering a dose of rBST puts an animal that might not otherwise be a high milk producer into the high producing group. Once in that group, they tend to exhibit the health problems of high producing animals. This point, which is of critical significance in the analyses of Comstock and Kronfeld, is not disputed by the defenders of rBST. But does rBST cause problems for animal health? Here we must parse the causal claims carefully. It seems clear that rBST causes an increase in milk production. Furthermore, it seems clear that something in the physiology of high producing dairy cattle causes a susceptibility to the so-called production diseases (such as mastitis) of concern to Comstock and Kronfeld. Here we have a case where X causes Y and Y causes Z. Z is production disease, a class of outcomes of clear significance with respect to animal welfare. Y is increased milk production, not necessarily of moral significance and X, of course, is rBST. The defenders of rBST seem to be saying that since Y, a class of events *not* having moral significance modulates between X and Z, then X is not the cause of Z and should not be held responsible for the moral harm associated with Z.

But the argument in defense of rBST can be given a further development that may make it seem a bit more persuasive. Although the argument is never made explicit, it might go something like this:

→ Since there are other ways of increasing milk production (such as feed regimens or conventional breeding) that are legal, it would be prejudicial to ban rBST.

→ Furthermore, there are ways to control the incidence of disease through careful management, and to treat resulting diseases using standard veterinary approaches.

∴ Therefore, no animal health affects (of regulatory significance) are attributable to rBST.

Here we still have original facts (e.g. X causes Y and Y causes Z), and we add some normative information, namely that there are other possible causes of Y (feed regimens and conventional breeding). Furthermore, these causes (call them X_1 and X_2) are legally permitted. So the argument now states that since the transitive causal relationship between X_1 and X_2 causing Y and Y causing Z does not provide regulatory grounds to ban X_1 or X_2, then the transitive relationship between X, Y and Z provides no regulatory ground to ban X.

But it is far from clear that the argument holds up if “ethical” is substituted for “regulatory”. Animal producers may have the legal right to try and increase milk production through manipulating feed regimens or genetics, but it does not follow that they are morally justified in either activity if doing so places their animals at substantially increased risk from production diseases. The proper moral conclusion may well be to rethink the entire complex of productivity enhancing technologies. Regulators reviewing rBST did not have this option, and it was never considered in the rBST literature. It may be naively idealistic to think that scientists, animal drug or feed companies or producers themselves will alter their behavior in accord with such ethical considerations. Dairy and meat industries alike are extremely competitive, so one does not deny oneself advantages that less scrupulous competitors are free to exploit. Nevertheless, the example of rBST illustrates the kind of ethical issues that can arise in conjunction with animal drugs, and they are quite unlike anything discussed in human medicine.

After more than a decade of use in the United States, one might think that the facts would be in and we would be able to say unequivocally whether critics or defenders are right. In fact, it should not be surprising to learn that there are still two points of view. Monsanto, the maker of Posilac™, the trade name for rBST, reports that the dire predictions of animal health catastrophe simply have not materialized. A brief scan on "bovine growth hormone" in any World Wide Web search engine will turn up any number of opposing points of view. Objective research on such issues is notoriously difficult to conduct due to the fact that all of the people who have relevant data (e.g. Monsanto, dairy farmers and veterinarians) have reasons either to prefer a particular verdict or to keep the data to themselves. It may be more telling to note that as of 2006 rBST has not been approved for sale in Canada or Europe, despite the fact that Canadian dairymen are reputed to be crossing the border to buy it in the US in significant numbers.

But the facts in light of experience are actually far less relevant to the ethical issue than might be initially thought, in any case. If Monsanto's current statements are true, the Comstock and Kronfeld were just wrong about the facts, and so were the technical studies summarized by Moore and Hutchinson. With different facts, the ethical evaluation would certainly reach a different conclusion, but that does not change the questionable treatment of causation, moral responsibility and regulatory relevance that accounted for the decision permit the sale of rBST in 1992. The ethical critique that has been given here focuses on a way of thinking through the links between animal drugs and animal welfare, especially as it relates to production disease. It reveals a lapse in the way that scientists and animal industries tend to think about animal welfare, or at least the way they did think in 1992. If rBST is not causing harm to animals, we can rejoice that the experts were wrong, but it does nothing to change basic argument given here.

Before moving on to transgenic animals, it is also worth stressing the irrelevance of the fact that rBST involved a genetically engineered bacterium to the above discussion. *Any* new drug might raise such issues without regard to how it is discovered or how it is manufactured. Biotechnology is relevant to such discussions to the extent that genetic technologies increase the range and effectiveness of the things that human beings are able to do with pharmaceuticals. If the pattern of analysis applied in the rBST case continues to be the standard for animal health products, we may not rest easy about the plight of the creature in a world of high-tech animal drugs, but this is a general problem in the ethical evaluation of new technology (in this case new pharmaceutical technology) and not a problem that has unique origins or features that arise in conjunction with recombinant techniques.

Transgenic Animals

The potential for transgenic animals raises more difficult philosophical issues. Many experimental modifications of animal genomes appear to have had little impact on animal health or cognitive stress, leading Ian Wilmut to note that, with the exception of the Beltsville pigs, "the effects of genetic change on animal welfare are usually trivial," (Wilmut 1995, p. 241). Rollin begins his less optimistic discussion of "the plight of the creature" with a history of attitudes toward the moral status of animals up to the present day consensus ethic that is the basis for his philosophical position. The balance of the 80 page chapter takes up three specific ethical issues associated with genetic engineering of animals: the welfare of agricultural animals, the engineering of animal models for human disease, and ethical issues in the patenting of animals (Rollin 1995, pp. 137–218). The issues of patenting and intellectual property are discussed in Chapter 9. As already noted, ethical issues involving the use of animals in medical research fall beyond the purview of a book on agrifood biotechnology.

This leaves Rollin with a relatively short (seven pages) discussion of the actual effects of biotechnology on food animals. The section begins with description of the Beltsville pig experiments described above, along with sheep experiments also done by ARS, and a third experiment on cattle (pp. 188–189). In each case, dysfunctional results led to disease and indisputable suffering on the part of the animals. These experimental results with food animals contrast dramatically with mice that are genetically engineered to exhibit a number of different traits with little obvious effect on the animals' well-being (Pursel et al. 1989). Based on these results Rollin stipulates norms for research and commercial production of transgenic animals.

With respect to research, institutional review boards (IRBs) "should demand that, in pilot research on agricultural animals, a small number of animals be used and that early end points for euthanasia of animals be established in advance and implemented at the first sign of suffering or problems that lead to suffering, unless such suffering or disease can be medically managed" (Rollin 1995, p. 189). It is commercial production, however, that poses the most serious threats to animal welfare. Rollin notes that genetic engineering may make animal suffering far more profitable than it currently is. One possibility is simply that clearly dysfunctional animals will prove useful as producers (e.g. bioreactors) of valuable products. Another is that genetic engineering may be used to make animals more tolerant of cold or dehydration, with unknown effects on animal suffering. (Fox 1992b, p. 217; Rollin 1995, p. 192) In response to these possibilities, Rollin calls for applying a principle of "conservation of welfare" to commercial food animal production: no genetic engineering will be permitted that makes the animal worse off than a non-genetically engineered animal in comparable circumstances (Rollin 1995, p. 179).

Rollin's reliance on the conservation of welfare principle results in some surprising ethical conclusions. For example, "if we could genetically engineer essentially decerebrate food animals, animals that have merely a vegetative life but no experiences, I believe it would be better to do this than to put conscious beings into environments in which they are miserable, though again this seems aesthetically abhorrent to us (Rollin 1995, p. 193). Such animals feel no pain and are in this sense are better off than normal sentient animals (e.g. capable of experiencing pain or frustration) living in conditions that are commonplace in confined animal feeding operations (CAFOs), today. While it is unlikely that genetic engineers will be producing decrebrate animals anytime soon, there are, in fact, quite realistic transformations to which the principle of welfare conservation might be applied. Peter Sandøe has reviewed the results of animal behavior research done on blind hens. This research indicates that blind hens experience far less physiological stress in crowded conditions than do sighted hens. There are measurably lower levels of aggressive behaviors such as feather pecking when blind hens are kept in conditions typical of confined broiler or layer production. This leads Sandøe to propose that one could argue for developing blind hens (whether through breeding or biotechnology) as a response to animal welfare problems in the poultry industry (Sandøe et al. 1999; Gamborg and Sandøe 2002). Rollin's 1995 discussion of the principle of conservation of welfare would certainly appear to support this conclusion. This is an important indication of where Rollin's view might differ from that of other advocates, for while Rollin is deeply concerned about animal suffering, he has long held the view that it would not be wrong to change the kind of beings that animals are (Rollin 1986).

Thus genetic engineering of food animals can lead to at least three kinds of impact on the lives of animals:

1. inadvertent and unwanted dysfunctional states calling for euthanasia of experimental animals;
2. unwanted but anticipated dysfunctions that are accepted by commercial producers because of the commercial value of the affected animals; and
3. intentional transformations that cause uncertain and controversial changes in the quality of animal experience.

Rollin has given us an application of what he takes to be the consensus social ethic with respect to each of these, but people taking a different ethical stance might disagree.

THE MORAL STATUS OF ANIMALS

Only three decades ago, debate over the moral status of non-human animals and the ethical significance of human use of these animals was infrequent. Ruth Harrison's *Animal Machines* (1964) precipitated four decades of intense debate, and a proliferation of philosophical treatments of the moral status of animals. Two of these, Peter Singer's and Tom Regan's, have become typical of the main strands in the animal rights movement, and are the most frequently cited works on animal ethics. A third tradition follows Kant in recognizing a form of duties to animals, while denying that animals have moral standing in their own right. Rollin's view, introduced above, is in some respects a philosophical mongrel grounded in the pragmatic tradition of philosophy. Arguably, however, the pragmatic approach provides the most satisfying moral guidance for animal agriculture in general. In opposition to Rollin's views on the permissibility of genetic modification, however, a number of authors have proposed specific objections to animal biotechnology.

Peter Singer's Utilitarianism

Australian Peter Singer published a book review of an early collection of essays on the moral status of animals in 1973 that, more than the essays he was reviewing, spawned the present philosophical literature on animal welfare, animal rights and animal liberation. Like his article on famine published a year earlier (Singer 1972), the first animal liberation article demonstrated both Singer's flair as a writer, and his ability to shock the world with philosophical positions that are little more than strict derivations from utilitarian moral theory. As already noted utilitarianism calls for balancing the trade-offs between cost and benefit or pleasure and pain at some optimum level. This means, clearly enough, that the pleasures of one person or group can come at the expense of another party's pain and suffering only when the pleasures can be said to outweigh the pains.

With a directness that is rare in philosophy, Singer compared the suffering of animals used in food production with the benefits that people derive from eating them. In light of current nutritional findings (better supported by the end of the twentieth century than when Singer wrote), it is doubtful that the aesthetic and nutritional benefits that humans derive from eating meat are strictly comparable to the discomfort and pain suffered by farm animals, so Singer concludes that the current system of animal agriculture cannot be justified (Singer 1973, 1975, 1995; Mason and Singer 1980). What is revolutionary in Singer's utilitarianism is his discussion of animal sentience and his use of this notion to ground a rough and ready conception of harm to animals. In Singer's view, sentience indicates a minimal level of mental capacity associated with the ability to experience pain and suffering (or satisfaction and happiness). Singer argues that those sentient experiences must be weighed against the (admittedly more complex) experiences of human beings in moral decision-making. His application of the utilitarian maxim aims at optimizing the total balance of "positive" (i.e. pleasurable or satisfying) and "negative" (painful, harmful or dissatisfying) sentient experience without regard to who or what is doing the experiencing.

This way of considering the sentient experience of animals in moral decision making can be extended and modified in a number of ways. For example, Richard Ryder defends a position on the moral significance of sentience that is very similar to Singer's. However, Ryder makes the philosophically crucial distinction between philosophies that permit welfare trade-offs between sentient individuals (e.g. one individual's pleasure compensates for another's pain), and his own view that it is the trade-off between pleasure and pain for an individual sentient being that matters. Utilitarians are traditionally committed to decision rules that aggregate costs and benefits to all affected parties; hence Ryder denies being a utilitarian. This means that Ryder would be even less receptive than Singer to a food technology that promised human benefit at a cost to the welfare of animals (Ryder 1990, 1995). Human/animal trade-off questions are crucial in biomedical ethics, where the issue is using transgenic animals for drugs, diagnostics, research or even organ transplantation. With respect to food biotechnology, where human needs are unlikely to be so compelling, the difference between Ryder and Singer may be academic. Neither would be willing to countenance significant animal suffering for the conveniences human beings derive from intensive animal production. What does matter for both is that sentience is the criterion for moral standing, and that food and agricultural production technologies which *worsen* the status quo for animal suffering are morally unacceptable.

It is neither obvious not indisputable how this ethic might be applied to the problems in biotechnology reviewed above, but it is reasonable to conclude that Singer's utilitarianism would accord closely with Rollin's consensus ethic (though as will become clear below, Rollin's views are in certain respects closer to Ryder's than to Singer's). Clearly any utilitarian of Singer's general ilk would find Rollin's prescriptions to be moving in the right direction with respect to current and possible future practice. The only question is whether they go far enough. A strict utilitarian such as Singer would share Rollin's view that "decerebration" is morally preferable to placing an animal in misery. Significantly, Sandøe also reasons from a utilitarian view when he makes the case for blind hens. It would be better of course (for Rollin as well as utilitarians) to have animals adding to the positive quotient of sentient experience, but if there is a way to eliminate deficits due to suffering it will be justified, even if it means eliminating the capacity for sentience altogether.

Tom Regan's Rights View

Tom Regan's *The Case for Animal Rights* (1983) is still probably the most exhaustive philosophical study of the moral status of animals more than two decades after its initial publication. This detailed and careful analysis of alternative philosophical positions rejects utilitarianism because it permits the use of individuals (including individual human beings) as a means for maximizing the aggregate total of sentient pleasure. Regan provided a lively and highly readable summary of his critique of utilitarian views in a 1986 article that shares the title of his 1983 book, and his complete development of "the rights view," as he calls it, has been reiterated in a form that should be accessible to most readers in *Animal Rights and Human Wrongs* (2003). Regan also rejects "indirect duty" views (see below) because they deny the possibility of owing moral duties to the animals themselves. Regan winds up with a rights view that recognizes the integrity and value of each individual animal, while also providing exceptions for cases where animal interests conflict directly with vital human rights. In such cases, human rights will take precedence (Regan 1983, 2003).

In Regan's view, an animal rights position requires moral vegetarianism. It is right to take an animal's life for human food only in life threatening circumstances. That applies to few of us, and even then, rarely. This makes much of food animal agriculture thoroughly beside the point, and there is, in fact, virtually no discussion of how animals fare in differing production settings in Regan's 1983 book. It might still be meaningful to ask whether genetic engineering could be performed on dairy cows or laying hens without violating their rights, but the spirit (if not the letter) of animal rights views would appear to preclude any genetic manipulation that was not (as with human genetic manipulation) intended solely for the benefit of the animal itself. Unfortunately, Regan was less than forthcoming with respect to this question even in a publication nominally devoted to animal biotechnology (Regan 1995).

Perhaps it is all just too obvious. Steve Sapontzis develops an animal rights analysis of animal biotechnology that makes the point clear:

> Overcoming our species prejudice and creating a world in which we treat those who are powerless against us sympathetically and fairly is what "animal rights" is about . . . . So, if animals do not yet have rights, it is not due to an inadequacy on their part but to a failure on ours—our failure to be fully moral agents. Overcoming our instinctive human chauvinism to adopt an animal-respecting moral perspective is need to erase that failure. Part of that transition would be acknowledging that the generic [sic] identity of animals is not a resource to manipulate for human taste, profit, curiosity or health without respect for the well-being of the animals themselves. (Sapontzis 1991, 184–5)

Sapontizis' emphasis on the genetic identity of animals anticipates the discussion of animal *telos*, below.

Kantian Views and the Broader Philosophical Tradition

The German philosopher Immanuel Kant believed that it was wrong to mistreat animals not because any harm was done to the animals themselves, but because doing so would be detrimental for the character of the abuser. One might become so habituated to abuse that one would be tempted to treat humans in the same way. This "indirect duty" view holds that cruelty is wrong, but not in virtue of a duty to the animal itself (Regan 1986, 2003). Stated this way, it is not a plausible account of how most people actually feel about animals; we generally think that our kindness is owed to them in their own right. Nevertheless, many people since Kant have felt that though it is wrong to abuse or harm animals, it is also wrong to place animals on an equal moral footing with humans, as the approaches of both Singer and Regan appear to do.

There are a number of ways to develop this position, many of which are not Kantian in the sense of sharing any fundamental assumptions or methods with Kant, and the matter of whether even Singer or Regan truly place animals and humans on equal moral footing is itself disputable. It is unlikely that technically oriented readers would find a careful discussion the nuances and distinctions among theses positions enlightening, and the arguments will be summarized broadly. Among philosophers, R.G. Frey was, in the early years, often called upon to oppose Regan in debate. Frey has defended the view that human beings deserve the full moral respect of rational agents (i.e. other human beings, at least, and possibly God, the angels and space aliens of superior intelligence) because their possession of language equips them with the capacity for interests that are of much greater complexity and richness than any simple sentient experience. Frey himself characterizes this as a utilitarian rather than a Kantian view, and Frey does not deny that animal suffering counts for something (Frey 1980, 1998). Yet the upshot of Frey's argument is that human interests (which would include the interest that animal producers have in continuing to farm) exist on an entirely different moral plane from the sentient experiences of brute animals. Charles Blatz has defended a similar view, arguing in more classically Kantian language that the difference derives from the fact that language and rational thought give human beings a capacity for autonomous choice. Blatz has applied this view in an argument intended to show the permissibility of genetically engineering food animals for the kind of production traits that would be economically valuable (Blatz 1991).

A further example can be found in Carl Cohen's contributions to *The Animal Rights Debate*, a book that arose from Cohen and Regan being called up to take opposing views on the use of animals in medical research. Here Cohen summarizes a variety of ways that one might argue philosophically for human rights, some clearly Kantian and some clearly not. He notes that historically all of these philosophical approaches have presumed a radical difference between the moral standing of humans and non-human animals, then suggests that Regan's attempt to extend the concept of rights to animals produces incoherent results. The persuasiveness of Cohen's argument here relies heavily on the compelling human needs that medical research is intended to address, and also on the very plausible claim that while it is possible to obtain consent from humans that are used as research subjects, on cannot do this with non-human animals. Much of the philosophical argument thus gets focused on what has come to be called the "marginal cases" problem: Why not human beings who have severely compromised cognitive capacity (and hence cannot give consent) for medical research? Singer, in particular, has argued on utilitarian grounds that instead of subjecting animals to the pain and suffering of medical research, it would be preferable to use human beings who are so compromised that they are beyond pain. Even a cursory discussion of this problem would take the present discussion far afield. Cohen's limited comments on using animals for food express sympathy with Regan's views, and he does not discuss genetic engineering except in the context of medical research (Cohen and Regan 2001).

Non-philosophers have also attempted arguments to stake out a similar position. In an early public meeting called to debate the ethics of animal biotechnology, David Meeker, then of the US National Pork Producers' Council, argued that while animal welfare counts, even relatively trivial human interests (such as testing his daughter's make-up on laboratory animals) override animal welfare concerns. (Meeker 1992). Unlike Meeker, Frey, Blatz and Cohen agree that many current human uses of animals are unacceptable. Genetic engineering is acceptable to Blatz because the "immiseration" (his word) of pigs does them no harm in itself. However, when harm is done for no overriding human purpose (in Blatz's view the creation of suffering animals like the Beltsville pigs is an example) genetic research cannot be considered part of an ethically defensible project. Blatz writes, "When the best we can say about an endeavor is that accidentally it might pay off in and ethically compelling way, while at the same time that endeavor is expected . . . to involve costs which we should avoid (other things being equal), then we should not engage in that endeavor" (Blatz 1991, p. 173). Presumably Blatz would find the desire to wear make-up a less than ethically compelling endeavor, as well.

ROLLIN'S CONSENSUS MORALITY

My survey of approaches to the root problem in animal biotechnology can be summarized as follows: Singer's utilitarianism accords with Rollin's principle of conservation of welfare, and not surprisingly, given the welfare orientation of sentience utilitarianism. A strong rights view proscribes the use of animals for food, so food animal biotechnology becomes moot. A variety of views consider animal welfare as one component of a more comprehensive assessment of the moral acceptability of human projects. Blatz's neo-Kantian criteria for judging an ethical project to be of "overriding importance," would likely find experiments or commercial release of transgenic animals acceptable so long as they, too, were consistent with Rollin's principle, and since Blatz does not find immiseration of animals problematic, he has left little room for objecting to Rollin's "decerebration." Blatz's view leaves the window open for commercial applications that are detrimental to animal welfare, so long as they are part of an ethical project of overriding importance. Relieving hunger might constitute such a project, but in a world where the quickest way to increase the human food supply would be to stop feeding grain for commercial livestock production, it seems unlikely that food animal biotechnology will be linked to compelling ethical endeavors in the foreseeable future. This means that Blatz's view, like Singer's, collapses into a prescription that is wholly consistent with Rollin's principle of the conservation of welfare, despite the dramatic philosophical differences between Singer's utilitarian and Blatz's neo-Kantian views.

It is possible that this is exactly what Rollin means when he talks about a "consensus social ethic," though in many contexts he seems to be referring to something more like "received public opinion." Excepting the most extreme philosophical positions, authors beginning from different starting points converge on norms for the use of animals that would probably be shared by the majority of people, even if they have given little thought to the problem. On the face of it, Rollin seems to be describing a kind of moral conventionalism here: what is ethical is what we agree on. Yet Rollin's earlier work on animal rights (Rollin 1981) belies that interpretation. There Rollin develops a position that, like Frey's and Blatz's, relies heavily on an analysis of interests and agency. His analysis results in the view that animals have a moral right to life—not an *absolute* right, but one that demands careful analysis and justification whenever it is abridged (p. 49). The 1981 book was also where Rollin first used the notion of *telos* to flesh out the content of our obligations to animals. Borrowed from Aristotle, an animal's *telos* is "a nature, a function, a set of activities intrinsic to it, evolutionarily determined and genetically imprinted," (p. 39).

As developed in *Animal Rights and Human Morality*, Rollins view was that we should think in terms of animal rights because:

- rights direct us toward proper respect for the interests of individual animals, as distinct from utilitarian approaches that aggregate welfare;
- the term "rights," conveys the seriousness with which we should deliberate in choosing actions that are contrary to animals' interests; and
- the laws needed to protect animals' interests would establish rights that could be claimed by advocates on animals' behalf.

Yet none of this offers much in the way of advice as to what sort of consideration is actually owed to any specific animal. Animals' rights clearly would be quite unlike human rights, and this is so because animals' *telos* are quite different from the purposes and ends that we associate with human nature. *Telos* specifies the content of animal rights and helps us come to terms with our respective duties toward them.

This philosophical position remains consistent with the view that Rollin espouses in *The Frankenstein Syndrome*. Although Rollin has continued to refer both to rights and to *telos*, it is questionable whether he would emphasize these terms had he the opportunity to begin anew. They have led to widespread misunderstanding. Rollin's commitment to rights as *the* fundamental moral notion is far weaker than Regan's, for example, and though Rollin is clearly influenced by Aristotle, he recommends the notion of *telos* more as a heuristic for considering animal needs and interests than as a naturalistic foundation for morality. Given this orientation, Rollin can find nothing wrong with using genetic engineering to change an animal's *telos*. This was, at least, the position that Rollin defended in 1985, expanded upon in the 1995 book, and reiterated in a 1998 paper. By 2003, Rollin's position had started to soften a bit. He has apparently been persuaded by an argument that goes something like this: The loss of a capability that would have contributed positively to a creature's well-being constitutes a form of harm, even if that loss occurs before the creature has had any opportunity to exercise the capability. Thus, decerebrate animals (or even blind hens) are worse off than normal animals of their species. This result almost certainly brings Rollin much more closely in line with the "consensus social ethics". Few people presented with the blind hen argument embrace the thought of blind hens. But Rollin's new view only complicates rather than settling the issue with respect to animal transformation through genetic engineering. The loss of a capability is indeed a form of harm, but it is not a decisive harm. It may tilt the balance of our moral deliberations against genetic engineering, but it also may not (Rollin 2003b).

Rollin has also clarified his use of the Aristotelean notion of *telos* in a 1998 paper. For Aristotle himself, there is an important difference between human *telos* and that of non-human entities such as rocks, plants and animals. For the non-human world, *telos* is a principle of explanation that accounts for certain dynamic processes in nature. The *telos* of an acorn is the oak tree it will become. Although this usage is at least superficially quite similar to the "genetic potential" sense that Rollin seems to have in mind, for Aristotle only human beings have a *telos* that gives rise to moral significance. Only the human *telos*—fulfilling our potential for rational life—involves moral dedication in its very being. Rollin acknowledges this point and also puts some distance between himself and some of the others who have embraced the idea of animal *telos* (discussed below). He traces his use of *telos* to lectures given by the Columbia University pragmatist John Herman Randall. Like John Dewey, Randall was particularly impressed with Aristotle's practice of drawing philosophical principles from particular situations. Both Dewey and Randall tended to use Aristotelean concepts as if Aristotle had coined them as purely contingent responses to practical problems (Rollin 1998). Whether or not this adaptation of Aristotle can be defended, Rollin's 1998 essay clarifies the philosophical pragmatism inherent in his general approach, giving even more support to the reading given of his "social consensus ethic" discussed above. Others have borrowed Rollin's terminology to articulate the strongest objections to genetic engineering.

ANIMAL *TELOS* AND OBJECTIONS TO TRANSGENIC ANIMALS

Although it has proved devilishly difficult to specify, the notion that animals have a "nature," with which humans should not tamper has broad appeal. Neither rights nor utility arguments provide an easy account of why this should be the case. To the extent that one can claim rights for individual animals, the argument provides a philosophical foundation for proscribing actions that harm an existing animal. But do unborn animals have rights to a particular constitution or *telos*? As Regan has argued, utilitarians make organisms into "vessels of sentient welfare," (Regan 1986). What matters is how these vessels are filled with experiences of satisfaction or suffering, not the shape or nature of the vessel itself. So although there is something less than unanimity on terminology, many critics of transgenesis have searched for something like *telos* to characterize what is at issue.

Although Bernard Rollin takes credit for introducing the notion of animal *telos* it is Michael W. Fox, the noted veterinarian and animal protectionist, who has done the most to popularize it. Others have used substitute phrases, appealing to biological or species integrity, or to the intrinsic value of animals. Some of these appeals are philosophically sophisticated, but more often they call for substantial philosophical amplification and development before one can discern what is actually being claimed. The most sophisticated discussions of *telos* and its moral significance have been offered by philosopher Alan Holland and theologian Henk Verhoog.

Fox, Rifkin and the Limits of Telos

Two of the most vociferous critics of biotechnology have used the notion of *telos* in public statements opposing genetic engineering of animals. Jeremy Rifkin was quoted as offering the following testimony before the Recombinant DNA Advisory Committee of the US National Institutes of Health in 1985: "The crossing of species borders . . . represents a fundamental assault on the principle of species integrity . . . such an intrusion violates the *telos* of each species and is to be condemned as morally reprehensible" (quoted in Mauron 1989, p. 252). Unfortunately, the term *telos* does not appear as an important concept in Rifkin's other writings, so we can only guess what he may have had in mind some 20 years ago.

Michael W. Fox made frequent appeals to the concept of *telos* in his early writings on genetic engineering of animals. He used the notion to propose ethical limits to genetic engineering, rejecting the idea that "we may alter the *telos* of an animal provided that there is no suffering." Fox defines *telos* as the "beingness" of an animal, "its intrinsic nature coupled with the environment in which it is able to develop and experience life." He lists ways of harming *telos* and goes on to say, "To contend that we can enhance the *telos* of an animal—and thus by extension believe that we can improve upon nature— is hubris" (Fox 1990, p. 32) In the same article he writes,

> The organism and its environment are one, and we recognize that unity and harmony as health and the full expression of the animal's *telos*. The *telos* is in part preconditioned (if not predestined) for, and dependent upon, a particular environmental niche and optimal conditions for its normal development and expression, which in turn means health and fulfillment for the animal. To deny such health and fulfillment by keeping the animal under impoverished and even stressful environmental conditions (as on a factory farm) is to cause harm. (Fox 1990, 34)

However, in Fox's 1992 book *Superpigs and Wondercorn*, *telos* is not even mentioned in the chapter on ethics. Elsewhere Fox defines the term there simply as "a Greek word meaning "end" or "aim"" (Fox 1992a, p. 22). He notes that scientists have ridiculed the notion of *telos*, and quotes M.J. Osborn to the effect that the idea is "contrary to any evidence provided by biology and belongs rather in the realm of mysticism" (quoted in Fox 1992, p. 23). Though Fox goes on in this book to complain (with some justification) that these scientists have willfully failed to understand the ethical concept of *telos*, he was, apparently, not in a fighting mood. He concludes: "But the debate about *telos* is a matter of semantics. The real issue is whether living things have inherent natural qualities that we tamper with at our peril. I believe that they do. If this is mysticism, so be it." (Fox 1992, p. 24). Though it may be clear enough what Fox is after, it is far from clear that he has found the philosophical formulation that articulates it.

Sapontzis (quoted above) writes that respect for the genetic identity of animals entails prohibition of genetic engineering on animal genomes, a phrase that echoes Fox's "genetic integrity." But as Rollin notes, these formulae connote more scientific backing than they have in fact. Biology does not recognize *telos* as a fact of nature or (like Aristotle) as an explanatory principle. Rollin's point in using the term is to signify the set of functional needs that an organism is genetically predetermined to have. This informs our understanding of what we ought to do for animals in our care: we should not only desist from activities that make them suffer, we should take action on their behalf to be sure that their functional needs are met. Yet Rollin's original applications of *telos* provide no basis for resisting genetic engineering that changes those functional needs (Rollin 1986, 1995). Even his modified views do not provide the kind of decisive reasons that Rifkin, Fox and Sapontzis all seek.

Telos as Species Integrity

"Species integrity," is another unpromising candidate. There are at least three distinct moral claims that one could attempt in appealing to species integrity. One is that naturally evolved species are either valuable in themselves, or contribute to ecological stability in subtle ways. A second is that human transgression of species boundaries is itself wrong. The third is that species integrity captures what is important about *telos*. Biologist Robert Colwell offers a version of the first argument (Colwell 1989) His concerns represent important contributions to the debate over the environmental risks of food and agricultural biotechnology. However, as Alan Holland has noted, Colwell's argument applies exclusively to species that evolve under natural conditions, and not to domesticated species. As such, it cannot have implications for the topic of transgenic farm animals (Holland 1995, pp. 299–300).

This general groping and flailing for language to address the squeamishness that many feel with respect to biotechnology has continued since the earlier edition of this book. The announcement of Dolly the cloned sheep sparked a new round of very similar objections focused on "repugnance," that are discussed in Chapter 6. Phillipp Balzer et al. (2000) have proposed that we describe the problem as an affront to the animal's dignity. Bernice Bovenkirk, Frans Brom and Babs van den Bergh have argued that the terminology of species integrity is "flawed but workable," in stressing the need for involving broader segments of the general public in these debates. Traci Warkentin (2006) has also relied upon the term integrity in recounting a strong sense of disapproval over what she describes as the "dis/integration" of food animals through the applications of agrifood biotechnology. While all these approaches succeed in conveying the authors' repugnance, they remain vague in indicating exactly where the target of disapproval lies.

Perhaps the most straightforward way to characterize what's wrong with "tampering," as Fox puts it, is to claim that transgenic manipulation of animals goes against divine command, that it violates the will of God. Theologians such as Andrew Linzey have investigated this line of inquiry (Linzey 1990, 1995). Linzey complains, "*we are now employing the technological means of absolutely subjugating the nature of animals so that they become completely human property* (Linzey 1990, p. 180, italics in the original). His argument rests primarily on the theological claim that God's law can only be fully realized when humans disavow all invasive uses of animals, but he also offers a secular *reductio ad absurdum*. Quoting Vernon Pursel of the Beltsville pig experiments, Linzey proposes that genetic engineers reject the notion of species integrity, finding all genetic material the same, "from worms to humans." (Linzey 1990, p. 184). From this Linzey claims to deduce that if it is acceptable to create transgenic animals, it must also be acceptable to create transgenic humans. Since this is, on Linzey's view, an absurd proposal, he concludes that Pursell's rejection of species integrity is mistaken. Since rejecting species integrity leads to transgenic humans, it is unacceptable to reject species integrity. Thus, Linzey concludes that the concept is valid.

This is not a respectable philosophical argument, though Linzey deserves some credit for ingeniousness, if nothing else. Not only does it beg the question of whether creating transgenic humans is wrong, it commits a composition fallacy. Composition fallacies purport to deduce facts about the whole from facts about parts. The fallacy occurs here when Linzey deduces that since Pursell believes that is permissible to create transgenic animals, and that animals and humans are "the same" in genetic terms, he is logically committed to the belief that it is permissible to create transgenic humans. At most, however, Pursell is committed to the belief that it is acceptable to manipulate human genetic material, and most definitely *not* to the claim that creating whole transgenic human persons is morally acceptable. As others have noted, composition and division fallacies plague many attempts to stipulate an objection to animal biotechnology in terms of species. A division fallacy draws an inappropriate inference from the whole to its parts. Even if, however implausibly, some harm is done to the species in creating a transgenic animal, it does not follow that the individual animal is also harmed (Verhoog 1992; Holland 1995).

The 1997 edition of *Food Biotechnology in Ethical Perspective* concludes the discussion of species integrity by finding that many of these arguments actually turn upon claims to the effect that the environment is harmed (see Chapter 7), or that metaphysical boundaries are violated (see Chapter 10). Such integrity or telos arguments are thus not really about animals at all. A third type of concern has been added to the mix in the intervening decade, one that Rollin himself admitted in the 2003 paper discussed above. This is that however flawed the term "species integrity" is with respect to identifying something biologically meaningful or relevant, it nevertheless serves as a way to move public debate over the appropriateness of animal biotechnology forward (Bovenkerk et al. 2001). Moving public debate forward is the focus of discussion in Chapter 11. While all these claims merit examination on their own terms, they do not bear on the concerns of the present chapter because they do not say anything at all about "the plight of the creature." In fact, all these forms of species integrity argument apply as readily to plants or micro-organisms as they do to animals. This indicates how far we have strayed far from the notion of an animal's functional needs that was Rollin's motivation for introducing the notion of *telos*, in the first place.

TELOS AND THE ORGANISM

Of the authors who have toyed with the wrongness of violating *telos* only two have managed to navigate the turbulent logical currents to produce arguments worthy of serious consideration. If violating *telos* is to be a claim that bears on human obligations to animals, it must specify some harm, neglect or disrespect that is done to actual animals, not to abstract entities such as species, or to parts of animals, such as their genes. This means that *telos* must be specified as something that pertains directly to the individual animal—to the animal as an organism rather than its genes or species—or to the relationships between human beings and other animals, understood as whole organisms. The Dutch biologist and theologian Henk Verhoog has offered the most extensive reasoning along these lines, but English philosopher Alan Holland has given the most philosophically sophisticated argument.

Verhoog on Telos and Intrinsic Value

Verhoog argues that *telos* is an implicit background assumption for accounts of abnormality and suffering. For Verhoog, it is impossible to give an account of suffering without reference to *telos*. Verhoog and Rollin agree in thinking that sentience views (such as Singer's or Ryder's) define suffering too narrowly, but Verhoog rejects the idea that human beings may relieve suffering by changing an animal's *telos*. Such modifications rob animals of their being as the product of evolutionary history (Verhoog 1992, pp. 274–276). In relying on evolutionary history to define *telos* Verhoog makes an implicit appeal to species evolution as the source of an animal's functional needs. In doing so he treats species as less changeable than most contemporary biologists would say they are. Verhoog, however, calls the priority of biologists' conceptualization of species into question, stating that those who use a scientifically based definition of species have simply begged the key moral question (Verhoog 1992, p. 277). The biologists' way of defining species cannot be simply carried over into a moral argument without assuming what needs to be proven. Molecular biology reduces complex functions and structures to genetic factors. Rollin believes that biologists who study speciation are best qualified to define the term "species" and he accepts their criteria for determining what is and what is not a species. These criteria suggest that there is no natural order to the particular distribution of species to which human beings have become accustomed. If species are in flux, it is more difficult to see how there could be something ethically questionable in rearranging them.

Verhoog does not question Rollin's account of the biologist's definition. Instead he suggests that Rollin has begged the central question in assuming that biologists are better qualified to define species boundaries than are ordinary people. He notes how the order of species is implicit in key categories of ordinary language. His position is that animals are co-evolved with humans into distinct species through a conceptual as well as a biological process (Verhoog 1992). The implication is that part of what it means to be human is to live among well defined animal species. While he does not supply a full argument for preferring the common sense, natural language notion of speciation, Verhoog is successful in demonstrating that mere assumption of disciplinary biology's superiority is a question begging failure to enjoin the ethical issue at its root. He laments the loss of a personal relation between the biologist and his object of study: "There seems to be a reverse relationship between the degree of reductive objectivation and the degree of moral relevance of the entities studied," (Verhoog 1993, p. 94). Verhoog does not provide an argument for using ordinary phenomenal experience of life as the basis for ethical judgments, rather than the molecular account of life, but he does show that neither Rollin nor the advocates of the view he represents have provided an argument either.

Rollin did not acknowledge Verhoog's views in the 2003 paper in which his position on changing *telos* has most significantly been modified. He was responding to Jason Robert and Françoise Baylis (2003), who had argued that human biotechnology is controversial because the boundary between humans and other animals is integral to our moral vocabulary. Technologies that challenge this boundary destabilize our ability to make moral judgments at all. Oddly, Robert and Baylis also write that modifications of non-human animals are non-controversial, though perhaps they are thinking of the mouse biotechnology that has become commonplace in medical research. Rollin extends their argument to any modification of *telos*, and on this basis admits that contrary to views he expressed earlier (Rollin 1985, 1995, 1998), changes to *telos* could, on the grounds Robert and Baylis note, involve serious ethical issues.

But note that even with this modification of his view, the ethical issues that get raised by changing animal *telos* really have nothing to do with the animals themselves. Rather, the problem lies in the way that the appearance of these disturbing animals has challenged our ability to think and communicate with one another. The harm here is to ourselves or at least to other human beings and the human moral community. It is only when one takes the further step that Verhoog takes that this can be seen as having anything to do with the plight of the creature. In saying that ordinary language and ordinary conceptions of species boundaries have moral priority over the theories of biologists, Verhoog is arguing that human-animal relations are *properly* constituted, conceptualized and regulated in conformity with these ordinary language conceptions. When our capacity to conceptualize human-animal relationships is challenged by new technology, this does violence to the relationship, itself. Thus, even if animals do not suffer in the sense of enduring pain or disease as a result of this change, their moral standing is challenged, and their capability of appearing to us as moral subjects is potentially threatened. Verhoog is arguing that in robbing animals of their ability to be seen by us as whole beings, representative of a natural kind, biotechnology is having an ontological impact on animals, at least in so far as they are capable of entering into moral relationships with human beings. As such, it is Verhoog's earlier arguments that pose a greater philosophical challenge to Rollin's view that changing *telos* does no harm to the animals themselves.

Holland and Neo-Kantian Arguments

Alan Holland offers his own argument against changing animal *telos* in a single paragraph at the end of a long and mostly critical article evaluating Fox, Rollin, Verhoog and others who have taken up the question of *telos*. There he states that even Rollin's claim that changing *telos* to relieve animal suffering,

> turns out to fall foul of something akin to Kant's proscription against treating rational natures, which are ends in themselves, as means—even as means which could be regarded as beneficial to the animal in question. It was on grounds just such as these that Kant condemned suicide . . . . changing an animal's nature for the sake of rendering it less susceptible to disease is less than respectful of that animal's nature, since it would involve subordinating the whole nature to the cause of relief from disease. Essentially, it puts respect for the states of a subject above respect for the subject. (Holland 1995, p. 304)

This passage is put forward within a carefully crafted context that provides all the proper disclaimers dissociating the argument from what Kant might have actually thought, given his view (discussed above) that we have no direct duties to animals at all. Holland's argument presumes that respecting an animal as an individual subject is coterminal with respecting its nature, something it derives in virtue of being an individual of a certain species. Is this another division fallacy? Perhaps not. Another concept from German philosophy may help.

Most contemporary readers encounter the concept of "species being," in Karl Marx's 1844 manuscripts on alienated or estranged labor. There Marx lists four ways in which the capitalist institution of wage labor harms the worker through estrangement. First, workers are estranged from what they make, which belongs not to them but to the person for whom they work. Second, workers are estranged from that portion of their life spent at work, as they come to see only the weekend, holidays and retirement as the times when they can realize their autonomously chosen life goals. Third, they are estranged from one another, since they must regard one another as competitors for jobs. Finally, they are estranged from their species being. Human species being is to be the organism, the being, that realizes itself through productive work. Marx argues that wage labor separates workers from what it means to be most fundamentally human (Marx 1988, pp. 74–78).

Now there is some risk that this reference to Marx will cause even more mischief than Rollin's references to Aristotle. Marx clearly thought that species being is possible only for creatures capable of having an intellectual awareness of themselves as members of a species. Humans do this but it is doubtful that cows, pigs or chickens do as well. Nevertheless, Marx is useful in the present context because each form of estrangement that he discusses is both psychological and material. Estrangement is psychological in that it is experienced as anxiety and anomie; it creates a kind of existential angst. Arguably, many workers never experience the angst of estrangement that Marx describes. Yet it is the material fact of separation or estrangement that is most significant for Marx, as it has been for other social critics. Aldous Huxley's *Brave New World* offers a nightmare vision in which the psychological peril of existential angst is relieved through drugs and (ironically) genetic technology, but the moral lesson of *Brave New World* is that such relief only makes the moral problem worse. It is wrong to educate, acclimatize or behaviorally condition humans so that they are estranged from their humanity. It would be equally wrong to attempt (or inadvertently affect) this feat with genetic engineering.

A great deal of moral philosophy that has been done on behalf of animals extends concepts that have traditionally been thought to apply only to humans beyond the human community. A similar move is being made here. Does it matter that in the present context we are speaking not of human nature or human species being, but of non-human animals? Does one do unacceptable violence to Kant, Marx and Huxley in making an analogous argument against genetic engineering of animals? Given that we routinely speak of animal natures, given that those who tend to sheep, cows, pigs or horses develop a fine appreciation of "the sheepness of the sheep, the pigness of the pig," it would seem that the burden of proof for falls on the side of *denying* animal *telos*, understood in this restricted sense. If *telos* is meaningful in this sense, why should we not *also* conclude that it would be wrong to genetically engineer animals that are incapable of participating in the *telos* characteristic of their species?

AGAINST CHANGING THE *TELOS* OF FOOD ANIMALS

Rollin may have reached the conclusion that such engineering is *not* wrong by adopting a radically individualistic notion of *telos*. Each organism has functional needs, and having a given set of functional needs may be typical of animals in given species. Knowing the needs typical of a given species then becomes a way of know the actual functional needs of any individual. But moral obligations are bound up entirely in meeting the needs of individual organisms, and nothing follows with regard to whether it would be permissible to deliberately bring into being a creature with an entirely novel set of functional needs. If this is Rollin's position, it has two possible unsettling implications.

First, it may follow that if it is permissible to estrange an animal from a given set of functional needs with genetic manipulation, it is also permissible to estrange an animal from functional needs through behavioral conditioning or even surgery. It is not clear how strongly *telos*, or the functional needs that define it, is genetically determined. If genetic determination is very strong, such non-genetic forms of estrangement are unlikely to be fully successful. Attempting them would constitute ordinary cruelty. If, however, functional needs are, as Fox and Verhoog argue, fixed by the interaction between genes and environment, Rollin's original view permits much broader manipulation of animals than it might have seemed. Sandøe's blind hens bring home the practical implications of a permissive view on genetic modification. Whatever we finally decide about a proposal for transforming animals, there is a problem with any philosophical principle that makes the case for transformation this easy, this one sided. As Holland notes, we seem to be in a mindset in which the animal's suffering is the only thing that prevents us from regarding it as a moral nullity, entirely at our disposal for the satisfaction of any need or desire. Dispose of suffering and we may indeed be Gods.

Second, if *telos* is radically individualistic, what would be wrong with the genetic modifications Huxley described in *Brave New World*? Such humans would not strictly be humans at all. They would lack ordinary human functional needs, and it would not be wrong to create such sub-human creatures. The Kantian argument brought forward, along with the Marxist twist added here, provides an account of why the *Brave New World* modifications are wrong. But an interpretation of *telos*, human nature or species being that is radically individualistic robs this argument of its moral force. Yet it seems morally arbitrary to attribute significance only to human *telos*, human nature or human species being, ignoring the received practice among animal care givers of recognizing highly analogous traits characteristic of other species.

Clearly the *telos* that is characteristic of any species (including humans) is instantiated only in the individuals of the species. If we recognize immorality in acts that would modify a human genome to the point that the resulting individual would no longer be characteristic of the human species, why is it not also immoral to modify the genome of other animals so that the resulting individuals are uncharacteristic of their species? Until someone can offer a non-arbitrary reason for making this distinction, radical forms of transgenesis for animals should be regarded as morally problematic. My only hesitancy in reiterating this conclusion, drawn initially in 1997, is the obvious point that there are many things we do to animals that we would regard as deeply problematic if they were done to humans. Eating them, for example. However, it is important to emphasize that here we are considering acts that are wrong not because of their affect on individual humans, but because they so vitiate our ability to make sense of humanity. On this point, my argument links with Verhoog's. The problem may lie in practices that disturb our ability to conceptualize our relationships with animals in moral terms. This is not a harm done to any individual animal, to be sure. It relates, nonetheless, to the plight of the creature, as surely as it relates to who we are, to human beings' conception of themselves as moral agents.

ANIMAL BIOTECHNOLOGY AND MORAL OBLIGATION

The above analysis supports the conclusion that forms of transgenesis that estrange an individual food animal from the functional needs, the *telos* characteristic of its species, are morally questionable and likely immoral. The fact that such transgenesis is done to relieve the potential for suffering is irrelevant. However, this principle may proscribe less than is initially thought. In the first place, few extant examples of transgenic animals appear to have such a dramatic effect on the individual animals. There may be little reason in the foreseeable future to apply such a radical form of genetic engineering to food animals, in the first place. The more difficult cases that Rollin considers arise in the arena of biomedical research. As noted at the outset, these cases involved compelling human needs. They are negotiated under an aura of emergency conditions and exceptional circumstances that simply do not apply to the discussion of food animals. Thus while the principle stated above would prohibit the use of genetic engineering to create a breed of decerebrate poultry, intended for intensive factory farming, it would not rule out every case in which genetic engineering might be used to relieve the suffering of animals being used in the exceptional circumstances of biomedical research. Such practices should not, it would seem, become too routine, but they would have to be subjected to a very different philosophical analysis, in any case.

The majority of moral duties relevant to food animal biotechnology are captured by Rollin's principle of conservation of welfare. We should not initiate production practices (using transgenics or other forms of biotechnology) that make food animals worse off than they are now. If that status quo can be maintained (at least), products to increase food quality or productivity are acceptable. If animal well-being can be improved through biotechnology, all to the good. Evaluating animal welfare is not easy (see Broom 1995), but the products of biotechnology do not present unique challenges. With Rollin (as with most mainstream animal protectionists and the general public), what counts is sentient experience of pain, fear, suffering and stress, along with traditional measures of animal health. While it would be inappropriate to sacrifice important human needs to the improvement of animal well-being, a strict logic of comparing costs and benefits to humans and animals should not be employed to rationalize actions that make food animals worse off than they currently are. The consensus morality is that food producers can do better, and they have a moral duty to try.

CHAPTER 6

ETHICAL ISSUES IN LIVESTOCK CLONING

The cloning of an adult sheep at the Roslyn Institute in Scotland was announced in February 1997. Dolly, the progeny of this experiment, became an international celebrity. The announcement of her birth precipitated one of the most heated debates over the ethical use of a biological technique. Much of the debate centers on the ethical acceptability of using the adult-cell nuclear transfer technique as a human reproductive technology. However, a number of empirical studies on public attitudes to agrifood biotechnology show that many members of the public view the cloning of animals from traditional agricultural species as an ethical issue in its own right. Some studies also reveal a reticence toward consuming meat from animal clones that far exceeds the general level of resistance to the consumption of foods from so-called GM crops. These studies indicate that in the public mind, at least, livestock cloning qualifies as an ethically significant form of food biotechnology (Torgerson et al. 2002). Accordingly, this chapter provides an overview of ethical issues in livestock cloning.

The discussion begins with a brief discussion of cloning, offering a few definitions and clarifications and moving on to general ethical issues or concerns that might be associated with cloning livestock. Some have alleged that environmental impact associated with livestock cloning, specifically as it relates to genetic diversity and monoculture, provides a strong case against the practice. I will argue that this is in fact a psuedo-problem, significant more for its role in shaping opinion than in any actual implications for diversity. The chapter then takes up four more substantive ethical concerns associated with mammalian cloning, especially as regards cloning of traditional livestock species such as sheep, pigs or cattle. First is the ethical consideration that must be given to the welfare of the animals involved in cloning research or, should the day come, commercial production of clones. Next, some of cloning's social consequences for the livestock production sector will be reviewed, as well as the ethical significance of links between human and animal cloning. Finally, the chapter reviews arguments for the conclusion that animal cloning is repugnant, a claim that itself has two implications. On the one hand, some claim that animal cloning is intrinsically wrong; on the other hand some make the weaker claim that repugnance is a sufficient reason for rejecting food products from cloned animals.

The analysis developed below supports the permissibility and value of animal cloning research, though it calls attention to crucial areas where the failure to follow fair and open procedures is itself ethically questionable. These procedural issues should be taken very seriously by cloning researchers as well as by public labs or private firms involved in the development of agrifood products associated with cloning. Chapter 11 provides an argument for the hypothesis that much of the opposition to cloning and genetic technology is motivated by a general feeling of foreboding about the drift of agricultural technology, and a feeling of being excluded from the social decision process. Genetic technologies are not singularly problematic; it is the general direction of technical change in agriculture that is at issue. As the general argument of the entire book suggests, genetic technologies may be singled out for criticism less because they are feared than because they are a target of opportunity for those who have deep qualms about the direction of change in our food systems (see Thompson 1998).

However, any adequate empirical analysis of the surmise offered in the previous paragraph is far beyond the scope of this book. The discussion of livestock cloning is, thus, inevitably somewhat narrow. Although some might advocate a more negative assessment of cloning than is proposed below on the grounds that it is just an instance of the agri-food system's pervasive tendency toward mindless and unfeeling technical "improvements," such critiques do a disservice when they fail to undertake a careful analysis that attempts to understand how specific effects are related to particular features of an agricultural technology. In the case of cloning, that analysis ends with the conclusion that to single out cloning is to promote a poorly informed and unsophisticated critique of what needs to be changed in agricultural technology. Any temporary political gains that might be gleaned from a rejection of cloning based on unsound arguments are repaid with further decline in the broader public's capacity to understand agriculture, its problems and prospects, and its role as the cornerstone for human civilization.

LIVESTOCK CLONING

The word "cloning" refers to a large class of reproductive technologies performed in laboratory, industrial and even household settings. Home gardeners who propagate plants with cuttings are performing a rudimentary form of cloning. The biological fact common to all forms of cloning is that the new organism or cell has the same genetic make-up, the same DNA, as the original organism or cell from which it was cloned. This is, of course, very different from sexual reproduction (common to most of the complex organisms that are the basis of food and agricultural production), where progeny reflect a recombination of DNA drawn from each parent. For convenience of discussion I will use the term "clone" to indicate the cell or organism that has been produced through cloning. I will use the term 'clonee' to indicate the cell or organism that has been cloned.

While cloning of plants is relatively routine, mammals have only been cloned during the past two decades. Cloning techniques are still emerging and being refined, so the term "livestock cloning" indicates an ill-defined class of approaches to asexual reproduction of farm animals. However, at this writing the approaches are essentially of two kinds. *Embryonic cloning* can be used to make multiple copies of embryonic cells, each of which will undergo cell division and growth, producing genetically identical animals. Embryonic cloning produces clones with no clonee. Rather, an embryo that might have developed to produce one adult organism is multiplied so that it produces two or more. It is *adult cell cloning* that has sparked debate since it was first announced by Ian Wilmut in February of 1997. Here, the DNA is removed from the tissues of an adult, developed organism and inserted into an egg cell that has had its own DNA removed (Wilmut et al. 1997). The terms “clone” and “clonee” are fully appropriate to describe adult cell cloning. The basic biology of adult cell cloning has been described many times before. Readers desiring a more detailed yet non-technical discussion of cloning should consult one of the books or articles that appeared after Wilmut introduced his cloned sheep “Dolly” to the world (see Silver 1997; Kolata 1998).

