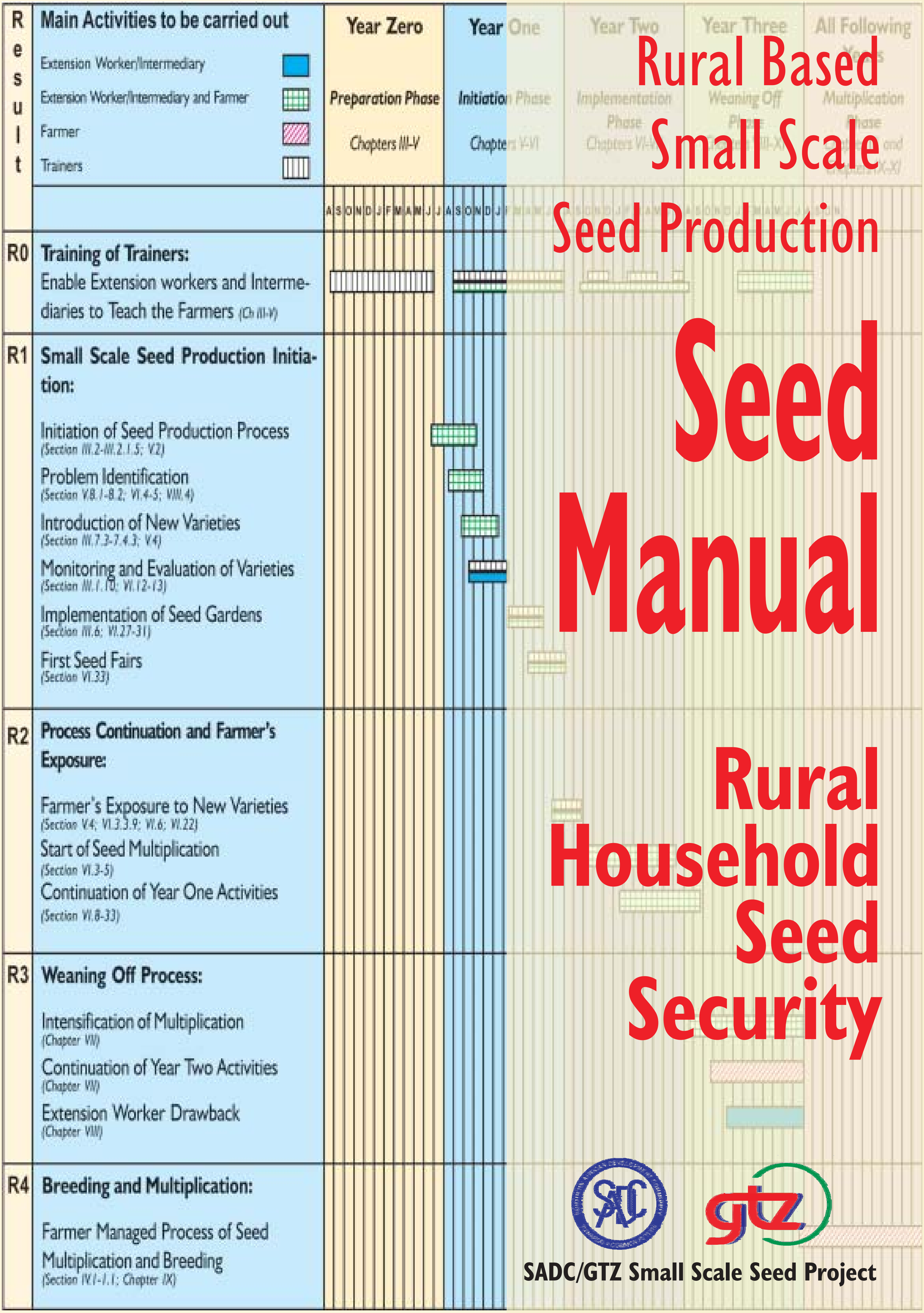


Rural Based Small Scale Seed Production

# Seed Manual

## Rural Household Seed Security

SADC/GTZ Small Scale Seed Project

## GTZ IN BRIEF

The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH is an international cooperation enterprise for sustainable development with worldwide operations. It provides viable, forward-looking solutions for political, economic, ecological and social development in a globalised world.

GTZ promotes complex reforms and change processes, often working under difficult conditions. Its corporate objective is to improve people's living conditions on a sustainable basis.