Both embryonic and adult cell cloning have been proposed for application in the production of animals for food, fiber or milk production, though the most likely near-term uses of both techniques are in research contexts. Embryonic cloning, for example, permits researchers to conduct a wide variety of traditional production studies (such as feed or drug effectiveness) on cohorts of genetically identical animals, thus providing a degree of experimental control over genetic variables. Since 1997 and for perhaps the foreseeable future, adult cell cloning has been most used in conjunction with genetic engineering. Since the rate of successful gene transfer and expression in animal species is small, researchers find it useful to clone those few individuals that result from successful gene transfer. Since it is not possible to determine success until an animal has developed beyond the point that embryonic cloning can be performed, adult cell cloning is, by necessity, the method of choice for this procedure. This chapter will focus on adult cell cloning of livestock species. This is not to imply that embryonic cloning faces no ethical challenges. Indeed, some issues that apply to adult cell cloning apply to embryonic cloning as well.

GENETIC DIVERSITY: A ETHICAL PSUEDO-PROBLEM

We may begin by reviewing why genetic diversity might be thought ethically significant in the first place. First it is important to distinguish the diversity of species within a wild ecosystem from the diversity of alleles in the gene pool of an inter-fertile species. Both forms of diversity are important in ecology, and both are used as indicators of ecosystem health. As such, diversity in ecosystems has been identified both as an indicator and an intrinsically valuable environmental characteristic. However, it is only the latter form of diversity, diversity of alleles in the pool, that is relevant to the current discussion. All the moral claims depend on a presumptive hypothesis of evolutionary biology. Greater variation in a species’ gene pool supports a higher capacity to evolve in response to environmental threats. A pathogen that attacks one particular sequence of DNA, or one particular protein synthesized by DNA, may be ineffective against another. Hence where it is possible for organisms in the species to have variation in the genetic sequence, it will improve the ecological fitness of the species to maintain this variability.

Genetic Diversity, Ecosystems and Agriculture

When speaking of wild populations in wild ecosystems, genetic diversity confers an ability to adapt to a changing environment of pathogens. This, in turn, gives the species more resilience, and hence a more secure hold on its ecological niche. If maintaining natural variety is itself a goal, genetic diversity is both an indicator of natural variety and a means to protect it. However, the case for agriculture is markedly different. Reducing genetic diversity is endemic to agriculture. When an ordinary peasant farmer selects seed to replant based on taste, color or drought tolerance, the plants grown from the chosen seed will have less genetic diversity (hence less fitness) than those in the wild population. A *land race* is a crop or animal variety created through this centuries long process of farmer trial and error. Land races survive not because they have a greater genetic capacity to resist environmental threats than their wild relatives do, but because farmers intervene in the environment to protect crops and livestock from at least some environmental threats—predation, competition for food, sunlight and water (see Vavilov 1992).

Compared to modem plant varieties and animal breeds, land races have much more genetic diversity. They will resist a larger array of diseases and will produce under a broader array of climatic conditions. James C. Scott (1976) argues that subsistence and industrial producers adopt distinct strategies for coping with risk in response to this situation. Peasant farmers must avoid the risk of starvation at all costs. They tend to maintain a high degree of diversity in their crops in order to decrease the chance of a total crop failure, even when doing so decreases yields in an average year. Industrial producers face financial risks, which are calibrated to the average year. They do not depend solely on their own farming for their food supply, and can afford crop failures so long as they do not occur more frequently than average. What they cannot afford is to produce less than average yields year in and year out, for the price of their commodity will tend to reflect the cost of production for producer's getting an average (or better) yield (Bellon and Berthaud 2004).

Subsistence farmers thus have an incentive to maintain the genetic diversity in land races, while industrial producers have an incentive to produce the highest possible average yield. In both cases, genetic diversity takes on significance because it can be a contributing cause in crop failure. In the subsistence case, crop failure leads inevitably to hunger and famine. In the industrial case, it leads to financial losses, which may be recouped in subsequent years. However, if all farmers are producing crops (or livestock) from the same, narrow gene pool, the chance that any given pathogen will destroy the entire industrial crop is greater than the chance that the same pathogen will destroy a crop grown from a land race. This does not rule out the possibility that genetic diversity in agricultural plants and animals might possess (or lack) some characteristic that would be causally related to a particular balance point between the maximal diversity of wild species and the narrow diversity of industrial crops. The main way that agriculture affects both the diversity of wild species in an ecosystem and the genetic diversity within wild species is when natural habitat is converted into agricultural production. Making an agricultural crop or livestock species more or less genetically diverse could certainly affect the rate of habitat conversion. Nevertheless, the usual arguments stressing genetic diversity in agricultural plants and animals stress the risks borne either by individual producers or by the human population at large when plant and animal diseases become epidemic (see Doyle 1985).

We may summarize the discussion as follows. Genetic and species diversity are important components of ecosystem health in wild ecosystems. If we have obligations to preserve wild ecosystems, then we have obligations to preserve and promote both forms of diversity. Agriculture necessarily involves some reduction in the ecological fitness of plants and animals and a corresponding intervention in the environment to protect the less fit organisms from threats that would destroy them in a wild ecosystem environment. As such, striking the balance point between increasing average yields and the ecological resilience of plant and animal species and varieties is a constant problem for agriculture. This agronomic problem becomes a moral problem to the extent that farming methods threaten food shortages, endangering the lives of the humans who depend on the food system in question.

Genetic Diversity and the Critique of Genetic Technology

Jack Doyle (1985) was one of the first to raise questions about the environmental impact of the new agricultural biotechnology, and much of his argument in *Altered Harvest* depended on considerations such as those reviewed above. In particular, the 1973 Corn Blight in the North American Great Plains formed a key foundation for Doyle's analysis. At that time, a vast majority of maize cultivars in use shared a common genetic source Texas T cytoplasm. The Texas T cytoplasm gene locus made plants vulnerable to Corn Blight, resulting a massive North American crop failure and temporarily high prices for cereals and animal feeds. According to Doyle, the problem was that cultivars lacked sufficient genetic diversity, hence were too widely susceptible to a particular disease. The narrowed genetic diversity of com cultivars had been brought about by conventional breeding techniques. Thus, Doyle cautioned, new biotechnologies (of which cloning would be a prime example) could inadvertently increase the risk of a catastrophe equaling or exceeding that of the 1973 Corn Blight.

Doyle popularized a kind of genetic diversity argument that has been linked to cloning by distinguished authors such as Paul Raeburn (1995) and Bernard Rollin (1997). Like Doyle, Raeburn is primarily interested in crops, and the moral significance of diversity owes to its role in averting the risks of widespread crop failure and famine. These issues are discussed in more detail in Chapter 7. Rollin, however, applies the argument to animals. Describing the narrowing of the gene pool in domestic egg production, for example, Rollin writes, "Given the advent of a new pathogen or other dramatic changes, the laying hens could all be decimated or even permanently destroyed because of our inability to manage the pathogen" (Rollin 1997, p. 31). He goes on to note that "agriculture's only safety net against ravaged monocultures are hobby fanciers . . . who perpetuate many exotic strains of chickens" (Rollin 1997, p. 31). Rollin thus reiterates an argument that Doyle and Raeburn made with respect to cereal grains in relation to poultry.

Yet the case for cereals is importantly different than the case for eggs. So what if a layer monoculture is decimated by disease? Egg prices will rise, to be sure, but the producers who are responsible for narrowing the gene pool in the first place will experience the brunt of the losses. If poultry producers are foolish enough to take this risk, they should be expected to suffer the consequences. This looks less like an ethical problem than an instance of just deserts. The cereals case differs from any livestock case in that catastrophic failures in any of the main cereal crops rice, maize or wheat could precipitate a global food crisis. Catastrophic failures in any single livestock commodity beef, pork and poultry would certainly create an inconvenience. Yet in virtue of the fact that livestock consume more protein than they produce, such an event would not negatively affect total global food supply. There may, as always, be tragic distributive problems associated with any economic disruption of the food system (see Sen 1981), but they operate independently of cloning, engineering and genetic diversity considerations.

In short, genetic diversity arguments applied to livestock do not hinge upon moral concerns. Disease resistance and resilience are components of average yield for crop farming and animal production. Farmers must strike a balance among all the factors that contribute to yield, but in normal circumstances finding that balance is consistent with the farmer's self-interest (Wooliams and Wilmut 1998). The balance becomes a moral issue when farming methods place the broader human population's food supply at risk. While this is a serious threat with respect to cereal crops, failures in livestock production do not lead to general famine. Nevertheless, the genetic diversity argument against cloning has been taken further by Lantz Miller (1998), who does not cite problems associated with famine risk.

Miller follows Rollin's reasoning in noting that narrow gene pools create an opportunity for the evolution of pathogens and the rapid spread of disease. Miller answers the "so what" question by noting that more animals will suffer. Hence, genetic diversity in livestock herds is important because animals will suffer as a result of catastrophic disease outbreaks is higher and the chance of such outbreaks is higher when cloning technology is used on a widespread basis. In addition, he notes that a herd of clones is less fit than a herd of naturally bred animals. Miller seems to attribute ethical significance to the degree of fitness. Yet his argument here is unclear, especially in light of the fact that agriculture necessarily involves some reduction in natural fitness. It appears that Miller has simply muddied the kind of ecological fitness concern that lies at the basis of diversity in unmanaged ecosystems. Translation of this concern to agricultural systems requires more sophistication than critics of cloning, including Miller, have thus far demonstrated.

In tying ethical concern to the well being of animals in a herd of clones, Miller has also shifted the ground for diversity arguments in a fundamental way. He claims that reduced diversity in livestock herds s significant because it creates a health risk to the animals, and that the moral significance derives from viewing this from the animals' point of view. Conventional diversity arguments attach significance to the fitness and resilience of the entire breeding population, but Miller's argument derives part of its moral force from the impact on individual animals. It is thus a hybrid of diversity and animal welfare concerns (see Thompson 1998). It will thus be necessary to revisit this aspect of Miller's argument below.

OTHER ENVIRONMENTAL PROBLEMS

Since livestock cloning is closely associated with genetic engineering of livestock species, it may prove useful to briefly review how some of the issues that will be discussed in Chapter 7 relate to cloning and animal production. Beyond possible adverse effects on genetic diversity, there are at least three additional environmental risks associated with transgenic technology. First, there has been a longstanding debate about the potential for gene flow between engineered and wild plants. Here, genetic engineering could reduce diversity (hence fitness) in non-domesticated organisms, as well as agricultural species. Gene flow, however, is not normally a problem in livestock production. Potential for gene flow in livestock can be controlled by limiting the opportunity for engineered livestock to mate with wild relatives. This concern will receive no further attention here. Second, genetic engineering could increase reproductive fitness, while reducing survival fitness. For example, fish have been genetically engineered to grow faster. Faster-growing (hence larger) fish may have a reproductive advantage over wild or non-engineered competitors: they may be able to mate at a higher rate. However, if genetically engineered fish are in other respects *less* fit for survival in the wild (as common opinion in molecular biology has it), the result will be a narrowing of the gene pool and a corresponding decline in fitness for the species as a whole (Muir 2001). Risks of this sort are extremely significant where wild and domesticated animals enjoy opportunities for inter-breeding. Since that is generally not the case for modem livestock production, this kind of risk can also be eliminated from consideration in the present context.

The third form of impact may be the most significant from an environmental perspective. Cloning and genetic engineering can be used in a research program that expands the range of livestock farming, displacing fragile and endangered habitat for wild species. For example, if genetic technology were used to develop a strain of cattle resistant to African trypanosomiasis (sleeping sickness), the result might well be that vast areas of the Rift Valley would, for the first time, be available for livestock grazing. These lands are currently home to the last migratory herds of gazelle, wildebeest and zebra, as well as elephants, rhinos, giraffes, lions and hippos. Biotechnology that would displace these animals from their habitat raises serious environmental issues, indeed. Here, biotechnology affects the diversity of wild populations by depriving them of habitat. In view of the fact that human residents of the Rift Valley are subsistence farmers and pastoralists, highly vulnerable to famine and food crisis, there is also a strong rationale favoring such applications of biotechnology (Rossingol and Rossingol 1998).

Although this is an under-appreciated environmental risk, it is important to note that cloning itself would not produce this result, for it would not result in an organism with adaptive capabilities different from those of the clonee. Cloning might be one component of a large-scale program to bring this about including genetic engineering and conventional breeding, and any such program deserves careful and thorough ethical debate. If the genome of the clonee could, if multiplied throughout a herd, pose risk to wildlife or environment, cloning certainly provides a way to affect such multiplication, for example. Furthermore, the indirect route to narrowed genetic diversity not in livestock themselves, but in wild populations suggests that a very different concern has been raised. No longer are we considering the same issues of genetic diversity raised by Doyle and Rollin. Now the issue seems to relate more squarely to habitat preservation, and the argument from genetic diversity is a tortuous route to this familiar concern in environmental ethics.

To conclude, though there are important environmental ethics issues that attach to genetic technology, it is not clear that livestock cloning gives rise to any of them in a unique way. It is, however, important to be careful in stating the spirit in which this conclusion is offered. The analysis here depends on a particular conception of how environmental concerns differ from social issues (discussed in Chapter 8) or animal welfare concerns (discussed in Chapter 5). In reaching the conclusion that livestock cloning passes the environmental tests, it is important to note that some, like Miller, tend to advance criticisms that are here associated with social issues or animal welfare under the banner of environmental impact. The preceding discussion presents reasons why those who foresee environmental risk from livestock cloning owe us a more careful analysis of the mechanisms that underlie this risk, as well as a more thorough discussion of why the unwanted outcomes are ethically significant.

ANIMAL WELFARE

Does livestock cloning subject animals that are involved in either research or commercial production settings to undue stress or any unjustifiable compromise to the standards of good husbandry? There is a vigorous debate over the definition and measurement of welfare impact from conventional and industrial animal production systems. Hence it is difficult to state exactly what level or kind of animal welfare is to serve as a criterion. However, it seems reasonable to evaluate cloning in comparison to current practices using Bernard Rollin's *principle of the conservation of welfare* (discussed in Chapter 5). Rollin's principle was devised to cover cases of genetic engineering. It states that, other things being equal, it is unethical to produce an animal worse off with respect to suffering and deprivation than comparable animals of the species produced through conventional breeding. Applied to cloning, it means that *if* cloned animals had substantially lower welfare than conventionally bred animals, it would be acceptable to produce them only if doing so serves some morally compelling end (such as the cure for a serious disease) (Rollin 1995).

Rollin's principle rules out certain forms of genetic manipulation. Yet given Rollin's principle, cloning raises an animal welfare concern only to the extent that cloning is the proximal cause of some impact that would not have been experienced by a conventionally bred animal in similar laboratory or production settings. As Rollin (1997) himself has noted, cloning does not introduce modifications in the genome. There is little reason to expect a genetically based detrimental result for animal welfare. There are, however, some borderline cases. For example, some individual organisms may be natural models for human disease (or as noted such disease model creatures may be produced through genetic engineering). If these individuals are cloned for the purpose of research, cloning becomes implicated in ethical disputes over the development of research animals, the animals' suffering, and the relative benefit of the research. Some critics of animal research will almost certainly want to raise this argument against cloning. Even though cloning may be essential to the production of these research models, however, it is the genome of the original organism and its clones that leads to suffering, rather than cloning as such. Furthermore, cloning can be applied to healthy, fully functional individuals, as well. The animal welfare argument against cloning misidentifies the proximal cause of suffering.

Rollin himself has sketched these implications in his 1997 article, "Send in the Clones Don't Bother, They're Here." He considers and rejects claims alleging that cloning is inherently unethical, concluding that it is wrong only in cases where it produces unacceptable consequences. Rollin applies this reasoning both to cases of livestock and human cloning. He then offers examples of possible applications for each, and suggests that we may rely on deeply felt intuitions for guidance as to whether a particular application violates basic tenets of our social morality. He concludes, "There seems to be nothing inherently wrong with cloning either animals or humans, though clearly the uses to which the technique is put may raise moral issues" (Rollin 1997, p. 39).

What about Miller's argument to the effect that cloning would expose more animals to disease risk? A straightforward application of Rollin's principle would rule out any practice that increases exposure to risk of disease or ill-health. However, is cloning the practice that does this, or is it using cloning technology to produce a disease prone gene pool? Cloning can as easily be used to increase genetic diversity in a gene pool. It is a way to keep genes from individual animals who have experienced a reproductive failure in the gene pool, and to multiply the number of "copies" of a rare or endangered genome available for interbreeding (Wooliams and Wilmut 1998). Rollin's principle rules out the foolish use of cloning that Miller describes, but this is an argument against foolishness, not cloning as such.

Applying Rollin's principle of conservation of welfare to cloning is complicated by factors that Rollin does not acknowledge. The extensive public debate on human cloning has shifted the burdens of proof for a defense of livestock cloning. Specifically, the vast majority of commentaries on human cloning state that human cloning must not be attempted in the near term for two reasons. First, cloning techniques described by Wilmut produce many unviable embryos, raising the possibility of human birth defects. Second, given the low yield of Wilmut's procedure, it does not justify the physical and emotional stress on women who must donate viable egg cells or endure implantation of the cloned embryo for surrogacy. President Clinton's National Bioethics Advisory Committee (NBAC) concluded that risk to the well-being of both cloned child and to women involved in donation of egg cells or surrogate mother hood is unacceptably high (NBAC 1997). This was, in fact, the NBAC's primary rationale against human cloning, implying that if cloning techniques could be made safe and reliable, ethical objections to human cloning would become moot. The question arises, why would these welfare arguments against cloning humans not also apply to livestock?

This is, I believe, an answerable question, though I have located no published sources that answer it. The reasoning involves two points. First, livestock born with birth defects would routinely be destroyed irrespective of cloning, while humans would not. Hence livestock would not endure lives of suffering, where humans would. Second, the fact that animals are routinely sacrificed for slaughter or research makes the acquisition of host egg cells unproblematic, at least from any perspective that finds food animal production itself unproblematic, and artificial insemination is also a routine industry norm. Thus, if current practices of euthanasia, slaughter and artificial insemination are acceptable in research and food production, then the use of these practices in developing cloned animals should be acceptable, as well. These considerations are probably obvious to most animal scientists, but they may be obscure even to people who have broad knowledge of animal production. Yet they might well be contested. Suppose cloning produces animals that with only slightly reduced welfare. Would researchers terminate their experiment in that case? Should they? Such questions have become pertinent as conflicting biological evidence over the longevity and susceptibility of clones to disease has entered the literature. To complicate matters even more, Wilmut has written that egg cells for nuclear transfer must be obtained from live, healthy animals using surgical procedures (Wilmut 1998, pp. 16–17). There is no clear public record where these questions are answered. This points toward an unmet responsibility on the part of cloning researchers. Researchers should get an explicit statement of the animal welfare implications of cloning into the peer-reviewed literature as soon as possible.

Even if the factors that differentiate welfare concerns for human and livestock cloning experiments can be made clear, there are still unanswered questions related to the welfare of clones (Wilmut et al. 2000). The British animal protection group Compassion in World Farming has come out against livestock cloning, citing a prevalence of abnormal births. In reaching this judgment, the group discusses Wilmut's work with Dolly, noting some of the concerns raised above: "... only one of the 11 surrogate mother ewes who actually gave birth had a normal delivery. Four had caesarian sections and six were induced because of prolonged gestation. Eight of the 14 lambs born died within 2 weeks." They also note health problems experienced in a herd of cattle produced from embryonic cloning. Compassion in World Farming also notes the concern raised by Miller (see above). "A herd of cloned animals genetically engineered to have resistance to one disease could turn out to be very susceptible to another one" (Anonymous 1999). Wilmut himself has raised concerns about the health and longevity of clones within the context of arguing that it is too soon to contemplate using adult cell nuclear transfer to clone human beings (Jaenisch and Wilmut 2001). Other cloning researchers have published some limited data indicating that cloned livestock are healthy and do not experience negative impacts on welfare (Lanza et al. 2001). Nevertheless, one cannot rule out the possibility that some hitherto unappreciated mechanism will limit the acceptability of livestock cloning on animal welfare grounds.

Although the ultimate verdict on cloning's impact on animal welfare must await the evidence of empirical studies, Gary Varner (2000) has noted that adverse impacts are not the results one would expect from adult cell cloning. Errors in DNA replication and recombination are the main source of birth defects in ordinary sexual reproduction. In theory, cloning eliminates this source of error, because an intact genome is transferred in toto. Because scientists know a great deal about the clonee, it is possible to screen for a wide array of disease susceptibilities. There are thus reasons to think that cloning could substantially reduce the rate of dysfunctional animals produced through ordinary sexual reproduction (see also Silver 1997, who makes the same point with respect to human cloning). In the absence of a reliable track record, one must decide whether this research is so risky to animals that it should be discontinued. As already noted above, that is an issue on which we can reasonably expect cloning researchers to make a clear and explicit defense.

In summary, animal cloning does not appear to introduce novel forms of impact on animal well-being when compared to other reproductive technologies, though the jury is still out on the frequency with which adverse impact occurs in cloning, and thus on the acceptability of animal welfare for clones. Researchers have a responsibility to address reasonable questions from non-specialists and to collect and publish data on animal health and welfare. Given the nature of the debate over human cloning, they should be prepared to explain why human and livestock cloning differ in morally relevant respects. Eventually they should be able to show that increased efficiency of the procedure will make its safety (for clone and recipient of embryo transfer) comparable to that of ordinary reproduction through embryo transfer. Furthermore, there should be a refereed and published review of the reasons why welfare considerations do not support an argument to eliminate or restrict cloning of livestock so that what is obvious to every animal scientist can become part of the public record.

SOCIAL CONSEQUENCES

Some of the most hotly debated ethical issues associated with human cloning have to do with the social impact of the technology. Critiques fear a "commodification" of interpersonal relationships (see Pence 1998). In agriculture, too, social impact has been a longstanding area of concern with respect to new technology. Economists and social theorists have documented the "treadmill effect" of agricultural technology with respect to mechanical and chemical inputs. Here efficiencies of scale combine with other market forces, causing a concentration of and increase in scale for producers of a given commodity. Recombinant bovine somatotrophin was alleged to have negative effects on small dairies as a consequence of the treadmill effect (Hallberg 1992). It is possible that cloning could become the kind of capital intensive technology that would be beyond the reach of many producers, while giving already well-capitalized animal producers significant efficiencies. A significant constituency would regard this result as unfair, particularly in light of the public funds that have supported cloning research. Krimsky (1991) and Busch and co-authors (1991) have raised this argument with respect to other genetic technologies. The general principle here is that government and publicly funded researchers have a responsibility to maintain a level playing field for producers. However, the potential effect of cloning on the economics of animal production is highly speculative at this juncture. It will become relevant to study the social impact of farm-oriented cloning when the specific applications have been better conceptualized.

Producers have expressed interest in cloning as a reproductive strategy that will allow greater control over genetics and herd composition. However, the best known work on animal cloning is not geared to farm-oriented applications. Livestock cloning research is being done in agricultural and veterinary settings, but the primary applications are in pharmaceuticals and medical technologies, such as human organ replacement. This suggests that the treadmill argument may be irrelevant to cloning, and that a more subtle kind of social consequence is (or perhaps already has) taken place. Agricultural and veterinary research has traditionally been organized around a goal of improving productivity and quality for food and fiber. Livestock producers have supported public sector research because they believed that it would help them be competitive while serving the public good. Political support from livestock producers established an implicit social contract with the animal science and veterinary research community. Under this contract, researchers would conduct objective scientific enquiry into topics that were of interest to the producer community (MacKenzie 1991).

There is little doubt that these new cloning research projects directed toward medical and health applications serve the public good, but it is more difficult to see how they benefit producers of food animals. Animal breeders like the prospect of cloning a prize animal, rather than re-entering the genetic lottery through conventional breeding. Yet it is not yet clear that routine cloning for livestock production purposes will be economically feasible. In addition, some animal producers appear to think that pharmaceutical and medical applications of transgenic and cloned animals will be to their benefit, offering a new product for the live-stock producer. On the face of it, this would appear to be an ill-founded hope. These extremely valuable animals are unlikely to be raised under conditions that resemble even a technologically advanced food animal production facility. If this trend proves out, then livestock producers have effectively lost a major portion of their scientific support system to the better-funded and politically powerful pharmaceutical and medical supply industry.

As with welfare concerns, assessing the significance of social impact is complicated by the lack of clear information about factual matters. Certainly some livestock cloning programs in both academic and commercial sectors *do* hope to develop applications for livestock producers. What balance is being struck between livestock research for the farm and food sector and research that will primarily be used in human medicine? It is worth stressing that biomedical applications may be a very good thing for the public at large. Compelling ethical arguments justify biomedical applications of transgenic and cloned animals. Yet one wonders why producers have not protested this development occurring at the expense of their own painstakingly built system of public sector research in support of agriculture. At the least, scientists and administrators have an ethical responsibility to communicate the likely applications of transgenic and cloning technology, and should not encourage producers in the hope that biomedical applications will somehow benefit them. “Selling” a cloning research program to animal commodity producers should turn only on the technology’s likely application to food animal production.

LINKS TO HUMAN CLONING

The report of the United States National Bioethics Advisory Commission (NBAC 1997) stresses the risk and the inconvenience of a cloning program to the developing child and to surrogate mothers or women donate egg cells. Yet livestock cloning programs will surely improve the efficiency of cloning. Eventually the risks and inconvenience may appear acceptable to people who wish to have a cloned child, for whatever reasons. The pattern of developing a pharmaceutical or medical procedure through veterinary research, then applying it to humans has been repeated many times. In most cases, this pattern is a good thing, but cloning is not like most cases.

There is ample evidence that society is not prepared to countenance the application of cloning technology to human beings. In the United States, the NBAC report contained statements from philosophers, theologians and a number of other experts on a host of questions. Who would be the legal parents of a cloned child, and how, in general, does cloning affect our conception of familial relations? Do individuals control their own DNA, or would it be permissible to clone people without their permission? Would clones be stigmatized, or would they suffer from a psychologically based identity complex? Editorial opinion on the prospect of human cloning ranged from simple repugnance (discussed below) to concern about the legal and psychological impact of human clones. At the same time, some groups are already asserting that access to cloning technology is a part of their reproductive rights (Pence 1998). While this controversy has not resulted in legislation against cloning in the United States, a number of other nations have taken policy actions intended to restrict, limit or ban the reproductive use of adult cell cloning on human beings (Eiseman 2000).

Society needs time to survey the myriad of ethical issues raised by human cloning. There must be time for scholars, religious or cultural leaders and journalists to consider each question in detail, and to prepare the larger public for the changes ahead. Such a period of reflection and debate may or may not result in the sort of political division associated with abortion on demand. It is possible that, with legal status questions answered, society will be quite ready to accept cloning of human beings. However, without answers to these legal questions, and with the still present possibility of a visceral negative judgment on the part of many citizens, it would be foolhardy and unethical to move human cloning closer to reality in the absence of a vibrant public debate. And this is precisely what research on livestock cloning will do.

Livestock researchers do not intend that their research should lead to human cloning, nor is human cloning a logically necessary implication of that research. In nations such as the United Kingdom a legal ban on human cloning ensures that a public debate will be required to apply live-stock cloning to humans. The situation in the United States is crucially different. If safe and efficient cloning techniques are developed, physicians and patients who want to use it have the right to do so. Legal, social and psychological issues will not be the subject of a public debate, but will be decided in the courts or by trial and error. Such a situation creates anxiety, producing conditions for stigmatization of human clones, and significant social resentment and disorder. This is, admittedly, a speculation, but public debate on human cloning must begin with speculations, and then move toward fact and consensus in the fullness of time.

Within the United States, livestock cloning advances the likelihood of human cloning without also advancing public understanding of the issues. Few livestock researchers have enjoined the debate that followed the announcement of Dolly, despite the fact that many have more knowledge of cloning as such than the frequently quoted biomedical scientists. Perhaps animal researchers do not see this public debate as within their purview of responsibility, but I am arguing that it surely is. The ethical problem *does not* consist in the way that livestock research accelerates the timetable for human cloning, but in fact this acceleration is hidden from public view. Allowing a contentious technology such as human cloning to become feasible through technical means alone, without legal, social and ethical review, is inconsistent with democratic values. Those who are doing this research have a responsibility to continually advise the public that this day is drawing near, and to support a vigorous public discussion of social, legal and ethical issues.

REPUGNANCE

There is little doubt that the initial public reaction to the 1997 announcement of successful adult mammalian cloning was one of repugnance. A *Time/CNN* poll supported news reports and editorials that characterized the discovery as shocking and revolting. Few researchers close to cloning research appear to share this repugnance, however. Cloning may, thus, be offensive primarily to those ignorant of genetics and reproduction. There are, however, two ethical arguments that relate to the public's reaction of repugnance. First, some argue that this is a sufficient reason to oppose all forms of cloning research. Second, a weaker and more focused claim can be made with respect to food animals. Those who find the technology repugnant (for whatever reason) should not be coerced into consuming cloned animals without their knowledge and consent.

Repugnance and Intrinsic Wrong

Leon Kass's article "The Wisdom of Repugnance," is one of the most widely read articles on cloning. In it Kass considers and rejects the case for human cloning on a point by point basis, but his central argument is that mammalian cloning itself stimulates a repulsive reaction from many, and that this repugnance is sufficient ground to regard cloning as intrinsically wrong. An act is intrinsically wrong if there is in every case some degree of wrongness associated with it, and a beneficent motive and good consequences do not erase that wrongness. In making this case, Kass relies on a conservative tradition in ethics that harks back to the philosophical writings of David Hume, Adam Smith and Edmund Burke. These philosophers believed that morality was based on sentiments of sympathy with others, and that emotional attachments were a key component in any moral judgment. Hume and Smith sought to systematize moral philosophy consistent with scientific method, but they took emotional reactions to be part of the basic data to be systematized. Burke believed that emotional reactions like repugnance reflect a deep-seated and culturally ingrained wisdom. All three wrote before Darwin, but their approaches to ethics suggest an evolutionary argument: whether psychologically or culturally based, feelings of attachment or revulsion exist because over the long run they help individuals and social groups prevail against their competitors. Societal stability is the result of respecting these emotional reactions, and departure from them entails the risk of upheaval and dissolution. Hume was also the philosopher who argued most forcefully for a logical and conceptual separation between fact and value.

The suggestion that repugnance represents a kind of wisdom has distinguished advocates, and deserves respect. However, similar arguments have been brought forward to defend racism, slavery and religious oppression. The argument from repugnance thus needs an additional rationale. Kass sketches two themes that, in his view, distinguish our reaction to animal clones from abusive conservative arguments. First, in defending abominable practices such as slavery or racial and religious intolerance, conservatives committed themselves to a position that was incompatible with basic human rights. That is not the case with respect to human or animal cloning. No one can currently claim a legal or moral right to utilize a totally unprecedented technology. Second, even if cloning does not *violate* any fundamental human right, neither is it *required* by any fundamental human rights. It is a practice that society may permit or ban without violating any fundamental principles of justice. As such, our feelings of repugnance constitute a sufficient reason for banning it.

This argument is fairly persuasive for those inclined to accept its conservative premises. Three points should be noted in reply. First, Kass's argument is focused primarily at *human* cloning, though he finds many instances of animal cloning repugnant, as well. However, to the extent that repugnance to human cloning is what is really at issue, responses that weaken the inevitability of human cloning, given research with animal clones, also address Kass's concern. That is, if a robust public discussion results in a firm consensus to "draw the line" at the human species, the repugnance that Kass feels can be somewhat alleviated. Second, if there are morally compelling applications of animal cloning, citing these applications may be sufficient to overcome immediate reactions of revulsion. If the technology is crucial to certain disease therapies, we might even be able to argue for a right to the use of cloning technology on animals, contrary to Kass's suggestion. Finally, more than any other of the above issues, repugnance would appear to be amenable to public discussion. If a public informed about the technology and its likely applications still found it repugnant, it would strengthen Kass's argument. There is no reason, however, to think that this would be the result of an extensive program of education and debate.

Repugnance and Consent

It is well known that culture disposes people to regard some potential sources of nourishment as non-foods, especially with regard to animals. In Islam and Judaism, foodways are religiously based, but they may equally be based on customary norms. In the United States and Europe, for example, it is clear that dog, cat, and even horsemeat should not be incorporated into meat products for human consumption without clear and explicit information. In each of these cases, the repugnance that Americans or Europeans feel toward consuming such products is culturally based, yet is universally regarded as a sufficient reason to ban their use in food products except under stringent conditions of informed consent. The revulsion felt by the public at large is not scientifically based, and will, clearly, vary from place to place and time to time. Nevertheless, the ethics of informed consent supports an individual right to choose what one will eat, irrespective of the demonstrated dietary risks and benefits (Thompson 2002; Streiffer and Rubel 2004). This suggests that if people regard livestock cloning with repugnance, that fact establishes a rationale for seeking informed consent.

The role of informed consent in consumer food choice is complex, and the following discussion reviews the more thorough discussion given in Chapter 4. One philosophical approach notes that only informed consumers could make appropriate comparison of the relative value of their food options. On this view, information is a precondition for efficiency. However, an argument that starts with minority rights rights to practice religious rituals and cultural practices, for example provides a much stronger basis for insisting that food from clones be clearly identified. If people are likely to adopt religious or quasi-religious values about the acceptability of eating meat from clones (and the evidence is that they are), then a market structure precluding the expression of those values violates liberty of conscience. It is, in short, unjust.

The mechanisms for seeking informed consent include but are not limited to labeling of meats or other food products derived from clones. Any reliable policy of labeling involves costs and economic consequences that may well outweigh the ethical significance of insuring informed consent. As such, it is impossible to conclude strongly for labels in the absence of a more careful analysis of the policy options for protecting consumer choice and of the relative cost and benefit for each option. Nevertheless, the strong presumption in favor of informed consent demands the immediate recognition of two responsibilities. First, economists and policy analysts should join with livestock scientists in a thorough investigation of policy options for making clones available as food products. Second, existing practices that do not segregate cloned animals are ethically unacceptable and should be halted until such time as it is clear that general repugnance to cloning has disappeared. In addition to being an ethical responsibility, segregating cloned animals may also be in the livestock industry's best interest. If the public feels that it has been "fooled" into eating an offensive product, a negative impact on public trust of the meat industry is sure to follow.

In concluding this section, two points deserve review. First, the revulsion felt by many upon learning of cloning experiments is not trivial, but it may well fade. As such, it provides a reason to go to greater than normal lengths to engage the public with this emerging line of scientific research. Second, given the repugnance with which cloning is associated, integrating cloned animals into the human food supply requires informed consent. Any food system practice that does not allow individuals who do not want to eat meat or milk from clones to act upon their values at a reasonable cost is ethically unacceptable, and ought to be illegal.

CONCLUSION

In conclusion, genetic diversity arguments are spurious, while four areas of ethical concern do appear to be relevant to animal cloning. None, however, provides an unambiguous rationale for opposing cloning of livestock. Each case appears to involve societal judgments about the constraints on and acceptability of certain livestock practices. The most powerful ethical concerns tend to link livestock and human cloning, and to matters of informed consent with respect to human consumption of clones for food. With respect to the former issue, the acceptability of livestock cloning turns in part on establishing a clear barrier between work on livestock and the eventual application of those technologies on humans. With respect to the latter, acceptability demands a public policy response that acknowledges the repugnance with which some regard cloning. In a democracy, building barriers and changing policy require political resolve, and perhaps legislation. As such, the foremost ethical responsibility of reproductive research is to develop a forum in which rational, informed exchange of information and point of view can occur (see Thompson 1999).

Put another way, the most powerful argument against livestock cloning is that under current practice, a potentially acceptable and beneficial technology is foisted upon a wary and untrusting public. It is the foisting that is wrong in this case, and not the technology itself. Animal researchers can respond to this situation by doing something that too few bench scientists have been willing to do. Take time (and if necessary, money) to create situations where members of the public will become better informed, and where you can listen to their concerns. This conclusion applied to cloning is, of course, also the larger conclusion of the entire book. A full development of the argument for it appears in Chapter 11.

CHAPTER 7

ETHICS AND ENVIRONMENTAL IMPACT

Consumer safety may be the most fundamental ethical responsibility for food biotechnologists, and the ethics of transforming or cloning agricultural animals is certainly the most philosophically controversial. Yet ethical responsibility for the environmental impacts of food and agricultural biotechnology is arguably the most widely discussed, and this has been true even since food and agricultural biotechnology was only a speculative possibility. For example, Jeremy Rifkin's early books *Algeny* (1983) and *Declaration of a Heretic* (1985) interlaced speculation about environmental catastrophe with broad philosophical critique of genetic engineering. The environmental themes were revisited in Rifkin's 1998 book *The Biotech Century,* though in this effort the philosophical dimension was significantly reduced. Yet even in Rifkin's more overtly philosophical writings the basis for his environmental concerns remain obscure. The following passages are typical: "when it comes to advancing our power and control over the forces of nature, our species has shown little willingness, of late, to temper its technological prowess by debating whether or not to proceed." and "With genetic technology we assume control over the hereditary blueprints of life itself. Can any reasonable person believe for a moment that such unprecedented power is without risk?" (Rifkin 1985, p. 44).

Rifkin was regarded as the *bête noir* of biotechnology during the years when his organization The Foundation on Economic Trends was filing (and winning) lawsuits against the National Institutes of Health and enlisting a broad coalition of religious leaders in protest against animal patenting. The specter of environmental risk has always attended these efforts, and as products of agricultural biotechnology entered more active stages of development and finally commercial application, environmental risk also became the focus of extended discussion and debate within the scientific community. No less than five study committees from the United States National Research Council have addressed various dimensions of the environmental risks from agricultural biotechnology between 1987 and 2003. The technical literature on environmental risk has grown steadily since 1995. Yet while these technical studies bring knowledge and sophistication to the quantitative estimation of environmental risk, they largely adopt an implicit and unspoken stance to the root issues of environmental risk: what is an environmental risk, and what are our responsibilities (both singling and collectively) to avoid, mitigate or in other ways respond to environmental risk?

SCIENCE AND PHILOSOPHY IN THE ANALYSIS OF ENVIRONMENTAL RISK

Many critics of agricultural biotechnology discuss environmental risks and link them to ethics, but in almost every case the connection between environmental risk and ethical responsibility remains obscure. Proponents of agricultural biotechnology are unlikely to link environmental risks to ethics, and in fact tend to discuss environmental risk as if it were a purely technical issue. Despite this marked difference between the language of boosters and knockers, much of the dispute over environmental risks from transgenic plants or animals concerns matters of fact. Do farmers use more or less herbicide with herbicide tolerant crops? Do Bt crops increase the probability that insects will develop resistance to Bt, and if so, what are the ecological affects? Even after nearly a decade, few of these empirical questions have been empirically researched, and some are unresearchable. Even though current science has not resolved these issues to everyone's satisfaction, the dispute involves factual content, not ethical values.

Empirical disputes are often interwoven with philosophical differences, however. Some of the key philosophical disputes concern the way that we understand the process of acquiring knowledge through a combination of logic and evidence. For example, what kinds of evidence can be used to estimate the probability of an unwanted environmental impact? Empirical approaches can involve monitoring of commercial production and data collection, or can involve controlled experiments. It is also possible to make a subjective guess as to how likely it is that a given event will occur. While empirical approaches sound more scientific on the face of it, subjective approaches can actually be more reliable, especially when the people making the guess have long years of relevant experience. Hence we can ask: Does plant breeder experience with traditional modification count as a source of evidence for the risks of transgenic plants, or must the only acceptable evidence come from experiments conducted under controlled conditions? Some epistemological disputes intertwine with ethics. One area in risk assessment that has been relatively well studied concerns the way that controlling for Type I vs. Type II errors can result in vastly different estimates of risk. Good scientific practice normally endorses the view that one should adjust statistical confidence intervals to minimize the chance of accepting something false as true. Where public safety is concerned, ethics may demand that we err on the side of believing that there is a measurable probability of harm until statistical data indicate that there is not (Brunk et al. 1991; Cranor 1993).

There are also philosophical issues that arise in response to the acceptability, mitigation and communication of risk. What is the relative seriousness of the events we are concerned about? How, for example, should we weigh the chance that caterpillars become resistant to Bt against the health risks of using chemical pesticides? Whose estimate of risk should be used when making regulatory decisions? How much proof do we need that an activity is causing harm before we take action? Should catastrophic risks (e.g. risks that there will be a very serious outcome) be treated different than low-level chronic risks? Should we aim to make wise trade-offs between risk and benefit, or should we take a more precautionary approach?

What kind of information is the public entitled to know? Should we be hesitant to disclose information that we suspect will lead people to make incorrect judgments about environmental risks, or are we obligated to disclose everything and let the chips fall where they may? The list of questions here is indeed overwhelming, and it will be impossible to do full justice to them in the succeeding discussion. Hence, the discussion will focus on the overarching approach that is made to understanding and managing environmental risk. The scientific and regulatory community has gravitated to an approach that is implicitly committed to the idea that under some imaginable circumstances, the benefits of food biotechnology will outweigh the risks. If one takes this approach the facts about the relative levels of benefit and risk become extremely important. Yet for some critics it is clear that the mere potential for environmental damage provides the basis for opposing any given food biotechnology, even when the probability of damage is relatively small, or when the compensating benefits are relatively large. Here the facts matter less. The contrast between these general ways of thinking about biotechnology will be a main focus below.

On top of these risk questions, there are also philosophical questions about the nature of humanity's relationship to the broader environment. What are humanity's environmental responsibilities, in general? Should we think of them strictly in terms of impact on human beings, or impacts on animals or ecosystems have significance without regard to their effects on human beings? Do humans have a duty to preserve wild nature, and if so do these limits place inviolable constraints on activities (such as genetic engineering) that could result in irreversible changes to natural ecosystems? How does agriculture fit into our conceptions of wild nature? Do agricultural ecosystems become involved in complex webs of aesthetic and practical value, or are they to be seen purely as instruments for producing food and fiber commodities? Such questions lie at the heart of environmental ethics.

The questions in the first group involve our understanding of evidence, knowledge and the philosophy of science. They can be characterized as epistemological. The second group of questions on managing risk involves the way that we understand our ethical and political responsibilities for coping with unwanted or unforeseen consequences of technology. They can be called ethical questions. The last group of questions concerns the fundamental relationships between humanity and nature. They can be characterized as questions of moral ontology. But in the analysis of environmental risk from agricultural biotechnology, questions do not arise in such an ordered fashion, and there is little to be gained from trying to impose a set of categories derived from disciplinary divisions in philosophy, in any case. A more natural approach is to begin with the risk-benefit (or expected value) approach to thinking about environmental risk that is the standard starting point for scientific assessments of risk. Many of the epistemological issues can be most easily identified and discussed as problems that someone attempting to use this approach to understand risks from biotechnology might encounter. But the decision to use this approach is not ethically neutral. In fact, the risk-benefit framework is closely (though not irrevocably) associated with utilitarianism, and some of the objections to using it are also fairly standard ethical objections to utilitarianism. This contest between the risk-benefit framework and its alternatives is the root issue for this chapter. But we close with a few comments and speculations on even deeper ontological issues, considering how these might bear on the justification of an ethical approach to the question of environmental risk.

ENVIRONMENTAL RISK: AN EXPECTED VALUE APPROACH

When risk is defined as a function of the probability and value of an unwanted event (such as insect resistance to Bt, the movement of herbicide tolerance into weeds, or loss of endangered species as a result of agricultural encroachment) it becomes possible to interpret environmental impact in terms of expected value. The idea of expected value was developed hundreds of years ago by philosophers and mathematicians who were trying develop a rational theory that would tell them whether or not to take a bet offered in a gambling game. As the term suggests, an expected value is the value one expects to realize at some time in the future. For the gamblers the relevant future is after the game is played; for modern environmental risk analysts it is the real and indefinite future that extends before us into infinity. The two key factors in conceptualizing an expected value are the value V (e.g. benefit or harm) that would be experienced if the event were to occur, and one's expectation that the event actually *will* occur. This expectation can be represented as the likelihood or probability P of the event. Expected value is a function of V and P. For gambling games the values (V) at issue involve the reward of associated with a win, and all the probabilities can be computed mathematically. In classical theories of expected value, the function for combining V and P was derived by imagining repeated play of the same game. Eventually the probabilities would play out, and simply multiplying V times P produces the break even bet, which is to say, the value one can expect to earn from playing the game. Of course, on limited plays one can win or lose (which is why they call it gambling, after all).

Some might object to the suggestion that environmental risks should be understood through the model of a gambling game, but a generalization of the gambling analysis is deeply embedded in a great deal of contemporary social science. Rational behavior is, on this view, understood to be decision making in virtually every aspect of life that remains consistent with the rough idea of making choices that "pay off." That is, a *rational choice* is one that has the best chance of realizing the ends sought by the decision maker. An expected-value approach to risk emerges naturally in this general orientation to decision making. For environmental risk analysis (as in many areas of life) it is considerably less obvious what function should be used to combine V and P, but assigning an actual cardinal value may be far less important than having a general sense of what one stands to lose or gain (e.g. V) and the chances that the losing or winning outcomes will actually occur (P). In any event, thinking of environmental risk as an expected value lends itself nicely to a scientific approach, because if one can just figure out what events one is interested in avoiding, science has many tools for measuring P.

Despite the multiplicity of scientific tools for modeling and predicting the behavior of environmental systems, many environmental scientists would be hesitant to suggest that they are able to achieve even approximate quantification of P, even when V is well defined. While recognizing at the outset that uncertainties plague attempts to measure environmental risk as an expected value, it is nonetheless extremely important to probe the philosophical foundations of the expected value approach more deeply. As noted, expected value emerges in conjunction with a particular way of construing both prudential and ethical guidelines for making choices. To reiterate, a rational choice is made by comparing all the expected values (e.g. costs and benefits) accruing from a decision to proceed with a particular course of action. If one had a complete list of expected values for each of the principle options under consideration, one could apply decision rule such as "Choose the option that maximizes benefits, relative to costs," to make the choice. Approaches to food safety and to animal welfare that were described as "utilitarian," in previous chapters apply this general strategy, and it has many applications to environmental risk, as well. Comparing expected values as a means of ethical decision making has one overwhelming strength: it combines the predictive power of science with the common sense ethical maxim, "act so as to bring about the best consequences, all things considered." Utilitarian approaches have some fairly standard problems, however, some of which have already become evident in previous chapters. The problems in environmental applications will be discussed in due time, but the simple common sense inherent in weighing the consequences of one's actions, and in using science to estimate their likelihood demands that this approach be given strong consideration.

The Consequentialist Framework

Utilitarianism is the most typical and certainly the best-developed example of a general approach to making ethical decisions that involves the comparison of expected values. The name for the general approach is *consequentialism*. All consequentialist ethical theories evaluate expected values in light of a decision rule that determines which options should be chosen, but not all consequentialist theories evaluate expected values in the same way, and not all of them use the same decision rule. Utilitarianism uses an optimizing decision rule called the utilitarian maxim. It is often popularized as "Do the greatest good for the greatest number." The utilitarian maxim requires the decision maker to weigh benefits against risks (and other costs), and to choose the "best" course of action. For example, in some types of decision-making, decision makers do not take benefits into account. Instead, they may have scales of acceptability for environmental risks that reflect both the severity of outcomes and the likelihood of occurrence. They are still using expected values, and they are still employing the consequential model of rational choice. They are still using an approach in which benefit can, in principle, outweigh risk, meaning that there are specific and potentially fulfillable criteria by which the activity in question will be deemed permissible. But instead of seeking an optimal ratio of benefit to risk, they have adopted a decision rule that considers only risks. They are not, however, using the utilitarian maxim as their decision rule for choosing which risks to permit, and which to disallow.

Many different methods for assessing probabilities, evaluating outcomes, and integrating expected values under decision rules are currently employed in environmental decision-making. There is thus the potential for methodological and philosophical disagreements about matters such as whether benefits should count, even among those committed to consequentialist ethics. Too often critics have presumed that one version of the approach characterizes the entire field. Steven Kelman, for example, takes cost-benefit analysis to task for requiring a common unit of measure for risks and benefits, usually money (Kelman 1981). Yet while some economists do use common units when estimating expected values, doing so is not a logical or philosophical requirement of consequentialist ethics, nor is commitment to the idea that one must maximize the ratio of benefit to cost. A decision rule that eliminates all options having low-probability/high-consequence risks from consideration, for example, is entirely consistent with the expected value approach, even though doing so might exclude the option that has the greatest expected value.

Procedures for risk-benefit and cost-benefit analysis can be specified in cookbook detail. Doing so commits anyone who uses the procedure to an entrenched philosophical view on environmental risk without the benefit of opportunities to examine and debate the assumptions and decisions incorporated therein (MacLean 1986). Alternatively, one may defend expected value style risk analysis as a way of organizing information that is relatively objective, and that allows everyone to see where key philosophical decisions have been made (Leonard and Zeckhauser 1986; Railton 1990). Misunderstanding may also arise in connection with the affinity between the expected value approach and economics. Economic cost-benefit analysis often uses the principle of potential Pareto improvement (the proposed course of action must produce social benefits that are sufficient to compensate costs to losers, or simply, benefits must outweigh costs) as its decision rule, and interprets the result as a form of social efficiency. Yet there are many instances in which we make choices that sublimate efficiency to other values (Gibbard 1986; MacLean 1990). Although it is important to be mindful of these critiques, the important point to note here is that each addresses a specific interpretation of the expected value approach, not the approach itself.

The expected value approach to environmental risk was proposed very early on as a way to understand risks associated with agricultural biotechnology. Amidst controversy over genetically engineered ice-nucleating bacteria in the 1980s, Martin Alexander argued that six factors determined the potential for ecological harm as a result of research on genetically engineered organisms: the probability of release, the probability of survival, the probability of multiplication, the probability of dispersion, the probability of gene flow, and the probability that any of these events are harmful (Alexander 1985). Though Alexander may have intended this argument as implicit assurance that the environmental risks of genetic engineering are very low, it was soon interpreted as the basis for an expected-value approach to the assessment of risk from field release of genetically engineered plants. Much of the subsequent technical literature on environmental impacts of food and agricultural biotechnology (including all the NRC reports) is occupied with assigning probabilities to each of Alexander's six factors without specifically addressing the ethical issues that must be considered in bringing the expected value approach to bear on human action. The book *Risk Assessment in Genetic Engineering* (Levin and Strauss 1991) includes a series of sophisticated overview papers by scientists, all of whom presume that risk assessment means identification of potentially harmful events, and quantification of the probability of those events (see especially chapters by Sharples and by Strauss). While making this assumption falls short of actually endorsing the expected value framework, discussions of the environmental risk of food biotechnology repeatedly appear committed to this framework, generally without argument (see Davis 1987; Sharples 1987; Huttner 1993; Hino 1994).

Philosopher Robert Wachbroit's contribution to *Risk Assessment in Genetic Engineering* takes an initial look at some of these issues. Wachbroit notes that potential harms may be "thin" (confined to human mortality and morbidity) or "thick" (including social harms that accrue as psychological costs, even when none of the harmful events are realized). He also notes that there are problems in deciding how evidence bears on probability assignments. Wachbroit concludes by noting that even when risks are assessed adequately, the communication of expected value results may be politically and ethically problematic (Wachbroit 1991, pp. 367–377). Using the expected value or risk-benefit framework requires key philosophical value commitments in each of the problem areas Wachbroit notes. One group of issues involves hazard and harm, and a second group of issues involves the ideas of probability and uncertainty.

UNDERSTANDING HAZARDS AND HARM

Risk analysts make a distinction between hazard and risk. A hazard is a situation with the potential for harm. Hazard does not reflect any characterization of the likelihood that this harm will actually occur. To speak of risk requires an analysis of exposure as well as hazard, where exposure is a characterization (usually quantitative) of the course of events that must occur for the harm to materialize. Thus, Alexander's rough argument offered in the mid-80s was in fact a broad characterization of the exposure pathways for environmental risk from agricultural biotechnology. Hazard identification and exposure quantification (more typically called risk measurement) thus represent the two key technical phases in environmental risk analysis. Hazard identification is an activity where risk analysts compile a catalog of situations that have the potential for harm. Hazard identification is usually characterized as a purely technical element of environmental risk analysis, one in which value judgments do not enter. But to characterize a hazard, one must have some idea of possible harm in mind. And harm is a normative concept. It implies the value judgment that potential events being anticipated are unwanted, are adverse or represent damage or loss.

The ethical component of hazard identification is a specification of why and in what sense the events in question are considered to be harmful or unwanted. In many cases, the "badness" of the events in question is not particularly controversial. Negative effects on human health, especially death, are non-controversially regarded as harmful events. Yet even in such obvious cases the badness or evil that is associated with death or injury reflects an ethical rather than a scientific judgment. Some environmental hazards (notably broad spectrum toxins in chemical pesticides) also revert to forms of harm that involve human mortality and morbidity. For the most part, environmental risks associated with agricultural biotechnology have involved more subtle and indirect forms of harm, though contamination of food supplies or even environmental exposure to some of the substances being produced through crops engineered to produce pharmaceuticals or industrial products could have direct effects on human health. For these more subtle forms of harm, it is particularly important to take some additional pains to articulate and specify the ethical dimension of hazard, the reason that potential events are viewed as possible forms of harm.

Although the ethical reason for seeing many environmental hazards as having potential for harm is very nearly as non-controversial as with respect to human mortality and injury, it is still useful to articulate the normative dimension of hazard in very explicit terms. One can apply different values to a number of the environmental hazards that have been mentioned in connection with agricultural biotechnology. Some values are simply prudential: it would be foolish for anyone to neglect potential outcomes that would frustrate the very aims and interests that are being pursued in undertaking an activity such as developing or using a biotech crop. Other values are more clearly ethical either because the aims and interests are of a general or more fundamental nature or because the harm is visited on someone other than the party that undertakes the action in question. Hazards such as weediness or acquired pest resistance may be associated with both prudential and ethical types of harm. No framer wants to create new weeds; that's more trouble for farmers. Measures for managing or accepting the risk of one form of harm (such as economic loss) may not be effective for others (such as ecosystem damage). Furthermore, although it may be obvious to a farmer or an agricultural scientist why weediness or acquired pest resistance is a bad thing, it may not be at all obvious to someone whose interest in the biotechnology debate derives from concern about the polluting effects of agricultural chemicals or impact on wild nature. Constantly repeating the claim that weediness or acquired pest resistance are hazards may create the impression that these events are intrinsically evil, or at least comparable to the hazards of chemical pesticides. There is thus a need for more explicit attention to the ethical underpinnings of hazard identification. Here, briefly, are some of the things that might be said about the ethics of some frequently mentioned environmental hazards.

Acquired Pest Resistance

One of the main hazards associated with Bt crops is the possibility that constant exposure to the Bt toxin will cause resistance. Although the empirical evidence pertaining to the likelihood that this hazard will be realized has become substantially more mixed over time, it is nevertheless worth devoting some effort to a clear characterization of the harm underlying the classification of acquired pest resistance as a hazard. The value question is this: Is there any ethical significance to the possibility that insect pests might become resistant to Bt as a result of genetic engineering? Clearly companies that produce Bt crops do not desire this event, since it would negate much of the value of their product. On this account, avoiding acquired pest resistance looks more like an issue of prudence than of morality. Surely it would be difficult to argue that the insects themselves are harmed by an evolutionary development that increases their survival rate. Though there is little evidence of concern about harm to the insects themselves in the literature on acquired pest resistance, by any standard it cannot be said that insects that acquire resistance are harmed more than the insects that are killed by Bt.

Two possibilities present themselves for understanding this eventuality as an ethical problem. One stresses ecosystem impact: it is not the insects, but the ecosystem that is harmed. "Harm to ecosystems" is an important class of environmental hazards that has been associated with genetic diversity as well as acquired pest resistance, and the underpinnings of seeing ecosystem impact as a form of ethically significant form of harm will be taken up below. A second possibility notes that many firms are producing seed for Bt crops and many farmers will buy it. Each firm has an incentive for utilizing strategies (such as mixing Bt seed with non-Bt seed) that minimize the risk of acquired pest resistance, as does each farmer. However, if *other* firms and farmers are following this strategy, then one can acquire an economic advantage by not following it, and most of the environmental benefits will still be intact. Of course since everyone knows that competing firms and farmers face this opportunity, no one wants to accept the increased risk brought on by defectors from the strategy without also getting some of the benefits. The strategy thus collapses in an instance of the assurance problem (Thompson 1995a, pp. 26–31).

Since firms and farmers cannot rely on naked self-interest and prudential values to protect themselves from each other, they must resort to an enforceable norm. They must recognize that they have a duty to resist narrow self-interest in this case, and to engage in the cooperative strategy. The duty may need to be enforced by a trade association or by the government in order to be effective, but just as laws against theft are enforced by the state, the fact of enforcement does not undercut the moral basis for the norm. Note here that the norm is justified *because* it is necessary to help individuals act collectively to bring about the best consequences. This is a classical instance of the consequentialist pattern for endorsing norms as constraints on self-interest, and it should be regarded as valid ethical argument for regarding acquired pest resistance as an ethical, rather than simply as a prudential, harm. In this case a clear statement of the ethical rationale underscores the importance of cooperative efforts both in mitigating the likelihood that the hazard will materialize, and also in creating an understanding of which interests will be harmed and the basis for regulatory action.

Weediness

One possible hazard is that genetically engineered crops will become weeds, or that genes for herbicide tolerance will flow to wild relatives and then these herbicide resistant relatives will become weeds. To some extent, the problem of weediness exhibits the same pattern as acquired pest resistance. No farmer or biotechnology company wants weeds to become resistant to pesticides, but people must cooperate in order to assure that it does not happen. But other than that, what's ethically bad about weeds? A weed is just a plant in the wrong place, but whether a plant is in the wrong or right place depends on a value judgment. For the most part, the weediness of herbicide tolerant plants is a straightforward form of harm to other people, rather than to the environment at large. People who are dependent on chemical herbicides for the food crops they grow (or eat) will be harmed if those crops are plagued by herbicide tolerant weeds. Food prices will increase, and if farmers substitute more toxic herbicides, those living near fields will be harmed from that, too (Lebaron 1989). If firms and farmers make decisions about which technologies to develop and deploy based on economic returns, they are not likely to include impacts that affect others. These externalities—costs that are borne by others—must be included in a complete analysis of consequences, and doing so requires an enforceable norm. This norm stipulates that costs to all affected parties must be included in the evaluation of risk.

Some have argued that the problem with herbicide tolerant crops is continued reliance on herbicides at the expense of more sustainable strategies (Comstock 1989a). This is a subtle but crucial ethical point here. Risk assessment is comparative, not absolute. The expected value approach demands a judgment about which options to assess, and typically the assessment is made in comparison to doing nothing, accepting the status quo. Economic cost-benefit analysis was developed to assess large public works projects. If a dam or a public policy produces more benefit than cost, it is considered justifiable because cost and benefit are measured relative to the status quo. Yet when environmental risks of biotechnology are assessed, the relevant comparison to the status quo may be more complex than it is for a project such as a dam, or a highway. Specifically, the status quo may also be fraught with risk from chemical agriculture or from famine and pestilence and a third alternative may be far more attractive. An expected value argument is clearly vulnerable when it omits the consideration of options that are both reasonable alternatives and have substantially different expected value (Railton 1990, p. 57).

Although tracing out these harms from weediness as we have done above is in some respects is an unexceptional piece of deduction, making the chain of reasoning explicit makes some important (and more general) points more obvious. First, there are two kinds of completeness problems: hazard identification should specify all potentially affected parties, and a comparative risk analysis should consider all relevant alternatives. Second, the rationale for emphasizing completeness is genuinely consequential; completeness is important *because* it is necessary to understanding whether a technology will tend to bring about the best consequences. Finally, the harms noted so far are harms to people. Environment is the route of exposure, but the harms described are morally very familiar: economic loss, damage to health, and hunger. They do not pose the philosophical challenges of harm to non-human animals, for example. No reason has been articulated thus far why biotechnology should have attracted the interest of people primarily concerned with protecting the environment for its own sake.

Genetic Diversity

Environmental impact on genetic diversity was discussed in Chapter 6. Adverse impacts on the diversity of organisms in a given ecosystem or on the diversity of alleles existing within an interbreeding population of organisms represents a much more broad and ill-defined class of environmental hazards, but such impacts may also be of much greater ethical significance than weediness or acquired pest resistance. Here it may be useful to have examples of both types of diversity before us. Recombinant vaccines are being developed for use on livestock that will protect against trypanosomiasis, or sleeping sickness. If successful, this product of biotechnology will allow the expansion of pastoral livestock production in Africa. This expansion is predicted to be a substantial benefit to human beings in Eastern Africa, but could have adverse impact on the habitat of threatened and endangered species. The case of recombinant vaccines thus poses an interesting and difficult ethical dilemma, in that human well-being is pitted against that of endangered species. In the context of the present discussion, however, to focus will not be on the trade-offs, but simply on the underlying ethical rationale for seeing this impact on the diversity of species in African ecosystems as an environmental hazard.

Impact on diversity of alleles within a species can be illustrated by the speculation that Bt maize has the potential to reduce the genetic diversity of Mexican landraces of Maize. The Mexican landraces are open-pollinated varieties that have been grown continuously by Mexican campesino farmers (e.g. small-scale farmers producing for both subsistence and limited commercial use) for centuries. There are important cultural and economic issues associated with the potential for impact on landraces of Maize, but here the environmental hazards will be the exclusive focus. These landraces maintain a much more diverse population of alleles than are found even in the foundation stocks of Maize maintained by commercial seed companies. While there is dispute about the likelihood that introgression of the Bt gene into these landraces will actually have an adverse effect on the diversity alleles, the focus here is not on exposure, but simply on hazard, that is, why a loss in the diversity of alleles might be a bad thing.

The harm associated with either type of impact on diversity might be evaluated in many different ways. First, Mexican maize varieties and the larger wild environment may contain species and genes whose application for medicine or agriculture is currently unknown. Such potential applications represent speculative use value. Second, in the case of recombinant vaccines, people who enjoy hunting or observing wildlife would be deprived of this pleasure. The wildlife has a recreational value. Third, people who simply enjoy knowing that the animals or the traditional varieties are there would be harmed if they are not. The wildlife and traditional crops have existence value. Clearly, measuring these values is challenging, but speculative use value, recreational value and existence value are all recognized as relevant to human welfare, and are standard types of value studied in environmental economics (Mitchell and Carson 1989).

There is an additional possibility, however. The ecosystems may have intrinsic value totally apart from any human use or aesthetic appreciation of them. The suggestion that this is the case has been at the heart of philosophical debates in environmental ethics for two decades. Holmes Rolston is one of the leading proponents of this view. Rolston describes four ways in which traditional ethical thinking should be extended beyond human beings. The first of these, extension to higher animals, is consistent with philosophical views on animals described in Chapters 5 and 6, but Rolston also argues that all living organisms are "evaluative systems" that conserve interests of their own and are therefore deserving of our respect. Rolston extends moral concern beyond organisms to species, arguing, "the life the individual has is something passing through the individual as much as something it intrinsically possesses. The individual is subordinate to the species, not the other way around" (Rolston 1991, p. 84) Rolston introduces this claim not to protest against alteration of animal *telos* (see Chapter 5), but as part of a chain of reasoning that ends by attributing moral significance to ecosystems themselves. He resolves the tension between human and ecosystem values as follows: "Humans count enough to have the right to flourish in ecosystems, but not so much that they have the right to degrade or shut down ecosystems, not at least without a burden of proof that there is an overriding cultural gain" (Rolston 1991, p. 92), and "Intrinsic value is a part in a whole and is not to be fragmented by valuing it in isolation," (Rolston 1991, p. 95).

If one follows Rolston, the expected value analysis is not complete until the ecosystem is treated as possessing intrinsic value itself. The key philosophical issue is whether to assign value to consequences that do not refer back, however elliptically, to a consequence (psychological, physical or economic) on human beings. Bernard Rollin rejects Rolston's eco-centric approach soundly in his book on genetic engineering of animals (Rollin 1995). Bryan Norton has written several detailed studies of this philosophical problem and he takes Rolston's view more seriously than Rollin. Norton concludes that so-called anthropocentric or (human-centered) approaches may differ from eco-centric or intrinsic value approaches in terms of their cognitive content, but that when anthropocentric ethical systems are properly inclusive and far-sighted, they tend to produce the same ethical prescriptions as eco-centric ones (Norton 1987, 1991). If Norton is right, then perhaps there are practical or pragmatic reasons to focus on the values to human beings, values such as recreational use in the case of African wildlife, or the cultural significance of traditional Maize cultivation, in the case of Mexico. Nevertheless, the relative paucity of materials that raise the difficult philosophical issues that need to be considered in completing an environmental risk analysis means that the consensus on this point is quite thin.

UNDERSTANDING PROBABILITY AND THE QUANTIFICATION OF EXPOSURE

Obtaining an expected-value estimate of risk requires us to take the likelihood that hazards will actually occur into consideration, or some form of risk measurement. While risk quantification is not typically thought of as involving ethical or philosophical dimensions, there is, in fact, a long history of philosophers and philosophically minded scientists or mathematicians noting ethical problems that can arise in the process of characterizing and quantifying exposure. Going all the way back to Stephen Stich's 1978 article, the ethical literature on expected-value approaches to genetic engineering focused on problems in understanding probability. Stich himself raises the possibility that recombinant DNA research may lead to negative consequences that are entirely unanticipated, and notes that "it is doubtful whether there is *any clear empirical sense* to be made of objective probability assignments to contingencies like those we are considering" (Stich 1978, reprinted 1989, p. 235 italics in original). Though he characterizes this problem as serious, he produces a list of factors that anticipate many of those noted by Alexander in 1985 (see above), and notes that since the eventual probability of harm is the product of the probability of all these factors, it is possible to place an upper limit on the probability of an unanticipated and catastrophic event. This is typical of how one accommodates uncertainty in the expected value framework.

Authors with an expressed interest in the ethical dimensions of uncertainty have contributed a great deal to risk studies, but prior to the late 1990s there were few philosophical discussions that pertained specifically to agricultural biotechnology. Since that time, a large literature has emerged in connection with the precautionary principle (or the precautionary approach). While this literature makes frequent use of the word "uncertainty" in rationalizing a preferred approach to the environmental (and also food safety) risks of biotechnology, there are in fact a number of different arguments that might be (and indeed are) made. There is first of all the distinct possibility that "attending to the uncertainties of environmental risk," might mean exactly the same thing as attempting to address hazards and their likelihood in systematic fashion, which, of course, is just what the expected value approach attempts to do. If so, then the risk assessment and risk management methods in routine (but increasing) use for addressing environmental risk simply *are* an example of "the precautionary approach." This is clearly what is at work in Indur Goklany's white paper, "Applying the Precautionary Principle to Genetically Modified Crops" (2000) though Goklany would not be regarded as a critic of biotechnology. It is also likely that the philosopher Hans Jonas would have seen much of what goes on under the rubric of environmental risk assessment as consistent with his notions of technological ethics (Jonas 1984). Few participants in the debate over agricultural biotechnology would own up to this possibility, but some of the statements on the need for precaution seem to be calling for something very much like expected-value risk analysis.

Second there are philosophical interpretations of uncertainty that are well known within science and risk assessment. One fairly narrow interpretation of the word "uncertainty," relates to the statistically measurable margin of error that exists when an inference based on a particular sample is generalized to the entire population of similar cases. This narrow sense of uncertainty is often broadened slightly to indicate the possibility of error that might exist due to modeling errors. Such types of uncertainty are not measurable, but the meaning is similar to that of statistical uncertainty. In either case, an estimate of risk may be off because the procedure for quantifying exposure fails to accurately describe reality. Both statistical and modeling uncertainties arise all the time in expected-value approaches to risk, and an entire repertoire of responses can be made in response to them. Choosing which response to make is an ethical issue, but like the issues involved in relating hazard and harm, it is an ethical issue that is often addressed within the process of specifying and applying the expected-value approach to risk. These issues are taken up here as dimensions of exposure quantification.

It is fairly clear that most of the people who have called for application of the precautionary principle or a precautionary approach understand themselves to be calling for something that is *not* a standard component of environmental risk assessment. There are, again many possibilities. Philosopher Carl Cranor has appealed to the precautionary principle as a specific burden of proof in tort actions for environmental damage, where plaintiffs have faced a very difficult challenge in proving that harm was the result of a specific environmental insult. This sense has been broadened slightly to advocate for the view that proof of harm should not be required before government regulatory agencies take action to ban or control a possible hazard. This is, in fact, the language that was used in a European Community directive advocating the precautionary approach. In itself, however, this does not constitute a deviation from standard regulatory practice using environmental risk assessment. The USDA's Animal and Plant Health Inspection Service (APHIS) is the US agency charged with the broadest responsibility for protecting the environment from the risks of transgenic plants. Their regulatory approach for biotechnology has been derived from almost a century of conducting risk analyses and making regulatory decisions regarding the importation of exotic plants and animals into the US, and attempting to control the inadvertent import of plant and animal disease. APHIS has never applied a standard remotely approaching scientific certainty of harm in making these regulatory decisions.

It is, of course, possible to argue that APHIS should have applied even more precaution than they historically have, or at least that they should be more cautious as they undertake decisions involving transgenic plants. But here the debate concerns the relative level of precaution, rather than an entirely different approach to risk. Other regulatory agencies apply totally different standards, and it is quite plausible to regard some of the precautionary principle rhetoric as an inchoate critique of these principles. The US Environmental Protection Agency (EPA), for example, regulates the pesticide aspects of crops such as Bt maize or cotton under a statute that requires them to consider the benefits of the pesticide to US farmers. Although they are given some leeway in the trade-off standards they apply in weighing benefit and risk, they effectively must incorporate uncertainties into the computation of expected-value in order to make such comparisons. The Organization for Economic Cooperation and Development and the US Food and Drug Administration (FDA), for example, have each developed a principle of "substantial equivalence" for determining which new foods and food products (including those derived from biotechnology) need to undergo strenuous regulatory review for food safety. These are, in effect, pre-risk assessment risk assessments, whereby some fairly broad principles of guidance are applied to determine whether more detailed processes of hazard identification and exposure quantification are warranted. There is considerable debate as to whether this policy adequately protects public health, and it is quite reasonable for critics of substantial equivalence to describe themselves as taking a more precautionary approach. Yet it is still difficult to interpret this as an alternative to expected-value approaches to risk, since someone who rejects the principle or substantial equivalence is in effect calling for *more* scrutiny using expected-value risk assessment. (see Miller 1999; Milstone et al. 1999).

Yet for all this, it is abundantly clear that many advocates of the precautionary principle see it as an alternative to the expected value approach. There are, in fact, a number of very respectable philosophical arguments against the expected value approach. I have myself made two broad arguments against it in the first edition of this book as well as in other publications. I have not, however, associated these arguments with the phrase "precautionary principle," nor do I think of them as being philosophically derived from Hans Jonas's *prinzip verantwortung*. Discussions of these ethical, philosophical limitations of the expected value approach follow in the succeeding sections of this chapter. Beyond the obvious fact that there are benefits in political tactics to using terminology that is both obscure and highly popular, I am at a loss to explain why anyone whose objections to expected value track closely with mine would describe them in terms of the precautionary principle. I take some small comfort in the small but growing cadre of philosophers who seem to agree with me (see Comstock 2000; Soule 2000; Pence 2002; van den Belt 2003).

There are also some interesting and ethically significant aspects of exposure quantification that have escaped the attention of the precautionary crowd, so before moving on it is worth returning to the argument Wachbroit made in 1991, as well as the argument Stich made in 1978. Wachbroit raises a wholly different set of conceptual issues associated with probabilities. Psychological research has revealed sources of bias in eliciting subjective probabilities. Even experts appear to be vulnerable to these biases. Some argue that these problems introduce a different kind of uncertainty into the expected value approach, one with ethical implications for the use risk-benefit comparisons. Furthermore, the approach to exposure quantification that is outlined by Alexander and becoming standard in environmental risk assessment implies that a series of independent events must take place before harm occurs. If these events are placed on a logic tree, each event acts as a gatekeeper in the series of events that lead to harm. As long as they are truly independent, the need to pass through many gates before experiencing harm functions much like redundancy in engineered safety systems where a series of backups must fail in order to have a system failure. People who know a great deal about all the things that have to happen before a failure occurs tend to think that the chance of all of them happening makes failure very unlikely. Before dispensing with the expected-value framework it is important to consider not only these problems, but also those aspects of uncertainty that lead people to call for more conservative approaches within the expected value paradigm.

Psychology and Subjective Probability

Although it is possible to conduct empirical studies and collect statistics, many of the probabilities for environmental risk of food biotechnology are derived from expert judgments. These judgments are informed both by experimental results from studies of the mechanisms believed to underlie environmental risk, but in fact they rely quite heavily on experience with plant, animal and microbial systems. In 1991, Wachbroit argued that objective or statistical notions of probability are simply not meaningful for evaluating the environmental risk of genetic engineering because statisticians understand probability as the long-run frequency for events of a given type. One can assess frequency for gene expression or gene flow, and these frequencies bear on the risk that a specific harmful event will occur, but there is no frequency for a single event. As such, experts are using this information to form opinions about the risk of an event. If experts disagree, as they clearly do, then "we are left in the dark about the probability of a single case. And the probability of a single case may matter" (Wachbroit 1991, p. 374).

What is more, well known psychological studies have documented that human beings incorporate heuristic tools in their subjective risk judgments, and these tools are capable of introducing systematic bias into the assessment of risk. Although experts may perform better than lay persons in forming risk estimates when they are dealing with matters closely related to their area of expertise, they fall victim to these biases when they attempt to synthesize their knowledge beyond their expertise (Tversky and Kahneman 1982; Hollander 1991). The upshot of all these problems is that probabilities are subject to error, and that the expected value paradigm does not give us clear guidelines about how to cope with this problem.

It is this problem that has led one of the leading philosophical theorists of risk to argue that decision makers should be obligated to consider multiple risk assessments developed by groups with substantially different interests. Kristin Shradrer-Frechette has argued that risk decisions can be made more democratic if something like a science court is used. Scientifically, statistically competent judges would weigh competing assessments of risk, and would be required to write opinions stating why they have chosen to favor one assessment over the other (Shrader-Frechette 1991). Whether or not this would be practical in the case of biotechnology, the proposal is important because it stresses the need for articulated reasons behind the judgments about subjectively derived probabilities. Such reason giving could be fairly readily incorporated within the expected-value framework.

Other than my own previous citation of Wachbroit's 1991 article in the first edition of this book, I am unaware that the issue he raises has caught on with any of biotechnology's critics. Yet I suspect that these sources of error in exposure quantification feed general qualms about expected-value risk assessment. Certainly they lead up to the kind of concerns relating to uncertainty discussed below.

The Small Probabilities Argument

But there are also uncertainty/probability arguments that lead people to argue for *less* caution with respect to agricultural biotechnology. Stich was reviewing the possibility that a human health epidemic might be caused by the enfeebled strain of *E. coli* that was produced in the wake of the 1976 Asilomar conference. He concluded that since the probability that this organism would survive and replicate outside the lab is clearly very low, even the highest estimate for the probability of a "worst case" scenario must be very low. If the benefits outweigh risks in the most likely scenarios for a worst case result, then "lower estimates of the same probabilities will, of course, yield the same conclusion" (Stich 1978, reprinted 1989, p. 236). It is clear that many scientists who have reviewed the risks of agricultural genetic engineering (including Alexander himself [1985]), have employed a similar pattern of reasoning (see Brill 1985; Davis 1987; Adelberg 1988; Curtiss 1988).

What is ethically important about this form of argument is that *if* one adopts an expected value approach to ethical issues, and *if* the probability of *any* harmful environmental consequences is exceedingly low, then there is little point in debating many of the philosophical questions described above. When the probability of harm is a function of small and independent (or logically redundant) probabilities, it is sure to be very low. The low probability of harmful events discounts their expected value to zero, or near zero, when compared to benefits, even when the projected harms themselves are catastrophic in nature. The small probabilities argument works hand in glove with a *de minimus* approach to risk. When probabilities shrink sufficiently, the event may be ignored in risk-benefit decision-making. Taking this view of the risks leads scientists to conclude that debate is a politically motivated waste of time (see Trewavas 1999, Borlaug 2000).

Of course, it matters a great deal whether the probabilities really are low, and this fact may explain why so much of the technical literature has focused on that question. It is as if we are observing a gambit played by scientists who want to circumvent many of the other ethical issues with *de minimus* approach. The result has been more than a decade of speculation, research and debate on how to assess environmental risks from genetically modified organisms with little closure. Henry I. Miller has had enough of this debate and has published a series of acrimonious papers ascribing disreputable motives to the scientists and government officials who have kept it alive (see Miller 1995a; Miller et al. 1995; Miller 1999). Miller and his various co-authors argue that there is no empirical evidence suggesting that transgenic organisms are more likely to have unwanted environmental consequences than are organisms produced through conventional breeding. He then accuses those who pursue the assessment of risks from genetically engineered organisms of bias and inconsistency.

The substance of Miller's argument makes a point that relates probabilities to the problem of identifying relevant options noted above, however. Expected value assessment is most meaningful when we are applying comparable assessment methods to every option. One cannot know that a risky prospect has greater probability of harm than the status quo—the null hypothesis for a risk-benefit analysis—unless both are assessed. Of course, the ethical conclusion that one might draw is that we need to do environmental risk assessment of organisms derived from conventional breeding, too (see Thompson 1987), but Miller is more inclined to conclude that *any* environmental risk assessment is unnecessarily costly. To put his point in the language of the expected value framework, the cost of assessing risk may outweigh the benefit of knowing more.

But it is also possible that small probabilities are an artifact of complexity and redundancy in the way that one conceptualizes or models exposure. If one thinks that exposure is the result of a long chain of independent events, each with a probability less than one, then the length of chain itself begins to create the impression that exposure is unlikely. The final occurrence of the harm depends upon each event happening in succession, and each event's happening is conditional upon every previous event already having happened. This means that the quantification process is a long multiplication problem with each unit in the problem having a value between 0 and 1. Even if each event has a probability of 50% in Alexander's six-link chain, the final probability of harm will be 0.015625 or less than 2%. As chains become even longer because they are seen as composing more and more independent events, exposure becomes less and less simply in virtue of modeling complexity. Should this bother us? This, as far as I can discern, remains a relatively undiscussed problem in the literature on risk from biotechnology, but doubts of this sort may be behind the inchoate worries expressed by ecologists who decry reductionistic thinking. At any rate, these are somewhat more technical ways to arrive at philosophical and ethical questions about how to deal with uncertainty. It is partly Miller's interest in these problems that has placed him at the forefront of boosters when it comes to debating the precautionary principle (Miller and Conko 2001).

Uncertainty in Exposure Quantification

One problem is that scientists are trained to minimize the chance of accepting a false claim. This norm protects the integrity of the theory building process, but is it appropriate when assessing risk? Philosophers such as Carl Cranor (1993) and Kristin Shrader-Frechette (1991) have argued that the appropriate norm in risk assessment is to minimize the chance of failing to accept a true claim, or the chance of failing to anticipate and prepare for a risk that might be present, even when the data is insufficient to prove that it is.

This problem was formulated in general terms by philosopher Nicholas Rescher quite some time ago. Uncertainties can plague not only the statistical significance of data, but our knowledge of what might happen, or how harmful any given event might be in the long run (Rescher 1983, pp. 94–95). Thus, uncertainty is a potential problem not only in calculating exposure, but also in identifying hazards. Although this situation need not lead one to reject the expected value approach, ethical decision making under this form of uncertainty "becomes a matter of comparing not expected values as such, but *ranges* of expectation" (Rescher 1983, p. 102) Rescher presented three alternatives for coping with this problem: make an expected value decision based on the median of the range, on the worst case scenario, or on the best case projection. It is not obvious which of these alternatives is most consistent with the consequentialist desire to choose so as to produce the best consequences. Individuals undoubtedly make their own choices based on whether their personalities tend toward risk-taking or risk aversion, but it is not immediately clear how to translate such personality factors into the sphere of public choice. Rescher's work shows analytically *why* people like Miller would be ready to move ahead with food biotechnology, while others would not, but it provides no ethical basis for deciding which of them is right.

RISK COMMUNICATION

Communication of risk is difficult for many reasons. One is that that many advantages of the expected value framework evaporate under circumstances where decisions must be endorsed by a large number of people. Another is that the interminable debate over probabilities for environmental risk of genetic engineering erodes public confidence, making a difficult task all that much harder. Yet it may not be obvious why communication of risk would be thought necessary within an expected value framework, in the first place. As such, we begin there and take up the sense in which risk communication problems begin to provide a basis for challenging the entire framework of expected value afterwards.

Risk Communication and Expected Value

Simply put, ill informed people can disrupt the orderly development and deployment of any technology, including technologies that have, after thorough risk analysis, been shown to have very attractive risk-benefit ratios when compared to available options. Scientists and policy makers working with chemical technology and nuclear power learned this lesson through cruel experience (Covello et al. 1991). Most participants in research on or commercial development of food biotechnology have already learned that public opposition can cause delays and can even sabotage promising products. Virtually all of the National Agricultural Biotechnology Council's annual consensuses seeking meetings have stressed the need for more public education. But the expected value approach to ethical responsibility produces a very different rationale for achieving consensus than do other philosophical approaches that will be taken up below. Here, risk communication is needed because ill informed people will ruin the best laid plans. It is not that they are entitled to this information, nor that they are entitled to a role in performing the information seeking elements of an expected value analysis. They must be informed only because failing to inform them introduces unacceptable costs.

This lack of entitlement under the expected value approach is philosophically crucial for understanding debates over risks associated with agrifood biotechnology. The expected value approach provides broad guidelines for comparing the chance of harmful outcomes from food biotechnology to the chance of beneficial outcomes. It is philosophically committed to the idea that the ethical course of action is the one that brings about the best outcome. It would seem that to execute this approach, a decision maker must simply assemble the best information available, and then do the right thing. There is no obvious place where the expected value approach requires a decision maker to share information with others, even if they are affected parties. Someone who discharges the ethical responsibilities demanded by the expected value approach will have taken their interests into account already. Affected parties may have been surveyed to determine their preferences. A decision maker will want to do that because this kind of information helps determine whether an outcome is beneficial or not. But such forms of communication with the public may or may not involve informing them about risks.

Clearly the most powerful ethical argument for risk communication is based on the importance of informed consent. On this view scientists and policy makers have a direct responsibility to inform people about the risks of food biotechnology, whatever results. The discussion of food safety in Chapter 4 contrasted an expected value approach to one based on informed consent. However, informed people may make less than optimal choices and therein lies the rub for a committed utilitarian. Respecting consent need not produce the best outcome, and may produce very bad outcomes. As long as one is working within the consequentialism of the expected value framework, the decision of whether or not to inform people is contingent on the utility of risk communication, on one's assessment of whether communicating about risk yields better or worse outcomes. In this respect, the informed consent argument is not consistent with the consequential ethical foundations of expected value. If one truly can bring about the best consequences without undertaking a risk communication effort, there is no ethical obligation to do so. Furthermore, when communication is likely to backfire, to cause harmful outcomes or needless costs, one is obligated to be uncommunicative. Risk communication is important within an expected value framework only when one must rely on the cooperation of others in order to bring about the desired result. But this very aspect of the expected value framework itself has consequences when the framework is deployed in a democratic society, and these consequences commence the unraveling of the expected value approach.

Erosion of Public Confidence

As already noted, multiple messages may erode public confidence in the reliability of risk information. If public cooperation is important to efficient implementation of expected value decisions, the normal process of conjecture, debate and refutation that is part and parcel of science may contribute to the defeat of expected value assessments for environmental risk. The usual response to this has been to decry public ignorance of science, to accuse the public of superstitious and irrational thinking, and to call for public education. Physicist H.W. Lewis adopts this stance as the premise for his widely read book on technological risk, for example, though he did not take up genetic engineering (Lewis 1990). Lewis ends with a prescription for making a strong separation between risk assessment and risk management, a prescription that amounts to saying that scientists will provide information for an expected value analysis, but it is up to the politicians to make it work.

Wachbroit makes a further point, noting that the expected value approach relegates communication to a role of *"handling"* the public," rather than informing them (Wachbroit 1991, p. 374). He calls this formulation of the ethical responsibilities associated with genetic engineering "tendentious." Clearly he is right to note that people do not like to be handled, and react with justifiable suspicion when they think that representatives of the science community are patronizing their concerns. If this tendentiousness is experienced as arrogance on the part of the food biotechnology community, preventing the erosion of public confidence will be made all the more difficult (Thompson 1995b). Ironically, following out the general prescription of the expected value approach may result in conduct which produces anything but the best consequences!

Decision Making for Large Groups

Consequential or expected value decision making adopts a scientific notion of objectivity in the sense that it strives for an impartial account of the best outcome, but it ends in paradox when it fails to recognize the strategic dimensions of acting in pursuit of the best outcome. In this context, a choice is "strategic" whenever the outcomes depend not only on what the decision maker selects, but on how other people act in response. Applying the expected value approach to environmental risk questions seems at first to be an instance of non-strategic choice. One examines the chance that any given product of food biotechnology will result in harm, either to other humans to the environment itself. If the assessment is that the probability of harm is very, very low, ethics seems to weigh in favor of pursing the technology, provided that expected benefits outweigh the standard costs of research and development. But acting on this analysis, objective and unbiased though it may be, appears to provoke a ruinous response from the public.

This leads next to the educational strategy: Let the public be informed! Ironically, *this* course of action has the strategic consequence of infuriating them further. The public does not like to be educated solely for the strategic purpose of "handling" their dissent. Their resentment erodes their trust in the handlers, which is to say that it leads them to mistrust science. What was at first only ruinous with respect to a specific product threatens to become ruinous for the entire food biotechnology industry. What can one do now? This is an extraordinary question that has recently come to bedevil many analysts of science and risk (see, e.g. Beck 1992; van Dommelen 1995). Arguably, what one must do (now for consequential reasons) is what one would have done if one would have never been tempted by the expected value framework, in the first place. And so, at last it is time consider the alternatives to it.

ENVIRONMENTAL IMPACT: CONSENT, RIGHTS AND RESPECT FOR NATURE

The expected value approach remains powerfully influential among scientists and public policy analysts. It continues to be analyzed, developed and modified both by philosophers with a specific interest in risk (discussed above), as well as those such as Peter Singer (1979) or John Harris (1992) who are philosophically committed to a utilitarian approach. Both of these latter figures are more interested in biomedical issues than food or environment, however, and they have contributed little that is directly relevant to the matter at hand. Nevertheless, a larger group of environmental ethicists and philosophically informed environmental critics of biotechnology rejects the expected value approach, and adopts alternative philosophical positions. Many of these positions either do not specifically address food biotechnology, or call on moral foundations that are more readily analyzed in terms of either social consequences or food safety. While positions on social consequence and food safety are taken up elsewhere in this book, it is important to undertake a brief and necessarily speculative review of the case against expected value, and of those claims that do bear specifically on the environmental impact of food biotechnology.

Against Expected Value

Chapter 4, on food safety and Chapter 8, on social consequences recount arguments against the expected value framework as it is typically applied to those issues. In both of these instances, failure to involve and consult with affected parties (a failure apparently sanctioned by the expected value approach) is thought to violate fundamental moral rights or principles of democratic participation. With respect to environment, the rejection of the expected value approach is usually tied to a critique of economic approaches to agriculture and the environment. Clearly some of these critiques turn on citizen participation in environmental decision making (see Kloppenburg 1989; Mellon 1992; Levidow 1995a). These arguments rely on ethical claims about the role of science in democratic government that are identical to those that establish the case of an ethics of consent with respect to food safety, or an ethics of participation with respect to social consequences. Yet other critiques address the economics of natural resources more directly, and make substantially different arguments than are made with respect to food safety or social consequences.

Philosopher Annette Baier, for example, argues that expected value approaches to risk "poison the wells," by introducing a means-end language into ethical discourse that obscures the importance of virtue and respect for nature (Baier 1986). Other critiques have noted that mainstream economics fails to acknowledge ecological limits to human use and exploitation of the natural environment. To the extent that expected value approaches are committed to economic methods, they may fail to assess some of the most serious environmental risks (Daly and Cobb 1989). These arguments have been extended to research on food biotechnology by Gary Comstock (1989b, 1990) as well as myself (Thompson 1988a). Naturalist Aldo Leopold deplored the tendency to find economic rationales for actions taken on behalf of the environment (Leopold 1949, p. 210). He believed that those who work on environmental issues divide into two groups. Group (A), "regards the land as soil, and its function as commodity-production; another group (B) regards the land as biota, and its function as something broader" (Leopold 1949, p. 221). The "something broader" is ecosystem health.

Leopold's comment synthesizes the force of Baier's concern—adopting the expected value paradigm reveals a character flaw—and also a concern with humanity's limited ability to foresee consequences. Environmental philosophers frequently interpret Leopold as rejecting a utilitarian or expected-value approach to ethics in these remarks (Hargrove 1989, pp. 102–104, 1994). It is clear that in directing our attention to a concept of ecosystem health, Leopold means to reject some of the more narrow forms of consequentialist ethics, and that he means to attribute intrinsic value to ecosystems, as discussed above. Although this may reorient our thinking in a dramatic way, it need not be conceived as inconsistent with a broadened form of consequentialist, expected value thinking, nor need it be thought of as utterly inconsistent with goals of human use (or even economic development) (Callicott 1992).

Although many environmental philosophers clearly think of themselves as rejecting the consequentialist's approach, a subtle logical point threatens to convert the debate into an exercise in philosophical hair-splitting. R.M. Hare, one of the most penetrating defenders of consequentialism in recent decades, makes a distinction between moral heuristic and moral theory. The consequentialist, expected-value tradition is, for him at least, a moral theory: it is intended to give a philosophically defensible (e.g. true) account of right action, just as physical theory is intended to give a true account of the world's structure. We should no more expect ordinary people making ordinary moral judgments to utilize moral theory than we should expect carpenters and tradesmen to utilize physical theory in their trade (Hare 1981). The criticisms noted above are intended to show that consequentialist, utilitarian approaches to environmental issues are not practical. They all provide reasons to constrain, if not to abandon, the use of expected-value thinking when engaged in the practice of identifying one's responsibilities with respect to food biotechnology. They do not preclude the possibility of finding a comprehensive, philosophically based account of the best outcome, and of showing that the actions one would take by following a heuristic of virtue or ecosystem health are abstractly justified *because* they lead to the best outcome. However, those interested in moral practice, in acting responsibly, might be better advised by appropriate heuristics, heuristics that have little to do with moral theory *per se*. Thus even a consequentialist philosopher might advocate non-consequentialist reasoning. But what would such reasoning look like?

Environmental Ethics in Consumption

Environmental ethics arose amidst political controversy over preservation of wild areas. Nature conservation became a worldwide effort in the late nineteenth century, and it was everywhere characterized by the A/B cleavage Leopold found among his colleagues. The cleavage was personified by Gifford Pinchot and John Muir.

Pinchot, founder of the US Forest Service and conservation advisor to Theodore Roosevelt, tended to see conservation as a strategy justified by its future economic returns. Muir, founder of the Sierra Club, saw nature as sacred. Although Muir and Pinchot were frequent political allies in opposition to squanderous natural resource policy, they clashed on a number of water projects that sacrificed beautiful wild areas of the American west for the sake of cheap hydro-electric power (Norton 1991).

These conflicts pose the key philosophical issues as questions of consumption. So called conservationists adopt a view quite compatible with the expected value approach, and argue that ethical responsibilities regarding nature were discharged by making wise use of nature. Against them are preservationists who reject the implicit assumption that nature is there for human consumption, if not now then later. Following the writings of philosopher Arne Naess, the preservationist tradition has matured into a movement called "deep ecology" (see Devall and Sessions 1985; Sessions 1995). As characterized by its most extreme exponents, deep ecology becomes misanthropic, recommending preservation of global ecosystems through eventual human extinction. Though mainstream proponents of deep ecology deny the charge of misanthropy (Sessions 1995, p. xiii), deep ecology (as well as other positions that could be described as "eco-centric") continues to have a preoccupation with consumption. The persistent image is that wild areas are "lost" to human use. This image may be entirely appropriate when applied to questions such as role of genetic engineering in expanding the boundaries of African cattle production. There it is clear that one kind of ecosystem (though one in which human beings already have significant impact) will be lost if recombinant vaccines are successful in converting it over to range.

Deep ecology and ecocentrism, however, are strangely silent with respect to that part of the world's land mass that has been dedicated to agricultural production for centuries. It is as if once land is given over to production, deep ecology advocates lose interest in its role in ecosystem health. Human use so thoroughly ruins and pollutes nature that there is little point in even specifying norms for productive use of land. There is nothing in the deep ecology view that entails this conclusion, and it may simply be inattention to agricultural issues, rather than antagonism, that has led to this state of affairs. An agricultural-environmental ethic, however, would not be an ethic of consumption. A truly environmental ethic for food production would change move away from "A" side of the cleavage described by Leopold, where soil is understood solely in light of its contribution to commodity production, but it would be an ethic of production, nonetheless (Thompson 1995a).

Farming and food production inherently make productive use of nature. Any act of production transforms and in that sense consumes its inputs, but an ethic framed only in terms of constraints on consumption will never get to the heart of the production process. Traditional farming in Europe, North America and other countries of European settlement has embraced a strong ethic of production for centuries, though that ethic is complex and has often been implicit in religious beliefs, folklore and farming practice. The ethic presumes that the farmer (meaning the entire farming community) exists in symbiotic relationship with nature (usually articulated simply as "the land"). As farmers bring forth the commodities needed to sustain themselves, they must respect a complex system of natural constraints. They must preserve soil fertility, they must conserve water, they must limit erosion, they may not overgraze their pastures, etc. These constraints define a duty of stewardship for farmers that is consistent with long run self-interest but which may diverge from former interests viewed over the short term.

The potential for tension between short and long term self-interest rests at the heart of traditional moral wisdom for agriculture and the food system. The children's fable of the ant and the grasshopper contrasts the hard working ant, who stores food for winter, with the lazy grasshopper who lives for today. Such stories place industriousness and self-reliance at the heart of morality. The good person is, above all, not a burden on others. Of course the industrious are more than willing to help the unfortunate, for even the most self-reliant person needs a hand now and then. Such simple ethical principals tend to be lost in the shuffle when philosophers frame ethical theory in terms of rights or utility. It is therefore worth stressing how the agrarian view of environmental ethics emphasizes hard work and self-reliance within a framework of food production and community obligations.

Environmental Ethics in Production

For traditional farmers, stewardship duties coexist with other duties that emerge out of symbiotic relationships. Each member of the family depends on every other for survival, so carrying out one's chores reinforces both personal loyalties and a virtue of industriousness. The network of loyalty extends to the community level, as neighbors help one another in time of need. Virtues of stewardship, industriousness and charity interact and mutually reinforce one another. They are all driven by self-interest, since failure to perform the duties of stewardship, industry and charity bring on ruin. The intricate network of these virtues also constrains self-interest in an ecological fashion. While traditional farmers have the same drive to produce more and to make good trades as anyone, an unrelenting emphasis on this drive creates negative feedback. One's standing in the community falls. Soil fertility may decline. Hard work and productivity are virtues when they are held in balance with other virtues; they translate into the vice of greed when self-interest is allowed to drive this one dimension of farm life, unchecked by others (Thompson 1995a).

Many agricultural scientists will react unfavorably to this kind of language, so it is important to put the same argument in language that makes less appeal to moral terminology. Arguably, the environmental problem with scientific agriculture, of which biotechnology is a part, is that it has undercut or obscured the feedback loops that bind stewardship and the other virtues of traditional agriculture together. In most instances, technology has lengthened the feedback loops that constrained traditional agriculture, rather than eliminating them. Nitrogen fertilizers have lengthened the time lag between abusive land use and eventual soil depletion, for example, as modern irrigation systems (especially those that pump groundwater) lengthen the time lag between overproduction and water shortage. Other affects on feedback are more complex. Traditional farm communities would constrain their food choices according to seasonal cycles. Although they might want foods out of season, they were content with a seasonally determined diet for they had some sense of the costs involved in producing or procuring the foods they ate. Modern grocery stores have made the feedback loops between effective consumer demand and the environmental costs of food production all but invisible. Price is the only signal that food shoppers get, and they have no way of knowing whether low prices conceal short and irreversible environmental exploitation, or not (Clancy 1997).

Agronomist Les Lanyon has argued that transportation, fertilizers and other production technologies have lengthened both the spatial and temporal dimensions of feedback loops in the nitrogen cycle. The cycling of nitrogen through soil, into crops, from crops to animals (including humans) and back into soil is, perhaps, the most basic ecological principle of food production. When this activity takes place in a relatively constrained geographical area, feedback on nitrogen cycling will occur first with depletion of soil fertility, and declining crop production. However, when crops that are fed to animals are hauled thousands of miles from the point of production (as they are in the United States), and nitrogen in animal manure is disposed of as waste, the feedback is more likely to appear as nitrogen pollution in the watersheds where animals are concentrated (Lanyon and Beegle 1989; Norda and Lanyon 2003).

One must admit that the moral significance of this change in feedback is ambiguous. Lengthening feedback loops is not inherently bad. It can introduce flexibility into the food production system, and increase the number and type of responses that humans may undertake in discharging their duties of stewardship. An expected value approach would assess the costs of pollution or the risks environmental damage and would attempt to weigh them against the benefits. The environmental ethic of production sees the moral significance not simply in the costs accruing from fragile feedback loops, but in the deterioration of decision making capability that occurs when feedback becomes invisible, and when actions appear to have no consequences. When this kind of decline becomes so pervasive that it becomes typical of farmers, policymakers, scientists and other key decision makers, it is appropriate to use the moral language of virtue and character to describe what has gone wrong, to say that the ecology of the virtues has given way to the narrow pursuit of self-interest. The problem is not just that there may be environmental damages, but that this transformation of food production is creating a society of people who are incapable of moderating their activity, even when the consequences are pointed out to them.

This latter point is crucial to the evaluation of biotechnology, for plant, animal and microbial biotechnology's contribution to the probability of environmental insults may be quite small, especially when compared to chemical and mechanical farm technologies. Yet if biotechnology continues to lengthen and obscure feedback loops in our food system, and if preoccupation with biotechnology blinds scientists and public administrators to the environmental dimension of agriculture, its effect on the moral character of farmers, food consumers and public administrators will be regrettable. Something like this sentiment may lie at the heart of agro-ecologist Wes Jackson's animosity toward biotechnology.

After reviewing controversy over ice-minus and the Beltsville pigs in passing, Jackson writes, "Some gene splicers will explain that what that hog needs is some more fine tuning to make it right—they clamor for more research. Quite frankly, I am concerned less about this hog monster than about the human monster, created by our culture, the monster who sees nothing wrong with creating such a hog," (Jackson 1991, pp. 207–208) Jackson goes on to argue that scientific reductionism has led us astray, and that we should, in food and agriculture, concentrate instead on building an ethic that makes us "native to our place" (p. 210). This phrase ties Jackson's dim view of biotechnology to his other writings in the agrarian tradition (see Thompson 1995a, pp. 123–126). The task of agricultural science must be to illuminate, rather than obscure, the system feedback loops that bind person to community, and community to land (Jackson 1994).

Ecofeminism

There are other and more radical ways of reaching a similar conclusion. For example, Regine Kollek argues that biological science itself is committed to a view of the world that blinds the scientist to the context of life. While some, such as Richard Lewontin (1992) and Ruth Hubbard (Hubbard 1990; Hubbard and Wald 1993), have argued that reductionism and genetic determinism make molecular biologists insensitive to evolutionary and ecological dimensions of biology, Kolleck presses the issue more deeply and in direct connection to ecological risk. She argues that scientists have fused a Cartesian, reductionist image of the world with blindness to the influence of commercial interests in order to rationalize the release of genetically engineered organisms (Kolleck 1995).

Kolleck's critique is advanced as a component of ecofeminist philosophy that is itself complex and multidimensional (Davion 1994). Among ecofeminists who have specifically addressed biotechnology and genetic engineering, Maria Mies cites historical links between science and military or imperialistic projects, and writes, "Without selection and elimination, this technology would be quite different, hence, it cannot claim to be neutral; nor is it free from the sexist racist and ultimately fascist biases in our societies. These biases are built into the technology itself, they are not merely a matter of its application" (Mies 1993, p. 195). Vandana Shiva portrays food biotechnology as an extension of the green revolution that, in her analysis, obliterated and systematically destroyed indigenous women's more ecologically sensitive knowledge and control of farming techniques (Shiva 1993). Evelyn Fox Keller argues that molecular biology is built upon three intellectual shifts: (1) Biologists shifted their understanding of the basis of life from complex organism-environment relations to the physical-chemical activity of the gene; (2) they redefined life as the information encoded in genes; and (3) they recast the goals of biology from observation to experiment. Keller links these shifts to a preoccupation with mastery and the penetration of nature that was characteristic of male dominated science (Keller 1990). Her analysis provides a bridge between the explicitly environmental concerns of Mies and Shiva and the more abstract reasoning of Kolleck.

Molecular biologist Martha Crouch has argued that the structure of scientific research militates against pursuit of environmental goals. Although much of her argument stresses the interpenetration of commercial forces into scientific disciplines (a topic taken up in Chapter 7), she also appeals to feminist principles. For example, she compares the network of connections that are bound together and embodied in her home grown tomato with the network of a genetically engineered tomato. The latter network includes many experts and organizations that have no intrinsic interest in Crouch or her tomato. Unlike the friends and neighbors who are bound together in her garden tomato, these experts and organizations cease to have any concern with Crouch after she has purchased their product (Crouch 1991, 1995). However, after listing impacts on women and children Crouch concludes with a statement that sounds more consequentialist than feminist: "*None of these effects are desirable. Therefore biotechnology should be discouraged*" (Crouch 1995, p. 107). Arguably, it is her emphasis on the whole network rather than comparing costs and benefits, that places her in the ecofeminist camp.

What these feminist critiques share with the agrarian analysis is a concern with moral character. What they lack is a clear statement of how practice relates to moral character, to the formation of virtue and vice. Such an account is available in other strands of feminism. Annette Baier has built upon the work of psychologist Carol Gilligan in claiming that a feminist ethic emphasizes relationships, in contrast to utilitarian and rights-based approaches to ethics that emphasize individuals apart from their social network (Baier 1994, pp. 20–25). Agrarianism is also a relational ethic, deriving moral content from the manner in which individuals are imbedded in families, families in farm communities, and communities in the natural world. The relationships that emerge in farm production shape the virtues of stewardship, industry and charity in a manner that cannot be captured by theories of utility or rights (Thompson et al. 1994, pp. 242–257). Jim Cheney ties this relational, virtue oriented theme in feminism to the need to respect diversity and broad themes in environmental ethics (Cheney 1994). Baier and Cheney both make more sweeping claims than the agrarian critique, however. Their conclusions about virtue extend to many areas of modern life, not just environmental stewardship. In linking her argument to peasant agricultural systems in India, it is Shiva who replicates many of the points made about lengthening and concealing feedback loops in the agrarian analysis, above (Shiva 1995a), and who brings ecofeminism closest to the agrarian critique.

ETHICS AND ENVIRONMENTAL RESPONSIBILITY FOR FOOD BIOTECHNOLOGY

Whether agrarian or ecofeminist analyses are used to assess food biotechnology, critics must admit that corruption of moral character is not a necessary consequence of genetic engineering in agriculture. Clearly it should be possible and even fruitful to utilize the techniques of rDNA within an agrarian or ecofeminist framework if it is possible to use science at all. There is, however, little in the principles of food biotechnology that will direct its practitioners to an ecology of virtue (excepting possibly the study of evolutionary processes at the molecular level). It will take a conscious and dedicated effort to integrate deliberative consideration of environmental values and stewardship into the scientific institutions (universities, companies, professional societies and government agencies) in order to recreate the understanding of humanity's place in nature that came naturally to traditional farmers. That understanding was implicit and it has eroded quickly where farming has embraced unrestricted technological expansion. To the extent that food biotechnology is simply part of that expansionist attitude, it contributes to humanity's malaise. If you are not part of the solution, a wise environmentalist slogan goes, you are part of the problem. That sentiment captures the central environmental moral responsibility for food biotechnology.

Scientists and decision makers trained in economics or politics may gravitate to an expected value analysis of the environmental risks associated with genetic engineering in the food system. Such gravitational pull is understandable — prediction is the long suit of science, after all — but it should be resisted. It is, in the first place, self-defeating on its own terms. The thoroughgoing expected-value risk analyst is forced to abandon the tools and concepts of expected value when it comes time to communicate with the public. What is more the expected-value approach moves the locus of ethical deliberation away from the ecology of virtue, away from our attempt to understand how our food production practices are embedded in a web of social and ecological relations. When efforts to anticipate consequences become detached from the ecology of virtue altogether, it is arguable that they become corrupting, a theme that will be taken up again in Chapter 11.

None of this is to suggest that we can do without predictions, or without attempts to understand how food and agricultural biotechnology will affect the environment. It is important to have information on the risks of food biotechnology, and it is equally important to have information about its potential benefits. Characterization of the benefits, like characterization of risks, is an empirical and contested matter. Susanne Huttner and two co-authors think, "the potential benefits of biotechnology applied to agriculture are broad—encompassing virtually the entire food-production system" (Huttner et al. 1995, p. 38). In contrast, Krimsky and Wrubel conclude their study by saying:

> Our research indicates that there is little basis for the claim that biotechnology has been burdened with overregulation and that such regulation has thwarted innovation. Some evidence suggests that regulatory inaction or confusion has kept firms from investing in transgenic organisms. Furthermore, there is little doubt that biotechnology is having a significant impact on agricultural research, that it is responsible for inducing structural change in sectors involved with plant germ plasm, but that there are no signs of significant change in the refashioning of agriculture toward environmental goals (Krimsky and Wrubel 1996, p. 252).