The GTZ was founded in 1975 as an enterprise under private law. Its main client is the Federal Ministry for Economic Cooperation and Development (BMZ), but the company also operates on behalf of other German ministries, partner governments and international clients, such as the European Commission, the United Nations or the World Bank as well as on behalf of private enterprises. GTZ works on a public-benefit basis. Any surpluses generated are channelled back into its own international cooperation projects for sustainable development.

The GTZ maintains a presence in its partner countries through its international and local experts and management staff. With many years of experience in developing solutions customised for partner countries' problems, the GTZ develops concepts and implements measures in cooperation with its partners which are tailored to the prevailing conditions. In this, it relies on a combination of sectoral, regional and management skills, alongside with specialised know-how, international management experience and intercultural competence. International cooperation for sustainable development needs new alliances.

The GTZ seeks new partnerships in social, economic and cultural areas. It has always cooperated closely with other national and international organisations in development cooperation. In addition – where technically and financially expedient – the GTZ draws on the knowledge of the private consulting sector, independent experts and specialist public institutions in both the Federal Republic of Germany and other countries. In more than 130 countries of Africa, Asia, Latin America, the Eastern European transition countries and the Newly Independent States (NIS), GTZ has over 10,000 staff. Around 8,500 of these are national personnel. GTZ maintains its own offices in 65 countries. Some 1,000 people are employed at GTZ Head Office in Eschborn near Frankfurt am Main.

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# Rural Household Seed Security

Editor

**O. Neuendorf**

**HARARE 2004**

SADC/GTZ Small Scale Seed Project

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# Contents

## Contents

Training Manual on Small-Scale Quality Seed Production

# Foreword

Seed specialists, governments, donors, development agencies, politicians, churches and NGO's in general, have realized that seeds are the single most important input in all plant based agricultural systems and development because they determine parameters for yield as well as the productivity of other inputs.

However, despite the importance of seed as a precursor for growth and development in crop based agriculture, access and availability of quality seed continues to be a problem in many countries of the Sub Saharan Africa. Small scale farmers continue to experience chronic difficulties in accessing seed of improved varieties from the formal sector, due to lack of resources and inaccessible product markets, and lack of options and information with regard to seed, varieties and crops. This situation inevitably compels farmers to rely on recycled seed whose productive potential has been exhausted over the years resulting in lower yields and continued food insecurity at house hold and national levels.

Seed companies on the other hand do not generally have a commercial interest in many of the crops grown by small farmers. Diminished profit margins as a result of higher transaction costs are among the factors limiting seed companies from participating in these areas. Consequently, there is lack of an effective seed delivery system in many rural areas that better suit the seed needs of small scale farmers and has contributed in part to seed insecurity of the majority of rural farmers in Africa

Today, many countries are seeking alternative ways of making seed available, particularly to the majority of small farmers through the informal seed sector and one way has been through the promotion of community based seed production and entrepreneurship in which seed is produced within communities and sold there in  and beyond.

The GTZ/SADC supported Small Scale Seed Production Project (SSSP) played a major role in this endeavor in the 10 years of its operation in Southern Africa and has in the process assisted many countries to achieve their objectives in this regard.

Experiences by SSSP point to the fact that promotion of community based seed production and entrepreneurship requires that the farmers involved are adequately trained and have a good  understanding of the intricacies of the seed industry. This task lies with the individuals and institutions involved in seed extension and training . Seed farmers will rely on a cadre of these individuals and institutions for their training needs in seeds.

Unfortunately training in seeds in many countries of the SADC region is not easily attainable. The universities and colleges curricula have little bias in seeds, which has to a certain extent not better prepared trainers to impart seed knowledge in general.

# Foreword

## Training Manual on Small-Scale Quality Seed Production

This manual is designed to fill this gap and to be a practical guide for use by extension agents, NGOs, Seed companies, institutions of higher learning and others involved in seed work at various levels. We have endeavored to introduce how to use the manual which readers will find useful as a tool for planning and executing a seed multiplication program. A useful guide to the reader are the time spread sheets that lead through the growing season with possibilities to be directed to sources of information when needed and the excel spreadsheet as a comprehensive planner for follow ups and costing of the program.

We are hopeful that this manual will become a useful tool in the contribution to the fight in combating seed insecurity at farmer level.