Empirical disputes will not be settled by ethical analysis, though there is little doubt that people with different ethical values also lean toward accepting the version of contested empirical claims that most supports their philosophical inclinations. Many people involved in scientific agriculture and in commercial development of agricultural technology see nothing amiss in the environmental implications of the path that has been taken on both fronts since World War II. Few, if any, of these people have failed to support the development of food biotechnology. Others, including the author (Thompson 1995a), see these trends as disturbing. Many of those who would like to redirect agriculture have come out in opposition to food biotechnology. Sometimes this opposition is based on their projection of the true environmental impacts of biotechnology. Sometimes opposition is based on the belief that better investments of research funds could be made in low-input or sustainable agriculture (Hassebrook 1989; Merrigan 1995). Sometimes the opposition seems to come from force of habit: "if biotechnology is supported by my enemies, I'm against it," or so the reasoning seems to go. The tools of recombinant DNA are certainly not a sufficient basis for the redirection of agriculture, and it is always difficult to determine which will be the most reliable means of doing so, but it is impossible for me to imagine organized agricultural and food research directed toward any cause, including environmental ones, that denies itself the tools of biotechnology. Others, such as Hugh Lacey (2005), disagree.

It is possible, then, to draw the following conclusion. Research and regulation should assiduously pursue the goal of making agriculture and food production more sustainable, and of making the environmental impacts of the food system easier for everyone to understand. There is no reason why techniques of recombinant DNA should be singled out, however. This is an imperative that applies to all food technology. Where there is conceptual evidence that transfer of genetic materials might result in ecological impacts that differ from those of traditionally modified plants and animals, research should be performed to empirically test these hypotheses. To attack government programs that support this research is ethically unconscionable. Nevertheless, it is probable that excessive opposition to biotechnology has provoked otherwise reasonable people to make such attacks. It is time for advocates of sustainable agriculture to refocus their efforts toward support of food biotechnology that advances an environmental agenda, and to abandon the reactive strategy of unilateral opposition.

Risk assessments will be most useful when they are integrated into ecosystem models. There we will be able to see how feedback loops are affected at the ecosystem level. But there are other feedback loops that matter just as much. These are the loops that integrate our conceptions of private and public interest into an integrated conception of moral virtue, and that make good environmental practice seem like nothing more than enlightened self-interest. Even virtuous farmers are generally unaware of how their practice reinforces their moral character (and this is why linking farming with virtue is often naive and misleading). It is not clear that anything happens "automatically" in the complex and highly articulated system of feedback loops that comprise modern life. The virtues that came naturally to farmers of the past may have to be taken up and promoted explicitly. The science and business community has been reluctant to do this, and though that reluctance is not surprising, it is nonetheless disturbing.

CHAPTER 8

SOCIAL CONSEQUENCES

Previous chapters have considered food and agricultural biotechnology's potential for unwanted impact on the health and safety of individual human beings, of non-human animals and on the broader environment. The last category of unwanted impacts includes those that affect individuals' economic welfare and daily practice, as well as impacts on human relationships, including households, communities, organizations and other human institutions. For any technology, social consequences such as these can be markedly dispersed in both space and time, and can accrue through a tremendous variety of mechanisms. Innovations in irrigation and cultivation technology dramatically change human relationships, for example. Large scale water management can require extensive coordination of individual activities which in turn creates capacities for coordination of human action that penetrate throughout the fabric of a society. Particular innovations that occurred in relatively isolated geographical areas are now spread throughout the world (Crosby 1986; Hugill 1993). The development of timekeeping technology revolutionized social organization, making spatially discontinuous coordination of bureaucratic activities possible and paving the way for the creation of modern states (Mumford 1934; Landes 1983). Recent historical and sociological studies of technology have linked such disparate events as the rise of psychoanalysis to the development of the steam engine (Edge 1973), and the sexual revolution to the automobile (Jeansonne 1974).

Any attempt to manage technology's social consequences is controversial in part because the mechanisms that link technological innovation to its eventual impact are generally opaque to non-specialists (including many of the scientists, engineers and administrators who bring about the innovation), and often obscure even to scholars of technology. This basic conceptual problem would limit our ability to discuss and debate the social consequences of technology in the best of circumstances, but the situation is further complicated by the fact that irrespective of his contribution to the political ideology that came to be known as Marxism, Karl Marx was indisputably a master theorist of technological change and its social consequences. Marx was clearly wrong on many things, and the political vision he advocated in response to the problems of industrialization became associated with some of the worst political regimes of the twentieth century. Omitting Marx's thought from any discussion of technology's social consequences is either naïve or intellectually dishonest, but Marx's ideas continue to be regarded as suspect and the use of his name inevitably colors the manner in which that assessment is received, especially in the United States.

The upshot is that simply predicting the social consequences of food biotechnology can spark controversy, irrespective of the norms or values that are applied in evaluating the ethical significance of those consequences. It is as if only Communists or someone disloyal to democracy would be interested in such predictions. Clearly, there are non-Marxist ways to appraise social consequences. Four main non-Marxist themes may be isolated from the philosophical literature on social justice: rights theory, utilitarianism, procedural theory and virtue theory. Once Marxist political theory is added to these, a matrix for examining the ethical significance of social consequences begins to emerge. On one axis are the respective approaches to justice, on the other are the main types of social consequence that have been associated with food biotechnology: impact on small or family farms, impact on agriculture in developing countries, and impact on the organization and structure of science itself. This chapter begins with a brief discussion of some key mechanisms that link technological innovation to social change, then moves to summary statements of the five theoretical positions described above. The balance of the chapter fills in the matrix by speculating on how each of these five theoretical positions might be applied to the three main types of social change. It must be repeated that technology's capacity for unanticipated social impact makes any effort to anticipate social consequences subject to a high level of uncertainty and incompleteness. The effort reflected in this chapter is no exception.

THE SOCIAL CONSEQUENCES OF FOOD BIOTECHNOLOGY

The economics of food and agricultural production is the driving force behind the technological changes leading to social consequences that are the focus of this chapter. Farmers are always looking for ways to do things a little better. As societies become organized on the industrial model, it becomes possible to make a living (sometimes a very good living) by making things that help farmers do a little bit better and selling them. Agricultural economist Willard Cochrane developed these unexceptional observations into an analysis of the technological treadmill in agriculture: When a new production technology allows farmers to reduce the cost of production, early adopters of the technology reap substantial profits. They can produce more than their neighbors can with a comparable investment of time, labor and capital. As long as commodity prices are stable, this extra production is translated into extra profit. However, as more and more people adopt the new technology, total food production begins to rise, and commodity prices begin to fall. This (almost) always happens because the world can only use so much food. When prices fall, those who continue to use the old technology find themselves operating at a loss, and many go out of business. Those who adopted the new technology find that higher profits disappear; they are running harder (e.g. producing more volume of food) to stay in the same place (e.g. retain an income level comparable to what they had before the new technology came along) (see Cochrane 1979, pp. 389–390; Browne et al. 1992, p. 56).

Cochrane popularized the technological treadmill in the United States during the 1950s and 1960s, although the idea that farmers were on a treadmill of some sort was commonplace even in the 1930s (see Griswold 1948). He made a concept central to Marx's analysis of technical change acceptable to conventional economists and to the conservative American farming community by toning down the rhetoric and by applying it to an industry (e.g. farming) where the tension between ownership and the wage rate for labor was more psychological than social. Marx himself had characterized the phenomenon that later became known as the treadmill this way:

> During the transition period when the use of machinery is a sort of monopoly, the profits are exceptional, and the capitalist endeavors to exploit thoroughly "the sunny time of this his first love," by prolonging the working day as much as possible. The magnitude of the profit whets his appetite for more profit.
>
> As the use of machinery becomes more general in a particular industry, the social value of the product sinks down to its individual value, and the law that surplus-value does not arise from the labour-power that has been replaced by the machinery, but from the labour-power actually employed in working with the machinery, asserts itself. (Marx 1867, p. 405)

These passages from *Das Kapital* may state Marx's "law" in very general terms, but they indicate that Marx was aware of the technological treadmill one hundred years before Cochrane. In agricultural economies with competitive land markets, the treadmill produces an additional effect. Early adopters invest their windfall profits into land, buying up land holdings from the failing smaller farms. The net effect of productivity enhancing technology is summarized by the phrase, "fewer and larger farms." Mainstream agricultural economists (who hardly think of themselves as Marxist) have now accepted this economic analysis.

This dictum of "fewer and larger farms" was applied to biotechnology in a theoretically unexceptional, but politically ground shaking, study of recombinant bovine somatotropin (rBST) by Cornell University economist Robert Kalter. Kalter fed the productivity increase predicted for rBST into economic models of the dairy sector, and to no social scientist's surprise, out came the "fewer and larger farms," result (Kalter 1984, 1985; Kalter et al. 1985). Publication of the result precipitated uproar, however. The rBST case may have been the first time that producers realized the likely impact of production enhancing technology, and organized to fight it (Buttel 1986; Browne 1987). Kalter's early studies also sparked a debate over the mechanisms of technical change among economists. The socio-economic mechanisms linking technical change and social transformation among farmers are more complex than a simply statement of the treadmill analysis might suggest. One point of dispute arose because Kalter's study came on the heels of controversy over adoption of mechanical tomato harvesters in California. In that case, only relatively large farms could afford to adopt the new technology; a tomato harvester is an expensive piece of equipment that is uneconomical to operate on a small plot of land. However, the reduction in market price for fresh and canning tomatoes did indeed have the effect of putting many small growers out of business, in this case leading not simply to "fewer and larger" but in fact to "no small, and even larger large" (Schmitz and Seckler 1970; Berardi and Geisler 1984; Ruttan 1991).

The tomato harvester case was well known among small farm activists, who might have organized to fight *any* significant technical change that came along in about 1985. Biotechnology came to be thought of as *very* significant technical change largely because this is the way that the scientists developing biotechnology described it. In fact, there is little evidence that most kinds of agricultural biotechnology now in the field or contemplated for development possess the "size bias," exemplified by the tomato harvester. This point was made by economists who disputed Kalter's prediction (Yonkers et al. 1986), implicitly defending the biotechnology industry. In this way, the seeds were sown for a debate over the social consequences of biotechnology that involved seemingly arcane disputes among economists. Cochrane's treadmill concept makes no appeal to size-related efficiencies, however, though size efficiencies could clearly exacerbate the trend he predicted. Nevertheless, the "fewer and larger," consequence is not a necessary consequence of economic theory, even when size-bias is absent. Farmers might also capture savings by reducing inputs and continuing to produce the same volume of output. Such behavior would have little effect on prices, but farmers would share a small savings from reduced production cost. Economist Loren Tauer summarized the complex strands in this economic debate as it applied to rBST, noting that even if biotechnology does reduce the profitability of dairying, many small dairies will simply accept a lower return and remain in business. Many other technological forces were affecting the economics of milk production, not the least of which are automated milk and animal health monitoring systems that are far from scale neutral. Tauer concluded that it is impossible to measure the effects of biotechnology on small vs. large farms, but "to argue that BST will have no differential impact by farm size is tenuous at best. The issue is the extent of the impact" (Tauer 1992).

A further complication of the technological treadmill argument concerns the rate at which farmers adopt new technology. Part of the treadmill logic is that early adopters reap windfall profits that they then reinvest in more land as the late adopters go bankrupt. If everyone were to adopt the technology all at once, price adjustments would be immediate, there would be no windfall profits and no one would go broke. Everyone would be making less money, but that would only be a problem in a world where agricultural subsidies do not make up the difference, anyway. Thus, the next round of debate over agricultural biotechnology concerned adoption rates, and a number of economists undertook studies of this problem. As one might expect, it turns out to be complex. Farmers in some parts of the US could benefit from Bt maize, but not others. Would there be regional adjustments in profitability? And everything depends on how much the companies charge for the new biotechnologies. If their economists are very sharp, these firms will be able to set the seed prices low enough so that farmers need to buy transgenic seeds, but high enough that most of the windfall goes to the biotechnology company. If the profits go to the technology provider, this has the ironic result of reducing the treadmill effect. Studies on the economic impact of biotechnology continue to be released every year, generally identifying reasons why the impact of the technological treadmill has been (or will be) more muted than might have originally been expected.

Though "fewer and larger farms," exhausts the meaning of the treadmill for many economists who study technical change, sociologists have always been interested in the same changes that interested Marx: the structure and character of ownership and labor relations. If there are fewer farms, where do the farmers go? The Marxist assumption is that they go into labor markets as wage laborers. The treadmill is thus an account of how societies that consist of many independent, owner-operated farms become societies that consist of a few land and capital owning investors, and legions of workers who must accept the going rate for wage labor. The social transition described by the treadmill is, thus, a change in social structure. A society of owner-operators, each with individual control over their work activity and relatively equal economic opportunity to succeed, gradually becomes a society of capital owning bosses who control the work life of laborers, and who determine the future direction of society through their investment decisions.

Clearly genetic engineering is not the only or even the most important technology implicated in this transition, and the transition itself was arguably complete in industrialized countries long before 1980. However, sociologists who have studied biotechnology conclude that biotechnology may be heavily implicated in the technological changes that bring this transformation of social structure to peasant agricultural economies in the developing world (Buttel and Barker 1985; Kenney and Buttel 1985). Furthermore, though it is easiest to understand the structural transition in terms of individuals and families moving from family farms to wage labor, there are more abstract (but equally important) shifts that occur. Sometimes the transition is concealed by global trade patterns, as an entire nation of small farmers become displaced or marginalized, while urban populations come to depend on industrialized agriculture from Europe, North America, Japan and Australia (Buttel et al. 1985). Furthermore, even the winners among the fewer and larger must share a larger portion of their farm profits with the companies that produce the technology, and they become dependent on those companies in a manner quite similar to the way that wage laborers depend on their employers (Kloppenburg 1988).

The socio-economic linkages that tie biotechnology to global markets and subsequently to the economic welfare of farmers everywhere across the globe can themselves be affected by political action. The sale of commodities across international borders is subject to the terms of international agreements and also to national policies that regulate not only prices and supplies but also food safety and environmental impact. Such agreements and policies can sometimes be manipulated by the political action of people who have figured out that they have nothing to gain and much to lose by allowing the kind of social transitions described above to occur. To put this point slightly differently, agreements and policies get negotiated politically under circumstances in which many if not all parties have an understanding of where their comparative economic advantages lie. It is not surprising that people want to renegotiate international agreements and reform national policies when technological innovation comes along to change those comparative advantages. People can also act to strengthen their political hand in such negotiations by creating the impression that the new products do not meet standards to which consumers have become accustomed. Thus if consumers don't like GM foods for some reason, that might be very helpful to economic interests that see themselves as having little to gain. But once these political actions have been taken, a social reality is created that has real economic consequences. If one has created a market for non-GM foods, for example, then economic interests can be threatened by "genetic pollution," that is, the movement of transgenic seeds or pollen into a crop being grown for the non-GM market. Simply put, social causality is very complex often leading to unexpected and ironic results.

Finally, the technological treadmill and its long-term consequences can have effects on the structure of agricultural research. In most parts of the world, agricultural research has been conducted by non-profit and government agencies. It has been thought to be in service to the public good, in large part because 100 years ago, the vast majority of the world's population was engaged in farming. As the treadmill transition reduces the farming population to 2% of the whole or less, three mutually reinforcing drivers spur the privatization of research. First, as farm population declines, the political base for publicly supported research declines. With fewer farmers, there are fewer people to write congressmen or argue for policies that favor the agricultural sector. Second, as farm population declines, productivity enhancing research comes increasingly to look like a subsidy to special interests, rather than a service for the public good. With a significant majority of the population in farming, policies that serve agricultural interests can be seen as serving the public good, but when farm producers make up less than 2% of the population, this interpretation becomes less plausible. Finally, as farms become fewer and larger, the costs of marketing to farmers are lower and the potential rewards are higher. Private venture capital is attracted into agricultural research in way that it was not when farmers were many and poor (Kenney 1986; Busch et al. 1991). Publicly funded agricultural research—once understood as benefiting a broad segment of the relatively less well-off — now appears redundant at best, and can even be seen as a subsidy to the large companies developing agricultural technologies with the goal of profits in mind.

This account summarizes a great deal of social science research and in doing so omits many themes important to the assessment of agrifood biotechnology's social consequences. Four points must be emphasized in completing the summary, however. First, the engine that is driving most of these changes is simple economic rationality. People who adopt or invest in the development of new technology do so because they think that they can benefit economically; people resist the technology because they think that resistance will benefit them more than simply adopting the new technology. Second, *any* production enhancing technology is likely to have these effects, and the impact of any specific product or class of products such as biotechnology will be diluted or intensified by that of other technologies—computerization, satellite imagery, mechanization—that may be coming on line at the same time. Third, the above analysis omits several key sources of impact on broader society. Consumers generally benefit (even if farmers do not) when production-enhancing technology is adopted (see Tweeten 1991). Furthermore, the widespread use of genetic engineering is clearly affecting the way that people think about everything in nature, including themselves (Nelkin and Lindee 1995). There is, in short, cultural change on top of all this socio-economic change. The mechanisms that link a production technology to these secondary and tertiary consequences are even more obscure, more controversial and more difficult to trace. Some will be picked up in discussing the ethical significance of social consequences from agrifood biotechnology below, but others are simply not captured by the matrix organization of this chapter. Fourth, none of what has been said in this section need entail anything at all about whether the social consequences described are good or bad, fair or unfair, just or unjust. Clearly many of the authors who predicted or analyzed social consequences had opinions on these questions, but one must have a reasonably clear picture of what makes for right and wrong, for fairness and justice, before such questions can be approached with even a modicum of philosophical rigor or conceptual clarity.

THEORIES OF JUSTICE

This section provides a whirlwind overview of the main themes that emerge in philosophers' attempts theorize the elements of social justice. Hopefully it is obvious that a subject with a 2500 year history cannot be adequately summarized in a few pages, and that any serious advocate of the ideas described herein would insist on much more sophisticated and subtle accounts of them. Nevertheless, an appreciation of the ethical debate over social consequences presupposes some familiarity with the terms of political theory. Although none of the ideas or concepts described below will be entirely foreign to those who follow political debates, they are typically so thoroughly blended with partisan and interest group politics that it is risky to rely on the notions of "left," "right," "conservative," or "liberal," that are common in political journalism.

The main themes have already appeared in previous chapters. A utilitarian or consequentialist approach to social justice evaluates social changes in terms of whether they tend to produce an attractive ratio of benefit to cost for all affected parties. Rights based theories evaluate social change as acceptable when they take place under circumstances where rights are respected and enforced, and as questionable—possibly unacceptable—when they do not. These two alternatives emerged in one form or another in each of three previous chapters, as did the related idea that it is fair procedures that make for justice, without regard to outcomes. The importance of virtue arguments was raised in connection with ethics in production and feminism, discussed in Chapter 7. Only Marxism is making its first appearance in this chapter.

Utilitarianism and Utilitarian Theories of Justice

Previous chapters have explored the contrast between expected value treatments of food safety and the problem of consent, utilitarian and other sentience views on animal welfare and the expected-value approach to environmental risk. In each case, some variant of utilitarian philosophy is evident. Utilitarianism is the moral and political philosophy usually associated with the English philosophers Jeremy Bentham and John Stuart Mill. Bentham and Mill advocated the view that the fundamental principle for evaluating an individual's action, a public policy or law, and even a broad social change was "that principle which approves or disapproves of every action whatsoever, according to the tendency which it appears to have to augment or diminish the happiness of the party whose interest is in question" (Bentham 1789, p. 2). Known alternately as "the principle of utility," "the greatest happiness principle," and "the utilitarian maxim," the rule is usually generalized to consider the greatest good for the greatest number of affected parties, all things considered. Mill reserved the term justice for "certain classes of moral rules which concern the essentials of human well-being more nearly, and are therefore of more absolute obligation, than any other rules for the guidance of life" (Mill 1861, p. 58).

Clearly, the principle of utility needs a great deal of specification before it can be used as a decision rule for policymaking, but even in its general form it entails a number of philosophically significant commitments:

- The justice of an action or social change is determined by its effect on the welfare (e.g. health, wealth or well-being) of individuals.
- The effects of an action or social change on multiple individuals are to be summed or aggregated.
- Rights, norms and legal codes are relevant to the morality of an action or social change only insofar as they are instruments for bringing about consequences for individuals.
- Actions or policies are justified when they achieve a maximum (or at least optimum) production of welfare, when compared to other alternatives (Sen 1987).

These philosophical commitments have been debated extensively for over 200 years. Many social theorists have developed interpretations of the utilitarian approach that abandon or modify one or more of these assumptions. Some have argued that it is impossible to use the theory because individual welfare cannot be measured. Others have questioned the maximization rule. Whether one is committed to maximizing welfare or not, the practice of comparatively ranking multiple options tends to turn utilitarian moral evaluation into a procedure that seeks optimal or efficient distributions of benefit and cost (Thompson et al. 1994, pp. 50–62). Working out the details of these modifications will tire all but the most patient readers, however, and a simple presentation is adequate to the task at hand.

Social changes brought on by productivity enhancing technology have been generally thought consistent with the principle of utility. Those who advocated agricultural research at the turn of the century clearly thought that improvements in technology would benefit the farmers themselves (Rosenberg 1961). The treadmill concept shook this belief, but not the utilitarians' favorable view of technical change.

If the combination of benefits to food consumers (in the form of reduced food prices) plus benefits to the winners in technical change is sufficient to compensate for costs to the losers, the end-state redistribution of welfare (consumers and big farmers are better off, small farmers are worse off) is still consistent with the principle of utility. Several generations of agricultural economists applied utilitarian principles to the evaluation of technical change, and liked what they saw (Tweeten 1987; Thompson 1988b; Thompson et al. 1994, pp. 233–245).

There are a number of side issues that can complicate the utilitarian action, such as cases where the result of individuals making individual decisions that seem on the face of it to benefit each wind up with the worst result for all of (Epstein 1996), the problem of "externalities," that is, consequences—either costs or benefits—borne by parties who are not key decision makers. From a philosophical standpoint, one does not have a defensible utilitarian analysis until external impacts are accounted for, but since technical change affects not only humans and animals, but also subsequent generations extending into the future, a complete analysis of external costs may be difficult to achieve. Nevertheless, those who apply a utilitarian analysis of social justice tend to be favorably disposed toward technical change. This is true whether one assesses technological change in the broadest sense (see Rosenberg and Birdzell 1986), or whether one applies the theory specifically to agriculture and food biotechnology (see Huttner et al. 1995). History teaches that technology seldom delivers all the benefits that are promised, and that costs are often higher than expected. Nonetheless, when costs and benefits are averaged over winners and losers and over time, it is difficult to argue with progressive tendencies of technical change, evaluated in utilitarian terms (Rosenberg 1992; Tenner 1996). The utilitarian approach suggests that we should just accept the results of technological innovation, subject (perhaps) to some minor modification to address problems of collective action and externalities. Of all philosophical theories of justice, the utilitarian view comes closest to providing a rationale for traditional views of technological progress.

Justice and Rights

Labels for genetically engineered foods are justified in terms of a consumer "right to know." Harms to animals or even ecosystems are said to be unjust because they violate rights held by these entities. In many disputes over public policy and technical change, rights arguments appear in direct rebuttal to utilitarian arguments. Often the point is to reject the utilitarian practice of aggregating or summing benefits and costs. Harms that violate the rights of an individual are thought to be so severe that no amount of compensating benefit to others can justify them. More generally, if someone (or some thing) has a right to X, whether X be information, property, economic opportunity or life itself, they may make a justified claim to X. This claim imposes duties to others and on the entire society who must either deliver X, or must at least not interfere with the rights holder's pursuit or disposal of X. These duties "trump" or override other cost/benefit considerations (Fineberg 1980; Donnelly 1989).

Technical change would be justified on a rights view so long is it did not violate any individual's rights. Note that this principle has the potential to be both more and less exacting than a utilitarian approach. It is more exacting in that even a single rights violation makes technical change unacceptable. Even if only one party's rights are violated by a technical change, the change is deemed unjust. It is less exacting in that changes need not pass an efficiency test, nor would one worry about collective action dilemmas, so long as each individual is making choices protected by rights. Of course, anyone can claim a right; the question is when are these claims justified? What rights do people (or animals) really have? There are two broad strategies for answering this question that bear directly on the problem of technical change. They are distinguished from one another through the difference between negative rights, or rights that require only that others forbear (e.g. not perform) harmful acts, and positive rights, or rights that require one to undertake action on behalf of others. Libertarian theories recognize negative rights only. Broader rights theories include both negative and positive rights. These broader theories will be referred to here as "egalitarian."

Libertarian theories. Libertarians approach the question of which rights to recognize by assuming that the most desirable state is one of perfect and complete liberty. However, if everyone is at complete liberty, everyone is also at risk, for people who are totally free are free to harm one another. Hence it is rational to accept principles that restrict liberty at exactly the point that an exercise of liberty would be harmful to someone else. This reciprocal restriction of liberty means that one has a negative duty with respect to harming others, that is, a duty *not* to do things that harm others. Other people are justified in claiming that one must forbear such harmful actions, hence they have a moral right that is violated when harmful acts are performed. Libertarian rights protect the life and personal security of people, their liberties of conscience, movement and speech, and their free use of their property, so long as that use does not harm others (see Thompson et al. 1994, pp. 39–44).

Libertarian protection of property rights provides the strongest philosophical argument for free-market economic principles. It is always wrong to interfere in someone's use or exchange of property, unless of course that use constitutes a harmful act. This means that it would be wrong to interfere even in collective action dilemmas where individuals use property in ways that are contrary to their own interests. Although they may be making themselves worse off collectively, no individual's act violates the life, liberty or property of another. On the other hand, libertarian theories also provide the strongest philosophical arguments for intervening to prevent externalities. If a person's use of technology harms another, through pollution or exposure to environmental risk, for example, it is wrong, irrespective of whether it provides social benefits that compensate for those harms (Machan 1984).

Egalitarian theories. Many of the rights claimed by individuals in advanced societies require more than abstinence or non-interference by others. If one has a right to education, someone must do the educating when this right is claimed.

If one has a right to information, someone must provide it. If one has a right to employment, someone must offer a job. These positive rights expand the scope of rights arguments considerably, and they also increase the likelihood that there will be conflicting rights claims. Clearly if there are positive rights that require the entire society to set up schools, for example, these rights will require taxation that, on the face of it, violates individuals' negative rights to control the use of their property. Rights theorists who admit positive rights are thus deeply concerned with the problem of limiting the expansion of rights claims and with reconciling conflicts among rights. Most approaches do this by placing positive rights in a hierarchy, so that claims to basic needs such as minimal health care, food and income opportunities are met for everyone. Once such basic rights have been guaranteed, it may be possible to expand the scope of rights claims to include literacy, higher education, or perhaps even recreational opportunity (Shue 1980).

Positive rights arguments provide the most plausible way to interpret the ethical significance of structural changes brought about by technical innovation. The agrarian transition described above has had mixed results for human opportunity. On the one hand, it has created opportunities for work outside of agriculture, and is the cornerstone of liberal societies that aim to guarantee a wide variety of positive rights to healthcare, education and opportunity for their citizens. On the other hand, the transitions described by sociologists are changing the agricultural production sector so that fewer people control decision-making. The autonomy of individuals may be eroding at the same time that the universe of food choices is expanding (Busch et al. 1991, pp. 191–203; Burkhardt 1992). If people have a positive right to have control over their lives and destinies in a strong sense, the decline of rural communities in which many (if not most) people had the opportunity to work for themselves, rather than for wages, may be seen as an inherently regressive social trend.

Justice and Virtue

Both utility and rights are historically recent innovations when viewed in the 2500 year time frame of philosophical thinking. The view that a society is just to the extent that it provides a structure of interpersonal relationships, incentives and reinforcements to virtue is a more traditional way of conceptualizing justice. Philosopher Alisdair MacIntyre launched a revival of virtue theory with his book *After Virtue* (1984). He offers the following as a "partial and tentative definition of a virtue. *A virtue is an acquired human quality the possession and exercise of which tends to enable us to achieve those goods which are internal to practices and the lack of which effectively prevents us from achieving any such goods*" (MacIntyre 1984, p. 191) by "practice," he means

> any coherent and complex form of socially established cooperative human activity through which goods internal to that form of activity are realized in the course of trying to achieve those standards of excellence which are appropriate to, and partially definitive of, that form of

> activity, with the result that human powers to achieve excellence, and human conceptions of the ends and goods involve, are systematically extended. Tic-tac-toe is not an example of a practice in this sense, nor is throwing a football with skill; but the game off football is, and so is chess. Bricklaying is not a practice; architecture is. Planting turnips is not a practice, farming is. (MacIntyre 1984, p. 187)

MacIntyre criticized the moral traditions that discuss moral character only as an instrument for maximizing utility or respecting rights. This characteristically modern way of thinking about character and virtue inverts the proper form of the relationship, as seen by a virtue theorist (MacIntyre 1984, pp. 108–120). The virtues we associate with good moral character are *not* tested by whether they encourage social utility or respect for rights. Virtues emerge out of the practices that represent the deepest moral commitments of a community. It is only when these moral commitments are understood that it becomes possible to talk about the morality of social utility or rights.

Virtue theory presents at least three ways in which technical change might be thought ethically problematic. First, to the extent that technical change is linked to social rationalization and to increasing sway of economically formalized interpersonal relationships, it may contribute to a general decline in the virtues. Second, to the extent that technology makes the performance of tasks routine and unreflective it contributes to the loss of human practices. Third, to the extent that traditional agrarian societies and family farms represent repositories of human practice and its virtues, technical change in the food system is particularly inimical to an ethics of virtue. How would a virtue theorist address these themes? Each will be considered in turn.

Rationalization and commodification. Some of the most sweeping objections to biotechnology are based on the view that once sacred spaces are being given over to the economic sphere. Things, processes or activities that were never even thought of as being capable of being traded, bought or sold are now being "commodified," or turned into goods that can be owned or exchanged at a price. On this view, it is objectionable to even think of life and life processes as "having value," in the sense used by utilitarians, or as being claimed as a property right. Even applying the moral categories of cost and benefit to these hitherto untraded, uncommercialized qualities or dimensions of life is itself morally despicable (Nelson 1994, Kimbrell 1993).

In truth it is difficult to pinpoint the moral force of these objections. Perhaps it would be more straightforward to characterize them simply as religious views. The view that modern society is becoming dangerously subject to legal and customary norms of commercial exchange, individual satisfaction and rigidly structured rules and codes does not appear to require an explicitly religious foundation, however. Surely many people are tempted by this sort of thinking on occasion, and surely some who are strongly committed to it base would describe their views in the language of community and virtue, rather than religion. Though all technology and modernization are part of this threat, biotechnology can be viewed as particularly significant in virtue of its capacity to bring an entirely new domain of objects into the realm of commodity exchange.

The loss of practice. Philosopher Albert Borgmann has argued that one of the great creeping threats of technology is that it turns practices that define and give meaning to human life into automated or rote routines. Cooking can be a practice in which a person strives for excellence, balancing nutrition with budget and aesthetics, or it can simply be a means to an end, something that should be accomplished as efficiently as possible. One irony of modern food technology is that it allows those who see cooking simply as a means for being fed to realize many of the nutritional, economic and aesthetic benefits that would, in earlier times, have been reserved to those who excelled in cooking as a practice. Borgmann clearly appreciates the trade-offs that new technologies involve, and he would certainly not neglect nutritional, economic and aesthetic benefits associated with new food technologies. Nevertheless, he does believe that the cumulative affect of such technologies is that people cease to occupy themselves with practices, at all. In doing so, they become shallow and base (Borgmann 1983).

There can be little doubt that biotechnology *can* be employed in ways that erode practice, though it is also likely that biotechnology is itself a form of practice for the scientists who undertake the work. However, it may also be possible to deploy biotechnology in the service of practice, just as technology such as silicon rods has improved the practice of fly-fishing, rather than eroding it. This is an important ethical argument, but not one that cuts deeply against the development of food biotechnology. It is only in conjunction with either a commodification argument or an agrarian argument that loss of practice could be of more than cautionary significance.

Agrarian virtue. MacIntyre's view is particularly important to questions in the food system, and it is significant that he uses farming to illustrate his notion of a practice. As was argued in Chapter 7, agrarian societies traditionally conceptualized their morality in terms of personal loyalties and virtues. The agrarian transition that has been brought about by technical change has created a world in which people interact with counterparts that are far more distant in space and time, reducing the importance of personal loyalties. Relationships are specified more by economic transactions or by claims of legal and political rights than by family or community roles. Indeed, any given individual in modern society may occupy many roles throughout their life, so much so that role morality and virtue can no longer support an adequate account of social justice.

If one believes that technical change has led to the erosion of agrarian societies, and one believes that these societies were better suited to the production of virtuous citizens than are industrial societies, it is possible to generate a broad and sweeping argument against those changes in agricultural technology that militate against the continuation of family farming. This argument differs from utilitarian or rights arguments that evaluate the ethics of agrarian transition in terms of technology's effects on individual farmers and their dependents. What matters morally is not that these individuals are harmed, nor that their rights are violated by excluding them from key decision making opportunities. The wrongness of this change consists in the fact that future generations will lack the virtues, indeed the very idea of virtue, that emerge naturally out of agrarian communities.

Marxism and Socialism

Marxism is often defended as scientific in the sense that it provides an account of technical change and of the structural transformation of society under conditions of capitalism, but does not entail a commitment to internal norms or ethical principles that produce judgments about the justice of these conditions. This view of Marx and Marxism permits one to argue that the moral critique of capitalism for which Marx is famous follows from a combination of his empirical analysis of technical change, plus fairly standard, humanistic ethical commitments of the sort that have been described above. Robert Tucker (1972) has argued that such ethical commitments are implicit in Marx's early philosophical writings, and that his later political writings simply work out these principles of self-realization for the emerging Europe that he saw. G.A. Cohen (1978) has defended Marx's economic thought and has supplied fairly straightforward liberal interpretations of rights and utility theory to form arguments that support the case for concern over the structural transformation of society.

Either of these analyses, and Cohen's in particular, might provide grounds for utilizing Marx's important analysis of the economic consequences of technical change in an ethical argument, but neither represents a significant philosophical alternative to the approaches to justice that have already be sketched above. Marx could be read as an egalitarian arguing for the positive right to dignity, though there are elements of his thought that seem utilitarian, such as his emphasis on the economic consequences of technical change. What would separate him from the agricultural economists who see technological change as progressive is first a different view of the harm done to those who lose their homes in agrarian transitions, and second a long term view which sees these transitions eventually coming to ruin in a general collapse.

Those who stay closer to Marx's actual texts on revolution and political change, however, might point out that Marx thought of Western ethics and political theory as expressions of a false consciousness, brought on by capitalism's need to conceal its contradictions and to repress the working class. Under different material conditions, this analysis goes, a totally different consciousness will emerge, one that will so little resemble the arguments of utility, rights and virtue that there is little point in attempting to describe it. Ethics and political thought are totally reflexive in this form of Marxism; they emerge out of the societies that produce them. Though an ethicist might wish to pose categories that would permit the critique of technology, it is impossible to attain the distance from technological and economic engagement that would allow one to do so (see Portis (1994) for a concise description of this view).

Taken seriously, however, this view of Marx utterly vitiates the relevance or value of a project such as this book. One cannot think sincerely about the ethics of food biotechnology, for to do so is simply to reflect the technology within the false categories of late twentieth century capitalism. This result has too often given Marxists an excuse for doing something that Marx himself would never have done, to wit, excusing his own views from ruthless criticism and self-examination. Thinkers in the Marxist tradition such as Herbert Marcuse, Theodore Adorno and Max Horkheimer have contributed greatly to the critique of technical change. Yet even with these figures it is difficult to assess whether their contributions rest on normative foundations that differ substantially from those of Bentham, Mill and Kant. Some of the most powerful recent contributions to technology studies tie the critical theorists back to liberal moral foundations (Feenberg 1991, 1995), or look ahead to a procedural analysis (Mepham 1996).

One of the most penetrating sociological studies of food biotechnology, by Jack Kloppenburg, Jr., is also one of the most overtly Marxist. Kloppenburg makes a convincing case for the claim that early twentieth century changes in seed technology (especially the development of hybrid varieties of maize) came about so that seed companies could appropriate a larger share of the value added in crop production than they would have had with open pollinated varieties. Farmers may save seed from open pollinated varieties to replant in succeeding years, but must purchase new seed corn for hybrid varieties every year. Kloppenburg argues that this pattern of technical change is an instance of the Marxist pattern: the capitalist uses technology to gain a larger share of the value, and gains this share at the expense of labor. In the standard treatment, a new technology lowers costs and eventually dominates the industry (e.g. the treadmill). Those who work in the industry (including small entrepreneurs who cannot continue to produce for lower returns) are forced to accept wages offered by the owners of technology (e.g. capitalists).

According to Marx, the pattern continues until wages are driven to a near subsistence level. Kloppenburg exhibits analytic genius in showing how a seed technology allowed a similar shift in returns on production from labor (e.g. the farmer) to capital (e.g. the seed company), but without disrupting the ownership structure in agriculture. The egalitarian might argue that this shift is just a violation of (or at least an erosion of) opportunity rights; it certainly reduces the farmer's autonomy and control in disposing of his primary assets (labor and land). In his book, *First the Seed*, Kloppenburg appears to make this kind of egalitarian rights argument, but in other contexts he has argued that a radical transformation of social structure and property rights will produce a new "moral economy" (Kloppenburg et al. 1996). Perhaps this is a version of the Marxist view that a new social order will produce its own morality, one that those of us in an existing order cannot appreciate. Other left leaning social theorists have used the term "moral economy" to describe social relations held together not by government or capital, but by a shared moral vision of the community. Kloppenburg is drawing on a long line of thinkers who have argued that the institution of alienable property rights in land and in food commodities introduced commercial practices in the food system that have inexorably (if slowly) undercut the moral economy associated with traditional village agriculture (Thompson 1963). This kind of argument links Marxism with the strand of virtue theory that decries rationalization and commodification.

Feminism

Philosophical feminism encompasses a wide variety of doctrines, methods and argument forms that attained visibility and influence during the last quarter of the twentieth century. In most cases, feminist philosophy shares principles and approach with philosophical studies that emphasize the perspective or experience of racial or ethnic minorities and colonized peoples. There is thus a conceptual link between feminism narrowly construed as philosophy that arose in response to social movements dedicated to empowerment of women, and a broader interpretation of feminism that sees it as encompassing some philosophical components in post-colonialism, gay and lesbian studies as well as black studies, African or Middle Eastern studies, Hispanic studies, or Asian studies.

To some degree, all these approaches and intellectual movements have challenged epistemologies of the modern period (1550–1900). In particular, they have noted how European science tended to emphasize sharp conceptual boundaries, dichotomous logic and programs of reductionism in the sciences. These intellectual practices have contributed to social values that see women as radically different from (and generally inferior to) men, as well as to scientific values intolerant of ambiguity in data or systems of classification, approaches that may have neglected elements of ecological, historical or social context in their approach to various phenomena. Feminism has emphasized gender differences within broader contexts of continuity, and has tended to valorize, rather than denigrate, difference. Biologists such as Evelyn Fox Keller or Donna Haraway have suggested that women scientists may come to their subject matter differently from men, may be more tolerant of apparent contradictions and more ready to accept the possibility that phenomena in nature are themselves ambiguous or continuous. Regine Kolleck (1993) relies on these ideas in feminist epistemology to mount the criticisms of environmental risk analysis discussed in Chapter 7.

Within the discussion of social consequences, feminism may be more important as a series of challenges to the dominance of rights and utilitarian thinking. Here it is important to note the work of psychologist Carol Gilligan, who discovered that women seem to take a different path in moral development than do men. While men arguably proceed through stages of growth in their ability to think morally that culminate in utilitarian-style cost-benefit thinking, on the one hand, or Kantian-style emphasis on autonomy and rights, on the other, Gilligan found that young women do very poorly on the psychological tests that had been developed to measure stages of moral development in young men. Instead of gravitating to principled decision making (be it the utilitarian maxim or Kant's categorical imperative) young women seem to maintain a broad and somewhat ambiguous set of loyalties to other individuals. Keeping their network intact seems to have priority over principled decision making, at least as a utilitarian or neo-Kantian might style it (Gilligan 1982).

Gilligan's work became one voice among many challenging the presumption that utilitarian or rights based ethical theories were the only philosophically respectable approaches to questions of justice. In this respect, feminist political thought stands alongside MacIntyre's virtue theory and Marxist critiques of the approaches to justice that had emerged out the nineteenth and early twentieth century. While virtue theory and Marxism suggest that these approaches inappropriate restrict the language and argument forms in which moral claims are made, feminist thought couples this idea with the claim that these restrictions silence the voices of oppressed groups, specifically of women and minorities. Thus, just as Gilligan's work suggests that women may emphasize the integrity of a family, community or friendship group over principled decision making, distinctively principled philosophical approaches (such as utilitarianism or rights theory) tend to reinforce the neglect or exclusion of a decision style strongly associated with women. Other feminist approaches stress the way that experiencing oneself as on the margins of society or "other" than the dominant social group (e.g. white men) creates a mentality in which people would not articulate their needs or interests in a language (such as that of social utility or rights) that is strongly associated with that of the dominant group.

A number of authors have drawn on feminism in developing their studies of biotechnology. Judy Wajcman's widely cited book *Feminism Confronts Technology* established a precedent for thinking that the feminist approach would be particularly fruitful in examining a domain such as technology, where men are primary decision makers. Her review of reproductive technologies stresses biomedical applications of biotechnology, but is conceptually broad enough to encompass agrifood biotechnology, as well (Wajcman 1991). Vandana Shiva has often claimed that the interests of traditionally marginalized groups including women, peasants and people of color are at risk in the commercialization of transgenic crops. Two of her early efforts made explicit links to feminist political thought (Mies and Shiva 1993; Shiva and Moser 1995). However, it may be more typical for those who take a feminist approach to follow the route taken by Haraway (1997) and by Finn Bowring (2003) where agrifood and biomedical applications are not really distinguished in making broadly positive (in the case of Haraway) or broadly negative (in the case of Bowring) judgments about this new domain of technology.

Other authors make few explicit references to feminism per se, yet apply styles of analysis that seem to draw heavily on feminist traditions. Traci Warkentin, for example, discusses some of the issues in animal biotechnology that are covered in Chapter 5 by oscillating between traditional philosophical authors such as Bernard Rollin and Allan Holland, on the one hand, and the feminist novels of Margaret Atwood, on the other (Warkentin 2006). Annette Burfoot and Jennifer Pudrier describe efforts to collect and preserve plant, animal and human germplasm as expressions of European colonization and a male fascination with control, but make no explicit appeal to a feminist approach (Burfoot and Poudrier 2005) It may thus be that the primary relevance of feminism in the present context is that feminist approaches have broadened the philosophical basis for challenging the assumption that utility and rights frame the philosophical terms of debate for a theory of social justice. Feminists are providing a new vocabulary in which to articulate moral claims about agrifood biotechnology's moral significance. They are by doctrine and personal inclination less likely to specify clear principles that could be applied to issues in agrifood biotechnology in algorithmic fashion. They want to be included in the social debate, and they do not want anyone to prejudge what they have to say.

Procedural Justice

The usual reaction to superficial categorizations of different approaches to the idea of justice (like the ones just given) is to ask, "O.K. Which one is right?" Arriving at this intellectual watershed is crucial to any exercise in practical ethics, and three possibilities present themselves as reasonable ways to proceed. One is a resort to relativism, the view that everyone (or every society) has their own view. A second is to undertake a more sophisticated philosophical argument intended to show that one of the alternatives already discussed is indeed right, the others wrong. The third alternative is to propose a procedural or pragmatic theory. There are both practical and philosophically compelling reasons for neglecting the first two choices here. Both involve substantial detours into increasingly abstract political, moral and metaphysical philosophy. Both will lead the discussion far afield from food biotechnology. Readers who feel sorely tempted by either approach are encouraged to pursue these lines of reasoning elsewhere.

What is more, one can make the case that a procedural or pragmatic approach provides the best interpretation of justice for technical change. A procedural theory holds that it is less the substance or outcome of social transitions that makes them just or unjust, but whether they were the result of fair procedures. Under some interpretations, regular rights theories or free market transactions are thought to describe fair procedures, a result that replicates results from the theories of justice described above. A more promising approach suggests that a fair procedure is one that would be both capable of rendering a decision or verdict on the ethical acceptability of technical change, and unbiased toward any particular view of social justice, such as the utilitarian, libertarian, egalitarian or virtue accounts just described. It is extremely difficult to imagine what such a procedure would look like in its most general form, but once one makes the pragmatic decision to constrain the problem to the issue at hand, the social consequences of food biotechnology, the task becomes manageable. Discourse ethics is one particularly useful approach to describing fair procedures.

Matthias Kettner summarizes work of German philosophers Karl-Otto Apel and Jürgen Habermas in describing "discourse ethics." Arguments, whether moral or scientific, attempt to isolate not only the correct prescriptions or conclusions, but also the best reasons supporting a prescription of conclusion. Under epistemically ideal conditions, constructing, evaluating and revising arguments is a dialogical process that "tends to not so much reflect unequal powers, differences in social status, [or] divergent intellectual abilities of the participants but rather the force of the better argument only (Kettner 1993, pp. 162–163). Kettner describes five morally relevant constraints on discourse.

1. *The generality constraint:* Discourse must be open to all competent speakers whose interests will be affected.
2. *The autonomous evaluation constraint:* People must be free to construe the issue and their own interests in whatever terms they deem appropriate.
3. *The role taking constraint:* Participants must be free of neurotic fixes that preclude them from adopting a hypothetical stance towards their own and others interests and values.

4. *The power neutrality constraint:* The process must be free of external coercion.
5. *The transparency constraint:* Statements and reasoning offered must be aimed solely at establishing the best reasons for accepting a prescription or conclusion. Strategic discourse is not allowed.

As Kettner conceives it, discourse is open-ended; revision is always possible. However, when participants engage in a process of argument and critique (e.g. discourse) under these conditions, it is possible reach a rational consensus on the best answer, given current information. In each of these respects, ethics does not differ from ordinary scientific inquiry (Kettner 1993).

Discourse (or pragmatic) ethics reorients the significance of ethical theories such as utilitarianism, rights theory and the like. Rather than being interpreted as *the* authoritative account of right action, an expected value or rights analysis is interpreted as a starting position and form of argument for discourse ethics. When the philosophical positions represented by these approaches engage one another in a purely abstract way, discourse ethics takes the same course as classical ethical theory; that is, it attempts to establish which is the best theory. However, when these philosophical positions are engaged in a practical inquiry such as assessing ethical responsibilities for the development of agrifood biotechnology (and when strategic considerations are truly set aside) many of the philosophical points that keep inquiry open become irrelevant to the problem at hand. For example, once public cooperation and risk communication elements are integrated into the problem of environmental risk (see Chapter 7), there is a point at which continued pursuit of the expected-value approach becomes self-defeating. This does not prove that expected-value approaches are wrong in deep philosophical sense, but it does show that they are incapable of solving the problem at hand. Such practical or pragmatic elements of discourse ethics are essential to its prospects for reasonable closure (Thompson 1996).

The ideal conditions described by Kettner will seldom be realized in practice, hence actual public debates over biotechnology are unlikely to reach an ethically defensible consensus (Theune and Korthals 1995). This, however, is a limitation that applies to any effort at specifying or clarifying ethical responsibilities in public life. The most that *any* approach to practical ethics can hope is to illuminate issues for the individuals who are able to approximate ideal discourse conditions, if only in their mind's eye. Discourse or pragmatic ethics have a more subtle limitation in that the actual terms in which discourse or argument will be carried out must utilize moral language and concepts that are not supplied by discourse ethics itself. Kettner's Autonomous Evaluation Constraint holds that any participant must be free to formulate their norms and values in whatever language they wish, but this is a constraint that can be applied only to the starting positions of discourse. If the procedure is successful, that language will evolve and common terms will emerge as participants in discourse ethics challenge and reiterate each other's positions.

It is very likely that participants will converge on language for articulating norms and values that closely resembles that of three strategies described above: utility, rights and virtue. Indeed, many philosophers who work in practical ethics describe the point of their work *not* in terms of yielding "the" right answer to a practical question, but as contributing to the clarity, consistency and depth with which people grasp the issues at hand (Singer 1979; McLaren 1989). Philosophers' contribution, in short, is to make discourse ethics more efficient. Still, participants in discourse ethics will need to work carefully through the positions that appeal to utilitarian, rights based or virtue based ethical reasoning, and will need to express their own positions, arguments or objections in the same terms.

Discourse or pragmatic ethics is the most defensible philosophical approach to conceptualizing and applying ethical reasoning to food biotechnology. However, many philosophers who apply the concept of discourse ethics explicitly in their analysis of biotechnology (see von Schomberg 1993, 1995b; McNally and Wheale 1995; Gloede 1995; Levidow 1995b) tend to produce extremely convoluted analyses that, for all their theoretical brilliance, contribute little to actual moral discourse on biotechnology. The key moral implication of the procedural approach is that scientists and policy makers, like all participants in the biotechnology debate, have a moral responsibility to ensure that Kettner's five conditions are met, if not in public fora, then at least under some controlled circumstances in which ethical issues can be seriously pursued. There is little doubt that members of the biological science community have collectively failed in this responsibility, but that is a fact that bears more on public trust in science than on social consequences, per se. As such, these themes will be revisited in the final chapter.

The balance of this chapter completes the matrix by considering three broad problems where biotechnology has been linked to social consequences. The first is the impact of biotechnology on small farms, a topic that has already been discussed somewhat already. The second is the impact of biotechnology on the developing world. The last section examines the social consequences of biotechnology for science itself. These three categories do not exhaust the topic of social consequences; yet more detail would exhaust the patience of even very committed readers. These three topics have, at intervals, figured importantly in the debate over biotechnology, and it is worth giving them a more detailed examination.

SOCIAL CONSEQUENCES FOR SMALL AND FAMILY FARMS

Willard Cochrane's technology treadmill updates Marx's analysis of technical change and applies it agriculture. The introduction of a continuing stream of productivity enhancing technology has a general tendency to shift the structure of industrialized agriculture toward fewer and larger farms, to reorient returns on food production toward capital from land and labor, and to limit the scope and flexibility of decision making for primary producers. Although more detailed empirical specification of these general trends might be controversial in its own right, the point of this section is to examine the ethical significance of these general impacts. Thus the question considered from a number of philosophical perspectives: Is there an ethical justification for resisting the transition from smaller (and family oriented) to larger (and industrially managed) farms? Alternatively, is there an ethical justification for promoting it?

Family Farms: Utilitarian Arguments

Economists have struggled mightily with this problem for decades. A strict application of utilitarian welfare economics implies that the ethical significance of impact on family farms must be measured in terms of stress (both financial and emotional) placed on farm families, and on their long-term income capacity (Hussen 1979). The United States Department of Agriculture was applying such criteria to the evaluation of technical change in US agriculture as early as 1940 (USDA 1940). It is also conceptually possible to include other, more esoteric forms of welfare value in the calculation. In explicitly applying a utilitarian framework, Luther Tweeten argues that welfare costs to family farms are outweighed by the benefits of production enhancing technology to consumers, but he thinks that policies aiming to protect family farms from such forces are nevertheless valid in virtue of family farms historical value (Tweeten 1983). Although Tweeten does not say how he measured it, apparently historical value was able to offset the value of lowering the cost of food for consumers, tipping the balance in favor of family farms. One might also note the aesthetic or symbolic value of family farms, but comparative ranking of these values will be speculative, at best (Thompson 1988b).

Gary Comstock observes that family farms have emotional value for many people. "Since family farms are "ours," since they are objects of love, and since they are now sources of considerable anguish, we ought to rescue them" (Comstock 1987, pp. 402–403). Although he does not present emotional value within the context of making a utilitarian argument, the anguish of which he speaks is a good candidate for standard utilitarian analysis. Just as resource economists have produced ways of evaluating the recreational and existence value of wild nature, why not use similar techniques to assess the value of family farms? It would be possible to generate a discussion of the utilitarian approach to social consequences that rivals that of Chapter 6's analysis of environmental impact, describing the moral significance of each category of value, and discussing how it might compare other forms of cost and benefit. As Jeffrey Burkhardt concluded in one of the first published discussions on the ethical implications of social change from biotechnology, it is exceedingly unlikely that this approach will produce a convincing argument against any product of biotechnology, absent serious health or environmental risk. The more potent ethical criticism derives not from the claim that the social costs of small farm stress outweigh the benefits of biotechnology, but that the way this change is coming about is not fair (Burkhardt 1991, pp. 320–324).

Family Farms: Rights and Fairness

The fairness theme is capable of generating two related arguments against technical changes that militate against small or family farms. One is that the process of technical change is unfair because small farmers' (or others') interests are not adequately represented. The second is that a social structure composed largely of small family farms is inherently fairer than one of fewer and larger farms. The first argument is philosophically straightforward, though highly controversial. Clearly technical changes have the capacity to substantially alter the nature of people's opportunities, the value of their property and their prospects for prosperity, but what rights are being violated?

Technical change and the violation of rights. One possible answer is that it is farmers' rights that are violated. Kloppenburg notes that biotechnology such as herbicide tolerant seed limits farmer choice. If you use one company's seed, you must also use their herbicide. Kloppenburg predicts that companies will use genetic engineering to integrate the entire farm production process, linking seed to an entire package of chemical inputs and processing technologies. This would, he argues compromise farmer decision making and choice (Kloppenburg 1984). However, it is hard to frame an argument that convincingly shows that farmers are being deprived of any rights here. The old technologies are still available; farmers still have a right to use them. What they do not have is a right to both the old technologies *and* to the economic returns that are promised with the new ones. This, however, is an unexceptional situation, and not one that promises to suggest important moral objections to biotechnology.

Perhaps it is consumers who are being denied rights. As Comstock notes, people love family farms, and may wish to preserve them by favoring family farms in their market behavior (see also Hunter 1992; von Duijn 1995). Citizens have few direct measures to affect technical changes through economic markets, and those that are available (such as boycotts) tend to be highly ineffective (see Smith 1990). Nevertheless, consumers would not be in a position of being deprived of their rights unless biotechnology companies systematically attempted to prevent them from finding out about the source and origins of their food. Some evidence suggests that this is indeed part of the political and economic agenda of the food biotechnology sector, and such behavior is not only morally indefensible, it promises to erode public trust as well. This is thus an important but fairly narrow basis on which to formulate a rights-based objection to agrifood biotechnology.

Other arguments charge that technology makes sweeping challenges to democratic rights. Langdon Winner argues that technical changes have social effects that are quite like changes in the legal or constitutional structure of society. Citizens of a democracy would not tolerate such sweeping changes coming about through governmental action without due process, but scientists and business leaders seem to able to bring about wrenching social change through a process that is totally isolated from public influence and participation. Such actions amount to an almost total usurpation of the most fundamental democratic rights (Winner 1983). Winner's general argument surfaced in biotechnology debates over the "4th criterion," a proposal to regulate technology based on social impact (Lacy and Busch 1991).

This is an argument that deserves to be taken seriously, but it is also an argument with such far ranging political consequences that it deserves to be at the heart of political debate on humanity's technological future, not consigned merely to the debate over agrifood biotechnology. Whatever philosophical merits the argument has, it proved singularly ineffective in the rBST debate in the United States, at least. The Executive Branch concluded a review of literature on the social consequences of rBST with a telling sentence: "At no time in the past has the US Federal

Government prevented a technology from being adopted on the basis of socio-economic consequences" (US Executive Branch 1994, pp. 35–36). Using the 4th criterion to regulate biotechnology would almost certainly have broader unintended consequences than biotechnology itself. It is thus not surprising that this approach has met with skepticism.

Family farming as a system of rights. The view that a society of family farms represents an almost ideal instantiation of fundamental democratic rights has a long history, though not as old as some would claim. The link between small farms and democracy is often attributed to Thomas Jefferson, but A. Whitney Griswold largely invented this alleged connection in Jefferson's thought in his 1948 book *Farming and Democracy* (Wunderlich 1984). Whatever its historical pedigree, the argument has figured in populist politics for a century and became a staple of US farm policy analysis since 1950 (see Brewster and Wunderlich 1961, pp. 200–203). Harold Briemyer may have offered the most persuasive version of this argument in a 1965 book *Individual Freedom and the Economic Organization of Agriculture*, and Jim Hightower (1976) was its most prolific spokesperson in the years preceding the introduction of agrifood biotechnology.

The general idea is that the transition described by Marx does indeed pose a moral problem for capitalism. Neither Breimyer nor Hightower would be so impolitic as to attribute the argument to Marx, but that is where it belongs philosophically. If capitalism systematically consigns labor to a situation of wage servitude, it cannot be considered morally legitimate. However, both Breimyer and Hightower think that wage labor jobs are perfectly acceptable so long as workers have an option. Farming, small-scale entry level farming that is, was to be that option. The argument here is that an economic structure including both wage labor jobs *and* the opportunity to enter or leave family farming at will is *ipso facto* an ethically just structure of economic opportunity rights. Takeaway the opportunity to be one's own boss on a farm and capitalism becomes coercive. If workers have no choice other than to accept going wage rates, capitalism is unjust. This version of agrarian populism would never succeed except in places where land is relatively available, but as the century turns the capital and knowledge requirements for operating a farm alone cast doubt on farming's capacity to stand as redoubt against the vicissitudes of the wage labor trap. If capitalism has this moral failing, agrifood biotechnology is not its singular undoing.

Family Farms and Moral Virtue

An initial case for linking family farms to claims about virtue and character was sketched in Chapter 7. A further construction of the ethical virtues of farming can be drawn from the writings of American essayist Wendell Berry. Berry's novels, poems and essays celebrate traditional farm life, and describe the virtues and character traits that are necessary for successful farming. Berry places the virtue of stewardship within a mutually reinforcing ecology of virtues that also include citizenship, industriousness, community and family. Like Griswold, Berry bases his discussion of citizenship upon a questionable interpretation of Jefferson's praise of farmers. Berry claims that Jefferson observed the effect of factory life on the character of the working class and concluded that wage laborers would be less reliable citizens than farmers. The specialization required by factory work made both workers and owners oblivious to the broader consequences of their actions. The ecological knowledge implied by a farmer's stewardship practices, by contrast, prepares farmers to be more mindful of the unanticipated consequences of their actions. For this reason, according to Berry, farmers are more valuable as citizens.

Berry also argues that industrialization undermines the moral meaning of work. Properly, work is both the formation and expression of personal identity. The hard work that is necessary for the traditional farm life has the effect of giving the farmer a well developed sense of self, an identity that attaches naturally and harmoniously to a set of interests that arise from work. The factory pattern of life, by contrast, encourages people to identify with leisure activities, and to acquire interests that are not related to their identity or self-expression in any essential way. Berry's understanding of work is ecological, a point that becomes clear when it is interpreted in light of his vision of community. Farmers depend not only upon each other, but upon the tradesmen and merchants of the rural town. These are particular, non-universal dependencies that establish strong moral bonds to specific individuals. A farmer is in community with people whose lives are linked by the work activities that form their personalities and identities. In such places, Berry argues, community becomes meaningful as an ethical concept (Berry 1977).

What is true for the community also holds for the family in Wendell Berry's ecology of the virtues. Traditional farm life assigns tasks to each member of the family, so that husbands do the plowing and planting, wives tend to butter making and baking, children tend chickens and elders make quilts, jams, tools and tend to other farm needs. Each member of the family can see the importance of their work life to the overall survival and prosperity of the family. The family, in turn, is the source of production that sustains each member. Children learn that actions have consequences. Self-interest is again turned toward the virtue of family loyalty. In industrialized economies, by contrast, the relationship between work and prosperity is mediated by money. Family life requires cash that must be earned outside the home. Jobs are held to support the family, but the family itself no longer exists to perform work. Those who don't work—children and retired elders—do not form part of the integrated, self-sustaining production that defines family identity on the farm. As a result, the family becomes defined as a consumption unit, and family members' appreciation of virtue in productive work begins to fade (Berry 1977).

To some extent, the virtue argument for thinking that family farms are significant has been taken up and reinforced by feminists. For example, Deane Curtin's book *Chinnagounder's Challenge* draws on agrarian philosophy to argue for a new conception of ecological citizenship. Curtin sees the decline of virtues that encouraged stewardship of natural resources and community solidarity resulting from an imposition of utilitarian philosophy in rural communities. He interprets this quite literally, stressing policies that John Stuart Mill, author of *Utilitarianism* (1861), implemented in his role as an executive of the British East India Company.

However, Curtin's general philosophical framework is feminist and post-colonial. He situates the entire argument not in the virtue theory of Alisdair MacIntyre or the agrarianism of Wendell Berry, but in the importance of perspectives and voices that were silenced by doctrinaire applications of neo-liberal political thought (Curtin 1999).

Neither Curtin nor Berry has much to say about agrifood biotechnology, and biotechnology could be at most one of many technological forces undoing the ecology of virtue in industrialized families. Furthermore, the entire argument on which the link to virtue is premised has implications that are troubling. Similar arguments would be made to oppose the rights of women, or to assert the rights of traditional families over those of single parent households, not to mention homosexual relationships (see Thompson 2000). These comments are not to dismiss the important themes that Berry introduces, but it is clear that much more work is needed to work out the implications of virtue ethics for food biotechnology.

In one respect, virtue theories share a problem with other ways to address the social consequences problem. Collectively these distinct philosophical approaches to social impacts on small farmers describe some of the most serious ethical challenges to agrifood biotechnology. With the dawning of the twenty-first century it has become apparent that scientific and technological developments have the capacity to reshape society in sweeping and unexpected ways. Langdon Winner is only one recent political theorist who has argued for public action to wrest some measure of control over technical change from the market-based forces described first by Marx and then by Cochrane. René von Schomberg's insightful papers (1993, 1995b) on science and policy apply the recent work of Ulrich Beck (1992), to an analysis of the problem. Arie Rip has become associated with a broad approach he calls "constructive technology assessment," in which scientists as members of the public interact extensively to plan and mediate conflicts (Rip et al. 1995). Andrew Feenberg's writings can also be mentioned in this connection, as can, of course, Hans Jonas himself.

But scientists and biotechnology companies must be justifiably frustrated by the attempt to lay one of the most fundamental moral and social problems of the late twentieth century at their door. Scientists must indeed participate more actively in the debate over technology and our future, but is it fair to hold biotechnology hostage to that debate? Furthermore, this is a question that impinges no less on developing countries and the structure of science (discussed just below), as it does on the small farm debate. And it will be revisited yet again in Chapter 10/11. So in a narrower sense, the lesson to be learned is that agrifood biotechnologies have been an excuse to revisit the cultural issue of family farms, the history of agrarian change, and the arguments from virtue. Biotechnology is not uniquely threatening to family farms and agrarian issues, though among the cluster of technologies that have brought on decades of change in these social forms, biotechnology is a uniquely attractive target of criticism. These are deep and important moral issues too frequently ignored by the intellectuals who carry on philosophical debates in Western societies. It would, therefore, be unwise to lose the opportunity to contemplate the moral significance of farming that food biotechnology has occasioned, but it would also be equally foolish to allow such considerations to form the basis for serious social and political roadblocks to the benefits that food biotechnology can bring.

SOCIAL CONSEQUENCES FOR DEVELOPING COUNTRIES

In plain truth, much of what has been just been said about social consequences for family farming in the industrialized world applies equally to resource-poor farmers in developing countries. Frederick Buttel (Buttel and Barker 1985; Buttel 1995) Henk Hobbelink (1991) and Vandana Shiva (1993b, 1995a) have predicted that biotechnology will have unfavorable impact on the rural poor in Africa, Asia and Latin America, while benefiting relatively better-off farmers in those regions. Farms will become larger and fewer. To be sure, the moral significance of agrarian transition in the developing world is different. More people, both in absolute numbers and as a percentage of the population, are affected. Those who are affected are much worse off to begin with, and are more vulnerable to displacement. They lack the alternative opportunities for employment that exist in more diversified economies, and many live in countries where social services do not provide an adequate safety net for the poorest of the poor. When food biotechnology displaces labor from agriculture (as it might, for example, if it hastened the advent of herbicides to replace hand weeding), it harms the land-less laborer, the poorest of the poor in the world's poorest societies. The human cost of agrarian transition in the industrialized world is measured in terms of financial and emotional stress, with occasional tragic consequences (see Hendrickson 1987). In the developing world it is measured in exposure, disease, malnutrition and death from the diseases of food deprivation.

Yet it is worthwhile to follow the philosophical tour through alternative philosophies of social justice once again. For one thing, although academic philosophers have had relatively little interest in the decline of small farms over the twentieth century, they have been much more attentive to the intellectual and moral challenges posed by unequal economic development on a global scale. As such, while one must look to agricultural economists or rural sociologists for a utilitarian or rights based analysis of the family farm issue, some of the most prominent philosophers of recent years have written detailed analyses of hunger and development. It is thus possible to see how social justice arguments are deployed by academic philosophers when we turn to social consequences for the developing world.

Peter Singer has used simple utilitarian logic to construct one of the most convincing moral arguments for famine relief: If giving aid to keep someone from starving has greater benefit to them than cost to the donor, one is obligated to do so (Singer 1972, 1977). It is plausible to think that a pattern of agrarian transition having limited moral significance in Europe, North America and Austria might yield far more serious consequences in places where many still farm at a near-subsistence level. If so, an equally straightforward utilitarian argument might be developed. If biotechnology accelerates the fewer and larger trend in the developing world, the suffering of those who lose their ability to farm outweighs any benefit to those who make more from farming.

Whether a reasonable expectation of such consequences can be laid on the doorstep of food biotechnology and genetic engineering research is exceedingly difficult to say. There are at least as many people predicting benefits to resource-poor farmers (see Persley 1990; Beachy 1991; Chappell 1996; Wambugu 1999; Mackey 2003) as costs, but counting the number of authors on each side of the issue is a poor way to decide the issue. When the first edition of this book was published in 1997, the literature on social consequences for developing countries included precious little in the way of detailed *ex ante* studies on the implementation and ultimate adoption of food biotechnology or its products. Perhaps the nature and impact of biotechnology in developing countries was so speculative in the 1980s and early 1990s that useful empirical and theoretical work was impossible, and perhaps studies are currently underway that will rectify the situation. A decade later, there are considerably more studies available (See Pardey 2001; Pray and Naseem 2003; Buttel and Hirata 2003). Nevertheless, there is nothing comparable to Robert Kalter's prediction of rBST's impact on dairy farmers (Kalter 1985), not to mention Loren Tauer's detailed follow-up studies (Tauer 1992; Tauer and Knoblauch 1996). The episode of predicting impact from rBST has led economists to rethink the entire enterprise of predicting the social consequences of new technology (see Lesser et al. 1999), so perhaps the lack of detail in projections for the developing world should not be a surprise.

We are, thus, limited to a largely conceptual analysis. When any account of the link between research and development of food biotechnology and its consequences for the developing world is given at all, one of three general arguments begins to take shape.

1. Biotechnology will harm people in developing countries through the "fewer and larger" mechanism of agrarian transition, documented in the developing through studies of the Green Revolution.
2. Biotechnology will harm people in the developing world through the mechanism of global trade. It will increase the gap between the efficiency of industrialized agriculture and resource poor farmers.
3. Biotechnology harms people in the developing world primarily through the mechanism of intellectual property.

The empirical assumptions of the first two arguments produce an ironic tension. One asserts that resource-poor farmers will be harmed if their countries get seeds and vaccines from rDNA technology, the other asserts that they will be harmed to the extent that they are forced to do without it. Nevertheless, the moral foundations of both arguments are similar. However they come about, such consequences are morally significant either in the same way that consequences to family farms in the North are significant, or in virtue of some morally significant relationship that obtains between resource poor farmers and peoples of the developed world. It is the latter possibility that stands in need of some elaboration. The third argument anticipates themes that will be taken up in Chapter 9, but it is appropriate to examine some elements of this heated debate within the context of biotechnology's unintended social consequences.

Duties Beyond Borders

How do philosophers articulate the moral duties that people living in societies with technologically efficient, industrialized agriculture have to the resource-poor farmers of the world, people using traditional, labor-intensive methods to farm at near subsistence levels? One answer is that there are no *special* moral duties at all. The wealthy have the same responsibility to the poor of other countries that they have to each other and to the poor of their own society. This answer need not produce an argument against foreign aid, for it is essentially the position taken by Singer. If one can do more good by helping the foreign poor than by spending the money some other way, one should help the foreign poor (Singer 1972). The foreign poor are not given special status, but the greater benefit they derive from a given resource (due to their relative deprivation) means that a utilitarian will gravitate through simple logic to a position of helping the poor. Rogers M. Smith (1989) has a less accommodating argument from the "no special obligations" assumption. He suggests that people in rich countries are free to allocate their charity however they wish. If more goes to their own poor, so be it. However, many philosophers and common citizens have argued for an alternative view, one that attributes special duties between North and South.

Political theorist Charles Beitz and philosopher Onora O'Neill have contributed some of the best argument for the special duties view (Beitz 1979; O'Neill 1986), but its basics are concisely summarized in an article by Thomas Nagel. Nagel's central moral premise is "that any system of property, national or international, is an institution with moral characteristics; claims of right or entitlement made under it, claims as to what is ours to use as we wish, carry only as much moral weight as the legitimacy of the institution will bear" (Nagel 1977, p. 57) Nagel believes that any social institution which perpetuates the vast inequalities that exist between industrialized and traditional agricultural societies cannot be just. Appealing to John Rawls' *A Theory of Justice* (1971) for his philosophical backing, Nagel argues that aggressive redistribution of wealth between these two groups are demanded by simple justice (Thompson 1992b, pp. 170–171).

If this view is accepted, what are its implications for food biotechnology? First, it is clear that when empirical work does demonstrate disadvantageous outcomes for traditional farmers, there are strong reasons to take those outcomes very seriously. They should be regarded as rights violations that threaten the legitimacy of the entire system of international food technology. Second, it means that scientists, corporations and public agencies should work to develop applications of biotechnology that contribute to the redistributive tendencies. Joske Bunders and Jacqueline Broerse have outlined the potential for applying biotechnology in service to this end, and have reviewed other literature on the subject (Bunders and Broerse 1991; Broese and Van de Sande 1995; Bunders and Radder 1995).

It must be admitted that many of the efforts underway to bring food biotechnology to the developing world are fraught with moral ambiguity. One in particular, the International Service for the Acquisition of Agricultural Applications (ISAAA) was discussed in the 1997 edition of this book as follows: ISAAA promises on the one hand to make proprietary technologies developed by biotechnology companies in Europe, North America and the technologically advanced countries of the Pacific Rim available to resource-poor traditional farmers free of charge. ISAAA has the potential to reduce the cost of transferring technology to the developing world, and to provide traditional farmers with seeds having traits such as disease or pest resistance for crops that are of little commercial interest. On the other hand, if *every* increase in productivity has a dark side, there is little reason to think that ISAAA's efforts will escape it, and ISAAA is also proving to be a Trojan horse for the introduction of intellectual property regimes into the developing world.

In the intervening decade, ISAAA has become an important force in the promotion of biotechnology throughout the developing world. They are, furthermore, the main source for information on global production and dissemination of agrifood biotechnology. Buttel and Hirata (2003) suggest that this data has been presented in format which suggests that adoption of GM technology has been far more widespread than may be the case. Food First, an activist organization long committed to the interests of developing country farmers, has characterized ISAAA as an organization more committed to promoting products of agrifood biotechnology than to helping the poor (Hickey and Mittal 2003). As such, the track record of agrifood biotechnology (and ISAAA in particular) must be regarded as somewhat murky. What does seem clear is that leading organizations oriented toward developing technology for the developing world (including ISAAA) have done little to frame or address issues in ethical terms. Hans Jonas' call for responsible technology has largely gone unanswered in a domain where moralistic rhetoric is commonplace. More attention needs to be devoted to the ethics of social consequences in the developing world, and opportunities for ethicists to research and write on this topic should be expanded.

The primary exceptions to this summary judgment are Hugh Lacey's important book *Values and Objectivity* (2005) and the Nuffield Reports of 1999 and 2003. The Nuffield Council on Bioethics is based in the United Kingdom and was established by the Nuffield Foundation in 1991. The Council is an independent body, funded jointly by the Foundation, the Medical Research Council of the UK and the Wellcome Trust. Although most of the Nuffield Council studies have focused on medical topics, they have published two important documents on agrifood biotechnology. The second of these reports is focused exclusively on social consequences for the developing world. The report argues that with a sophisticated plan for application and integration into local economies, crops modified for enhanced nutrition or greater agricultural productivity are of undeniable benefit to developing country farmers. However, the report also notes that European resistance to GM crops can create trade problems for developing countries, problems that could rebound in adverse impacts on even poor farmers (Nuffield Council 2003).

For all their strengths, the Nuffield Council reports do exhibit important philosophical weaknesses. For one, the reports do not examine or reflect philosophical perspectives that extend beyond utilitarian and straightforward rights based approaches to agrifood biotechnology's social consequences. While the Nuffield Council in general reflects a high degree of sophistication, they appear to have approached this topic with little experience dealing in agricultural issues, and to have relied very heavily on the insights of agricultural economists. Lacey's book, completed well after the Nuffield Studies, goes some distance toward remedying this oversight. He argues that an ecologically oriented approach to working with small farmers will be more effective than agrifood biotechnology, at least in the Latin American contexts that he has studied (Lacey 2005). His argument cannot be addressed adequately here. Lacey's book and the Nuffield reports each merit further attention and analysis. Both take the philosophical examination of social consequences from agrifood biotechnology further than the discussion offered here. Nevertheless, the summary judgment with which the 1997 edition of *Food Biotechnology in Ethical Perspective* concluded its discussion of social consequences for developing countries is still largely true today. Philosophers have had little opportunity to do serious work on agrifood biotechnology outside the developed world.

THE SOCIAL CONSEQUENCES OF INTELLECTUAL PROPERTY

Vandana Shiva, Calestous Juma and Pat Roy Mooney are collectively responsible for a large and growing literature on the moral significance of intellectual property rights on genes, rDNA processes, and whole organisms for developing countries. Shiva's Research Foundation for Science, Technology and Natural Resource Policy in New Delhi lists 24 publications on this topic, along with its magazine, *Bija—the Seed*. In the decade since the publication of the first edition, much of this work has been taken over by the CUTS Centre for International Trade, Economics and Environment in Jaipur, India. More than any other issue discussed in this book, the controversy over property rights in genetic resources extends beyond what can be reasonably summarized and discussed in comprehensive overview of ethical issues in food biotechnology. Omitting the subject altogether would constitute an unforgivable oversight, of course, but what can be said in this context is more an acknowledgment of this ethical issue and its attendant literature than a serious discussion of it. David Magnus's (2002) discussion of these issues provides further amplification and development of key philosophical themes.

At the nub the issue is that developed world researchers have for years collected germ plasm from centers of diversity that lie in developing countries. This germ plasm has sometimes been collected from the wild, but often simply by buying it at local markets where beans, potatoes and grain are sold for food. Scientists take the germ plasm back to laboratories of the developed world where it has been used by plant breeders to develop improved varieties. With the rise of intellectual property rights in plant varieties, breeders could claim ownership of these products, though in fact seed companies have long sold seed based on freely available varieties back to farmers all over the world. The rise of biotechnology in food production occurred at a time when political leadership in countries with Vavilov centers of origin were becoming cognizant of the value of their genetic resources, both for agronomic and for pharmaceutical uses.

Arguments are offered to show that native germ plasm is owned, either by indigenous farmers, their governments or collectively by the whole society. Other arguments are offered to show that *no* property claims on germ plasm are defensible, hence people in developing countries need not respect the PVPA registrations and patents awarded in the developed world. These are logically incompatible claims, of course, and one difficulty in applying philosophical rigor to this politically heated controversy is that advocates of developing country rights have been willing to toss out virtually any argument, hoping that it will work. On the other side, trade representatives and representatives of developed world biotechnology companies have often been unwilling to make any serious argument at all, preferring to rely on economic power and the privilege they currently enjoy under the status quo. The international property rights dispute is not an example of ideal discourse, to say the least.

Two philosophical threads might be untangled from this morass of issues, however. One is to examine how various ways of defining and defending claims to property bear on the international property rights issue. Since ethical arguments for establishing property claims will be taken up in the next chapter, that discussion will be deferred. The second thread concerns the social impact of IPRs, however they might be brought about politically, and whether or not they are thought to be ethically justified. It is evident that advocates of developing world farmers are of the opinion that IPR's deny them their due rights. Again, there are at least two ways in which this might be the case. First, it may be that developing countries farmers have IPR's of their own, and that seed companies are failing to recognize those rights, and failing to pay whatever compensation is due. This argument devolves back to the question of whether indigenous farmers have legitimate property claims over the germ plasm in question, hence it, too, can be deferred until the next chapter.

Secondly, one might think that IPR's will harm developing country farmers either by depriving them of something other than an IPR of their own, or by depriving them of some important economic opportunity in the future. The latter possibility is clearly real, for if biotechnology companies develop more productive seeds and place them on developing country markets, the logic of the technology treadmill dictates that those who adopt the new seeds early will benefit, and those who are too slow to adopt them may never get the chance. IPR's figure prominently in this argument, for it is IPR's that prohibit entrepreneurial farmers from growing up a handful of purchased seed and sharing it at no or low cost with the entire village. If better seeds become purchased inputs the pattern of harm is, once again, fewer and larger farms. Again, if it is marginal, resource poor farmers who are being put out of farming, the consequences of the treadmill may be serious indeed, but this is repeating an argument that has already been made before.

This leaves one remaining possibility, namely that IPR's will deprive developing country farmers of something that they now have. Articles in *Bija—the Seed* claim that farmers will lose the right to freely plant seed from land races or other publicly available varieties (Anonymous 1996). This is an unlikely result, however, and totally inconsistent with any of the moral foundations for IPR's. The legal codes that establish IPR's in developed countries specifically protect any existing uses of the raw materials from which new seed varieties or plants are derived. Only an extremely poorly crafted law, or a poorly administered legal system could have the result alleged in *Bija—the Seed*. Indigenous farmers would have an overwhelming legal case against anyone who attempted to prevent them from continuing to use their seeds and plants in traditional ways. Nevertheless it would be incorrect to conclude, as Western specialists often do, that there are no moral issues here. Legal codes are not always administered fairly in the industrialized world, and in countries where social hierarchy and local power count for much, the situation will be worse. Indigenous farmers may have a legal right to use plants in traditional ways, but they lack the resources and knowledge needed to protect those rights. It is unlikely that farmers will lose legal rights, but they may be harmed, nonetheless.

It must also be admitted that the international IPR debate rapidly becomes mired in the technical and metaphysical questions that arise in the process of administering patents. Is the discovery truly novel? Was it obvious? Does it work? These issues involve technical and legal dimensions that combine philosophy with juridical principles that vary from country to country even in the developed world. The next chapter provides a review of moral bases for claiming property rights. Nevertheless, intricacies of patent law are best left to the experts and the technical and empirical dimensions of how these questions must be answered are not well reflected either in my own analysis or that of any other philosopher I am aware of. On the other side, experts in the economics and legal administration of IPR seldom refer back to the ethical underpinnings of intellectual property with anything other than the broadest of all possible generalizations. Here, again there are opportunities for better scholarship.

Before closing the topic of impact on developing countries entirely, it is important to recognize that IPR's are often associated with a line of reasoning that emphasizes the profit-oriented nature of agrifood biotechnology. Although many of the non-governmental organizations that are active in opposing biotechnology on these grounds, Devinder Sharma's 2003 pamphlet *GM Food and Hunger: A View from the South* provides an good example of the argument that is frequently made. Sharma's treatment of the GM Food issue covers a lot of ground in only 40 pages, but a succinct summary of his argument runs as follows: Developed country scientists and biotechnology companies have promoted agrifood biotechnology as a response to hunger, but in fact they are motivated exclusively by profit. Sharma seems to think that the case against biotechnology is proven when the motivations of its developers become clear. Intellectual property (as well as GURTs) figure prominently in the evidence that he assembles to make that case. He concludes by writing, "Genetic engineering cannot make food at a cheaper cost. In fact, all indicators point towards still higher prices for food in the coming years. Genetic engineering therefore is not the answer to hunger. Like the Green Revolution, which bypassed the small and marginal farmers, the misplaced “gene revolution” will bypass the hungry,” (Sharma 2003, p. 38).

As the preceding discussion has aimed to show, Sharma’s conclusion derives some support from economic theory, despite the overarching commitment that many economists still have to capitalism, technological innovation and free trade. One thing that is philosophically interesting about Sharma’s argument is the emphasis that he places on motives, something that economists would probably discount entirely. Whether the developers of agrifood biotechnology are motivated by charity or profits matters little to the economic logic of “fewer and larger farms.” For this reason, the detailed discussions in the Nuffield reports also neglect motives, focusing instead on the local institutions for providing access to technology and for mitigating harm to farmers who do fall victim to the treadmill. Yet motives continue to matter in ethics, at least to analysts such as Sharma. Is he just wrong? This question must remain open for now.

SOCIAL CONSEQUENCES FOR THE CONDUCT OF SCIENCE

Sheldon Krimsky’s *Biotechnics and Society* (1991) and Busch and co-author’s *Plants, Power and Profit* (1991) both predicted that some of the most serious social consequences from food biotechnology would be experienced within the community of science itself. They predicted that commercialization of science would divert research away from basic research as well as from research aimed at publicly beneficial, but less profitable subjects. They predicted that the conduct of science itself would be hurt by burdensome licensing and IPR secrecy procedures, and by restrictions on the disclosure of proprietary information. They predicted that corporations would gain ownership of the products of biotechnology without paying a fair share of the costs for research and development.

To an extent, all of their predictions are being realized, though perhaps not to an extent that an impressionable reader of these books might have expected. The 1997 text of *Food Biotechnology in Ethical Perspective* continued with the following observation:

> At least two institutes at Texas A&M solicit annual fees from food industry firms for which these companies get nothing more than the right to “get close” to university scientists, as the director of one such institute puts it. As Director of an ethics center, I have yet to sense a desire for companies to “get close,” or to get early, privileged access to research results. To the extent that availability of funds inevitably influences what research is done, it is impossible to deny that research choices at Texas A&M are more responsive to market forces than they have ever been before.

Many voices were added to the list of those expressing concerns in the ensuing decade. In 2000, *The Atlantic Monthly*, a large circulation US news and opinion magazine, ran a cover story entitled “The Kept University.” Although broader than agrifood biotechnology and in fact more focused on drugs and medical biotechnology, the article brought the fact that university science was becoming increasingly allied with private industry to widespread public attention. The authors argued that this could compromise not only the direction, but also the results of university research (Press and Washburn 2000).

It remains to say what is ethically significant about these social consequences. An observer of the social consequences for science might ask, "So what? Scientists are adults. They've made their nest, let them lie in it!" One might even regard the notion of more market-driven science as a good thing. No more money wasted on dubious achievements, fit only for the fabled "Golden Fleece," awards that were once distributed by US Senator William Proxmire. We would not likely think that a new technology giving rise to a substantial reorganization of the dry cleaning industry raised moral concerns. Why is science different? The ethical significance of change within science can be answered along at least three distinct lines. I will call them the *aesthetic purity* argument, the *social function* argument, and the *public trust* argument.

The Scientific Purity Argument

One might argue that science, like art or sport, has an internal purpose that can only withstand so much pollution from extraneous sources. The internal purpose of science is pursuit of truth. According to this view, the social context of science is largely irrelevant to its essence, which is to employ observation, deduction and experimental procedures in the discovery of nature's laws and in the development and verification of logically coherent theory. Scientists must of course have buildings and equipment, just as they must eat and breathe, but the social and economic forces that impinge upon the conduct of research have no more effect on its essence than do the mental fatigue or bodily ailments that eventually force any individual scientist to quit the laboratory for sleep and relief. This image of science, though challenged of late (Latour 1986), is fairly standard throughout 20th century philosophy of science (see Brodbeck 1953; Russell 1955).

In this view, science is being characterized as a practice, much as farming is characterized as a practice explicitly by MacIntyre (1984) and implicitly by Berry (1977). Biotechnology is not ruining science in the way that it might be alleged to be ruining farming, for not only is science a deeply technological practice, the ability to use rDNA techniques in the activity of science takes great skill and art. Nevertheless, the commercialization of science might ruin its capacity to exist as a practice that gives meaning and focus to the lives of scientists. It might do this by substituting externally profit-driven goals for the internal goals defined by pursuit of truth. The potential for wealth production might divert scientists from the essence of science. To the extent that one sees science as a practice, internally determined and characterized by its essence, it is reasonable to interpret this turn of events as a form of corruption and a loss of virtue for scientists (Goldworth 1991).

Of course if science is just another job, it is silly to see the intrusion of commercial influences as corrupting. When science is viewed in its aesthetic dimension, it becomes possible to bemoan the loss of scientific purity, just as one might mourn changes that have taken place in art or sport (see Ruscio 1994) It is worth stressing that this is assuredly *not* the way that Krimsky or Busch and co-authors interpret the moral significance of social consequences for science. Both take science to be socially embedded in a way that denies the essentialist view of science as a starting point for moral evaluation. The argument from aesthetic purity is most likely to be made either by philosophers flirting with wistful nostalgia, or by scientists who can articulate the ideal of science as a practice from their own experience and life goals.

The Social Function Argument

John Stuart Mill offered a defense of strong academic freedom for scientists in his essay "On Liberty." Mill argued that scientists should be free from interference in pursuit of whatever interested them because, given the unpredictability of the applications of science, total freedom of thought is the best path toward realizing social benefit from science (Mill 1859). There have been many and many more systematic reformulations of this argument in the intervening century and a half. Measuring the social returns to research has become a minor industry among economists, and Robert Evenson (2002) has done research that specifically ties this theme to agrifood biotechnology. As is often the case with social science, this research seems to presume a broadly utilitarian framework without making any explicit philosophical commitment to it.

Philip Kitcher's book *Science, Truth and Democracy* makes just such a philosophical argument. Kitcher integrates some fairly conventional philosophy of science with a discussion of the philosophical critique levied by Herbert Marcuse, Theodor Adorno and Max Horkheimer, the Critical Theory school. These Marxist theorists had argued that by being situated in capitalist societies, scientific ideals of truth and method had become distorted. Kitcher rejects the Critical Theorists' criticism of scientific method, but accepts the argument that capitalism tends to have a distorting effect on the kinds of questions scientists ask, and on the kinds of research they eventually undertake. He then moves on to develop a theory of what science *should* do, what the research agenda *ought to be*, given the norms of democratic societies. Here, he argues that citizens in a democracy will want to support those scientific projects that are most likely to improve their quality of life. It is the ultimate consequences for human welfare that should determine the agenda for scientific research (Kitcher 2001).

Kitcher presumes that capitalist societies tend to deviate from this norm in favor of research that is profitable for capitalists. Research would be skewed to the kinds of questions wealthy people ask, and they can be presumed to ask questions about how they can become wealthier still. As such, he suggests a thought experiment in which citizens vote for the kinds of science they want. He is not advocating voting as a serious decision mechanism for research policy, merely using this idea to test how the ethical content of the utilitarian's goal of maximizing welfare for the population as a whole. He sees two main ethical problems with the voting ideal, one being that people cannot be expected to have enough scientific sophistication to accurately predict which lines of inquiry really are to their benefit. The other is that people may have immoral preferences for research; they may support research that reinforces their illegitimate preferences. It is the latter question that gets the longest discussion, and examples of medical biotechnology and genetics get a fair amount of attention. Kitcher is concerned that racial prejudice or faulty views on the links between genetics and moral conduct will skew the voting (Kitcher 2001).

It is not clear how Kitcher's worries over immoral preferences might affect the evaluation of agrifood biotechnology, but concern over the general public's understanding of science is frequently sounded by agricultural scientists. Kitcher's response to the problem (again *not* focused on agrifood biotechnology or the GM debate) is to suggest something like a "citizen jury" in which people are given access to various expert perspectives on the likely prospects of science (Kitcher 2001). While many agricultural researchers will be in the wings applauding this call for greater public education, scholars of agricultural science would not expect them to be happy with the result of such an effort, were it actually to occur. Lawrence Busch and William Lacy have argued that food and agricultural science became structurally tied to commercial interests well before the advent of biotechnology. These ties produced an institutional structure that was conservative and tradition bound in its choice of research problems, just the opposite of what Mill and Kitcher envision (Busch and Lacy 1983). The predictions in *Plants, Power and Profit* are an extension and application of that earlier work. If their empirical analysis is correct, then utilitarianism would support the same conclusion as the aesthetic purity argument, but for very different reasons. Science should remain somewhat distant from commercial influence because, so-called free market economics to the contrary, commercial influences do not align science with public benefit. Yet neither Busch and co-authors nor Krimsky appeal directly to the social function argument in criticizing the social consequences of food biotechnology for science itself. Their arguments instead appeal to the importance of public trust.

The Public Trust Argument

If scientists working in research organizations have accepted public funds to pay their salaries and those of their graduate students, to provide physical facilities, and perhaps even to purchase equipment, is it fair that the results of their research should be controlled by private industries that may have contributed only a fraction of the total investment? This rhetorical question insinuates the moral principle that what has been paid for with public funds belongs to the public. To divert public property toward private use violates an ethical principle that should need no argument. As Busch and co-authors put the case, "society may pay twice: once for the research and again for its benefits and products" (1991, p. 196) But it should be noted that history and English professors regularly collect royalties on the books and poems that they publish (and in some few cases, the amounts are not trivial), but no one raises an eyebrow. Despite the authority with which Krimsky and Busch, Lacy, Burkhardt and Lacy advance this critique, there are murky questions in research ethics here that deserve a wider and more considered hearing.

Divided loyalties and conflicts of interest betray the public trust in another sense, as well. According to Krimsky, the most significant social consequence of change within scientific institutions is "the disappearance of a critical mass of elite, independent and commercially unaffected scientists to whom we turn for vision and guidance when we are confounded by technological choices" (Krimsky 1991, p. 79). We can interpret the public trust as a social contract, just as Locke and Rousseau understood it. Food biotechnology, however, has a role in this contract that differs from the science of Mill's day. Science is now seen to be essential to the protection of life and health. It can help identify threats to individual or environmental health that would have been written off as "acts of God," in earlier times. Science is also a source of threats to health, as the preceding chapters have documented. It is both a threat and a guarantor against threats. To those who fear the commercialization of science through biotechnology, the problem of public trust is a case of asking the fox to guard the henhouse (Thompson 1992a).

This way of construing the relationship between science and the public anticipates ethical issues that will be taken up in Chapter 11. They cut across every area in which food biotechnology might be thought to have unintended consequences and depend as much on public attitudes as they do on the institutional structure of science. As little as the public might care about the institutional effects of biotechnology within science they may well be among the most far reaching. These moral issues are being raised in connection to the way that universities and public research organizations are changing their funding relationships with the food industry, and to the changing importance of intellectual property. There can be little doubt that biotechnology precipitated many of these changes, as scientists established equity positions in private firms, and universities sought to establish more capable intellectual property offices throughout the 1980s (see Kenney 1986; Teitelman 1989), but similar things happened throughout other sectors of science. Many of the social changes on the structure of science now appear to be tied as much to the Reagan/Thatcher era, and to the end of the cold war as to biotechnology (Buttel 1995). It may be time to inspect the infrastructure of our research organizations and to think about repairing any damage, but food biotechnology and some revised relationship between public and private sector research will be the norm.

CHAPTER 9

CONCEPTIONS OF PROPERTY AND THE BIOTECHNOLOGY DEBATE

Philosophical theories of property are intended to offer general and explicit statements of the rationale for deciding legal and moral questions about the status property claims. Debates over property rights in biotechnology were occasioned by specific legislative proposals such as the US Animal Patent Act of 1986, and by filing of patent applications for DNA sequences and processes in the early 1990s. While these debates make occasional appeal to philosophical theories of property, moral claims were entangled with questions about filing requirements, tests for efficacy, and the rules for licensing and defending patents. Prior to the publication of the first edition of this book, discussions of intellectual property related to biotechnology and genetics tended to review legal mechanisms and to omit discussion of underlying ethical issues (see, e.g. Lechtenberg and Schmid 1991; Murashige 1994). The relative paucity of discussion on intellectual property at that time dictated the general approach of the chapter: Review basic philosophical approaches to property rights, and speculate on how one might use these approaches in constructing an argument relevant to agricultural biotechnology.

Since the first edition appeared in 1997, the ethical dimensions of intellectual property rights for agricultural biotechnology have received considerably more attention. Authors having a considerable background in the law of intellectual property have contributed some of the new discussion, though medical, rather than agricultural, biotechnology has generally been their focus (Eisenberg 2003; Barton 2004). Scholars in bioethics have also weighed in on the debate. Sigrid Sterckx (1997) has argued that a clause in European patent law proscribing patents for immoral inventions applies to products of biotechnology. David Magnus (2002) has argued that biotechnology is a means for expropriating traditional farmers' contributions to genetic resources, and that sanctioning this expropriation with patents awarded to scientists and biotechnology firms is a form of injustice. Lori Andrews (2002) has issued a call for an entirely new way of thinking about the ethical rationale for intellectual property in light of biotechnology.

There has also been a robust debate over the so-called Terminator gene. "Terminator" was the facetious term that critics of biotechnology used to describe a family of gene constructs intended to make seeds sterile. Advocates of the technology prefer to call them "genetic use restriction technology" or GURTs. Like rBST, one can often discern how an author views the case by the terminology used, so I will henceforth alternate between "Terminator" and "GURTs". The first and most famous GURT was protected by a patent awarded jointly to the United States

Department of Agriculture (USDA) and the Delta and Pine Land Co. in 1998. Delta and Pine was subsequently purchased by agricultural biotechnology giant Monsanto, making the Terminator case emblematic not only of several key issues relating to intellectual property, but also of Monsanto's clumsy handling of public relations (see, Specter 2000; Charles 2001). Terminator was brilliantly exploited by the knockers, who often stressed the irony of a life science company's attempt to produce seeds that would not reproduce (Berlan and Lewontin 1998; Mellon 1998; Shah 2001; ETC. Group 2002).

There are at least four substantive ethical issues raised by GURTs. First, there is the patent itself. The patents on Terminator constructs are patents on genetic sequences, hence there is the question of whether genes should be "ownable" at all. Second, there is the way that GURTs effectively make genetic traits "ownable" through a physical, technological means. Historically, farmers can replant seeds from the crops they grow year after year. They purchase seeds once, but genetic traits that are present in the germ plasm of the crops they grow will be passed in the next generation of seeds, which can be saved and planted again. Seeds containing GURTs produce a crop bearing seeds that will not germinate, meaning that farmers must buy new seeds every year. Thus GURTs "take" an effective property right on the continuing genetic potential of the crop germ plasm from farmers and "give" it to seed companies. If farmers want the improved genetic potential of the crop, they must buy it over and over again. This physical transformation in the control and salability of genetic traits can occur without regard to whether the GURT itself is patentable. Is this way of technologically altering the traditional property relationship between farmers and seed companies ethically justifiable?

The third ethical issue is biopiracy, or expropriation of traditional farmers' contributions to genetic resources. Farmers develop the genetic traits in their crops through generations of trial and error. These farmer grown, farmer developed crops are called *land races*, and are different from conventional crop varieties produced by plant breeders. Ever since the advent of scientific plant breeding, scientists have collected samples from land races in search of desirable genetic traits. The genes responsible for these traits are then bred into scientifically developed crop varieties, which, in the case of varieties developed for commercial use, may then be sold back to the very farmers that developed the land races and to their descendents. Critics of agricultural science have long argued that the developers of land races (or their heirs) have a moral property right in the genetic traits of these crops, even if international law has failed to invest this right with legal force (Mooney 1979; Fowler and Mooney 1990). Though virtually any form of scientific plant development might fall prey to the biopiracy critique, Vandana Shiva has singled out biotechnology and Terminator seed as particularly egregious examples (Shiva 1997; 2000).

Finally, do Terminator genes pose unacceptable risks to human health or to the environment? Although this question should certainly be posed for any application of biotechnology, some have apparently envisioned especially catastrophic risks in connection with GURTs:

> I would like to mention a major environmental risk associated with Terminator, concerning more than one billion poor people whose main food source is based on replanting second generation seeds. The introduction of death genes in crops such as rice or wheat would have a great impact on the fate of millions of people: considering them non-target organisms, the negative impact of Terminator raises to unacceptable levels. (Giovanetti 2001)

This author may believe that Terminator genes will be fatal to people who eat them, though it is more likely that she has envisioned Terminator genes becoming established in food crops beyond the commercial varieties in which they have been intentionally introduced. In fact both scenarios are equally unrealistic. Plants containing GURTs are far less likely to have environmental impact of any kind than are all other plants precisely because GURT technology dramatically reduces the plant's reproductive fitness. That is its *intended* effect, and some have endorsed the use of Terminator type genes as a means to limit the risk of unintended gene flow from transgenic plants (Muir 2001). Yet clearly farmers who save the seed progeny of Terminator crops expecting them to perform comparably to the parent will observe a devastating crop failure in the following year. Furthermore, even normal crops planted in the vicinity of Terminator crops can be affected by Terminator pollen. If seed saving or pollen drift is widespread throughout a particular region in the developing world, the result could indeed translate into a human catastrophe (Pinstrup-Andersen and Schiøler 2000). This risk probably provides a sufficient ground for opposing the development of Terminator seeds in staple food crops, especially in poor countries where farmers are saving seed for subsistence needs.

It is worth taking a few pains to emphasize the distinctness of these four arguments. The last concern, that Terminator seeds could be the cause of a local or regional food crisis, is a powerful argument against the technology. Assuming that the risk argument can be sustained, it would be a persuasive reason to override any property right claimed by the developer of a new seed type, and to ban GURTs that dramatically reduce the fertility of seeds. Such bans would clearly be justified in the developing country settings where crop failures would be followed immediately by localized famine, but might also apply more broadly. Unless one could show that distribution of GURT protected seed has been carefully controlled, the potential of unintended consequences of a localized but catastrophic nature cannot be dismissed. But it is also crucial to see that this is a *risk* argument, unrelated to the link between GURTs and intellectual property.

The other three arguments, however, are more central to the focus of this chapter: On what ethical grounds can property rights in genes or gene processes be sustained in the first place? The first set of questions appear to address that question directly, but in focusing the concern on patents and patentability, there is a chance that we may get sidetracked in legal arcana of patent law. There are, in fact, many ways to establish ownership of a good, and the second set of questions make this point abundantly clear. If genes or genetic traits are not the sort of things that it is ethically justifiable to own, why should it matter whether the ownership is established by a patent or through technological means?

At the same time, it is important to see that while the first two questions involve the ethical or legal basis on which we might claim that someone can claim to own a gene or a genetic trait on ethical grounds, the biopiracy question is significantly different. On the face of it, this question seems to involve not whether genetic traits can be forms of property, but who has the ethical right to claim them as property. If one argues that corporations and developed world scientists are taking the property of farmers who created land races, one would appear to have accepted the legitimacy of property rights in genes and genetic traits already. The alternative would be to argue that genes and genetic traits are public goods that are unethically and inappropriately placed in private hands when biotechnology companies expropriate them for commercial purposes. But if this is the view, then the farmers and descendents of farmers who develop and conserve land races should not be in position to claim ownership or demand compensation. This distinction is not always carefully observed in the literature on biopiracy. Indeed the lack of consistency (much less subtlety) in the position of those involved in debate over property rights and agricultural biotechnology is one of its most frustrating features. As such, a general framework for examining the philosophical and ethical approaches to property rights might help clarify the debate.

THE THEORY OF PROPERTY

After decades of neglect, philosophers produced an extensive new literature on property and property rights during the last quarter of the twentieth century (Becker 1992). Even a representative summary of this literature is impossible, but though terminology differs, most authors distinguish two central ethical questions, as well as two philosophical approaches to the development of theoretically adequate replies (e.g. Ryan 1984; Goldman 1987). The two ethical questions to be asked are:

1. What counts as property? That is, how are we to understand the concept of property and which sorts of things can and cannot be classified as property, given a particular moral conception of property?
2. Who owns what? How are assignments of ownership to be made? How is the general distribution of property within society to be justified?

The Terminator debate illustrates that it is not always easy to keep these questions separate, but it is useful to begin a review of different conceptions of property by attempting to do so. Recombinant organisms or sequences raise philosophical questions that transcend the categories of standard technological ethics in part because they appear to challenge accepted ways of answering the first question. As we have seen, some critics of biotechnology have suggested that it will have a disproportionate negative socioeconomic impact on the poor in developing countries, and this appears to be a version of the distribution question. Such questions about the distribution of benefit apply to many technologies; problems in the redistribution of wealth and property are not uniquely attributable to use of recombinant techniques, and they are a component of standard technological ethics. Many issues relating to social consequences and problems of distribution were taken up in Chapter 8 and the allegations of biopiracy raise yet another version of the social impact question. While these allegations will be revisited in the closing section of this chapter, the definition problem (Is it property?) will be the main emphasis.

Separating these two questions helps illustrate how the first question may or may not be a normative one, depending on one's point of view. The matter of what can and cannot be property might simply be a matter of fact, determined by empirically observable characteristics of the good in question, or it might simply be a matter of legal convention. Legal positivists insist on purely descriptive language in analyzing legal concepts and would regard the definition question simply as a matter of ascertaining how property rights are in fact defined and administered in any given society. The definition question can also be asked in a purely normative vein: what sorts of things is it moral, ethical or otherwise legitimate to regard as property? Human beings, for example, clearly have been held as chattel property throughout history. One strategy for opposing slavery has been to argue that even regarding humans as property was itself morally wrong, that the concept of property cannot be applied to human beings without committing a wrong. This view of slavery interprets the question of property status normatively. John Locke (1690) proposed a different strategy for opposing slavery: admit that human beings can be property, but argue that ownership rights must be assigned reflexively and that they are not transferable (except, for Locke, in unusual circumstances, where it can be legitimate to acquire slaves). Locke's philosophy of property accepts a positivist answer to the first or definition question as it relates to human beings, and opposes slavery through its answer to the distribution question, holding that the only legitimate distribution of ownership rights for human beings is self ownership.

These philosophical ploys in addressing ownership and slavery may seem esoteric in the present context, but they illustrate how convoluted philosophical debates on property can become. What is more, the conceptual resources available for analyzing any sort of property claim have been influenced greatly by the question of human slavery. It will prove helpful to revisit this theme in reviewing the applicability of alternative concepts to biotechnology. Prior to the Human Genome Project (HGP), the ownership of human beings had not been thought to have much to do with patentability. The US Fourteenth Amendment banning slavery has been interpreted to exclude human beings from otherwise applicable aspects of patent law. In 2000 US President Bill Clinton and UK Prime Minister Tony Blair issued a joint statement promising that the results of the HGP would be "freely available" citing again proscriptions that were introduced into property law in connection with the end of slavery. There are, thus, historically important ethical considerations regarding property rights that are not only logically independent of the technical legal apparatus developed to facilitate patents, but which establish ethical constraints upon patent law.

The word "property" in English and its cognates in other languages is simultaneously simple (people learn to use the word correctly at a fairly early age), and extremely subtle. While most of us would have little trouble understanding most sentences in which the word "property" appears, offering a definition of the term is very difficult. The term implies at least three broad and interrelated meanings: possession, land and characteristic or trait. It is property in the sense of possession that is most relevant to the debate over intellectual property, but land possession has dramatically framed our conceptions of property, and in intellectual property debates, it is ownership of something characteristic of other goods (the process by which they are made, their design) that is at issue, rather than the physical things themselves. I shall, nevertheless, studiously avoid using the term "property" in its third sense throughout this chapter, partly because there are numerous occasions on which it will become important to discuss the traits or characteristics of a good or thing. To refer to these traits and characteristics as properties of the good or thing (as philosophers are wont to do) invites confusion. In the broadest sense, then, "property" designates things that are ownable, things such as personal effects, assets or holdings.

Two broad philosophical approaches to the problem of defining what is and is not property circumscribe many specific theoretical positions. The first approach treats property as a social, linguistic or legal construct validated in terms of its instrumental capacity to produce or secure other ethical goals. Two principal examples will be offered, one emphasizing property rights as instruments for protecting liberty, and a utilitarian approach to property rights that has been singularly influential in biotechnology debates. The alternative approach treats the property status of an entity as an ontological question. That is, whether or not a good or thing can be claimed as an item of property is thought to depend upon whether it has (or lacks) key traits and characteristics, or upon being an entity of a particular kind. Several examples of the ontological approach will be mentioned, but two, natural law and labor theory, will be singled out for discussion.

INSTRUMENTAL CONCEPTIONS OF PROPERTY

One way to understand property is to see it as a social construction, a mutually agreed-upon convention, or a social institution. On this view, property consists simply in the fact that we abide by rules or patterns of conduct in our use or disposal of certain goods. The central ethical question then becomes, are those rules or patterns justified? An instrumental approach to property presumes that these otherwise arbitrary social conventions are validated to the extent that they prove useful in producing or securing some more fundamental kind of good. There are at least three types of good that property rights might be thought to produce, protect or secure. One is liberty. A second is social utility or value. A third is social stability. This third line of argument will not be developed in the present context. Philosophers such as David Hume have argued that recognition of property claims is necessary in order to resolve disputes or social conflicts (Hume 1777). Such disputes and conflicts would be most likely to arise only when individuals felt themselves to have legitimate property claims for other reasons. Furthermore, it is possible to analyze social stability as a form of social utility. As such, it seems reasonable to omit further discussion of stability arguments in the present context.

Whether focused on liberty or utility, the instrumental approach to property rights requires an argument to show how property rights can be understood as tools for securing the more fundamental good. This argument itself has two components. First, there must be some account of the more basic ends (be they liberties or social benefits) that property is thought to protect, to further or otherwise to produce. Second, there must be some account of the link between socially recognized and legally enforced property rights and the more basic end that they are thought to serve in instrumental fashion. Those who have seen liberty as the fundamental good furthered by property rights are *libertarians*, while those who see utility, happiness, satisfaction or some other use value as the fundamental goods are *utilitarians*.

Libertarian Theory

Property rights might be instruments for protecting civil liberties to the extent that freedom of action, freedom of expression and freedom of exchange depend upon the institution of property rights for their effective exercise. A person may feel constrained in his or her ability to produce or enjoy some goods if that person cannot be assured some degree of control over the use of the goods. Many liberties depend upon an individual's ability to have certain goods at that individual's disposal, and if the protection of such liberties is thought to be a valid social norm, then recognition of the corresponding property rights will follow. Libertarian political theorists (see Chapter 8) have argued that personal liberties are the most basic political good. In a morally ideal world, people are totally free and unconstrained, but in the real world, we give up our freedom to harm or interfere with others in exchange for the assurance that they will not harm or interfere with us. Thus the fundamental liberties civil rights, such as a right to assemble, free speech and a right of non-interference in personal affairs (Nozick 1974).

Clearly, if someone feels that they own a particular good, they are likely to regard another person's use or appropriation of that good as a form of interference. It has been less clear how the definition question (what sorts of things can be owned in the first place, and how does someone legitimately acquire the feeling that they own something) is answered on purely libertarian grounds. For this reason libertarianism is often associated with one of the ontological arguments discussed below. Libertarians have also been adamant defenders of the view that social benefits should not override the protection of noninterference rights. This means that they are especially reluctant to accept the view of the utilitarians, discussed below, that rights claims should only be recognized when doing so produces social benefits.

Utilitarian Theory

Utilitarian or value-based views are far more predominant in discussions of biotechnology (see Lesser 1989). Here, property rights are thought to be justified only when they facilitate the creation and allocation of social utility. In the most common philosophical theories, individual preferences are taken to be the most basic standard of utility. That is, one good is thought to have value in virtue of its being preferred over other goods by individual human beings. For utilitarians, rights of any kind are justified by the fact that they tend to promote happiness or satisfaction throughout the population at large. Property rights are no exception. Thus legal codes governing the use, control or exchange of goods should be evaluated in light of whether the population as a whole experiences greater satisfaction with them or without them. The "non-obviousness" clause in patent law is an example of utilitarian reasoning used to deny a property claim. For the utilitarian, creation of property rights is justified only when they increase net social value. Allowing someone to claim ownership of ideas or design principles that would be obvious to most people cognizant of general practice in a discipline or trade would only create obstacles to the dissemination of technology and the creation of value. The utilitarian will not sanction all and every appeal for property status, but only those that promise to increase utility.

ONTOLOGICAL CONCEPTIONS OF PROPERTY

Ontology is the division of philosophy that formulates theories about what sorts of things there are (e.g. physical objects, ideas, relations, mathematical objects) and attempts to account for the general differences in what is (e.g. the difference between a physical object and an idea, between a historically existing person and a fictional character). Simply obtaining an internally consistent account of these differences is difficult. An ontological theory of property accounts for what is or is not accorded the status of property by attempting to describe characteristics or traits that make a particular thing ownable, or capable of being a possession. These criteria may refer to specific traits that are either possessed or lacked by the object in question, or they may be purely relational, referring to a relation between the object owned and its owner, or to relations obtaining among a number of people or things.

As already noted, one way to build an ontological theory of property is to start by listing the sorts of things that are in fact treated as property in any given social setting, that is, to treat the ontology of property simply as a project of description. The fact that something is in fact regarded as an item of property is, on this approach, pretty good evidence that it *can be* regarded as an item of property. One might proceed further by asking whether new or unusual goods are in some way analogous or similar to those things that are already regarded as property. Alternatively, it is possible to begin with criteria that stipulate or appeal to a moral, theological, aesthetic or pragmatic standard and to use these standards to establish further criteria for determining the general sorts of things that can be justifiably understood as possessions or holdings, the broadest class of things that can legitimately be said to be owned. Ethical questions about whether a specific object should or should not be classified as property are determined by applying the criteria in individual cases.

Natural Law Theory

Natural law is a comprehensive approach to questions in ethics and political theory that has been largely omitted from previous chapters in this book. In one sense, of course, a natural law is a law of nature, the sort of regularity in nature that is the traditional object of scientific observation and experiment. In the sense relevant to property rights, however, natural law is "principles of objectively right conduct, the rightness of which is immanent in human nature or the nature of things" (MacCormick 1987, p. 275). Over its several hundred year history, natural law theory has embraced patterns of argument derived from many of the approaches that have been discussed in previous chapters, differing from them (if at all) only in claiming an objective ontological status for its fundamental principles. However, the objectivism of natural law theory is less relevant to the current chapter than is an approach to the general definition of property that is not captured in other approaches, and especially in instrumental approaches.

As noted, natural law theory presumes that what is natural is, in a deep sense, what is right. The idea that property is a component of natural law has been influential in European history. Such a belief is particularly plausible when one's concept of nature includes a benevolent, but also judgmental God, who has designed the fixtures of the earthly realms in accordance with His plan. Given such a theology, a natural theory of property may include an attempt to ascertain God's intentions as revealed in the characteristics of things commonly regarded as items of property. These would certainly include personal effects such as clothing, or common goods routinely bought, sold or transferred by gift. The natural law tradition can be understood as starting with these common items of property and attempting to discern characteristics that could be applied to other cases, including genes and gene processes.

Rivalry, for example, refers to whether it is possible for more than one person to use or consume the good without diminishing the amount of good available for others. Goods such as canned food and clean water are rival; goods such as street lighting and national defense are non-rival. A second natural characteristic is how easy it is to exclude others from using or consuming a good. Canned foods are relatively excludable in that one may lock them up, preventing their appropriation and use by others. By contrast, it may be fairly difficult to exclude people from access to clean water or street lighting. A third natural characteristic is alienability. Because the US Declaration of Independence begins with praise of rights to life, liberty and pursuit of happiness, Americans have come to think of "inalienable rights," as something like "supremely important rights" but *Webster's Third New International Dictionary* defines "alienability" simply and unambiguously as "the capability of being transferred to other ownership". Some rights can be transferred: the right to use a particular good such as land or water, for example. Other rights cannot be transferred from one person to another without being vitiated: my right to life or religious liberty cannot be meaningfully transferred to someone else, for example. Each person must have his or her own inalienable (inherently non-transferable) rights secured in a just society, arguably Thomas Jefferson's exact point when he wrote *The Declaration of Independence*, and the reason why he did not include the right to property as an inalienable right (Wills 1978).

Natural facts about alienability, excludability and rivalry provide one way to decide whether or not something can be claimed as property. Goods that are naturally rival, excludable and alienable are easily defensible as items of property. Goods which are highly non-rival and non-excludable are not natural candidates for property (Thompson et al. 1994, p. 202). These three traits leave considerable gray area where the relative rivalry, excludability and alienability of goods do not provide the basis for a secure judgment. In such cases, a fourth element of natural law theory may emerge which treats all of nature as a heritage to be shared equally by all human beings. John Locke was a staunch defender of property rights for the emerging seventeenth-century English middle class, but even he recognized that nature must be shared by all. Such a principle for deciding property claims would accept that highly rival, excludable and alienable goods are "fit" to become property, but would decide the gray cases in favor of a non-property or common-property determination. Justice Burger's majority opinion for the US Supreme Court decision in *Diamond vs. Chakrabarty* appeals to such a view implicitly, holding that Chakrabarty deserved a patent for his bacterium because it was his own handiwork, and not "a manifestation of nature, free to all men and reserved exclusively to none" (US Supreme Court 1980).

The Labor Theory of Property

However, ontological theories need not appeal to natural law. Theoretically, virtually any trait might be stipulated as a criterion. In an early paper on biotechnology and property rights philosopher Ned Hettinger proposes criteria that would challenge the property status of any living thing and would rule out all sentient life forms (Hettinger 1995). Hettinger's criterion is unlikely to win wide acceptance, denying as it does property status to domesticated animals and challenging a long history of well-established chattel property rights. Nevertheless it serves to illustrate how alternative criteria might be proposed. One might consider explicitly theological criteria, or criteria that test for autonomy or rationality as alternative developments of the ontological strategy.

One important alternative is the labor theory of property, also derived from John Locke. A labor theory of property holds that a person's productive work is the basis for a property claim. People are entitled to claim what they make or create as their own. The mere act of discovery does not establish a property claim, but the appropriation of the discovered good to some further purpose does imply some element of labor. As long as previous property claims upon the appropriated good are discharged fairly, the work that a person does in picking up, transforming or safeguarding the appropriated good establishes a property claim. In standard applications, ownership of goods produced while in the employ of another person or organization are, subject to prior negotiations, transferred from the laborer to the employer as a consequence of the wage or salary contract.

Some may dismiss the labor theory out of hand, thinking it a discardable artifact of eighteenth century political thought, but a labor theory of property is not to be confused with the labor theory of value accepted by Locke and by influential economists such as Adam Smith and Karl Marx. The labor theory of value made dubious claims linking the legitimate value (or justifiable price) of a good to the value of the labor expended in producing it. No respectable economist would endorse such an approach to value today. However, claiming that something is ownable (and, indeed, owned) in virtue of the labor invested in its appropriation, creation, manufacture or development entails nothing about its economic value. If value is determined by exchange, as neoclassical economists assume, it is clearly possible to invest substantial amounts of labor into items which are of no value whatsoever. A labor theory of property would nevertheless support the claim that such valueless items are the property of their manufacturer irrespective of whether they have exchange value or social utility.

LINKING INSTRUMENTAL AND ONTOLOGICAL THEORIES OF PROPERTY

Most theorists of property have had little interest in developing philosophically pure approaches to their subject matter. Instead, different approaches to property are often mixed and when a particular set of criteria for property can be shown to satisfy several different approaches, it has generally been thought all to the good. There are two important and robust links that deserve emphasis. One ties the focus of natural law theory on rivalry, excludability and alienability to the utilitarian focus on creating social utility, while the second ties the central criterion of labor theory to the libertarian interest in protecting human freedoms.

Linking natural law and social utility. Rivalry, excludability and alienability dramatically affect the costs and benefits of any individual or group's attempt to control the use of a given good. There is great cost, for example, in attempting to control a highly non-excludable good and little benefit in attempting to control a highly non-rival one. To the extent that this general pattern holds, relative degrees of rivalry, excludability and alienability will track the particular configuration of social rules that tends to promote optimal social utility, the best ratio of social benefit to social cost. However, a systematic departure from the pattern becomes crucial to the debate over intellectual property rights. Ideas and innovations have the potential to create social value, but since they are non-rival and poorly excludable, advantages to the creator or innovator are nullified when the innovation is shared by all. Lacking a socially constructed and legally enforced right to the innovation, the only way for an innovator to profit from ideas is to keep them secret. Utilitarian conceptions of property were the impetus for widespread development of patent offices in the eighteenth and nineteenth centuries. It should not, then, be surprising that biotechnology and intellectual property are often discussed largely in terms of a utilitarian or value-based approach. The creation of social value is the intellectual rationale for utility patents, especially in the United States. Hence, demonstrating the need for incentives to develop and disseminate biotechnologies has emerged as the key burden of proof in patent oriented debates (Lesser 1989).

Linking labor and liberty. As noted, libertarians have strong arguments for protecting existing property rights, but weak arguments for saying where these rights came from in the first place. The argument linking labor to liberty remedies this problem and is straightforward. A system of property rights that failed to recognize a person's property right in their own labor would compromise liberty by consigning people to effective servitude. There is little point in insisting on human liberty if the products of a person's labor can be arbitrarily appropriated without consent or compensation. This argument requires a slight modification of the labor theory of property developed by John Locke, because it stresses not the self ownership of each person, but each person's initial ownership of their own labor. While Locke thinks that one's self-ownership should not be regarded as an alienable good, ownership of one's labor clearly is.

In fact, leading libertarian theorists do stress the claim that that recognition of property rights in labor is necessary for the protection of liberty in just this way. Labor needs to be salable or alienable, in order to make it possible for someone to work for wages. Clearly, one way to earn a living is to produce *things* (buggy whips or bushels of corn) that can be sold to others, but many (if not most) people in contemporary society sell their labor. They agree to work for a period of time mowing lawns or making buggy whips. The wage they are paid reflects the local market for labor, the wage or salary for which comparably productive people are willing to work. To deny people the opportunity to enter into contracts with others *either* for the buggy whips they have made *or* directly for their work in the form of wages would restrict individual liberty (Hospers 1971; Paine 1991).

PROPERTY AND AGRIFOOD BIOTECHNOLOGY: ONTOLOGICAL APPROACHES

How do the several conceptions of property point in different, though not necessarily contradictory, directions when applied to questions in biotechnology? One reason why it is difficult to say anything definitive about property rights for biotechnology is that each of the conceptions of property developed over the centuries are now subject to forms of interpretation that differ substantially from those of the past. In the present context, it is less useful to strive for conceptual purity than to see how key concepts might be interpreted and combined to form a rationale for evaluating biotechnology. Nevertheless, the ubiquity of utilitarian argument in the biotechnology debate often pollutes ontological arguments, making it difficult to perceive how non-instrumental criteria are being applied. Ontological arguments will therefore be segregated, even if doing so introduces artificiality into the analysis.

Another reason for difficulty, however, is that the products and processes of biotechnology are themselves very different. At first, genetically altered organisms were at the center of debate, with considerably more emphasis on animals than plants. A new controversy emerged over US National Institutes of Health (NIH) filing of patent claims on various and sundry fragments of cDNA. While this action was widely criticized at first, the action was defended on the ground that legal procedures in the United States entail that failing to file effectively eliminates the opportunity for NIH to claim rights in the future, while leaving open opportunities for private companies to do so. What is philosophically interesting in the case is the likelihood that criticism of NIH reflects a widely held opinion among the scientific community that the sequences under consideration should be understood as discoveries, rather than as inventions (Anderson 1991; White 1994). Without implying anything about technical questions of patentability under existing law, it will be illustrative to consider how each conception of property might be applied both to whole organisms and to fragments of genetic code.

Natural criteria for property survive into the present in a form significantly altered from their application in natural law. In the first instance, the theological warrant for property has all but vanished, with theological arguments being offered most commonly to limit, rather than promote, the application of property claims. Thus, the new strategy is to reject Locke's original judgment that all things, including human beings, are property, and to make the normative argument that some things should not be considered to be property at all. It goes without saying that human beings will be the paradigm example of a non-property good. From this starting point, at least two rather different strategies for applying natural criteria are available. One stresses analogy to the human case, the other stresses rivalry, excludability and alienability. The application of labor criteria in contrast is fairly straightforward. Since scientists are people, don't they, too, own the products of their labor?

Ruling Out Ownership of Human Genes

One way to arrive at the conclusion that human beings cannot legitimately be understood as property, even as property reflexively owned, is to argue that the concept of property implies a status of subservience that is inconsistent with certain natural facts about human beings, to wit, that humans are free and autonomous agents, acting in pursuit of rationally chosen interests. Regarding oneself as one's own property might, on such a view, be self-contradictory, since one would be seeing the potential use or sale of oneself as a potential means for realizing those interests. This argument is representative of Kantian philosophy (Kant 1785). While it might still be possible to exchange labor for other goods on a Kantian view, the autonomous agent that is at the core of the Kantian conception of the person could not, with moral justification, be owned by self or other. As already noted, arguments of this sort have surfaced with respect to property claims over the human genome, but how is this relevant to agrifood biotechnology?

Recent attempts to extend this notion of personhood to nonhuman animals entail that ownership of any subject of a life, to use the phrase favored by Tom Regan, cannot be justified on ethical grounds. As sketched by Hettinger (1992), this view extends to any transgenic animals that also possess requisite moral characteristics such as consciousness and a consistent mental identity over time. The pseudo Kantian argument applies much more readily to individual animals and to human beings than to the products of genetic engineering. It is, after all, individual human beings who possess autonomy, rather than the species as a whole, much less a segment of code from the human genome. The argument could be applied to a case in which an individual's rights were compromised by experiments that extract or derive genetic technologies from samples of that individuals' DNA. Here, the individual in question might have been treated like property to the extent that others want to claim ownership of something uniquely derived from his or her body. The case is not without ambiguity, however, for body products such as whole blood and semen *are* bought and sold in many countries, including the United States. A Kantian modification of natural law that would rule against products of genetic engineering would appear to have an even stronger application to these more routine cases. Furthermore, the extension of this argument to plants or animals depends upon the controversial extension of Kantian arguments to non-human organisms.

Nonetheless, something like this argument appears to surface in the thinking of many people who oppose intellectual property rights in genes and gene processes. Michael Fox, for example, expressed the view that "the patenting of animals reflects a human arrogance towards other living creatures that is contrary to the concept of the inherent sanctity of every unique being and the recognition of the ecological and spiritual interconnectedness of all life (US Committee on the Judiciary 1988, pp. 64–65). Andrew Kimbrell believes that allowing patenting of plants or animals opens the door to patenting of human genes. He describes a "two-decade long slippery slope" in which apparently narrow decisions on the property status of genes and gene processes have laid the groundwork for what he regards as objectionable claims, based largely on their applicability to human genetic materials, or, he would argue, actual human beings (Kimbrell 1993, pp. 188–202). To some extent, these claims rest on matters already discussed in Chapter 5 on animals, or ahead in Chapter 10 on religious beliefs. In either case, however, it is not clear that these represent arguments that uniquely address the moral status of intellectual property. Instead, Fox, Kimbrell and other critics seem to apply an argument which states that transgenic technology is wrong, and hence that recognizing property rights related to transgenic property is wrong. The real moral work here is being done by the more fundamental arguments and that fact provides a reason to pass over these objections in considering the ethical status of intellectual property claims.

Rivalry and Excludability

An interpretation of natural property criteria that stresses properties of rivalry and excludability offers norms that are more applicable to biotechnology. In this view, the property rights would be recognized to the extent that natural features of excludability and rivalry are present. Ownership would be limited to that which could easily be controlled by virtue of its physical characteristics and property rights would primarily protect against common forms of theft. Such a view favors chattel property rights, or ownership of a specific individual, but provides strong grounds for rejecting all intellectual property rights. Biotechnology might even be used to engineer rivalry and excludability into certain organisms, by introducing and eliminating traits that affect reproduction or uses that deviate from intended purposes, as the discussion of Terminator and GURTs at the beginning of the chapter illustrates. An ingenious GURT might, for example, increase the rivalry of a hen that lays golden eggs by engineering traits that would preclude her being used for fried chicken. Such strategies would not, however, protect others from reverse engineering any organisms they legitimately could acquire. As such, they do not protect *intellectual* property, as that term is typically understood.

Indeed, the Terminator case is precisely a case of this general kind. Terminator seeds are rival in way that ordinary seeds are not. Ordinary seeds can be grown for food or they can be grown to produce more seeds to plant next year. Although one cannot, of course, both eat and replant a particular seed, the crop in the field seen from the farmer's perspective can be allocated to either or both of these purposes. They are nonrival. The Terminator crop, in contrast, cannot be used as next year's seed. Growing for food and growing for seed have become rival uses, and farmers must decide which purpose they have in mind before they buy seed. Note, however, that while GURTs are very effective at protecting seed from being used to produce even more seed, they are absolutely useless from the standpoint of protecting one's investment from a competing seed company. Without the additional protection of a patent, competitors can engineer the GURT out and incorporate the genetic trait into a crop variety of their own.

The analysis thus far suggests that truly *intellectual* property is not justified by the natural law standard, but that physical or technological transformations of rivalry or exclusion cost might well be. Adding the criterion of alienability into the mix may favor property rights in genes and sequences, since it is the technology of rDNA that makes these items alienable from the cells and molecules in which they occur naturally. Nevertheless, this interpretation of natural law is particularly important for the biotechnology debate because it provides the most obvious foundation for those who wish to ground property in something natural and to question biotechnology and genetic engineering in particular, in light of its alleged unnatural character. As already noted, these extensions of natural law are very much at odds with many current practices, but either Kantian or rivalry/excludability interpretations are more plausible than classical views that relied heavily on theology.

Do Scientists Own their Labor?

If natural law provides the strongest argument against property rights in genes and gene processes, perhaps labor criteria establish the strongest and most plausible claim for property rights in biotechnology. There can be no denying that transgenic organisms and even fragments of code become available to us as a result of a great deal of labor. This labor is both intellectual and physical, though perhaps not as physically onerous as that involved in clearing and improving land. If labor establishes a claim upon a parcel of land, it should also establish a claim upon the fruits of biotechnology research. There are, however, important qualifications. In Locke's examples, labor establishes a property claim through working land or gathering apples. These activities are different from intellectual discovery and design in several important respects. They are processes of physical production and consumption. They have tangible goods as their object, and most importantly, land and apples already have characteristics of rivalry and excludability. In these examples, labor can be seen as a process of alienating these goods from their natural surrounding. Once alienability has been added to their natural rivalry and excludability, property claims can be readily justified in natural law terms. One cannot, therefore, say that Locke thought of his labor criterion as distinct from natural law criteria.

Given the fact that intellectual goods fare less well on natural law grounds, it is less clear that property right to a discovery, particularly intellectual discovery, or an idea can be justified by the labor criterion. There are, however, several different shadings that can be given to the argument. One may answer the query as to whether intellectual discovery involves the right kind of labor in different ways—producing diametrically opposing results. Locke's view of labor can be interpreted strictly in terms of alienation of rival and excludable goods from nature. Since ideas, designs, and, more relevant to our purposes, genes or gene processes are neither rival nor excludable, no intellectual property claims in them are ethically justified. The alternative extreme is that *any* failure to recognize a claim of ownership in the product of *any* labor is an interference in personal liberty, hence all intellectual property claims based on the labor of the researcher are justified. In between, it is possible to argue that the relevant sense of labor involves transformation, not simply alienation, of goods existing in nature. This view might permit the argument that a transgenic organism or a process for isolating or manipulating genes will be defensible as property, while the fragment of code will not. The key to such an argument is the claim that something has been produced in making a transgenic organism, while something has merely been discovered in identifying the sequence. This claim is itself subject to nuance and alternative interpretations. Physicists, for example, must produce quarks in order to discover them. Is the situation similar for genetic sequences?

Labor and natural law criteria provide philosophically powerful insights into the way that we think of what is ownable and what is not, but the central concepts in these philosophical approaches are open-ended. They are subject to many and subtly different interpretations. Hence they provide the basis for extended philosophical and moral argument about intellectual property rights in biotechnology, rather than definitive answers. Readers looking for such answers may disappointed, but in truth all that can be done is to sketch some strategies for applying the basic principles of labor and natural law theory to biotechnology. This may be useful as an aid to following the thinking and argument of those who engage in this debate, and to forming an opinion, but it is just incorrect to imply that these approaches to property theory truly decide the issue one way, rather than another.

PROPERTY AND AGRIFOOD BIOTECHNOLOGY: INSTRUMENTAL APPROACHES

Much of the debate over biotechnology and patents has been framed in frank utilitarian terms, with little room for compromise or appreciation of alternative approaches. It is also possible to reinterpret elements of the labor and Kantian account in libertarian terms. In both cases, the justification of intellectual property rights for genes, gene sequences, and genetic traits or processes far less to do with what biotechnology is than with the coincidental effects of recognizing property rights to the goods in question. Clearly, however, a potentially enormous array of intellectual products and goods are being discussed. Recognizing property rights to a key sequence or gene transfer process for an agronomically important crop like maize or soybeans will have vastly different consequences than making a similar judgment for a minor crop such as rutabaga. Viewed in strictly ethical terms, these differences might be crucial to whether one would want to recognize intellectual property claims on either utilitarian or libertarian grounds.

Utilitarian Arguments Applied to Biotechnology

The actual consequences of intellectual property rights are especially relevant to arguments that justify intellectual property rights by the utilitarian argument that such rights give researchers the necessary incentive to produce products that are socially beneficial. Here it matters a great deal whether the market structure for seed and production of a given crop is diverse and competitive, or small, highly integrated and non-competitive. Will the intellectual property increase or stifle competition in that industry? The question cannot be answered in general terms. The consequences will depend both on the intellectual good in question and on the market structure at a given point in time.

It might be thought that a different question could be answered, though. Can it be said that, on average or for the most part, recognizing a general system of intellectual property rights will tend to promote the social good? Advocates of intellectual property rights have thought that it would. A 1991 review of intellectual property rights in agricultural biotechnology concluded with the statement that broader recognition of such rights would promote agricultural research, and that "This increase in research and greater interactions among scientists will rebound to the gain of society" (Lechtenberg and Schmid 1991, p. 105). Baruch Brody concludes his review of ethical arguments on animal patents that "the claim … that a patenting system promotes beneficial consequences by providing an incentive to create useful inventions … is the most widely used argument by proponents of patenting transgenic animals" (Brody 1989, p. 151). He also notes that the structure of this argument makes it "difficult to assess in particular cases, for it is often hard to tell how desirable will the outcomes be and how likely they are to occur". Yet he concludes that the general experience of developed countries with patents provides a reason for finding substantial moral support for patenting transgenic animals, a conclusion that would, one presumes, extend to all forms of food biotechnology.

More than a decade and a half after Brody made that assessment there is reason to be less sanguine. It seems reasonable to think that strengthening of intellectual property rights for biotechnology helped seed companies and food biotechnology firms attract venture capital (Berghorst 1991) and gave large chemical and pharmaceutical companies more confidence in developing new products. But the presumption rides on a narrow basis of research. Whether the growth of intellectual property rights has truly benefited food and agricultural research appears to be very much a matter of perspective. Those who have been successful in obtaining patents have benefited, often indirectly from enhanced status and better internal funding from their home institutions rather than from the patent's earnings. Yet for others, research has become almost prohibitively costly (Overhauser 1994; Sederoff and Meagher 1995), and most universities have found that an intellectual property office that returns more than 5% or 10% on its own operating costs is doing quite well (Haussler 1996).

Over time, some of the enthusiasm for patents shown by both public and private research groups in biotechnology has worn thin. One of the key issues has been freedom to operate, a technical dimension of patent law limiting both future research and dissemination of inventions that would reasonably be expected to infringe upon an existing patent. The problem was dramatized by the discovery that Ingo Potrykus's approach to vitamin A enriched rice (so-called Golden Rice) was potentially in violation of over 70 patents. At first it appeared that not only would Potrykus need all these permissions to proceed with Golden Rice, but the non-profit organization for which he worked could also be sued by each of these patent holders for failing to obtain permission simply to conduct the initial research. Some sources accused Potrykus of entering an agreement with AstraZeneca Corporation to develop Golden Rice largely to shed this liability (RAFI 2000).

The problem is not unsolvable. The Golden Rice situation was later recognized to be considerably less complex, as many of the original 70-plus patents were found to be seldom or never enforced, hence nullifying the possibility of legal action against Potrykus. Other permissions were donated, winning patent holders such as the Monsanto Corporation some badly needed favorable publicity. Intellectual property offices at universities and major corporations become practiced in securing freedom to operate, as "packages" of patent permissions get assembled that allow research and development to proceed. In July 2004 a number of public research organizations announced the formation of the Public Intellectual Property Resource for Agriculture (PIPRA). PIPRA is a consortium intended facilitate researchers in obtaining the permissions needed to conduct research and to develop new products intended for public benefit. Nevertheless, the fact that such agreements and negotiations are being worked out a quarter century after initial enthusiasm for agricultural biotechnology suggests that the bright expectations for patents in genes and gene processes appear not to have been realized (though neither have the worst fears of the starkest critics, discussed below).

Perhaps the rationale for intellectual property rights has little to do with food biotechnology as such, and more to do with a lingering and still influential view of scientific progress. When utility patents were initially established, there was a widely held assumption that innovations were intrinsically progressive. Today, that assumption can be questioned on a case by case basis. Indeed as previous chapters have shown, there is an extensive literature on unwanted and unintended consequences of specific biotechnology products, and on the procedures for anticipating and assessing them (e.g. Busch et al. 1991; Hallberg 1992). Yet assessment of social or even environmental consequences is absent from the burdens of proof for utility patents. The rationale for this absence is dual. First, courts have held that the place for evaluating costs and benefits is not at the level of patent review, but for specific product approval through the regulatory process (Lesser 1989). This judgment is consistent with US Patent Office practices which do not apply utilitarian criteria to specific patent applications at all. It is the patent system itself that is thought to be justified by utilitarian considerations, rather than individual patents taken on a case by case basis. Yet utilitarian arguments for utility patents rarely attempt to show that unwanted secondary social or environmental effects are outweighed by the benefits of protected innovations.

Can anything be said then about the ethics of utilitarian arguments for intellectual property rights to food biotechnology? First, one must admit that the general form of the utilitarian argument for intellectual property rights has a long and distinguished pedigree and that utilitarian arguments have indeed been very influential in setting public policy. Second, there is a distinct possibility of reasonable disagreement about whether the empirical evidence supports the extension of this distinguished tradition to food biotechnology. Lacking sounder empirical support than appears to be available, Brody's conclusion favoring intellectual property rights on utilitarian grounds seems too strong. The jury is still very much out on this question, and the longer the jury stays out, the less compelling the utilitarian argument sounds. The uncertainty that pervades assessment of the actual consequences of intellectual property conventions provides a basis for taking alternative ethical arguments all the more seriously.

In concluding this review of utilitarian arguments, it may be noted that the extent to which utilitarian theories have held sway in debates over intellectual property, generally, and with respect to biotechnology in particular is surprising. The argument most prominently introduced for recognizing property rights in genetically altered organisms or in segments of genetic code—that doing so will establish incentives for research that will ultimately be socially beneficial—is offered without qualification, despite the fact that similar arguments produce absurd conclusions for other forms of knowledge and ideas. Teachers would have more incentive to educate their students if they were entitled to a share of each student's lifetime earnings. Scientists would have more incentive to develop broad theories if they could capture royalties in every instance where the theories are republished or applied. Jazz musicians would have more incentive to produce catchy harmonies and melodic themes if they could capture the value created when other musicians incorporate these fragments into best selling songs. Parents would have more incentive to teach their children common sense if they could reap a larger share of the benefits from doing so. Again it seems that other non-utilitarian considerations seem to be at work in the background of our thinking, even if the debates have largely been framed in utilitarian terms.

Libertarian Arguments Applied to Biotechnology

The general claim of the libertarian view is that if an individual's labor originates the property right, then appropriation without consent violates that individual's civil liberties. The first step in assessing the applicability of this claim to food biotechnology is to ask whether the claim is, in fact, true. Here, the questions reviewed above in connection with a scientists' ownership of their labor come up once again. In particular, though the intellectual researcher is as entitled to own the immediate fruits of his or her labor as any day laborer, this entitlement does not establish the terms on which publication or dissemination will take place. Such terms are not difficult to divine for excludable, rival and alienable goods, for any uncompensated use of the goods deprives the laborer of a competing use and clearly compromises the laborer's liberty. Intellectual goods—ideas—are different. As long as the researcher decides to keep his own counsel, they are perfectly excludable. No one else knows they exist. Once public, however, they are notoriously nonexcludable and non-rival. The problem is not so much with the vulnerability of researchers' liberty as with the conditions under which it would be reasonable for them to consent to general publication.

In the *laissez-faire* system of non-interference rights proposed by libertarians, ordinary labor contracts represent a negotiated settlement between the labor and the capitalist, or final owner of the alienable good, and the voluntarily accepted wage represents the compensation necessary to secure consent. Such contracts might well differ with respect to intellectual goods, however. The intellectual laborer knows that upon publication, the intellectual good is both non-rival and non-excludable, hence he or she must negotiate not merely with one eventual owner or user of the good, but with every person in the society who is likely to use the good prior to publication. Presuming that such negotiations could be carried out, people in the society are likely to agree to such terms, since such an agreement may be the only way that they will get to use the good at all.

People will not, however, agree to rights and licenses controlling knowledge that is easily obtained. One person might pay for knowledge about a short cut to the airport, for example, but it is unlikely that everyone in society would be willing to recognize the exclusive right of any individual to such knowledge. Judgments about the novelty of the relevant knowledge will therefore become part of the negotiations. Such negotiations are likely to prove time consuming and expensive, however, and it can easily be imagined how a system much like patent law would arise to standardize the problem of assigning rights and licenses. The socially negotiated procedure solves the problem of missing criteria for publication and would provide the intellectual laborer with the option of seeking protection, or of publication with such future rights. The broad implication of libertarian theory is, thus, a strong property right in biotechnology on the part of the individual innovator and a socially negotiated system of making contracts for the exchange and use of innovations.

Novelty, however, is one of the criteria that is used in making patent decisions and it is worth noting well that it rests more securely on libertarian/consent standards than on utilitarian ones.

Libertarian or consent-based approaches to intellectual property, thus, end in providing a more straightforward prima facie justification for intellectual property rights than any other view. There are, however, two additional qualifications. First, it may be questioned whether any idea in food biotechnology (or science) generally can truly be traced to the labor of a single individual or even to a specific group of individuals. Science is a social process and scientific ideas are plausibly conceptualized as the result of a long and very public course of development. To the extent that discovery and scientific innovation are conceived as intrinsically public activities, the basis for the libertarian rationale begins to evaporate. Second, although the system of utility patents and its stress on novelty provides one account of the conditions under which people might consent to a system of intellectual property, it is hardly the last word on this subject. It is possible that researchers might consent to publication of their ideas for little more than enhanced status and public recognition, for example. That would appear to be the standard that has governed science for several centuries. The suggestions made in this chapter describe how one might begin to work out a consent-based system of intellectual property rights, but they do not provide a full accounting of the philosophical issues that would be relevant in the final analysis.

AGAINST PROPERTY RIGHTS IN FOOD BIOTECHNOLOGY

The above sections show that the philosophical case for recognizing intellectual property rights in genes, sequences and genetic processes is mixed, and that no thoroughly decisive arguments can be brought to bear either way. Yet there is a fairly large literature opposing intellectual property rights. A number of books have already been written on the subject and the literature has grown rapidly since the first edition of this book. As noted in Chapter 8, many of the presumptions on which criticism of intellectual property rights have been based are simply wrong. The furor over the Neem tree provided a dramatic example that anticipated many of the ambiguities associated with Terminator seeds. Critics claimed that patents granted to W.R. Grace for an insecticidal extract from the Neem plant would preclude Indian farmers from their traditional use of Neem (Anonymous 1995b). Similar claims have been made about attempts to patent substances used by folk healers in India (Anonymous 1996). Shiva's writings on biopiracy have continued this tradition, making India a hotbed of opposition to biotechnology (Barooah 1999).

Unfortunately, the critics' arguments are plagued by ambiguity. Patents never provide a legal basis for challenging uses of a substance, good or product that were established before the patent was applied for. As such, the idea that patent laws could be used to provide a legal basis for companies to prevent farmer (in India or elsewhere) from doing what they have always done is just factually incorrect. This is not to say that intimidation and extortion in the misuse of patents never happen, only that there is no legal basis for it. Representative versions of several arguments against intellectual property rights will be reviewed in this final section of the chapter. All either fail to make their case, mostly by begging the central question: are intellectual property rights for food biotechnology ethically justifiable in principle? In many cases, they beg the question because they fall victim to one of three ambiguous concepts. Many fail to distinguish between the consequences of the technology and the consequences of intellectual property rights. Others stumble over the very ideas of ownership and the commodity form.

CONSEQUENCES OF THE TECHNOLOGY VERSUS CONSEQUENCES OF INTELLECTUAL PROPERTY

As Milligan and Lesser (1989) noted in their review of the US debate over animal patents, most critics fail to address the central question because they use arguments that oppose the technology to oppose property rights in the technology. Intellectual property rights can be awarded for products (take chemical weapons, for example) that we may hope will never be used. In fact, owning property rights in such technologies may be instrumental to controlling and limiting their use. There may thus be legal grounds for recognizing a property right even when there are also compelling arguments to restrict a technology's use. Arguing that a technology is risky, harmful or downright evil is thus not in itself an argument against patents or other forms of intellectual property rights material to the technology. Nor is it clear that food and agricultural biotechnology would be stopped or even substantially slowed by an absence of such rights. It is, after all, the seeds and food products that will eventually determine the profitability of food biotechnology, and intellectual property rights are at best tangentially related to that. Milligan and Lesser acknowledge the legitimacy and importance of these issues, yet question whether these arguments bear on the question of ownership.

The issues raised in many criticisms of intellectual property rights are, thus, ethically legitimate, but would be just as legitimate in a world where legal mechanisms for creating and protecting such rights did not exist. They are, in fact, reasons for rejecting the technology. The equivocation of objections to the technology with objections to intellectual property rights is particularly relevant to GURTs, the discussion with which the chapter began. There it was argued that the risks of local or regional famine that can be associated with GURTs provides a powerful argument for being exceedingly cautious in their use. But this argument does not address the question of whether patents on GURTs are legitimate, whether the effective property rights obtainable by manipulating the physical traits of plants through GURTs are legitimate, or whether indigenous farmer's complaint that plant scientists are taking their property when they collect seed from land races is legitimate.

For the most part, critics such as Cary Fowler and Pat Mooney identify a series of potential risks to genetic diversity and smallholder wellbeing that might be associated with any agricultural technology that promotes monoculture and industrialization (Fowler and Mooney 1990). Jose de Souza Silva describes the long history of unequal exchange between North and South (de Souza Silva 1995); he does not, however, indicate how changes in the recognition of intellectual property claims to genes or genetic resources will affect the trajectory of that history. Vandana Shiva notes the importance of maintaining both genetic and cultural diversity (Shiva 1997, 2000), but aggressive pursuit of developing country markets for agricultural inputs such as seed, fertilizer and mechanical farm equipment can proceed in the absence of intellectual property rights protecting these technologies. Just as Milligan and Lesser note, these comments seem more directed at the consequences of using the technology than at the consequences of protecting it with intellectual property rights.

In fact it really seems to matter little whether the industrialization that these critics fear comes about as a result of one well-capitalized firm promoting a single technology for which it holds an intellectual property right, or several well-capitalized firms promoting similar technologies for which none of them hold intellectual property rights. Yet if nothing is done to regulate technology or to control the economic power of capital, that is what the difference between recognizing property rights and not recognizing them comes down to. On the other hand, with such regulation in place, the consequences for environment and distribution of wealth are likely to be very different, even when intellectual property rights are in place (or at least as far as we can tell). As their own arguments show, industrialization has occurred in the past without the need for intellectual property rights.

There is, however, a deep basis for this confusion. As the Terminator case illustrates, changes in technology, and especially biotechnology, themselves affect the excludability, rivalry and alienability of goods. Ideally a farmer might want a crop that grows only in the microclimate of his or her particular farm. That would be perfect natural excludability, but most farmers enjoy some degree of excludability from the fact that only farms having similar soil or climate characteristics can produce the crop. Farmers working in this group of farms have a collective natural property right in the crop. When a biotechnologist (or even a traditional plant breeder) transforms seed so that a crop can survive in colder climates, or can resist the pests and diseases of the tropics, this change reduces the natural exclusivity built into the characteristics of the crop. Genetic engineering makes even more obvious and dramatic changes in alienability. In learning how to move genes from crop to crop, the genetic engineer turns what was once an inalienable trait of the crop (the gene) into an alienable good (hence a candidate for ownership) itself.

If a strong natural law view of property was taken, it would be possible to interpret *these* technological changes as changes in property rights. This raises an interesting and under appreciated philosophical issue, but note that even if one wanted to pursue this argument, it would have little to do with the putative topic of this chapter, namely intellectual property rights. The question of whether it is ethical to transform the physical characteristics of excludability, rivalry and alienability is at best marginally related to whether a social convention to protect ideas, discoveries or designs should be established. Similarly, whether the social and legal consequences of the technology itself are acceptable is only vaguely related to whether genes and gene processes are sufficiently like the other kinds of intellectual goods that are protected by intellectual property rights to warrant extension of the social convention to them.

PROPERTY VERSUS PROPERTY CONVENTIONS

As noted early in this chapter, the fundamental ethical question is whether genes, segments of code or gene processes can be owned, consistent with our ethical beliefs and traditions for recognizing a given good as an ownable form of property. If this fundamental ethical question is answered in the affirmative, there are a host of additional questions about the social and legal means for protecting this property right. The frequent pattern of critics is to make sweeping statements opposing the legitimacy of intellectual property rights for biotechnology, then to support these claims with arguments that refer only to the defects of a specific system for protecting them. Henk Hobbelink does this, for example, when he writes that the "who owns it" question is the most profound question in the development of agricultural biotechnology, then launches into a series of problems with US-style patents (Hobbelink 1995, pp. 230–231).

Hope Shand, Vandana Shiva and even David Magnus commit a similar error in citing the biopiracy debate as point against intellectual property rights in genes or genetic traits (Shand 1991; Shiva 1997; Magnus 2002). In fact, the central point presumes that intellectual property rights exist, and that the problem consists in the failure of international patent systems to recognize the contributions (e.g. the prior ownership) of indigenous farmers in developing those rights. The underlying fairness question that critics of biopiracy raise is an important ethical question. It is, in fact, also a legal question. Given sufficient resources, representatives of farmers in developing countries might well be able to challenge patents awarded to scientists and seed companies through the courts (Feinsilver 1995). That they are not likely to do this has less to do with intellectual property as such and more to do with general ethical questions associated with the disparity between the access of the rich and the poor to legal services. Yet it must be admitted that intellectual property rights in plant characteristics exist in order to mount this important argument.

There *are* important legal questions that must be raised about any particular system for protecting intellectual property rights. Some of these legal questions have ethical implications, generally relating more to the fairness and effectiveness of a legal system than the property status of intellectual goods. Critics of biotechnology have probably opposed both the technology and the adoption of intellectual property codes because they believe that these underlying problems are unlikely to be resolved, and that biotechnology will be only another stage in the repression that has accompanied other changes in agricultural technology. These are, after all, quite credible beliefs. Yet it may be hoped that a more carefully reasoned statement of the underlying problems will win more friends. For their part advocates of biotechnology do themselves no credit when they correctly note the logical flaws in critics' arguments on intellectual property, then do nothing to address admittedly serious and legitimate underlying problems of social and legal justice. Yet the debate truly belongs not in this chapter, on intellectual property, but where it has been taken up in the consideration of social consequences.

OWNERSHIP AND COMMODITIES

A frequent theme in critics' arguments is that ownership of life is itself wrong. To the extent that the theme devolves from religious beliefs, the argument will be taken up in Chapter 10. A number of critics have developed secularized versions of the argument, however. The strongest versions are directed toward a widely shared sentiment that patenting of human genetic materials is morally abhorrent (Macer 1992b, 1994). Theologian Ted Peters relates this reaction to a shared horror felt in response to the manipulation of Nazi eugenicists (Peters 1994). Mark Hanson provides an overview of the way that this link between ownership of genes or gene process and improper commercial exploitation of life has been developed in medical bioethics. While he finds that vagueness and ambiguity pervade most approaches to the question, he concludes that patents do represent "an *encroachment* of commodification on our understanding of traits and organisms" (Hanson 2002, p. 172).

In order to make a claim relevant to the key ethical questions of this chapter, it must be stated clearly not only that doing certain things is wrong, but that owning (or claiming to own) genes, genomes, etc., is wrong. Andrew Kimbrell does make this claim pointedly in his anti-biotechnology polemic (Kimbrell 1993). Kimbrell introduces the point by reviewing the legal actions surrounding the case of John Moore. Two scientist/physicians who had been treating Moore for leukemia successfully commercialized a line of cell tissues drawn originally from Moore. Kimbrell finds it bizarre that the courts have held that the creation of this commodity is perfectly acceptable (though Moore himself enjoys no right of ownership in the cell line). Kimbrell argues that Moore's rights were compromised not by the failure to obtain consent or to share the income from Moore's spleen cells, but by the fact of commercialization itself. Individual rights, Kimbrell says, would be similarly compromised by experiments that extract or derive genetic technologies from samples of an individual's DNA (Kimbrell 1993, pp. 206–210).

The reader might wonder why this issue would even come up in a book devoted to food biotechnology. There are two reasons. First, it is entirely possible that food researchers will find good reasons to use so-called human DNA in food products and processes. Second, it is possible (though less frequent) to make an analogous argument with respect to all forms of life, not just humans (See Hettinger 1995; Hanson 2002; Loy 2003). The claim then is that ownership of genes itself compromises human dignity (or the dignity of life), irrespective of what one does vis-à-vis real human beings (like offering compensation or securing consent), or with respect to the other forms of unwanted consequence that have been the main topic of this book. Clearly one way to flesh out this argument is to give it a religious meaning. That theme will be taken up in Chapter 10. But how could this claim be made based on purely secular considerations?

One way would be to conflate ownership with domination and control. As noted at several junctures throughout the previous chapters, criticism of the view that nature is available for human domination and control has been a prominent theme in recent environmental ethics. Other chapters review the merits of the argument itself, but one way to see problems with property rights is to see these rights as permitting total license on the part of the rights holder. This however, has never been the view of what a property right involves in any existing legal system. Ordinary chattel property rights provide the counter example. Livestock are arguably one of the oldest and most universal forms of ownable goods. Sheep, cattle and goats are, in normal circumstances, highly rival and excludable goods, and their ready alienability allows them to serve as a symbol of wealth itself in some societies. Clearly there is variability from society to society about what an owner may permissibly do with livestock, but there are few societies (and no industrial democracies among them) where the owners of livestock may do literally whatever they please with their animals. Both legal and customary sanctions against cruel and neglectful treatment are commonplace (Thompson et al. 1994, pp. 167–173). Clearly there are verbal conventions where people use the word "own" to indicate a morally objectionable form of domination and control (e.g. "I own you; you're mine"), but to equate simply all forms of ownership with these morally objectionable senses is equivocation of the worst possible kind.

Something more subtle may be going on with respect to the arguments that refer specifically to human genes. How do we handle the permissibility or impermissibility of human slavery? As already noted several times, one philosophical tradition has it simply that human beings should never be regarded as "ownable" potential forms of property, hence slavery is never acceptable. Yet it is not clear what even this strong view implies for human genes. Kimbrell (like many) fails to avoid twin part-whole fallacies that are confusing by virtue of their complex logical relation to one another. A division fallacy occurs in inferring that because the whole (e.g. the individual human) cannot be owned, the parts (e.g. organs, blood, cells and DNA) cannot be owned. A composition fallacy occurs in inferring that because individuals cannot be owned, the whole species (represented by the genome) cannot be owned. One may indeed want to argue that genes or genomes cannot be owned, but the property status of individual human beings does not have any logical bearing on the property status of parts of human beings (e.g. their DNA) or the wholes (the genome) of which humans are a part.

These arguments that take up problems of ownership as they relate to human genes or to life processes seem to be raising profound issues, but they are currently raising them in a fundamentally confused and ineffective manner. Perhaps better versions of these arguments will be forthcoming, and specifically religious versions of the arguments will be discussed below in Chapter 10. For the present, however, the arguments seem to hang either on ambiguities in the word "ownership" or on the logical ambiguity of part-whole relationships. Until better versions of these arguments are available, the case of the critics must be regarded as unproved. Moral philosophy provides multiple ways to interpret the ethical status of intellectual property claims for biotechnology, however, and given that the case for recognizing these property rights cannot be regarded as entirely proven, even faulty arguments have psychological and political force. The next round of debate over intellectual property can advance our understanding of the issues by being more specific in avoiding all three of these ambiguities and in focusing more intently on the problems of intellectual property as such.

CHAPTER 10

RELIGIOUS AND METAPHYSICAL OPPOSITION TO BIOTECHNOLOGY

Chapter 1 states that ethical arguments against biotechnology can be divided into two groups:

1. Standard agrifood technological ethics: ethical concerns that might be raised with regard to the conduct of scientists, engineers and innovators, on the one hand, or the unintended consequences of technical change, on the other; and
2. concerns that relate specifically to biotechnology in virtue of its exploitation of life processes, including techniques for moving genetic materials from one organism to another.

Concerns typical of standard technological ethics will tend to be related to some products of biotechnology, but not others, or they will refer to general social institutions for the management and production of technical change. It is precisely this group of concerns that have been reviewed in the previous nine chapters of the book. Although products of food biotechnology may have been subjected to an extraordinary *degree* of scrutiny with respect to safety, animal well-being, environmental impact and social consequences, the scrutiny is not different in kind from that which can and should be applied to any technological innovation in the food system. Debate over the property-status of genetically engineered organisms, reviewed in Chapter 9, began to introduce considerations that were somewhat more unique to biotechnology. Yet the property rights that can be claimed over seeds and genetic materials have been controversial for some time prior to the innovations that permit crossing of species barriers, and much of what was seen to be controversial for property rights in seeds or genetically based traits reverts back to social and economic consequences. However, some of the more negative views on the moral permissibility of claiming property rights over genes and plant and animal varieties focus specifically on the fact that it is *genes* (or living things) that are at issue. These viewpoints broach the religious and metaphysical questions that are the focus of this chapter.

Many who base their concerns and objections to food biotechnology on religious grounds are applying arguments that are typical of standard technological ethics. They deplore risks to environment, animals or social stability that have a technological origin, and base their ethical arguments either on principles that articulate what is seen as an unfavorable balance of benefit to harm, or by appealing to principles of participation, rights and consent. Practitioners of a given faith often articulate their personal duty to embrace moral principles in religious terms. This can make an ethical duty seem more profound or vital, but there is an important sense in which the addition of religious motivation for acting ethically does not change the content of ethical claims made on secular grounds. The issue of securing consumer consent for the sale of foods modified through genetic engineering, for example, exists whether the duty to secure consent is based on a political or a religious conception of moral duty. Consent criteria become no easier (or more difficult) to satisfy when they are based on religion, and the question of who should bear the cost of labeling policies that protect consent is not changed. Perhaps those who feel religiously enjoined to reject consequentialist or trade-off arguments will be more tireless in the opposition to utilitarian reasoning than others, but the philosophical point at issue is not substantially changed (Deane-Drummond 1995).

Many statements on genetic engineering from religious organizations or religiously inclined people repeat topics covered by the preceding analyses. The fact that these topics will not be rehearsed once again in religious garb is not meant as disrespect to those who see a religious grounding of their concerns for risks or social consequences. The main task of this chapter is to examine two kinds of religious argument that do appear to contribute a distinct line of reasoning to the debate over food biotechnology and genetic engineering. The first group of arguments focuses primarily on intellectual property but the arguments discussed introduce some themes not discussed in Chapter 9. The latter group of concerns addresses process, not product. They will typically involve the claim that when one manipulates an organism using rDNA techniques, one does something that is itself wrong, without regard to the immediate consequences. This broad distinction between general technological ethics and the claim that genetic technologies (or property rights in genetic processes) are inherently unethical is important because only arguments in the latter group could produce a strong philosophical prejudice against every application of food biotechnology. This chapter will examine the most comprehensive of those arguments that purport to show the intrinsic immorality of all biotechnology.

METAPHYSICAL AND RELIGIOUS VIEWS

Unlike many of the other arguments discussed in this book, the arguments discussed in this chapter draw directly on particular religious and metaphysical beliefs. A *metaphysical* belief is a broad framing belief about the nature of reality. Belief in the existence of a world beyond one's own personal sensory experience is a common metaphysical belief, and one that is almost universally shared by those who engage in empirical science. When scientists conduct experiments, they claim to be learning something about a world beyond their own perception, a world they and other scientists are able to observe. Belief in the external world *frames* experimental science in that it is a background assumption that establishes what it means to do science, why experiments are relevant to the pursuit of knowledge, and why the reproducibility of results is both possible and important. Indeed, belief in the existence of an external world frames the activity and worldview of most adult human beings. It is a thoroughly unexceptional metaphysical belief. However, it is a notoriously difficult belief to defend when challenged by sophisticated opponents. It would be tedious (and it is not necessary) to specify criteria that distinguish metaphysical from non-metaphysical beliefs. Suffice it to say that the term does *not* imply the kind of superstition that is found in the "metaphysics" sections of popular bookstores. All of us have metaphysical beliefs that about the fundamental nature of the cosmos, human consciousness, the nature of ideas and the supernatural.

In using the term "metaphysical" to indicate broad categories of reality and experience that frame our understanding of self and world, we imply that not all metaphysical beliefs are religious. However, some of the beliefs and doctrines most typical of the world's religions are clearly metaphysical in nature. Belief in the existence or non-existence of gods, spirits or ghosts having (or lacking) powers to intervene in human affairs are metaphysical. Beliefs about the meaning of death, life after death, reincarnation, heaven, hell or purgatory are metaphysical beliefs. When beliefs about right and wrong action are combined with beliefs about the intentions or wishes of a creator god, or intertwined with beliefs about sin, karma or the fate of the soul they become both religious and metaphysical. As with the term "metaphysical," it seems wise to avoid broad or comprehensive definitions of what the term "religious" means, both with respect to metaphysics and ethics.

Most of this book deals with claims that would be compatible with almost anyone's metaphysical beliefs. For example, almost everyone agrees that food animals are sentient and can feel pain, though they might not agree on more fundamental beliefs about the nature of cognitive experience or spirituality. If, as Singer, Rollin and others argue, it is sentience that matters most with respect to animal ethics, it is possible to conduct an informed conversation about the ethics of food biotechnology's impact on animals without digging into people's views about the ultimate nature of reality or consciousness. Yet, the most troublesome and conceptually difficult objections to genetically modified animals make the claim that modification of animal genomes is itself wrong, irrespective of secondary costs and benefits. The OTA report *Patenting Life* refers to them as "metaphysical and theological arguments" (OTA 1988). Whether confined to beliefs about animals or extended to cover plants or microorganisms, metaphysical and religious arguments are the most potent objections to food biotechnology. Arguments based on technological ethics merely qualify the direction and application of biotechnology. Metaphysical and theological arguments might provide grounds to prohibit it altogether.

METAPHYSICAL AND THEOLOGICAL ARGUMENTS: A BRIEF OVERVIEW

A moral argument makes a metaphysical claim when the rightness or wrongness of an action is based directly on features ascribed to the ultimate reality or nature of being. Generally speaking, metaphysical claims state that something is (or is not) the case, and lack any context or criteria of verification through logic or empirical evidence. As noted already, the current consensus among philosophers of science is that all sciences presuppose some metaphysical beliefs, but empirically inclined philosophers would also argue that these beliefs are highly warranted in virtue of the coherence and predictive utility that is associated with the ensemble of beliefs constituting a scientific worldview. It is thus likely that every moral argument rests on metaphysical beliefs at bottom, but the arguments that have been analyzed in the first eight chapters of the book do not depend on the accuracy of some notoriously controversial metaphysical beliefs, beliefs such as whether or not there is a God, and of even whether there is an external world beyond our senses.

People often frame moral arguments in metaphysical terms unnecessarily, and perhaps unintentionally. For example, the scientifically inclined author of an early treatise on ethics and genetic engineering offers the following as an introduction to the discussion of human genetics:

> Man is an animal in that he grows, reproduces and evolves like all other organisms. However, unlike other animals, man possesses a mind which manifests itself in cultural phenomena, thereby posing problems for an effective study of his genetic inheritance. First and foremost, unlike mice, fruit-flies, and other animals used for gathering experimental data, man cannot be mated at the discretion of the scientist for the sake of determining the genetic make up of the offspring. (Santos 1981, p. 8)

The implicit sexism aside, this little passage by M.A. Santos makes at least three statements with important moral implications whose basis could only be metaphysical, given the balance of the his treatment.

1. *Human beings possess minds*. Literally, Santos attributes the possession of mind to the human species rather than individual human beings. This is questionable, but a charitable interpretation of his remarks yields this first, more reasonable metaphysical claim.
2. *Other animals do not possess minds*. Santos actually states that other animals do not possess minds that manifest themselves in the form of culture. In some contexts, this would be an ethically crucial distinction, but the less subtle interpretation seems more consistent with the author's apparent intent. These two statements are offered in support of the third.
3. *Man cannot be mated at the discretion of the scientist*. Again the actual statement is qualified, but Santos seems to mean this as an absolute moral proscription of discretionary mating of human beings for purposes of scientific research.

What makes these into metaphysical claims? Consider an alternative argument that would have established the case against laboratory breeding of humans by saying it violates fundamental human rights. Such an argument could be supported by a number of philosophical or religious views, including principles resting on consent, social consensus, long-run social utility or rational consistency, as well as the view that rights have a foundation in religious faith or in God's plan. The metaphysical connotation of Santos' prose arises in part from its dogmatic character: it just *is the case* that scientists "cannot" (as opposed to should not) mate humans. This metaphysical tone is reinforced by the obscurity of alleged links between the proscription and two other metaphysical claims. Why does the possession or non-possession of a mind bear on the permissibility of breeding? No reasons are forthcoming, leaving the reader with the impression that the author just "sees" the world this way, in much the same way that we simply "see" the world as spatially extended, or "see" time as irreversible. Metaphysical arguments may make perfect sense to someone who shares the author's intuitions, but usually offer little to those of us who don't.

Although the argument above does not address food biotechnology, it is worth reviewing for two reasons. First, it provides an example of metaphysical claims in support of a moral prescription. Second, metaphysical and theological arguments against food biotechnology are typically just special cases of arguments against genetic engineering *tout court*. If it is wrong to cross species boundaries, it is wrong no matter what species are being crossed. Authors such as Jeremy Rifkin and Andrew Kimbrell (see below) may have derived their metaphysically based view that genetic engineering is wrong from considering cases that involve human genes and that seem to revive the eugenics movements associated with the horrors of the early twentieth century. However, once such metaphysical views are articulated, they entail the wrongness of genetic engineering for plants and animals, as well as for humans.

THE RELIGIOUS CASE AGAINST GENETIC ENGINEERING

Since the earliest days of molecular genetics virtually everyone with any cognizance of this science has expected a basic and visceral reaction from religious conservatives. Clearly it would possible to think that the entire science of recombinant DNA is just wrong, with manipulation of plant, animal and human genomes simply being the most egregious violation of a basic and irreducible moral principle. The wrongness implied is often expressed as "playing God," the phrase chosen as the title for June Goodfield's 1977 book on the Asilomar conference. However, it is surprising how elliptical and non-specific statements of this basic moral proscription tend to be. Karen Lebaqz, a professor of Christian Ethics at the Pacific School of Religion reviewed a United States Presidential Commission's discussion of the possible meanings of "playing God" (US President's Commission 1982). The Commission concluded that fears of playing God are actually fears of the consequences from gene technology. This interpretation rejects the most straightforward interpretation, namely that, as Lebaqz puts it, "the *nature* of the knowledge involved is taken to generate a prohibition" (Lebaqz 1984). Lebaqz herself stops short of endorsing such a prohibition, stating instead that the problem resides in an unquestioned commitment to the rational analytic methods typical of technological ethics.

Even the most visible public activists tend to promote ethical prescriptions more through innuendo than through direct statement. A 1987 article by Andrew Kimbrell and Jeremy Rifkin separates ethical considerations from social and ecological risks, but when Kimbrell and Rifkin go on to specify what ethical considerations might be, what they produce is a list of questions:

> What is wrong with a cow the size of an elephant, or a sheep the size of a horse, or "glowing" tobacco plants? Is there any meaning in the morphology of animals or plants, both internally and externally? Should we alter nature or mutate, perhaps permanently, the forms and shapes of the biotic community so that they better conform to our agricultural or industrial needs? Do plants and animals have any right to be treated as sufficient "ends" in themselves, and not merely as "means" in a system of production? What are the ethical implications of the likely proposal to engineer plant or animal genetic material into humans? Finally, who is to decide these issues: Congress? Scientists? Corporations? Theologians? The public? Federal agencies? (Kimbrell and Rifkin 1987, p. 126)

Although it is easy to guess how Kimbrell and Rifkin would answer these questions, neither is entirely explicit in formulating a statement that genetic engineering is categorically wrong on moral or metaphysical grounds, even in their more polemical works.

Other critics follow the rhetorical strategy of listing unanswered questions. Writing some 15 years before he became the Chairman of President George W. Bush's Bioethics Council, Leon Kass took issue with suggestion that a genetically engineered organism is just a composition of matter (hence patentable), by asking "What about other living organisms—goldfish, bald eagles, horses? What about human beings? Just compositions of matter? Here are deep philosophical questions to which the court has given little thought …" (Kass 1985, pp. 149–150) Philosopher Baruch Brody noted that those who proffer metaphysical and theological arguments "themselves recognize that they need to do a lot more work to articulate the inchoate concerns they feel" (Brody 1989, p. 142) Brody notes that religious denominational statements and religious study groups decry the philosophical reductionism and materialism that they see in contemporary molecular biology, but that they are unable (or unwilling) to turn this revulsion into an explicit ban on genetic engineering. When pressed, they revert to the concerns of technological ethics that need no religious basis (Brody 1989, pp. 142–143).

What one wants is a statement to the effect that barriers to cross-species reproduction that exist in nature represent a divine or metaphysical order that is not to be breached, that interference in the natural mechanisms of reproduction is morally wrong because it violates God's will. It is not difficult to find common people who believe this. Anyone who cares to strike-up a conversation with strangers on airplane or among members of the local church will be able to add anecdotal testimony to the existence of this belief among the general populace. The early Hoban and Kendall survey showed that many adults cite religious motivation for concern about genetic engineering. Yet anecdotes and statistical surveys are even more "inchoate," than Brody's expert witnesses. The Reverend Wesley Granberg-Michaelson is typical. He will say that "The Judeo-Christian view says that … there are limitations on what we can do" (quoted in Brody 1989, p. 144), but he will not say that genetic engineering and molecular genetics research violate those limits.

Given the lack of directness in religious statements on biotechnology and molecular genetics, the most that can be done here is to conclude with a few generalizations and speculations.

First, it seems likely that many of the lay informants that cite religious values in their concerns about genetic engineering also hold metaphysical beliefs that flatly contradict fundamental factual tenets of evolutionary biology. Like creationists, they must regard biology's metaphysical claims as merely speculative, as nothing more than tools for organizing work, at best, and as false and probably dangerous beliefs at worst. It is tempting to dismiss these views as philosophically naive. Bernard Rollin is willing to write off *all* religious opposition to biotechnology as being committed to a view of nature that is entirely unsupported by modern science (Rollin 1986). Yet we are best reminded that were metaphysical disputes to be decided by vote, the party of evolutionary biology would almost certainly be a minority one. The potential for anti-scientific radicalism among the religiously conservative is unknown, and the implicit attitude of the scientific community seems to be, "Let sleeping dogs lie." This may be good advice from a political perspective, but surely an ethically responsible perspective on food biotechnology must find it at least a bit duplicitous. If we have an ethical responsibility to communicate respectfully with the wider public (the subject of the next chapter), it will be necessary to find some way of engaging religiously conservative beliefs in a respectful manner.

Second, the likely view of this silent majority notwithstanding, it is quite possible to formulate a religious argument against human intervention in reproductive processes without contradicting the basic metaphysical claims of evolutionary biology. There are several forms that such an argument might take. For example, in attempting to establish the conclusion that "cloning is not God's way," Lane Lester and James Hefley offer a religiously conservative argument that rejects the importance of conflict between religion and biology. They argue that the biblical objection to genetic manipulation is "the lack of a normal family background" (Lester and Hefley 1980, p. 60). Citing *Genesis* 1:27–28, they conclude, "Clearly God intended society to be built on the two-parent family" (Lester and Hefley 1980, p. 60). It is a matter for speculation how these authors would view food biotechnology, but their argument stands as an example of how one might formulate a religious argument without contradicting the factual claims of biologists.

RELIGIOUS STATEMENTS ON GENETIC TECHNOLOGY

Most religious groups that have made official statements on genetic engineering are primarily concerned with the possibility of human eugenics, but they express this concern in language that applies to food biotechnology, as well. The United Methodist Church (1992), for example, adopted a resolution on genetic science at its General Conference, which reads in part:

> Failure to accept limits by rejecting or ignoring accountability to God and interdependency with the whole of creation is the essence of sin.

> Therefore, the question is not can we perform all prodigious works of research and technology, but should we? (p. 2)

The resolution goes on to endorse genetic technologies in general, and to qualify their application largely along lines that conform to technological ethics, though it does oppose patents on organisms based upon, "the sanctity of God's creation and God's ownership of life" (p. 5).

The Methodist declaration was preceded by a ten page report from a special task force on genetic science. Significantly, almost one third of this report deals with food biotechnology, including discussion of the impact of rBST, herbicide tolerant crops and release of genetically engineered plants into the environment (United Methodist Church 1991). The task force treated these issues in much the same way that they have been treated in Chapters 4 through 7 of this book, which is to say that they noted no special metaphysical circumstances or principles that would produce an evaluation of the products in question that differs from evaluations based entirely on secular grounds. The task force report offered an endorsement of agricultural genetic engineering, subject to two qualifications. First, the report stressed public input into the planning and distribution of benefits from food biotechnology. Second, the task force urged that food biotechnology promote the sustainability of family farms, natural resources and rural communities (United Methodist Church 1991, p. 122).

The July 1989 recommendation adopted by the Central Committee of the World Council of Churches is even more focused on medical applications of biotechnology. It calls for a prohibition of testing for sex selection, proposes a ban on experiments involving the human germ line and makes several other statements on human reproduction. The recommendations oppose patenting of animal life forms, and call for "swift adoption of strict adoption of strict international controls on the release of genetically engineered organisms into the environment" (World Council of Churches 1990) No specific theological rationale for these recommendations is reported. The United Church of Christ offered a statement that was broadly supportive of food biotechnology, stating that "Genetic engineering gives us new ways to relieve suffering and increase food production," and "We support the application of genetic engineering to agriculture, forestry, mining and pollution control, provided there is adequate regulation and public participation in evaluating new uses" (United Church of Christ 1990).

There are thus two broad philosophical routes to such religiously based statements (pro or con) on genetic engineering. One proposes metaphysical statements that bear directly on the morality of genetic modification, irrespective of its technological consequences, but the other follows the form of philosophical analysis plotted throughout the first eight chapters of this book except that a particular philosophical position regarding technological ethics is grounded on theological or metaphysical beliefs. It is fairly clear that a number of theologians writing on public policy issues reject the philosophical foundations of utilitarian philosophy, and would, hence, discount the moral importance of the consequentialist or trade-off arguments that have been reviewed in previous chapters. The literature on abortion and on the use of nuclear weapons for deterrence exhibits this pattern of reasoning far more evidently than the literature on biotechnology (Finnis 1980).

The 1984 report on genetic technology from the National Council of Churches of Christ also notes a number of the ethical concerns discussed in the preceding eight chapters, and places the ethical critique within the context of religious faith. The report states that scientific findings and theories, "neither annul, displace, nor validate the belief in divine creation" (NCCC 1984, p. 22). The report continues,

> A high testimony to the value of each created human life and of all humanity was, and remains, the act of Incarnation. This is one of the foundation stones of the Christian faith. The life that was blessed by being created in the image of God was confirmed and ratified by the becoming-human of the eternal Word of God in Jesus the Christ. In Jesus Christ human kind is re-created and renewed. This rejuvenation supplies force for the Christian witness to the original goodness and value of human life. Life is the created gift of God: that conviction can be further enhanced in this world and made eternal by God's action in Christ.
>
> For these reasons, each and all human life is to be held in high respect. Traditionally, then, Christian theology regards the effect on human life as the primary theological criterion for making ethical judgments about genetic science. (NCCC 1984, pp. 22–23)

The report thus marries a moral principle that could serve as the basis for a thoroughly secular technological ethics (that the effect on human life is the primary criterion for making ethical judgments) to a metaphysical statement about God's role in creation and about the divine status of Jesus.

The report continues with a series of statements that rest on this "primary theological criterion." Immediately following, for example, the report states:

> We know that we and all human beings should be responsible for unborn generations of humanity. The human gene pool—that is, the totality of genetic material available for reproduction—is in danger of corrupting its offspring through imprudent, excessively risky genetic modifications. (NCCC 1984, p. 23)

Panelists warn of risks and stipulate moral principles for weighing risk and benefit that are entirely consistent with the secular analysis presented in other chapters of this book. Although this analysis is interlaced with statements such as "Life is holy because God is holy" (NCCC 1984, p. 23), the effect of these metaphysical statements is to reinforce the moral authority of the panel's concern for effects on human life. Nowhere does the report state that modification of genes could be wrong except in virtue of its impact on the quality of human life.

Analyzing a number of religious statements on genetic engineering, Audrey Chapman of the American Association for the Advancement of Science notes that they "do not engage in systematic and extended theological reflection as a basis for drawing ethical and policy guidelines." (Nelson 1994, p. 183) Chapman also notes that the statements are often vague and unspecific even when they do attempt to make pronouncements. The Church of Scotland's Society, Religion and Technology Project is especially remarkable given religious organizations' usual tendency to superficiality and incompleteness. A permanent and professionally staffed activity of the Church since 1970, the Project formed a working group on ethical issues associated with genetic engineering of non-human species that published its 337-page report under the title *Engineering Genesis* in 1998. This report does not represent a doctrinal statement on the part of the Church of Scotland. Rather it serves as an example of an alternative approach that delimits a number of issues and indicates how the Christian faith tradition can be brought to bear upon them. Most of *Engineering Genesis* deals either with characterizing the scientific subject matter (which includes non-agricultural applications such as the development of animal models for medical research) or with considerations that have been characterized here as general matters of technological ethics, that is, questions of risk, consent and the procedures and institutions that govern technology and research. The report does single out a number of religious and metaphysical objections to biotechnology, which are characterized as "intrinsic" ethical arguments. Five types of intrinsic argument are subjected to detailed discussion in *Engineering Genesis* (discussed below): (1) playing God; (2) natural or unnatural? (3) relationships; (4) trans-species gene transfer; and (5) the status of animals, plants and microorganisms (Bruce and Bruce 1998).

An earlier attempt to raise the level of religious debate about genetic technology was coordinated by the Institute of Religion at the Texas Medical Center between 1990 and 1992. The effort coordinated working groups on genetics issues at several sites. Although the focus of this effort was heavily oriented toward medicine, genetic counseling and genome mapping, one study group formulated a survey that asked respondents to represent their faith orientation to questions on the acceptability of genetic engineering applied to plants and animals. The anonymous Jewish respondent stated, "Cross species fertilization is prohibited," though he or she continues with the statement "genetic crossbreeding may be less of a problem … Submicroscopic actions are often not culpable even when macroscopic activities yielding the same results are." The respondent qualifies this, however, by saying that mystical Jewish communities "would be far more troubled with the new species or trans-species creation no matter how human beings created them" (Seydel et al. 1992, p. 35).

An anonymous Protestant respondent to the survey notes that "Within Protestantism generally there are no objections to selective breeding, cross species fertilization, or the creation of "new species" (Seydel et al. 1992, p. 60) The respondent goes on to note a number of specific product-related concerns that are typical of technological ethics. The Episcopal respondent answered all questions relating to plants and animals with the following statement:

> We are stewards rather than manipulators of God's creation. Something initially beneficial later can lead to unforeseen detrimental effects, i.e. green revolution; development of new species and loss of older ones and subsequent disease/failure of "new species." Ecological balance could be changed. All knowledge can be misused. (Seydel et al. 1992, p. 68)

It seems reasonable to interpret this somewhat obscure formulation as a generally favorable response with respect to the acceptability of food biotechnology.

The prominent theologian J. Robert Nelson was the convener of the Houston conferences. He collected and annotated material (but not principal addresses) collected at the conferences in an unusual book entitled *On the New Frontiers of Genetics and Religion* (Nelson 1994). The book also reprints a number of personal statements on new reproductive technologies written from different faith perspectives, along with selection of ecumenical and denominational statements on genetic engineering. It is thus an excellent starting point for readers wishing more information on the matters reviewed above in this section. However, the book is of even more limited relevance to food biotechnology than are religious statements in general because Nelson edited the results of the Houston conference to concentrate narrowly on medical technologies and medical genetics, omitting all direct discussion of food and environmental issues. The religious community's tendency to edit each other's views is a continuing problem for those who would wish to derive some insight into the faith basis for beliefs about food biotechnology.

THE RELIGIOUS CASE AGAINST PROPERTY: 1985–1995

Religious arguments were prominent in US debates over the extension of intellectual property rights (IPR's) in genes, gene sequences or in whole genomes, especially during the decade when IPR's were in their most intensive period of Congressional review and political discussion, making the debate over IPR's a useful test bed for probing religious attitudes to biotechnology. For example, several religious leaders testified against IPR's in transgenic animals prior to passage of the *Transgenic Animal Patent Reform Act*in 1989. Testifying on behalf of the National Council of Churches, the Reverend Wesley Granberg-Michaelson cited a biblical responsibility to preserve the integrity of creation. In calling for a moratorium on animal patents, he described patenting of transgenic animals as "an unprecedented shift in humanity's relationship to the God-given natural environment" (US House of Representatives 1988, p. 201). Rabbi Michel Berenbanm joined in calling for a moratorium, resting his case on the distinction between "what constitutes life and what is merely an inert manufactured commodity" (US House of Representatives 1988, p. 202).

The issue of patents and ownership again became the flashpoint for religious opposition to biotechnology in 1995. Religious leaders from Roman Catholic, Jewish, Muslim, Hindu and both mainline and evangelical Protestant churches in the United States issued a statement opposing patenting human and animal genes. The story made the front page of the *New York Times* on May 13, where Richard

Land of the Southern Baptist Convention was quoted saying, "This issue is going to dwarf the pro-life debate within a few years." The statement itself did not include a rationale, stating only that the signatories "oppose the patenting of human and animal life forms," but subsequent stories on the statement indicated that for most signatories, opposition was based on the belief that the basic units of life are sacred and demeaned by patenting. Catholic Bishop William Friend was quoted in the *New York Times* saying that alteration of human genes "compromises the incomparable dignity of the human species." Friend and many Catholics would accept the patenting of plant and animal genes.

While these statements reveal the seriousness of religious opposition to at least some forms of genetic technology, the arguments that supported it in the religious press are vague. They were opposed by faculty from religious or theological institutions such as Leroy Walters, Theodore Peters and Ronald Cole-Turner, each of whom argued that although new genetic technologies should provoke broad societal reflection on moral issues, reactionary opposition to genetic engineering must not be allowed to prevent or postpone research and development that could produce compelling benefit to humans. If intellectual property rights in genes and genomes would hasten such benefit, these theologically oriented authors support them. These arguments on behalf of IPR's reintroduce a pattern of philosophical argumentation discussed in Chapter 9, and testify, again, to the way that technological ethics bleeds over into the religious and metaphysical realm.

The vagueness of religious language reported in the press presents a challenge to philosophical analysis. We may speculate that one of two lines of reasoning undergirds religious opposition to patents. One, that manipulating genes is itself wrong, will be discussed below. Another viewpoint might countenance the manipulation of genes for purely humanitarian purposes, but balks at the institutionalization of IPR's in virtue of the seeming commercialization of life that this entails. In this view, the boundary that is threatened is not the species boundary between human beings and other animals, but the boundary between sacred and profane domains of human practice.

Delineation of the sacred represents a crucial moral boundary for virtually any religious cosmology or view of nature. To call a place or an activity "sacred" is to distinguish it from ordinary places or activities, and to denote the importance of respecting special rules, or of adopting a proper attitude with respect to the place or activity. In many religious traditions, but especially within the Judeo-Christian tradition, marking a place or activity as "sacred" denotes the impropriety of ordinary commerce within or with respect to it. Mark 11:15–17 and Luke 19:45–46 describe Jesus' expulsion of money changers from the temple in Jerusalem. In Luke, Jesus chastises the priests for profaning the temple, turning it into "a den of thieves." These passages from the Gospel emphasize the inappropriateness of commerce within sacred places, and underline the distinction between the sacred and ordinary commercial activity.

The way that any religious group understands the boundary between sacred and profane (or ordinary) activities is, of course, contingent upon religious beliefs and traditions that vary not only from culture to culture, but from time to time and place to place even with a coherent religious tradition. Yet we should not be surprised when religious believers classify human activities that involve food and fertility among the sacred. The act of "saying Grace," or blessing the meal just before it is consumed is a form of re-sacralizing foods that may have been bought and sold prior to human consumption. Even more significantly, ensuring fertility in all of its manifestations—human, livestock, plant and soil—is a common theme of sacraments in all religious traditions. Twentieth century theological traditions display considerable ambivalence toward fertility-based metaphysics, wanting no part of religious beliefs that sanction such practices as idolatry and even human sacrifice in order to promote fecundity. Nevertheless, it would be surprising if the most basic processes of reproduction for humans, animals, plants and microbes were not associated with some residual feelings of sanctity.

Religious objection to IPRs on genes, sequences and genomes might therefore be built on an argument with two metaphysical premises. First, it would be necessary to proscribe commercial transactions within the domain of the sacred, that is, to interpret the sacred as being violated or transgressed either by specific transactions or more plausibly when sacred activities become pervasively characterized by the buying and selling of alienable goods. Second, it would be necessary to designate the reproduction of human, animal, plant or microbial organisms as a sacred process. It would be logically possible to designate only some subset of these organisms as having sacred significance; hence supporting the judgment that commercialization of plant reproduction is morally acceptable, while IPRs for humans or animals are not. Although the details of these two premises would need to be specified through theological arguments specific to a given religious tradition, it is quite plausible to think that such arguments could be offered and found compelling by the faithful. Such an argument would not necessarily proscribe the application of genetic engineering in the improvement of plants or livestock, or in developing techniques for food processing, nor need it preclude the normal commercial exchange of food and fiber commodities produced using food biotechnology. It might, however, support the conclusion that IPRs in genes and gene processes constitute an abrogation of sacred boundaries, and produce a strong religious case against property rights.

ACADEMIC THEOLOGY AND GENETIC ENGINEERING

Theology within the setting of scholarship and university research is a discipline unto itself, with obvious connections to philosophy, but with a distinct literature and its own technical concepts, traditions and scholarly language. Scholarly academic theology often diverges from the religious beliefs of the laity, of the active clergy, and even from the doctrines of organized churches. While a layperson might wonder about the ethics of food biotechnology because of an immediate concern about the propriety of eating a given food, or buying a given seed, the question of genetic engineering emerges for academic theologians as one piece in a larger set of questions about the relationship between science and religion. At bottom, these questions do (or should) inform or impinge upon the more practically focused beliefs of the layperson, the parish priest, or the church functionary, but the pattern in the scholarly literature is to pursue much larger metaphysical themes. A 1986 book entitled *God and the New Biology* struggles with the implications of the reductionist turn in biology, and with the theological implications of statistical explanations (Peacocke 1986). The index does not include entries for "biotechnology," or "genetic engineering," because these topics do not arise.

Two examples of academic theology, Wolfhart Pannenberg's *Toward a Theology of Nature* and Langdon Gilkey's *Nature, Reality and the Sacred* represent very different approaches to their subject matter undertaken by two theologians with a lifetime of work on the subject. Where Gilkey softens tensions between religion and science, calling for an understanding of the sacred that does not challenge the metaphysical presuppositions of the sciences, Pannenburg attacks the metaphysical presumptions of science head on, provoking their advocates to modify (or more rigorously defend) all metaphysical beliefs, whether based on religion *or* science. Neither of these distinguished theologians examines the implications of their theology for genetic modification, much less food biotechnology. Deriving such implications from their more general views would itself be a task of theological scholarship.

Academic theologians have been somewhat forthcoming with respect to the ethical acceptability of genetic research and its biomedical applications. Georgetown University's Leroy Walters served on the National Institutes of Health's Recombinant DNA Advisory Committee for many years, but his approach to bioethics is not explicitly theological (Walters 1978). Walters is an example of a theologian who works largely within the sphere what has here been called standard technological ethics. Ron Cole-Turner's *The New Genesis* is a short but systematic enquiry into the theological implications of recent work in molecular genetics. Turner accepts factual allegations of molecular biology at face value, and displays equal interest in the importance of these facts for theological doctrines of creation and for the ethical implications of genetic technologies in biomedical applications. For the latter questions, he supplies an ethical analysis that is entirely consistent with technological ethics: concern for human dignity, for rights and consent, but no religiously based proscription of genetic engineering for purposes that benefit human beings (Cole-Turner 1993).

Ted Peters is another theologian active in discussions of medical biotechnology. As described in a 1984 paper, his ethical approach is explicitly theological, based on "proleptic eschatology." This means that Peters advocates an approach to enquiry that begins with a vision a future, harmonious global community, based on the lessons revealed in the life of Christ, then defines ethical action as that which will realize or bring about that vision. Peters has been active in organizing symposia on the Human Genome Project, and has worked to keep religious groups and denominations open to the beneficial applications of biotechnology, primarily with respect to human health, but regarding food and agriculture, as well. A recent paper applies his approach to the debate over stem cell research. There he takes conservative theologians to task, arguing that their unresponsiveness to the vision offered by the medical research community and to the theological arguments offered by more liberal theologians (such as himself) is indicative of an intellectual closure that is inconsistent with the Christian religious tradition. Though Peters has not addressed food and agricultural biotechnology specifically, his approach would appear to be broadly accepting of it on theological grounds.

Andrew Linzey is one theologian who has maintained a steady focus on non-human issues. Linzey has produced a complex theological argument for animal rights that (1) rebuts theological views (such as those of Santos and the NCCC) that see humans as unique, that (2) appeals to a particular conception of Christ's lesson for humanity, and that (3) interprets animal suffering as both morally and theologically meaningful. He asks and (unlike many) answers the key theological question: "What does it mean for humans to exercise a priestly role of redemption? Quite simply: it concerns the releasing of creation from futility, from suffering and pain, and worthlessness" (Linzey 1995, p. 55). This theology produces a religiously based case for animal liberation. Linzey concludes his book *Animal Theology* with a polemical chapter that equates genetic engineering of animals with the sin of human slavery. Yet this chapter does not claim that genetic engineering is wrong when applied to plants, nor does it depend upon metaphysical beliefs about the sanctity of species or of reproductive processes.

Linzey's opposition to genetic engineering is entirely a consequence of his views on the need for radical revision of the relationship between humans and animals. Genetic engineering comes in for his wrath not because it appears to constitute any novel threat not posed by animal experimentation, meat-eating or hunting (three other activities discussed) but because it represents a new instance of the same old threats. In Linzey's view genetic engineering requires that we see animals as exploitable for human uses. Since genetic manipulation is, in Linzey's view, premised on this morally indefensible attitude toward animals, it is itself indefensible. Precisely because Linzey does not base his concerns on species boundaries that must not be crossed or the moral significance of genes and genetic processes, his view is a poor model for the kind of religious beliefs that are (speculatively) at the root of lay concerns. It seems unlikely that many of the lay informants who have expressed qualms about genetic engineering of animals would go as far as Linzey in reformulating humanity's relationship with the animal world.

In the end, Linzey's argument becomes curiously muddled. On the one hand, he wants to claim that genetic engineering itself merely extends a theologically indefensible attitude toward animals. On the other, he saves his most explicit rhetoric for a critique of property rights in transgenic animals. He writes, "*No human being can be justified in claiming absolute ownership of animals for the simple reason that God alone owns creation*" (Linzey 1995, p. 148, italics in the original), but while Linzey seems to have special animosity toward IPR's for animals, his position entails far more radical changes for ordinary chattel property rights than for IPR's and genetic engineering. If creating transgenic animals is itself wrong, why focus the invective on IPR's? Perhaps the answer is that thinking of animals in terms of property is simply the most extreme example of the attitude Linzey wishes to decry. In any case, one could not infer a willingness to countenance transgenic animals outside of a system of property rights from Linzey's rhetoric. The most plausible way to read him is as proposing a categorical rejection of genetic engineering applied to animals.

The 1997 edition of *Food Biotechnology in Ethical Perspective* noted the paucity of theological literature dealing with food or agricultural biotechnology prior to 1997. A 1995 bibliographic survey of literature entitled *Ecology, Justice and Christian Faith* surveyed more than 500 books and articles in the scholarly journals of religion. The compilers listed only five publications that take up biotechnology. Three of these, Ian Barbour's *Ethics in an Age of Technology* (1993), Roger Shinn's *Forced Options* (1991), and Art and Jocele Meyer's *Earthkeepers* (1991), are books that address environmental risks of food biotechnology from a perspective of religiously based technological ethics. A fourth is an article by Deiter Hessel that takes the same approach. Hessel argues that biotechnology would be permissible only if it is carried out by those who view the human vocation as one of living in harmony with nature, rather than as extending the Baconian project of human power over nature. While these authors identify themselves as theologically oriented, the arguments they deploy do not rely on theological views of God's intentions regarding species boundaries. Those who adopt the eco-centric worldview would apply the norms of technological ethics for theological reasons (Hessel 1993). The last bibliographic entry is a paper by Richard Chambers entitled "Plant Breeders' Rights and the Integrity of Creation." In making a fairly strong statement against genetic engineering, Chambers rejects the pragmatism implicit in denominational statements on genetic engineering, calling instead for a theological basis. This paper, prepared under the auspices of the World Council of Churches (WCC), references another WCC document as pointing toward the sought for theological foundations, but Chambers does not characterize these foundations as clear or adequately articulated (Chambers 1988). These authors call for a theologically grounded view directed specifically toward agricultural and food applications of biotechnology, but in large measure, that call is not answered.

Following the announcement of Dolly—the first cloned sheep—in early 1997, theological debate over biotechnology began to shift slightly in the direction of non-human applications. Though not specifically a work of academic theology, the previously mentioned *Engineering Genesis* provides a thorough discussion of food and agricultural genetic engineering that includes citations and argumentation typical of an academic study. The authors follow a standard philosophical convention of distinguishing between *intrinsic* and *consequentialist* arguments against agrifood biotechnology. While the latter involve risks, costs and benefits that must be reflected in the trade-off balancing or utility optimizing style of ethical reasoning typical of utilitarianism, intrinsic concerns are intended to represent reasons that should not be subject to this style of thought. The intrinsic concerns discussed in *Engineering Genesis* tend not to rely on rights arguments such as those discussed in previous chapters, and in fact cite a number of religious and metaphysical objections to genetic engineering as it might be applied to plants, animals and microbes.

For example, the authors of *Engineering Genesis* characterize the phrase "playing God" as a call for humility and a theologically based proscription of human interference in God's plan for humanity. The report counters this call by noting that although the Christian tradition does indeed endorse humility, it also endorses human creativity in the manipulation and transformation of nature in the service of God's will. A similar line of argument is applied to the suggestion that genetic engineering might be "unnatural": Christian traditions provide sources for constraining human beings abuse of the natural world, but also for seeing scientists' work with genetic engineering as consistent with duties to serve as stewards of nature. The pattern of argument in *Engineering Genesis* is to note the diversity and complexity of Christian theology, and to indicate that grounds can be found both for opposing and for endorsing genetic engineering in agriculture and food. The overview of intrinsic concerns is followed by a lengthy discussion of issues relating to animal welfare, social justice, environmental impact and the safety and autonomy of consumers—a discussion not unlike the one undertaken in the first nine chapters of this book. The upshot seems to be a perspective on agrifood biotechnology that is, in the final analysis, accepting and cautiously optimistic, while also noting the seriousness with which standard issues of agrifood technological ethics must be addressed as products are developed on a case by case basis. If this is correct, then the primary significance of noting intrinsic concerns in *Engineering Genesis* is to endorse the need to engage those who express these views in respectful Christian debate, and to ensure that they have ample opportunity as individuals to live within the dictates of their personal faith.

The upshot, then, is that theologians and theologically oriented scholarship has yet to undertake metaphysically based concerns about agrifood biotechnology in a direct and straightforward manner. Those who take a more conservative theological perspective seem focused on biomedical applications, and to the extent that species boundaries are the concern, it is the boundary between the human species and all others that ought not be crossed. More liberally minded theologians seem to be anxious to place some distance between themselves and their conservative colleagues. The mainline churches' opposition to animal patenting that occurred in the 1980s and early 1990s appears to be something of an embarrassment to theological liberals, who now appear reluctant to say anything critical about applications of genetic techniques in the food and agricultural sector. If there is a middle ground, it is occupied by those such as Linzey, whose opposition to biotechnology has little to do with genetic manipulation as such, or the Church of Scotland's *Engineering Genesis* group, who emphasize openness to a diversity of theological viewpoints.

THE ETHICAL IMPLICATIONS OF RELIGIOUS VIEWS

Religious claims seem to turn on normative evaluations of boundaries. In this respect, the arguments extend a longstanding tradition in ethical thought. Ethical judgments throughout history have placed emphasis upon group boundaries. At its most primitive, ethical responsibility may have been confined to tribal loyalties. The ancient Greeks, inventors of Western philosophical traditions, defined ethical responsibility according to a hierarchy in which the stringency of obligation is reduced as one moves from the family to the city-state, from the city-state to Hellenic peoples, from Greeks to other humans, and from humans to the balance of nature (MacIntyre 1988). Boundaries that establish rights, privileges and obligations within a hierarchical scheme were implicit components of morality in virtually every human society. Members of the nobility would owe duties to one another that were not owed to commoners; men owed duties to other men that they did not owe to women.

As implicit components of morality, hierarchies were often unnoticed and seldom defended explicitly. However, the emergence of European science coincided with a series of philosophical challenges to hierarchical organization of ethical and political obligations. Important scientists from Boyle to Pasteur were intimately involved in a step by step transition toward egalitarian morality and democratic politics. The history of these developments is too complex to summarize here; the point is simply that science has progressed in league with social reforms that tore down old hierarchies. But it is not always easy to distinguish social and intellectual hierarchies. Nineteenth century conflicts over the ethical and theological significance of evolutionary biology should be well known to applied biologists. To some extent, they continue in our own time (Bowler 1984).

Emphasis on boundaries has multiple implications. First it imbues the human species with a unique moral and theological status. Both Santos and the NCCC panel stress the uniqueness of humans in the passages cited above. The stipulation of a theological boundary between humans and the rest if nature permits articles of faith such as, “The ability to receive God’s Holy Spirit is unique to human beings among all creatures” (Stump 1992) from a popular devotional magazine article entitled, “What Makes Us Human.” Second, boundaries establish absolute constraints on conduct, without regard to beneficial consequences. Conservative religious opposition to abortion and research using human fetal tissue or stem cells provides an example. Theoretical molecular biology challenges the intellectual basis for implicit acceptance of boundaries. Applied molecular biology has become the messenger that brings this challenge to the mass public.

The challenge of modern biology consists in the knowledge that recombinant DNA is effectively a new reproductive pathway that does not respect species boundaries. Like evolutionary theory, recombinant DNA provides a strong reason to question the existence of any metaphysical boundary between human beings and other life forms. Since boundaries are largely implicit in the practice and culture of human society, events that lead to explicit public awareness of boundary assumptions may themselves be thought unethical. The public act of questioning boundaries may be thought inimical to society’s interest in promoting good conduct. Research that raises these questions can itself be interpreted as a form of questioning, even when researchers have no such intent.

Practices that challenge implicit boundaries take on ominous significance, particularly for those who imagine morality to depend upon a tightly knit fabric of personal norms, philosophical and religious justifications, and social reinforcement. However, systematic ambiguity runs throughout the attempt to base opposition to biotechnology on the two implications of boundaries outlined above. On the one hand, boundaries imbue humans with a unique status; on the other they establish absolute constraints on conduct. Logically, these may be entirely separable issues. Raising questions about the uniqueness of humans does not, on the face of it, also imply a questioning of absolute constraints on conduct; so modern biology's "threat" to social order is somewhat imaginary. It is possible that the two questions are theologically, psychologically, or socially linked in some way that has gone un-explicated so far, but the burden of proof to show this should fall upon religious critics who wish to make use of a boundary argument. The concern, clearly, of the science community is that the faithful will draw the boundary so that all use of recombinant DNA for research and product development is found unacceptable. In fact, however, religious critics have more typically opposed patent protection for genes, sequences and gene products.

Such theologically less extreme arguments might nonetheless have extreme consequences for food biotechnology. One might conclude that fertility and reproduction are sacred in ways that preclude genetic engineering, not just commercial ownership of genes through IPRs. Here the emphasis would be on the moral limitations on intentional actions of human beings, not on God's role in the establishment of natural order. The argument would be much like the one outlined above with respect to sanctity and property rights, save that it would identify any human interference in reproductive processes as a violation of the sacred, rather than simply commercially motivated actions. Such a characterization of the sacred would have to be based on biblical or other theological sources unique to the faith tradition in which the argument would be developed. This is evidently not an argument that many theologically trained individuals are inclined to make, but it appears to be a philosophically coherent option for those who would turn inchoate concern into a strong prohibition of genetic engineering. It would advance our understanding of ethical issues respecting genetic engineering for those whose religious views are so inclined to attempt an explicit statement of such an argument, if only to clarify and sharpen the terms of debate.

Finally, Baruch Brody's observation on animal patents that may be the most important point to take away from any consideration of religious objections. It is the inchoate character of religious opposition that is its most significant fact. Religious leaders had more than a century to adjust to Darwin, yet it seems they are being expected to accommodate important social and political implications of genetic engineering in less than a decade, and with considerably fewer resources for deliberation and debate. The point to be taken is that it is important for all parties to attempt such arguments as can be made, and to have some patience with those whose views are not fully formed. The fact that a potent theological objection has not been raised thus far is only the weakest sort or evidence that it will not be raised sometime in the future. Developers of food biotechnology cannot wait forever before going ahead with their products, but they can and should assist religious leaders and religious groups in formulating and articulating their views, however inimical to the products of food biotechnology they might, at the outset, appear to be. Only in this way can the inchoate be verbalized, and only when verbalized can the objections of the religious be evaluated and met on informed and rational grounds.

CHAPTER 11

COMMUNICATION, EDUCATION AND THE PROBLEM OF TRUST

Most of the ethical issues discussed throughout the previous chapters would exist without widespread public resistance to food biotechnology. The ethical bases for concern about the impact of genetic engineering on food animal well-being or for concern about social consequences depend upon the validity of key norms, the accuracy of key predictions, and the truth of key factual assertions. It is at least logically possible for facts to be true, predictions to be accurate and norms to be valid entirely apart from whether any human being, much less a significant number of human beings, appreciates, believes in or endorses their truth, accuracy or validity. It is, however, all too easy to confuse public outrage over an issue (which may or may not be ethically well-founded) with ethics itself. Public knowledge of or attitudes toward biotechnology has not been an important focus of the analysis in previous chapters because the goal has been to examine food biotechnology from the perspective of technological ethics, without regard to the popularity of or political motivation for any given argument.

Yet it cannot have escaped the notice of any likely reader for this book that all forms of biotechnology have been the subject of enormous public debate and outrage. Public controversy over agricultural biotechnology was elevated even prior to the publication of the first edition of this book in 1997, but skyrocketed in the final years of the twentieth century. Social scientists have attempted to measure and to analyze public attitudes toward biotechnology, though their measurements do not present a consistent picture of the basis or degree of concern. In the late 1990s, the Eurobarometer survey comparing attitudes across the European Union revealed a widespread public skepticism about food and agricultural biotechnology, though succeeding versions of the survey documented shifts in the degree of concern and in the national identity of those expressing the highest degree of concern (see Durant et al. 1998; Gaskell and Bauer 2001; Bauer and Gaskell 2002). In the United Kingdom, a group at the Institute of Food Research, Reading also conducted a series of studies on public attitudes toward gene technology. Their findings correlate concern with ethical issues to perception of risk (Frewer et al. 1994; Sparks et al. 1994; Frewer and Shepherd 1995). Although it is widely believed that North Americans are far more accepting of biotechnology than Europeans, when the same survey research methods are used to sample both groups the differences are not so well marked (Priest 2001), However, in other respects there are striking differences between these populations. Marlis Buchman studied the 1992 Swiss referendum that established a constitutional amendment calling for the regulation of biotechnology, concluding that the referendum was supported primarily by people with a high level of education who occupied professional or salaried positions (Buchman 1995). Contemporaneous surveys in the United States show just opposite result (Hoban and Kendall 1993; Hallman and Metcalfe 1994).

One way to interpret the ethical significance of these surveys is that informants have one or more of the ethical concerns discussed in the previous nine chapters when they report resistance to biotechnology. If so, the surveys simply document that people actually do find these ethical issues problematic, lending political urgency to ethical problems, but not changing their philosophical character. However, this interpretation is not well grounded empirically. It is doubtlessly true that some survey respondents view biotechnology from the perspective of technological ethics that has been explored above, but the empirical studies indicate that something else is going on as well. Both the British and the American groups analyze their survey results in light of social problems associated with risk (see Wandersman and Hallman 1993; Hoban 1995; Bauer and Gaskell 2002). As the preceding chapters document, there *are* ethical issues associated with risk. Yet the ethical issues that arise when widespread public perceptions or attitudes toward risk diverge sharply from those of the scientists who are in a position to have more accurate factual knowledge of the likely outcomes are *not* the ethical issues discussed throughout the first ten chapters of this book. The divergence between public and scientific attitudes toward risk suggests that something has gone deeply wrong at the junction between science and broader society.

From the perspective of many scientists, the conclusion is that the public is too poorly informed to make reasonable judgments, and that public opposition is interfering with the conduct of research, especially in Europe (Rabino 1991, 1994). Scientists often respond to this problem with calls for public education or better communication. For 20 years the National Agricultural Biotechnology Council, a consortium of North American universities and non-profit organizations conducting research on food and agricultural biotechnology, sponsored an annual meeting to solicit consensus recommendations to government, the private sector and to NABC members. Attendance at these meetings is dominated by university and government scientists with substantial representation from the administrative offices of biotechnology companies. Attendees also include a few representatives from non-governmental organizations (NGO's) and farmers, but few members of the general public. Such a diverse group reaches consensus on relatively little, but every meeting has concluded that there is a pressing need for better communication and for public education.

Does this conflict at the interface between science and the public present special philosophical problems? Arguably there are two. The first is that the public conceives of the risk problem differently from scientists. This is not to say that they differ with respect to their assessments of probability and outcome, but that they understand risk issues according to different philosophical parameters. The second is that communication and public education themselves create moral responsibilities not covered in the previous nine chapters. These issues are interrelated. If the public interprets risk differently from scientists, communicating with the public through providing information on probability and consequence will do little good. I will argue that misconceived efforts at communication can do (and have done) considerable harm. The harm they have done is to erode public trust in science.

In addition to reprising many themes from the previous ten chapters, then, this chapter synthesizes discrete analyses of three philosophical problems: risk, communication and trust. Each of these topics might be worthy of a book-length treatment in their own right. Here I will offer summary analysis of each topic in reverse order, concluding with a section on the problem of trust as it relates to food biotechnology. Clearly there are many individual scientists with very different approaches and attitudes toward these public concerns, and just as clearly "the public," is an abstraction, for in reality there are many groups and voices that interact with scientists and scientific organizations. In the interests of efficiency, however, I will speak of "science" and "the public" as if they represented two coherent perspectives on the problems that have been surveyed in the first nine chapters of the book.

THE PROBLEM OF TRUST

Trust is a moral relationship. Two parties who trust one another have a moral expectation with regard to each other's conduct. The trusting relationship is one in which one not only believes that another will act in the fashion that is expected, but also that the other regards the obligation or responsibility to act in this fashion as a moral or ethical obligation, a moral responsibility. Philosopher Annette Baier has made an extended study of trust. She notes that people often confuse the moral relationship of trust with power relationships and with ordinary promises. Trusting differs from promising because promises require one person to keep faith with respect to specific conduct or obligations that are entailed in the act of actually making a promise. It is a contractual obligation. Trust, however, requires one person to act on another's behalf in ways that could not have been anticipated in a promissory act (Baier 1994, p. 137).

The distinction between trust and power is particularly relevant to the present topic. A number of the ethical issues analyzed above deal with unequal power relations between scientists, research organizations or the food industry and some other social group. Consumers want labels on foods derived from biotechnology. Farmers in developing countries are concerned that they will lose the right to use genetic resources that they have husbanded through generations of trial and error farming. Animal advocates find farm animals totally at the mercy of genetic engineers. In each of these cases, an inequality of power underlies the ethical problem, and the proposed response—required labels, restricting access to genetic resources, or animal rights—is justified in terms of claims made by vulnerable parties. Following research by Paul Slovic, Caron Chess described such tensions between the vulnerable public and the purveyors of biotechnology as problems in trust (Chess 1996). It is certainly accurate to say that the vulnerable parties (food consumers, indigenous farmers, animals) do not trust those who hold or seek power, yet, as Baier notes, it may be quite misleading to analyze issues of power as problems of trust. Even if the proposed reforms are made, the parties will not trust one another. They merely have more equitable power relationships. Correcting the ethical problem, thus, has nothing to do with establishing trust, and everything to do with redistributing power.

Baier also draws a distinction between trust and the more extensive and open-ended forms of interdependency that characterize spousal and parental relationships or other family and community ties. Unlike these relations that one has as a result of factors beyond one's control, trust is a relationship that may be initiated or terminated, and it may be characterized by specific limitations of scope or duration that are known to both parties. As she puts it, "Trust is acceptance of vulnerability to harm that others could inflict, but which we judge that they will not in fact inflict" (Baier 1994, p. 152). One would not accept total vulnerability, nor would one extend a relationship of trust indefinitely. There must be some point in time at which will be possible to reexamine a relationship of trust, and to revise it if necessary. "To trust is to give discretionary powers to the trusted, to let the trusted decide how, on a given matter, one's welfare is best advanced, to delay the accounting for a while, to be willing to wait to see how the trusted has advanced one's welfare" (Baier 1994, p. 136).

Baier builds her analysis of trust on prior work by philosopher Thomas Scanlon, who identified four principles that govern relations of trust.

M: One should not *manipulate* others by deliberately raising false expectations about how one will discharge the relationship.

D: One must take *due care* not to allow others to form reasonable but false expectations about how one will discharge the relationship.

L: One must take steps to prevent any *loss* that others would face through reliance on their reasonable expectation of what one will do in discharging the relationship.

F: One must maintain *fidelity* to precisely what one has assured others will be done; while one may not do less, one need not do more. Indeed one *should not* do more if doing so would alter the other's expectations in an unreasonable fashion (Baier 1994, p. 134).

Baier writes that these principles should be understood as examples of common vulnerabilities of trust, rather than as defining principles that circumscribe trust. She gives examples of broken trust that do not violate any of Scanlon's principles. Unique features not common to all instances of trust will characterize any given relationship of trust. "Trust comes in webs," she writes, "not in single strands, and disrupting one strand often rips apart whole webs" (Baier 1994, p. 149).

Baier's discussion of trust illuminates the problem of science and its relations to society in two ways. First, it helps us recognize that there are some dimensions of this relationship that have much more to do with power than trust. Many individuals (probably a majority of citizens in most industrial democracies) who purchase their food in supermarkets or restaurants are in a state of utter dependency on their food providers. It may not always have been so, for one needs to cast one's glance only a generation or two back to find a time when reliance on a highly centralized food system was a matter of choice, not necessity. Clearly there are ethical norms that the responsible parties of the key organizations should (and generally do) follow, but let us not deceive ourselves. We are long past the time where we could alter our dependence on the central food system without prohibitive cost. This is a relationship of power, not trust.

Yet it is business more than science that is deeply implicated in the web of power relations that define the food system. To a large extent, people still do trust scientists to guard the safety and abundance of their food and the integrity of the environment. Scientists trust society to give them the support and freedom to carry out this task. The first three of Scanlon's principles pick out some vulnerabilities in this relationship. Have scientists manipulated the public by promising too much? Have they taken due care to be sure that public does not form reasonable (but false) expectations, absent any malicious or manipulative intent by scientists? Have they taken steps to prevent or compensate for losses that trusting parties may have experienced as a result of what scientists have done? And what of it if it turns out that science comes up short on any of these three principles?

A more thorough discussion of the scientific community's performance is taken up below in the section on risk, but a preliminary discussion of each question is revealing. One of the most common criticisms of food biotechnology is that it has been oversold, that its proponents have, in their quest for dollars, created wholly unrealistic expectations (Teitelman 1989; Busch et al. 1991). Yet more seriously, even those scientists who themselves have criticized the moneymen and their overzealous colleagues have done little to dissuade members of the public from reaching unrealistic expectations. Thus even if violations of the *M* principle are exceptions, violations of *D* are the rule. Finally, much of the entire controversy over social consequences, over structural impacts on the size distribution of farms, over the increasing difficulty of family farming and the decline of rural communities is *precisely* targeted at *L*. Food and agricultural scientists, so their critics claim, at least, have not taken the required steps to prevent losses by those who have entrusted them with their welfare and well-being. There are really only two possible conclusions here. Either food and agricultural scientists have abused the trust of their farming constituency and the wider public, or they have not regarded their relationship with the public as one of trust with respect to the matters under contention.

SCIENCE AND THE ETHICS OF COMMUNICATION

Significantly, discharging responsibilities with respect to Scanlon's principle of manipulation (*M*) and his principle of due care (*D*) requires communication. *M* is a norm of communicative process: do not manipulate by insinuations that lead to false expectations. *D* is a norm of communicative mandate: you must take due care to communicate in circumstances where people might, left to their own devices, form false expectations. Yet while standard approaches to science communication would find *M* to be entirely unexceptional, few would go so far as to mandate *D*.

What and when are scientists obligated to communicate? There are two problems here. One is to understand the method and point of science communication; the second is to identify its ethical dimensions.

Communication and Public Understanding of Science

John Zimon, a physicist and member of the British Royal Society, has written some particularly relevant work on public understanding of science. He tackles why science communications generally go badly in his 1992 article "Not Knowing, Needing to Know and Wanting to Know." Each of his title phrases encapsulates a philosophical approach to communicating with the public. In the deficiency model of science communication, "not knowing," is presumed to be the cardinal fault of the average non-scientist. The scientist knows something the layperson does not. Better help the public overcome this deficiency. Of course, Zimon notes, this proves to be a ridiculous model for it is impossible to know everything, and equally impossible to circumscribe a specific set of facts, theories or methods that characterize the "science" that the public does not know. The rational choice model appears to address the problem raised in *D* because it presumes that people need to know certain key facts that bear on the likelihood of achieving their stated or apparent objectives. The problem here, Zimon notes, is that when we examine the everyday projects of ordinary people, we find that they do not lend themselves to the rational choice model. Put straight out, people do not frame their lives as a series of objectives for which they are seeking the most efficient means (Zimon 1992, pp. 13–17). Even if economists, political scientists or psychologists can *explain* or *predict* human behavior using a rational choice model, people do not represent their own life situations to themselves in such an organized, means-ends fashion. Information that links means to ends in a probabilistic fashion may indeed bear on whether people will achieve their goals, but it will not be taken up unless it is made available in fashion that better accommodates the way that people frame short-term means-ends thinking in terms of roles and narratives (Ludwig 1993). It is therefore not surprising that the rational-choice model should fail miserably as a theory of science communication.

Zimon offers the context model as a more adequate approach. This model starts with the presumption that from the perspective of a layperson, formal scientific knowledge is incoherent in that it is encountered piecemeal and fragmented from the broad theoretical models that frame knowledge claims for experts. Scientific knowledge is inadequate in that, "The use that people make of formal knowledge in any particular situation depends on their needs of the moment and represents only one element in a complex and varied response" (Zimon 1992, p. 18). People do accept this knowledge passively, but gauge its credibility according to factors that are fixed by the situation in which the knowledge is to be applied. The significance of this cannot be underestimated given much current thinking on science communication. Contrary to a model popularized by Paul Gross and Norman Levitt (1994) and applied to the biotechnology controversy by Norman Borlaug (2000, 2001), general attitudes towards scientific expertise are *not* particularly influential in shaping the public's understanding of science (Trachtman and Perrucci 2000). It is the specific context and the specific way that a given person's interests are affected by the information that determines whether people are likely to be skeptical about science communication. Furthermore, though conflicting views among experts may reduce a layperson's tendency to accept scientific knowledge at face value, the inconsistencies disappear as people apply their own values in selectively adopting or rejecting scientific knowledge claims (Zimon 1992, pp. 18–19). The context model demonstrates that those who would initiate communication efforts on behalf of biotechnology must realize at the outset that they cannot control the public's receptivity or interpretation of any given message.

The success or failure of a science communication effort must always be measured with respect to what people wanted to know before the effort was initiated. Unfortunately, the extensive public opinion research on food biotechnology does little to document what people want to know about it. The surveys indicate that people want to know *whether* genetic engineering is being used in the food they eat, though the particular significance that any given individual attaches to this information is unclear. In Susanna Hornig Priest's research on biotechnology members of focus groups given the opportunity to express their reaction to news stories on biotechnology identify an interest in ethical issues, defined in much the way that they are presented in the first nine chapters of this book. However, although focus groups initiate discussion in terms of the ethical significance of social consequences, property rights, and so on, they are not especially interested in extensive clarification of the values dimensions of these issues. (The members of these focus groups, in other words, are not very likely to enjoy reading this book.) Although the discussion must be *initiated* in terms of ethical issues, laypersons quickly become curious about both unwanted and beneficial consequences of biotechnology (Hornig 1993). In short, people want to know the things that scientists can tell them, as opposed to what philosophers can tell them, but they would prefer that scientists have some ability to present their information in an ethics-oriented framework.

It is highly speculative to extend this one study to a generalization about public understanding of or interest in biotechnology, yet interpreting it in light of Zimon's analysis suggests some interesting hypotheses. Since people participating in focus groups are removed from the hurly burly of everyday decision-making, the methodology itself presents an opportunity for less fragmented interest in biotechnology. Their interest, however, is still contextualized by human concerns. It extends both to facts about biotechnology and to facts relevant to specific goals, but only as a result of communication initiated within the framework of ethics and values. At the same time, the desire for fact-based information as a response to ethical issues suggests that it would be inappropriate to have ethicists (or public relations officers) conducting communication efforts. If this analysis is correct (an empirical hypothesis, to be sure) a communications effort conducted in terms of spreading factual information about biotechnology goes nowhere, while a communications effort initiated with a reasonably sophisticated overview of ethical issues spawns curiosity about the facts.

The Ethics of Science Communication

The work of Zimon and Priest helps define the pragmatic considerations that must frame a discussion of communication, but neither of these analysts take up communication about science as an ethical problem. For present purposes we can note three key norms for science communication. First, science communication should be truthful. This almost goes without saying, of course, since moral proscription of prevarication is one of most basic and widespread norms (see Kant 1799). Truth-telling is subtly difficult in science communication, where information must be translated out of technical and into ordinary language. It is easy to unintentionally mislead. Yet the basic moral claim here is straightforward; it is Scalan's *M*, described above. Second, Scanlon's principle of due care (*D*) states that there are situations in which communicators have a positive obligation to provide information. One part of this obligation is also fairly non-controversial once it laid out: scientists have a responsibility to inform the public about objective dangers and risks.

It would, for example, be unconscionable for a scientist who has evidence that a particular product is dangerous to withhold that information, or even to publish it in a forum where it was likely to remain unnoticed by users of the product. This, too, is a difficult norm to operationalize because it requires scientists to make torturous judgments about when it is appropriate to bring a concern into the public realm. Scientists try out a lot of hypotheses in the course of discovery, and the mere fact that some, if confirmed, would point toward a public hazard is insufficient reason to bring speculation forward. Yet the burden of proof for publicizing a hazard is certainly much lower than for accepting the hypothesis. Arguably, the burden gets weaker and weaker in proportion to the seriousness and irreversibility of the hazardous outcomes. Carl Cranor and Kristin Shrader-Frechette have analyzed this problem in terms of Type I and Type II statistical errors, arguing that it is often more important to act on a result that might be true than to avoid accepting a result that might be false (Shrader-Frechette 1991; Cranor 1993). The duty to inform become critical to one of the key events in the controversy over agrifood biotechnology when Arpad Puztai made public allegations about the risks of genetic engineering based on some very preliminary studies of transformed potatoes. This incident took on many of the classic elements of a whistleblowing case: Puztai was disciplined by his employer, who felt his move to publicize results was premature and alarmist, but became a celebrity among opponents of GMO's (see Krebs 2000). Puztai's case illustrates that even if the duty to inform in cases of risk to the public seems ethically non-controversial, determining the exact circumstances in which this duty becomes mandatory may be complex and controversial indeed. For present purposes, however, it is sufficient to note the problem and to point out that the need for striking a moral balance is quite clear, even if knowing how to reach it in practice is not.

While no one disputes the duty to inform the public about risks and hazards, a broader reading of the due care principle (*D*), might entail that the public has a right to know whenever its values are threatened. For example, if genetic engineering of food might offend a person's aesthetic sensibilities or religious values, scientists would have a responsibility to take due care in informing the public of this possibility. If social consequences would negatively affect small farms or rural communities, scientists would have a responsibility to inform not only those who are affected, but also those in the broader public who espouse values of solidarity with rural groups. Clearly there is a possibility of extending *D* beyond all reasonable scope here. Due care does not require informing every person who might possibly be offended by the results or products of research in food biotechnology. What may be more reasonable is to stipulate an auxiliary principle: that science as institution (and scientists as its representatives) has a responsibility to undertake public communication efforts that promote participation as a democratic ideal.

The basic argument for this view of communication has already been sketched in Chapter 8 on the social consequences of agrifood biotechnology. There Langdon Winner's conception of the technological constitution was summarized (Winner 1983) as well as Philip Kitcher's analysis of the relationship between science and democracy (Kitcher 2001). Either provides reasons why individuals and groups might feel that it is important to be involved in the earliest stages of decision making about biotechnology. Communication is fundamental to this problem: involvement implies notification that one's interests will (potentially) be affected, as well as some understanding of scientific and technological possibilities. It is not feasible to make research decisions by ballot, so some form of mediated participation simply *must* suffice to satisfy the ideal of participation. At a minimum, this means that members of the public must have some vehicle for advising the science community of its concerns, and for requesting information and response. Political theorists have long argued that a free press can satisfy this need (see Mill 1859), but the public must also have some assurance that scientists are listening. There is a desperate need for two-way communication, and for some means of assuring parties that their messages are being heard (Hornig 1991).

Describing and speculating on how to discharge this obligation would take the present discussion far afield, but the problem may seem more intractable than it is. It is quite possible to monitor public attitudes and concerns about food biotechnology in the press and through survey research. The results of such monitoring form the basis for many sections in this book. It is also possible to study how scientists, scientific organizations and biotechnology companies engage the media, as well as political institutions, and whether public concerns are reflected or even considered in the various fora that constitute science's internal decision making apparatus. Although the research these questions is limited, the results are not encouraging. Christopher Plein's research concludes that private industry successfully manipulated US political fora in which biotechnology would be debated in a way that placed public concerns in opposition to job creation and economic growth (Plein 1991). Susanna Hornig Priest's work shows that industry also shapes US newspaper coverage of biotechnology (though not always in the manner that they might intend) (Priest and Talbot 1994; Priest 2001). Brigitta Forsman and Stellan Welin describe how scientists and industry closed off public participation in a national ethics commission on biotechnology in Sweden (Forsman and Welin 1995). Ad van Dommelen documents how public and private sector scientists worked to restrict public participation in a participatory risk assessment in Germany (van Dommelen 1995). Angela Griffiths has shown that Canadian biotechnology researchers failed to even consider how a series of government directives (issued with broad political support) to emphasize sustainable agriculture might be incorporated into their research planning (Griffiths 1996). On the other side are precious few success stories. It would appear that the NABC's conferences have had some modest impact on biotechnology planning in the United States, for example, and when scientists turn out for the meeting, it is at least evidence that they are listening. But attendance is declining. The 1996 meeting attracted less than a hundred participants, despite being held in the most populous region of the United States. Attendance rose when European reactions to biotechnology hit the headlines, but waned again when the controversy subsided. By 2006, attendance was again less than a hundred. It is difficult to avoid the conclusion that scientists' willingness to listen to public concerns is proportional to the anger and threatening tone in which those concerns are expressed.

THE PROBLEM OF RISK

Risk issues present both a special case for the ethics of science communication, and they are particularly crucial to any discussion of food biotechnology. There is a pattern of give and take in risk debates that is widespread across policy issues for which scientific evidence is expected to be decisive. The first element of the pattern is criticism of the data, conclusions, or methods that have been used in assembling the scientific evidence. Criticism of this sort is part and parcel of science itself. The second element is an inference to the effect that uncertainty in data, conclusions or methods entails risk to members of the public. This inference is not characteristic of scientific reasoning; scientific risk assessment does not conclude that an activity is dangerous simply because it is uncertain. This divergence between scientific and "ordinary" rationality is, perhaps, the first wedge between science and the public when risk issues are debated. The final element is an attack upon the motives or values of scientists themselves, who are portrayed as trying to conceal risks and uncertainties from public view (Thompson 1986). The upshot is a political environment in which scientists are alienated from those who profess to speak for the public, and from their perspective, justifiably so. In order to see why this circumstance arises it is necessary to revisit the distinction between expected-value approaches to risk and those that stress consent.

Understanding Risk: A Reprise

As argued in Chapter 4, scientific research techniques are well suited to the measurement of certain key relationships between exposure to a given substance and the subsequent occurrence of harm. These relationships are important in food safety because high correlations between exposure and harm give cause for concern about the human health effects of exposure to the substance. Though important, the measurable relationships between exposure and harm create a misleading communications context when they are taken to *define* risk to the exclusion of qualitative characteristics. One has long heard the opinion that scientists study the *reality* of risk (Starr et al. 1976; Ruckleshaus 1983), or that people who are concerned with other factors that are relevant to risk are dealing with mere *perception*; while only the scientists deal with reality (Cook et al. 2004). This view of risk is logically and epistemologically insupportable (Thompson 1990), but what is important here is that it uses the language of perception and reality—ostensibly an objective, science-based distinction—to conceal a ethical value judgment. That is, the measurable correlations between exposure and harm are deemed *real* (which is to say, *important*), while other elements that may really be very important indeed for assigning responsibility or determining whether a person or organization should be trusted are consigned to "perception". Risk and reality are both politically potent notions. The judgment to emphasize measurable relationships is often justified; presuming that these relationships model the reality of risk is not.

How can the ethics of risk be untangled? How can one determine when it is appropriate to interpret risk as the probability that hazards will materialize, and when it is appropriate to have a broader and more flexible way of understanding risk? A close examination of the way that the word "risk" gets used by ordinary people in ordinary conversational contexts can provide a great deal of insight into these questions. "Risk" is a common English word. It cannot be appropriated as a technical term without inviting miscommunication. Careful listening to the way that the word "risk" functions in ordinary speech reveals a varied pattern of use. It is particularly important to notice that the word "risk" is both a verb and a noun, and that there are adverbial and adjectival forms of the root, as well. In contrast, the standard scientific definition, which holds that risk is defined as a function of exposure and hazard, readily converts into an ordinary language expression stating the chance or probability that a given hazard will occur. Thus, "the risk of agrifood biotechnology" gets treated as being equivalent to "the probability that hazards will occur, given agrifood biotechnology." Notice that while "the probability that hazards will occur" can easily be understood as indicating a certain state of affairs (e.g. it functions readily as a noun), it is not at all obvious how one would convert this noun-phrase into a verb, an adjective or an adverb. This means that word "risk" and its related grammatical forms are capable of conveying much more information in ordinary language (at the cost of being ambiguous) than the standard scientific definition of risk.

As a verb, to risk is to do something, to take action. Risks do not just happen; they are always undertaken or done by someone (or by something capable of taking action). This reflects a deep and philosophically important feature of ordinary language. Verbs such as "happen" "cause" or "occur" can appear in grammatically correct sentences in which the subject of the sentence is an ordinary thing, a natural phenomenon, and not an agent capable of acting intentionally. Earthquakes happen. Tsunamis occur with a measurable frequency. Volcanic eruptions can cause damage. But note well that when one puts the word "risk" in the verb spot, one generates nonsense: Earthquakes risk. Tsunamis risk with a measurable frequency. Volcanic eruptions can risk damage. These phrases sound odd to the ear precisely because the verb "risk" cannot appear in a grammatically correct sentence unless the subject of that sentence is an agent, a being that we understand as capable of intentional action. So a person can risk, and an organization can risk. An animal might be able to risk, because we do speak of animals as agents capable of intentional action. But a tulip does not risk being eaten by squirrels, nor does an earthquake risk the damage it might cause.

These grammatical points are subtle. Earthquakes pose risk, to be sure, but the insertion of the verb "pose" shifts the context so that we are now using the word risk as a noun and as a noun, it can and does frequently indicate a possible state of affairs. This suggests that there are at least two broadly distinguishable ways in which the word "risk" functions in ordinary language. One usage maps fairly closely with the standard scientific definitions. It is the *event-predicting* or "state of affairs" naming sense of risk. The other sense is reflected when the word is used as a verb. Here, risks are acts undertaken by agents capable of acting intentionally. This is the *act-classifying* sense of risk, for the point of saying that someone or some group "risked something" is to pick out that action and notice something special or distinctive about it.

I do not mean to suggest that these two senses of "risk" are always easy to distinguish. When people run risks they could not have taken consciously, the tendency is also to shift the word "risk" to its nominative form. So it is meaningful to say, "Jim risked his life by driving drunk." Here, the suggestion is that Jim's driving drunk was an intentional act, and also an act that is especially remarkable. But it would be odd to say "Jim risked his life by eating peas," or "The Romans risked their lives by using lead pipes," even though eating peas and using lead pipes are both intentional acts. In the case of Jim and his peas, the oddness is felt in that one waits for the other shoe to drop: "And *why* was eating peas so dangerous for Jim?" Would it relieve the tension if someone replied with the refrain we often hear from scientific risk assessors, "Well you know, there is no zero risk"? (Answer: It certainly would not.) To say something like "Jim risked his life by eating peas," is to imply something about Jim, peas or the context at hand that makes this particular case unlike the others where there is really nothing exceptional or worth noting about someone's eating peas.

As for the Romans, it would not be odd to say that the use of lead plumbing created a risk to their health, because we know what the Romans could not have known, that is that the chance of lead poisoning creates hazards to health. And unlike the above attempts to form risk-sentences with subjects like "earthquake" or "volcanic eruption" there is nothing grammatically incorrect in saying that that people risk things without knowing it: "She risked her life unknowingly by smoking cigarettes." So although this act-classifying sense of risk does not always imply that a person has knowingly chosen to risk, it does imply that the act in question is an intentional one. We would not, for example, describe an epileptic seizure as "risking one's life," despite the clear indication that there is a significant probability of harm associated with seizures. The reason is that enduring a seizure is not an intentional act. The grammar of risk allows "Why do you risk your life by having a cigarette?" but not "Why do you risk your life by having a seizure?"

It is clear that the word "risk" is also used in ordinary language to describe a trait of future events, namely, that if they occurred they might be harmful. We can and do talk about the risk of an earthquake, a tsunami or a volcanic eruption. If the word risk is used to describe this trait of events, or if it is used to refer to events having this trait to a strong degree, different event-predicting grammatical rules come into play. Since situations such as enduring a seizure are significantly correlated with some probability of harm, they clearly do count as forms of risk in this event-predicting sense. Indeed, there appear to be no situations that do not involve some degree of risk, at least when it is the event-predicting sense of risk that we have in mind, and when the conversational context is clearly in the event-predicting mode "There is no zero risk" is not at all an odd thing to say. Ironically, when grammatical rules for act-classifying are applied, an epileptic seizure is not a risk, but when rules for event-predicting are applied, it is. The philosophical grammar that distinguishes these two senses of risk is admittedly obscure (Thompson 1987). An epileptic seizure is a risk *to* one's life, but to have a seizure is not to risk one's life. Simply inverting the word order entails the semantic change. The differences between act-classifying and event-predicting uses of risk are not sharp enough to warrant the claim that there are two, fully distinct meanings. Nevertheless, the different uses of the word "risk" suggest opportunities for technical or formal specifications of the term risk that stress event-predicting grammar to the exclusion of act-classifying grammar (or vice versa).

The *expected value* analysis of risk, discussed in Chapter 4, trades heavily on the event-predicting grammar typical of ordinary use. Although there are many ways to specify risk quantitatively, those that follow the expected value approach define risk (R) as a function of the probability and value (utility) of future events (Friedman and Savage 1948). Expected values are themselves computed as a function of value or utility associated with the event $U(e)$, and the probability of the event's occurrence $P(e)$. There are several ways of representing risk as an expected value. One simple and intuitive function is

$$R = P(e)\ X\ U(e) \text{ for all } U(e) < 0$$

This concept of risk can be linked to decision-making through the expected utility theory of choice. Although there are several decision rules that can be applied to convert expected utility calculations into action (Rescher 1983), the simplest one assumes that the objective of decision-making is to select the option with optimal expected utility. The option with the highest net expected utility, once costs and benefits are weighed, is the one that should be chosen. To the extent that scientists adopt the expected-value approach to understanding risk issues, they refer exclusively to the event-predicting grammar of risk, and they reduce the broad and flexible grammar of risk to a set of quantitative relationships fixed by probability and value of harm.

The expected value analysis of risk places a great deal of emphasis upon quantifiable probabilities, plus it is easily linked to a theory of choice. These two factors make it very attractive as a conceptual approach for science-based public policy (Kneese et al. 1983; Freeman and Portney 1989). The expected value analysis of risk also provides a rigorous and sophisticated development of the event-predicting applications of risk that we note in ordinary language. The rigor in the expected value analysis, however, is achieved at the expense of act-classifying shades of meaning that can be detected in the ordinary concept of risk. Correlations between exposure and harm are extremely important in setting policy for food safety and quality, but they do not exhaust the ethically significant aspects of risk policy. Three examples follow.

Human Action, Risk, and Responsibility

As noted above, the expected value analysis of risk applies equally well to intentional actions and natural events. One can quantify the fatality risk of driving drunk, of undergoing a seizure, or of being caught in an earthquake. Simple comparison of the expected values makes these events appear morally commensurate, but they are not. We hold people responsible for their action when they drive drunk, but we do not hold people responsible for the consequences of enduring a seizure or an earthquake. The expected value analysis of risk provides no clue as to whether an agent would be held responsible for their actions, or correlatively, as to whether it would be responsible to act in a prescribed way. This underappreciated feature in the grammar of risk creates an opportunity for misleading communications, as well as for some morally troubling situations described below. Specifically, to write or speak *as if* the risk of a seizure or an earthquake is indeed commensurate with the risk of drunk driving allows the audience to hear a message stating a broad moral equivalence, as if these activities should be ethically evaluated in similar terms. This becomes relevant to agrifood biotechnology when a science communicator places risks from genetic transformation into a comparison with risks that are, like earthquakes and seizures, associated with natural hazards. An example would be food safety risks associated with microbial contamination.

To see this point, it is critical to understand how the act-classifying and event-predicting meanings of risk perform two distinguishable (but also overlapping) communicative functions. We do not classify the seizure or the earthquake as acts, but drunk driving is an act. The act classifying rules of grammar for risk are part of taxonomy for sorting actions into different kinds. Some actions are considered risks; others are not. Articulating the criteria for sorting would be a large philosophical and linguistic project in itself, but the examples given above seem to involve paradigm cases or ideal type classifications, so that judgments as to whether an act is a risk can be drawn by analogy. In our society, driving while drunk is a paradigmatic case of risk; driving while sober is not. It also seems that traditional familiarity with the act in question is a criterion. Using the new fangled convection oven is a risk; boiling peas on the stove is not. Any number of communicative functions may be fulfilled by this distinction, but one in particular is critical for ethics: calling an action a risk is one way of noting that a person will be held responsible for the consequences. Secondarily, it is a way of urging caution, rather than a claim that significant probabilities of harm exist or have been measured.

An idealized depiction of traditional tort law provides the clearest account of how classifying actions under the category of risk plays a role in making decisions and in assessing responsibility. Innovations in the case law of torts during the past two decades have introduced the expected value analysis into liability decisions (Schroeder 1986), so the following portrayal of torts should not be taken as a description of recent practice. Traditional torts are based on common law. The purpose is to assess whether the defendant wrongfully harmed the claimant bringing suit, and whether the defendant should be required to pay damages. The claimant may meet this burden of proof by showing first that the actions of the accused were risks, then that they actually resulted in harm to the claimant. This two stage burden of proof is critical to understanding the ethics of risk as they relate to culturally determined categories of action. Simple demonstration of harm is not enough to warrant damage in traditional torts, for the defendant's act is judged to be a risk only when it is something that a reasonable person would not do. If a reasonable person would have regarded the act as unexceptional and proper, the claimant cannot meet the initial burden of proof. The principle implies a general recognition that harm can occur as a result of happenstance, freak events or so-called acts of God, even when the actions of a defendant are completely ordinary acts of the sort that reasonable people perform everyday.

None of this is implies that this idealized picture of tort law should serve as model for legal regulation of risks from agrifood biotechnology. The point here is to describe an ethics of risk that (a) differs from the expected value model; and (b) draws upon the act-classifying sense of the word "risk." Tort decisions involve compensation for damages, but only when the person whose actions cause damage has acted in an unreasonable way. My argument here is that this picture of the reasonable person embodies an implicit division of human activity into at least two categories, one being normal, ordinary activities that do not impose extra burdens for deliberative evaluation or due care, and a second category of actions that do impose these burdens. There is, possibly, a third category of actions that are so clearly seen to be beyond the pale of reason as to be called "reckless." I am suggesting that the grammar of risk maps on to these rough categories in the following way: to describe an action as "risk" is to state that it is in the second or third category, which is to say that the action becomes a candidate for further judgments about moral responsibility for harm. Even when the person who is harmed meets the dual burden of proof (a risky act *and* an occurrence of harm), the defendant has an opportunity to demonstrate exculpatory factors, and the list of potential exculpatory factors is extensive. They include, for example, whether the defendant acted knowingly and whether the claimant had complicity in undertaking the risky course of action. So to say that an act is "risky" in this sense is not to *complete* an assessment of moral responsibility for harm, but a key point to note is that many unexceptional activities are not even candidates for ascriptions of responsibility for harm. They are not (in this sense) risks.

The key concept in proving both the initial claim of risk and in providing excuses is that of the reasonable person. In the traditional process of establishing responsibility, there is a large class of actions that are not risks, simply because they are so broadly accepted, even though there are measurable (and perhaps even relatively high) numerical probabilities that they might result in harm. As is generally the practice in common law and ordinary moral judgment, criteria for deciding what a risk is and what is not are established by drawing analogies to precedents. In the law, these criteria are set forth in judicial opinions and become more deeply embedded into law the longer they endure, and the more broadly they are applied (see Thomson 1986 for a general discussion of risk in tort law; see Schroeder 1986 for a discussion of how tort law has changed in response to expected value approaches to risk). Laws regulating agrifood biotechnology are statutory and administrative, so the traditional practice of torts may be a poor model for reflecting the kinds of regulatory decisions have been (or need to be) made with respect to risks. The point is not to advocate reliance upon traditional case law, but to show how this idealization of torts draws upon the act classifying grammar of risk in making a determination of responsibility.

From an ethical perspective, there are many reasons to stress the act-classifying sense of risk. First, it links harm (or the possibility of harm) with actions for which persons could be held legally or morally responsible, and it does so in a way that conforms broadly to culturally based understandings of rights, duties and human virtue. The expected value analysis, by contrast, stresses the sense in which every instance of harm falls into statistical patterns. One gains some management capacity by emphasizing expected value, but one impoverishes the conception of personal or group responsibility for risk at the same time. Second, since individual persons or corporate groups clearly are not responsible for the statistical pattern, the expected-value approach can make it seem as if they should not be held responsible for the harm that does materialize as a result of their actions. Statistical patterns are revealed by analyzing data that collates classes of events, including behavior by individuals and groups. To the extent that the probability of an event is associated with these statistics, it can be seen as dissociated from any single act. Indeed strict logic would see the inference from data about a population or class of behaviors to a statement concerning the risk of a single action as a division fallacy. The most plausible normative view is that risks *should be* managed at the level of statistical populations through mechanisms such as insurance or regulation. The notion of responsibility is lost altogether.

Third, the act-classifying sense of risk actually functions as one of the cognitive filters discussed in Chapters 1 and 2. There it was shown that it is not really feasible to think that every application of technology (much less every possible decision that people might make) could be evaluated on a case-by-case basis. Instead we rely on habits or “filters” to identify *when we should* actually try to consider costs and benefits in a conscious, deliberative fashion. The unexceptional actions that are classified as "not risky" are not subjected to this kind of evaluation, while those in the second group, those classified as "risky" are. It is possible that an expected-value or risk-benefit type of evaluation will lead to the judgment that the risk in question is well worth taking, but the point here is that the act-classifying standards implicit in our common-sense background beliefs perform as filters, identifying which actions *need* to be subjected to the kind of consequence-predicting evaluation characteristic of scientific risk assessment. Without filters of some kind, the whole exercise of comparing the expected-value of consequences devolves into incoherence: it is simply impossible to evaluate every possible course of action in a conscious and deliberative way.

Other reasons to emphasize the act-classifying sense of risk, and other ways to connect this way of thinking about risk with cognitive filters that organize our allocation of deliberative resources are discussed in the succeeding sections of this chapter. For now, a fourth and final reason can be noted: scientists who talk of risk from biotechnology *only* in terms of hazard and exposure deny the public an obvious opportunity to raise questions of agency and responsibility. This is an unfortunate way to shape the message from the standpoint of an ethics of communication. Not only does it introduce opportunities for misunderstanding (discussed below), but it frustrates communication on the issue that may well be of paramount importance to a layperson: Who is responsible? Whom must I trust?

Equivocation Problems and False Authority

Equivocation upon distinct meanings of the same term is one of the most egregious and indisputably fallacious forms of logical error. Although equivocation fallacies are conspicuous when exposed, they are often far from obvious to the people who commit them. Equivocation has ethical implications when it is the source of error in judgment, or in communication. Equivocation can also play a role in the creation of false authority. When a judgment or standard justifiable on one interpretation of the term is imposed upon a situation in which the alternative interpretation would be more appropriate this may simply be a mistake in judgment. But when a body of knowledge appropriate to one way of interpreting the term begins to be systematically applied to situations where the alternative interpretation is more appropriate, the nature of the ethical problem takes on a political dimension. Those who possess and promote this (inappropriate) body of knowledge become viewed as having authoritative expertise. In fact, their expertise may be much more limited than they (or anyone else) seem to think. More serious ethical issues arise when equivocation is used as a deliberate vehicle of deception.

The equivocation of interest here occurs when an act-classifying use of the word "risk" would be the most appropriate way to approach a decision or a communication effort, but the event-predicting sense is substituted in its place. I believe (though this is not the place to argue) that many well-documented anomalies in the literature of risk-studies can be traced to exactly this kind of equivocation. For example, researchers have been documenting a divergence between expert and lay attitudes toward risk for many years. Paul Slovic, one of the leading figures in this work on risk, summarized much of this work in a recent article entitled “Trust, Emotion, Sex, Politics, and Science.” His title reflects his conclusion that certain socially relevant variables (such as gender) are strongly related to the divergence between expert and non-expert attitudes toward risk, but also that other patterns of divergence cannot be so readily explained (Slovic 1999). My hypothesis is that the difference between the cognitive-filtering of act-classification and the outcome-optimization of event-predicting accounts for a significant part of the divergence that Slovic and his colleagues have observed in three decades of empirical research on attitudes to risk. My hypothesis is that the experts and lay respondents are not actually talking about the same thing. Furthermore, while the experts may be more correct than the lay public when it comes to well-specified and highly contextualized decisions (such as: should we regulate international trade in beef in order to control the movement of pathogens?), people in the lay public are more rational than the experts in the global sense. They are working from a background set of cognitive filters that would have to be in effect in order for the means-end optimization of the expected-value framework to have any intellectual coherence at all.

In the present context, further digression into the broader literature of risk studies would only move the argument even further from the ethics of agrifood biotechnology. Although simple errors of judgment and intentional deceptions occur in the discussion of agrifood biotechnology, false authority may be the most important ethical issue associated with equivocation on the act-classifying and the event-predicting meanings of risk as the word is used in discussing food safety and environmental impact. Most people apply the concept of risk in ordinary decision making without being fully aware of the semantic content or logical structure of either act-classifying or event describing usage. The context of speech is usually sufficient to specify the meaning intended in any given speaker’s utterance. The problem of false authority arises in connection with agrifood biotechnology when the expected value analysis of risk is applied in such a way as to make otherwise reasonable judgments appear illogical, uninformed, and even irrational.

One instance of the false authority fallacy occurs when actions for which individual or corporate agents can be held responsible are compared to natural events in order to derive standards for acceptable risk (c. Starr 1969). Many naturally occurring substances are estimated to possess greater carcinogenicity than heavily banned additives and heavily regulated chemical residues (Ames 1983), and we can expect a similar circumstance to be true for products of biotechnology. What should we make of this fact? The expected value analysis of risk can be interpreted to imply that there are certain trade-offs between risk and benefit that are acceptable, without regard to the origin of the risks. The preceding discussion of responsibility shows that origins are sometimes important. Although it is clear that the dangers of natural carcinogens have been tolerated or endured by human populations, the expected value analysis of risk begs the question of why we should tolerate or endure similar levels of expected harm from human action (Thompson 1987).

When responsibility is important, the permissibility of risk is determined by comparing the act to the standard range of things that human beings do, by considering the importance of the ends in view, and by examining the alternative ways of achieving those ends. In this context, the judgment that a risk is acceptable implies that there are overriding moral or prudential reasons for acting in an exceptional manner. Acceptability, in other words, implies an intentional attitude toward the act, not mere tolerance for passively enduring a state of affairs. There is a genuine philosophical issue here. It may indeed be a foolish waste of public resources to ensure against harms that are already far less likely to occur than harmful natural events. The important philosophical issue is not illuminated, however, when the expected value analysis is falsely applied to cases where human agency and responsibility for risk are clearly important.

The problem of false authority relates to the role of science in the public's ability to participate in democratic decision-making. There are always good scientific reasons for adopting the expected value analysis of risk, and there are sometimes good ethical reasons, too. When the expected value analysis comes to exclude the multiple shades of meaning that are associated with risk in common speech, however, some of the most natural ways of raising serious issues about responsibility for action appear absurd. People who are applying the grammar of risk in very standard and traditional ways are made to appear as if they are making logically insupportable statements, and the ethical issues that would be raised by these standard and traditional ways of talking about risk are made to seem chimerical and irrational. The danger is that the appearance of irrationality will be dealt with by handing policy over to experts; only in this case, the criterion for being an expert lies primarily in possessing an impoverished understanding of risk.

Moral Reductionism and Political Exclusion

Those scientists who do take the concerns discussed in this book seriously tend to understand them as separate issues, just as they have been presented here. They tend to think, for example, that it is possible to resolve concerns about food safety or environment without simultaneously doing anything about social consequences. To a large extent, these are seen as risk issues, with the risk understood as a function of hazard and exposure and risks in each category being determined by distinct causal mechanisms. With respect to food safety, the mechanisms are biochemical. With respect to environment, the mechanisms are ecological. The mechanisms for social consequences are economic or sociological, with relatively little biological base. Each of these mechanisms is triggered by functional characteristics of the plant or animal product, rather than by genes, hence none of these risks are unique or different in kind when products of biotechnology are compared to products of ordinary plant or animal breeding. What is more, following the analysis of the first nine chapters, each of these mechanisms is associated with a different set of ethical questions and a different kind of moral significance. For food safety it is the ethically unproblematic human health. For animals we are involved in a philosophically tricky extension of moral consideration to non-human species, but this is quite distinct from the moral evaluation of environmental impact. When we get to social consequences, we are back in the realm of traditional (but contentious) political theory. As these areas are distinct in terms of physical or social mechanisms, they are distinct in terms of the ethical values that make the unwanted consequences morally significant. For convenience, let us call this a *purifying* view of risk: muddled mechanisms are sorted out, and the appropriate moral concepts are matched to each.

The public, however, may not even make a distinction between individual scientists, scientific research, scientific theory and the specific products of biotechnology. Just as they may have elements of act-classification (reflecting uncertainty, intentionality or consent) in mind when they use the word "risk," members of the public may have amalgam of scientists, universities, theories, products and corporations in mind when they use the word "biotechnology." As such, it is not surprising that members of the public do not tend to see the risks of biotechnology in as ordered and distinct a fashion as scientists do. In fact, non-scientists tend to skip from concerns about food safety to environment to animals to property rights to social consequences as if they saw these risks in rather the same terms. Public speech on risks of biotechnology does support the idea that risks are brought about by different mechanisms with independent probabilities. Rather than seeing products of biotechnology as entailing a series of distinct and potentially manageable risks, they just see risk, not broken down into scientifically supportable mechanisms. Similarly, they may not recognize the tidy philosophical distinctions that have been used to separate questions of animal welfare from questions of solidarity with small farms. Because the propensity is run together what the purificationists want to keep apart, let us call this view a *hybridization of risk.*

Yet hybridizers do integrate all these various dimensions of risk in a rational fashion. Biotechnology is seen as risky in much the same way that renting a home or buying an appliance is risky. The landlord/salesman may charge you too much, or may have another way to cheat you with some hidden information. The home or appliance may break, and it may even cause injury. What's more, your spouse or family may not like it, and you may not be able to get your money back. All these dimensions go together in the risk of renting a home or buying an appliance, and they all attach to the person of the landlord or salesman. When you buy a house, risks that derive from structural features of the building become rolled together with risks that derive form the nature of the transaction. They often register in one's mind in terms of whether one's counterpart in the transaction can be trusted. In a similar manner, all the risks of biotechnology go together in the public mind, and they all attach to the person of the scientist. If the scientist behaves in a manner that lends credibility to any of these threats, biotechnology will come to be seen as extremely risky indeed. This, too, is a reasonable and time-honored way to manage the risks that might be created through one's dealings with others (Thompson 1997b).

A scientist (especially one who takes Zimon's "not knowing" approach to communication) is constantly trying to divert the public's attention away from personalities and toward the facts, to the mechanisms that actually create risk. The public, meanwhile, is intently focused on the behavior of the scientist, looking for evidence that these are people who can be trusted. Tragically, the attempt to divert attention away from personalities to facts is seen in this context as untrustworthy behavior, as an attempt to dodge responsibility. Speaking for consumers, activist Ken Taylor said as much in a 1991 address to the National Agricultural Biotechnology Council (Taylor 1991). British survey research on public attitudes toward biotechnology provides empirical support for this generalization (Sparks et al. 1994, p. 20). It is ironic that one of scientists' most deeply held values, the respect for facts, should be a key source of distrust.

There is, however, a deeper ethical problem here that relates to public participation in decision making. Thus far, purification and hybridization have been presented as alternative approaches to risk. It must be admitted that the argument from hybridization may not seem particularly compelling to someone trained in the sciences or philosophy. However, to arbitrate the contest between purification and hybridization in light of scientific or logical rigor is to misunderstand the burden of proof that hybridization demands. Ethical problems in food biotechnology are ethical precisely because someone might be responsible for *doing* something about them, and because that responsibility might entail social, institutional or governmental enforcement. Reasonable people can reach the conclusions of the hybrid interpretation without violating any canons of common sense. If we assume (as I do) that reasonable people should not be arbitrarily excluded from debate over policy and enforcement, then adherence to moral purification cannot be arbitrarily chosen as the standard for participation in debate. As such it is incumbent on those who would reject the hybrid view to justify the use of purification as an exclusionary tactic in governance and public policy, or failing such justification to ameliorate exclusionary applications of power with more inclusive political procedures. Put another way, those who choose the hybrid interpretation will be excluded from the seminars and lectures of scientists and philosophers. When they find themselves excluded from political or economic power the situation not only becomes more serious, but the fact of exclusion reinforces and validates the inferences that gave rise to the hybrid interpretation in the first place.

It is now important to understand the system of purification in both narrow and broad terms. Narrowly, it is a set of ethical concepts that allow us to partition the complex welter of inchoate ethical concerns into logically distinct categories. Purification also reflects a broader set of intellectual categories that serve as principles for organizing knowledge into disciplines, departments and areas of concentration and for organizing at least some governmental authorities into agencies, administrations, services, and offices. Environmental impact is studied by environmental scientists and regulated by environmental agencies. Animal welfare is studied by physiologists and ethologists and is regulated (if at all) by institutional care committees. Toxicology and pharmacology are the scientific provenance of food safety. US agencies such as the Food and Drug Administration (FDA) and Food Safety Inspection Service (FSIS) have analogues in most nations. Social consequences are studied by economists and sociologists and ethics is part of philosophy, but government does not regulate in these areas. Most industrialized countries afford a role in government to each of the categories. This role bestows political authority on the purified ethical analysis of animal biotechnology. What is more, funding for research and policy action also follows the bureaucratic organizational lines that conform to a purified view of risks. The hybrid interpretation is excluded, and it is important to see how.

Ethical criteria effect policy change only when policy makers can apply them in enforcing the law. As Rollin notes, religious believers may feel a moral obligation to practice rituals central to their faith, but the use of political authority to enforce such practices is now rare. As a practical matter political authority is mustered by convincing individuals in positions of power, be they monarchs, legislators, judges or bureaucrats, that the mandate under which they wield their power justifies or perhaps requires action. Only absolute monarchs, however, are defined as having unlimited mandates. The more usual case is represented by the Food and Drug Administration of the US Government, which has a clear mandate to enforce criteria that relate to human health, but no authority at all to even consider social consequences. This means that issues relating to human health count both ethically and legally, while issues relating to social consequences are not subjected to a legally binding test. Under the United States Constitution and the current Federal Code, authority to deal with social consequences reverts to the United States Congress, an institution unlikely to act on this issue in the foreseeable future due to practical limitations. However, the simultaneous inclusion of food safety and exclusion of religion and social consequence from public policy in the US gives legal force to purification, and deprives the alternative worldview of symmetrical legal standing. To summarize: FDA will regulate based on a pure, probabilistically based interpretation of safety. An understanding of safety in which social consequences have a bearing on one's feeling of well-being, for example, will be ruled out without being taken seriously. Those who advocate such a view have no standing, and are, as a matter of fact, likely targets of ridicule.

The system of purification is invested with political authority and power. At the same time, the system of purification reflects, to a large degree, the set of categories that define divisions of knowledge within academic and scientific research institutions. Each category of consequence, human, animal, ecosystem and social, would be the object of study by separate departments, disciplines or sub-disciplines. These departments are routinely (though far from universally) seen to be operating in logically distinct spheres. There is thus a double institutionalization of the system of categories produced by purification, first in government and second in the academic departments of the sciences, including the social sciences and to some extent the humanities. The significance of this double set of social institutions is subtle and complex. On the one hand, it may be interpreted as validation of the order produced by the purification itself, suggesting that similar patterns of purification have been replicated and reproduced in a variety of otherwise independent contexts. On the other hand, it may be that government and science have co-evolved so as to produce mutually consistent organizational divisions for addressing complex issues. The social histories implied by each of these two alternatives raise large and deep philosophical issues that must be set aside here, but so long as the second alternative is plausible, the anxiety that arises from seeing purification as a form of power seeking is not only warranted, but increased.

Seen from one vantage point, the system of purification establishes a leviathan of science and government. The basic assumptions that partition knowledge also partition government power. Those who do not share the basic assumptions or who rely on ordinary language rather than technical definitions of concepts are outsiders. Their arguments have no standing and cannot be converted into policy by the agencies that have been established with limited mandates. Scientists and scientific organizations, in the meantime, have been placed at the center of the leviathan. They control the definitions that are used to translate regulatory mandates into operational terms. They do the research that will form the empirical basis for policy decisions. It is unfair to suggest (as critics have) that scientists have an interest in manipulating the results of that research, for the long term viability of the leviathan depends upon objective research procedures. It is entirely fair, however, to say that scientists have an interest in maintaining the structure of the leviathan, for it assures their status and the continuing demand for their services. Both government and private industry need scientific institutions to perform the dual function of defining criteria and evaluating specific products or technologies, and this need establishes a market for science, both in the form of jobs and research funds. This means, however, that scientists have an interest in preserving the system of purification. Those who would propose alternative interpretations are, thus, enemies of science, not in any elevated philosophical sense, but in having adopted basic assumptions that fail to support the system of purification that links science, government and private industry in a mutually supportive network.

It is important to not to overstate the case here. An individual scientist's or lab's interests may, of course, diverge from those of the leviathan. There have been many individual scientists who have found reasons to criticize prevailing attitudes on agrifood biotechnology, for example, though virtually all of them have done so within the rigid risk categories of the purification point of view. The political winds that influence policy at the highest levels of government may also diverge from those of mainstream science. The case of climate change science is a case in point: US policy on the George W. Bush administration has never embraced the consensus view on climate change. Nevertheless, the convergence of epistemic style—a commitment to the even-predicting way of understanding risk, on the one hand, and the purificationist's tendency to see exposure mechanisms in chemistry, ecology and society creating wholly discrete categories of hazard—and the administrative approach to regulation creates a powerful, one can even say insurmountable, obstacle to those who cannot or will not express their concerns and arguments in the prevailing rhetorical form.

SCIENCE, TRUST AND DEMOCRACY

The argument can be summarized succinctly. Although public opposition to agrifood biotechnology should not be understood as a simple phenomenon with a single cause, trust in science, in regulatory agencies, in industry and in the institutions that link these three actors together would have mitigated many of the most egregious problems. Trust, however, depends upon effective communication, and the work of John Ziman and Susanna Hornig Priest was put forward as a model for what effective communication would involve. Some of the key stumbling blocks to effective communication occur in connection to the way that risk has been conceptualized by the technical and regulatory community. A better conceptualization would lead them to see their ethical responsibilities to interact with and listen to the broader public somewhat differently than they currently do. Most of the detailed analysis in this chapter has been focused on the epistemology of risk, meaning both the way that claims about risk function to organize human knowledge and to inform human action. My conclusion is that attending to these functions more closely would alleviate many of the social and intellectual tensions that have created controversy over agrifood biotechnology. Furthermore, I claim that science as an institution (though not necessarily every individual scientist) has an ethical responsibility to develop a better conceptualization of risk and to engage the broader public in conversation and deliberation on the types of science that they undertake.

To the extent that democracy is understood as a form of government distinctive for its receptivity to participation and resting upon consent of the governed, the events that turn ordinary people into enemies of science can be seen to compromise government, rather than science. This observation does not imply that the floodgates should be opened to any ordinary person's assessment of risk and safety. It is clear that government food safety agencies and other regulators of biotechnology have applied highly defensible standards in appealing to science as they have. Nevertheless, their appeal to science has changed not only science, but government, and the full implications of that change have yet to be recognized.

Many scholars of science and society who are struggling to make sense of this transition, often in a partial and confused way (and I do not exclude myself from this judgment). Bruno Latour has developed an approach that emphasizes how actors (including not just individual scientists and organizations, but also their tools and objects of study) are bound in networks that cut across the divisions of society (government, private sector, universities) and even across the way that we divide nature and society. (Latour 1986) His work provides one way to examine how science might be implicated in exclusive processes by using it to analyze who is in a network, and how epistemological arguments are used to define and defend network boundaries.

Ulrich Beck's work on risk is also a celebrated entry in the field. *Risk Society* attempts a wholesale revision of social theory in which risk relations replace class relations as the fundamental structuring concept. Rather than seeing an orderly class hierarchy as the structure of social relations, Beck sketches a disorderly and cross-cutting set of relationships based on who is vulnerable to who, in what respects, and with what resources for reversing, revising or refocusing the risk relationship. Beck sees the rise of risk society as in part the result of scientific skepticism and rules of evidence into ordinary life. Everything *is* seen in indeterminate terms, and nothing is ever fixed or proven once and for all. Ironically, this new public skepticism that arises out of science is then turned back on science, resulting in a broad scale questioning of scientific authority and intent (Beck 1992).

Academic philosophers have come rather late to this debate. Two efforts published after the first edition of *Food Biotechnology in Ethical Perspective* represent important philosophical attempts to articulate theories of science and democracy. One is Andrew Feenberg's *Questioning Technology*, a book written in some respects as a successor to works by critical theorists (such as Herbert Marcuse, Theodor Adorno and Max Horkheimer) published in English during the 1960s and 1970s. These German philosophers had updated Marxist views on technology (discussed in Chapter 8) by arguing that analytic philosophies of science had been built on positivist assumptions intrinsically linked to the values of capitalism and exploitation of nature. Feenberg rejects the idea that such problems can be fixed by better philosophy of science, but continues the critical theorists critique by arguing that key value judgments are implicit within the way that technological systems are implemented in society. To the extent that these values reflect the interests of powerful economic actors, technology can indeed lead to socially and ecologically dysfunctional results. Democratization of technology is put forward as the antidote to this situation (Feenberg 1999). Phillip Kitcher's book, *Science, Truth and Democracy*, devotes the first several chapters to reconciliation between analytic philosophy of science, which has emphasized the logic of explanation of prediction, and the critical theory of Marcuse, Adorno and Horkheimer. Kitcher remains committed to analytic models of scientific explanation and prediction, but accepts the critical theorists' critique of the institutions that have been developed to fund and regulate science (a critique that shares some elements of the purification view I describe above). Kitcher goes on to articulate a rather utilitarian view of *how* science should linked to democracy (Kitcher 2001). The confluence of work by Feenberg and Kitcher represents a new wave in philosophy that may, for the first time, embrace difficult questions about science and political power.

These difficult works have a number of conceptual and evidential problems. They are as much philosophical as empirical, and they will be debated for some time. Yet are scientists participating in that debate? Few are, and few are intellectually equipped with the sort of understanding of their own role and of the relationship between science and society that would allow them to make any but the most naive response. To all appearances, few scientists have ever thought about the social role of science, or of why science should be given a privileged position both in terms of support and in terms of the authority of its claims in governance. With few scientific voices participating in the debate, the gulf that C.P. Snow anticipated when he wrote of "two cultures," the sciences and the human studies, drifting apart with declining literacy and appreciation of each other (Snow 1964). Snow also wrote a short book called *Science and Government* in which he anticipated many of the problems discussed in this chapter. Government would become increasingly reliant on science for the formation and defense of public policy. This would provide a basis for taxpayer support of scientific research, but it would also place scientists in the position of being arbiters for important social positions. Snow felt that scientists were ill prepared for this role in 1961, and it is questionable whether anything in the education or professional life of food scientists and molecular biologists as made them better prepared for it at the second millennium.

Anecdotally, one hears reports of why scientists remain so distanced from the public debate over their work and the implications of their discoveries. Those who recruit for graduate training programs in the sciences look for intellectual talents that may seldom translate into a competence (or even interest) in broader public affairs. To choose otherwise would be to forego scientific talent, a choice inimical to the values of the scientific world. Vernon Ruttan, a leading theorist of agricultural research policy, argued that this is how it should be, that we should let the burdens of social responsibility rest easy on scientists' shoulders (Ruttan 1991). What Ruttan had in mind is that governments should compensate the losers from technical change, rather than allowing scientists to bear the brunt of lawsuits or political reprisals from outraged citizens. Meanwhile scientists should pursue their research assiduously, and wherever it leads.

But even this picture does not imply that scientists can rest secure in laboratory cocoons, both wielding social power through their ability to influence both economic change and public policy while isolated from politics, from even the constituencies they are nominally expected to serve. When viewed from an ethical perspective, food biotechnology presents supreme ironies. This is a technology that can be deployed to ameliorate (if not solve) some of the most pressing environmental problems of today, and some likely problems of public health and resource scarcity in the future. It can be used with foresight and sophistication, and though we cannot guarantee that there will never be unwanted health or environmental consequences, we have every reason to think that the tools of recombinant DNA can be used within the margins of safety that have been established by more than a century of improvements in plants, animals and food technology. Relative to our energy and manufacturing technologies, there is an impressive record of safety in agricultural technology. Furthermore, biotechnology can and almost certainly will be developed by people who hope to improve substantially on the environmental and public health record of the mechanical and chemical revolutions in agriculture.

Some of the issues that have been most contentious are, in the end, red herrings. Controversy over intellectual property rights (IPRs) is one. While those who have raised objections to IPRs have made a number of important points, none of them entail a policy against property rights in genes, gene sequences or processes of genetic research. Some objections address larger social issues that will have to be addressed through other political fora, if not through large-scale social change. Other objections note important points about how IPRs are defined and administered. The objections of those who speak for the developing world are notably in this category, but these are issues that will be resolved through negotiation, and the main ethical point is to ensure that those negotiations are conducted fairly. Religious objections, too, are, in the end, special cases of arguments raised on secular grounds, when they do not remain rather unfocused altogether. What seems most important is that religious communities have the opportunity to sort through these issues on their own, and they may need both financial and intellectual help in doing so: again, an eminently achievable goal.

There are some problems, but most of them are resolvable given the will to do so. Clearly there is strong evidence for some sort of procedure for protecting individual consent, for ensuring that those who choose to opt out of this new revolution in agricultural and food technology can do so. Clearly there is a need for animal researchers to take renewed cognizance of the new social contract for human use of animals, and to plan research and product development along lines that promote healthful and satisfying lives for food animals. Clearly there is a need for academics and public leaders to conduct an extensive public dialog on the social consequences of technical change. There should be television and radio programs, museum exhibits and public fairs dedicated to promoting a better understanding of technical change and its effects. The issue should be taken up by politicians seeking office and by NGO's seeking to influence government. Clearly scientists, those who do the work that initiates these changes, must be deeply involved in this debate, and clearly they must listen as well as speak. It is impossible to say how this debate *should* end, much less how it will, but it is clear that it should be initiated, and appropriate that discussion of biotechnology would take an early and prominent place in it.

All these things could be done and at a cost that would be a fraction of the investment that has already been made in food biotechnology. Furthermore, since the Asilomar conference in 1976, there has been a cadre of scientists working on recombinant DNA and its applications who have been willing to participate in these public debates. There is, thus, every reason for the cautious optimism I express in this book. Yet when one looks beyond a few individuals to the foot soldiers of biotechnology and to the institutions public and private in which the work is done, one sees very little willingness to engage these issues, and even less competence. The irony here is that the unwillingness of the biotechnology community to do the minimal things that need doing provides a powerful obstacle to trust. Why should the public trust a community of researchers who could more than meet public concerns by re-budgeting 5% (or less) of their time and financial resources when they simply refuse to do so? It is almost a case of the science community doing 90% of what it needs to do to earn the public's trust, then squandering their effort by begrudging that last 10%.

Concluding the first edition of this study in 1997, I wrote that while the future of food biotechnology is bright, and while the ethical issues seem far less than overwhelming, some of us who are optimists and would-be boosters remain cautious. Even if biotechnology fails to live up to its ethical and social promise, it will not bring about disaster. But it *could* live up to its promise as the first important science of a twenty-first century, a century where science recovers its moral compass and its position of leadership in social issues. Whether it will do that or not, of course, is what still remains to be seen a decade later.

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