Edward Dalitso Zulu

Coordinator SADC Seed Security Network

# Chapter 1 - Contents

## Contents - Chapter I

Training Manual on Small-Scale Quality Seed Production

# Chapter I

## I Background to the Manual

Small scale seed production is not a new concept. It has always been practised by small scale farmers, although in a less organized and structured manner than that of the formal seed production sector. Nevertheless, small scale seed production has not received sufficient policy attention from governments as compared to the formal seed production sector, which is dominated by seed companies. In the past, there was a general feeling among both policy makers and consumers that small scale seed production was only for on-farm consumption or farmer-to-farmer seed exchange. This lack of appreciation of local or informal seed production systems was one of the major causes for poor rates of technology transfer and adoption among small peasant farmers in developing countries. However, attention has recently been shifted to small scale seed production systems as an alternative and possible vehicle for technology transfer to the general farming public. It has now been recognized by most policy makers that the informal seed sector is an important part of the seed industry. It can complement the formal private sector driven seed industry for the provision of good quality seed for agricultural development and poverty alleviation among poor peasant farmers. This manual is one such contribution to the development of the informal seed sector in the Southern African Development Community region (SADC), which is vital for the growth of agriculture in the sub-region.

The Training Manual on Small Scale Seed Production is meant to be used by the individual farmer or farmer group, the intermediary or extension worker, as well as the trainer or trainers to train, elaborate and execute Small Scale Seed Production.

**The Objective of the Manual is:** Adequate Seed Supply Systems with a focus on small scale seed production are clearly described and easy to implement by farmers and farmers' groups.

# Chapter 1I - Contents



CHAPTER II

# Chapter II

## II How to Use the Manual

This manual has been designed as a seed production training manual with special emphasis on Small Scale Seed Production. It is intended to give practical "hands on" training in seed production. The manual is organized in such a way that Chapter III covers basic theoretical principles of seed production. This provides target user groups with the necessary grounding in a theoretical framework of seed technology. The information is both for trainers and farmers.

Chapter IV introduces the seed grower to the practical application of the principles introduced in Chapter III. However, Chapters IV – XI emphasise different aspects of the training process, depending on who is being trained and in what project implementation year the training is being conducted. Over the course of the training process, the principles of seed production are repeated so that the target group always has the knowledge "at their finger tips". This will ensure sustainability of informal seed programs. In this context it is strongly recommended to refer back to the publication "The Small Scale Seed Production Training Program". The programs Module 8 is developed as a planning tool for seed production and guides through the planning process including costing (CD-rom Spreadsheet) of the program.

Chapter X discusses the requirements for the commercialisation of the small scale seed sector, while Chapter XI discusses seed marketing.

It is then indicated which user group each chapter has been mainly designed for, as follows:

To be worked on by extension worker/intermediary

To be worked on by extension worker/intermediary and farmer

To be worked on by farmer

Relevant for training of trainers

# Chapter I1I - Contents

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Training Manual on Small-Scale Quality Seed Production

# Chapter III

## III Introduction to the Basic Theoretical Principles of Food Production

## III.1 Background to Breeding Food Crops

Food crops are the main source of human nutrition. The yield and quality characteristics of food crops have a direct effect on national and household food security. The farmer is compensated for his investment in the production of improved varieties of food crops through sale and consumption. Improved varieties are developed through plant breeding. The success of these high yielding varieties, however, depends on good crop husbandry practices.

### III.1.1 What is Plant Breeding?

Plant breeding is the art and science of changing and improving the heredity of plants. It involves a process of modification of various plant characteristics through identification and selection. The process can be carried out by trained plant breeders. However, farmers too have always been involved in crop improvement through their efforts to select plant types that are desirable for their purposes.

Successful crop improvement depends on the presence of genetic variation within a crop species. Where variation does not exist, modern plant breeders create it by making crosses among different genotypes and selection in segregating generations. The art of crop improvement lies in the ability of the breeder to observe differences of economic value in plants. Farmer breeders, however, rely largely on existing variations within their crops to create varieties for specific needs and purposes. African farmers, although practising traditional forms of agriculture, have developed varieties over the years that are adapted to their environment, including resistance to certain pests and diseases. Farmers have also maintained their traditional varieties through selection during and after active growth. Some of these farmer-selected varieties have been a valuable source for germplasm in scientific plant breeding.

### III.1.2 Reproduction in Food Crops

The breeding procedures applied in the development of new varieties are determined by the mode of reproduction. The reproduction in food crops may be by seeds (sexual) or by vegetative parts (asexual). Sexual reproduction occurs when male and female gametes fuse to form an embryo, which eventually develops into a seed. In asexual reproduction, plants develop from vegetative organs such as tubers as in the Irish potato, or runners as in the sweet potato. Some crops, such as cassava, are propagated through stem cuttings. However, most food crops are reproduced through sexual means.

### III.1.3 Pollination and Fertilization

Sexually reproducing crops have male and female organs. These organs are contained in a flower. A flower is a simple structure made of four major floral organs: sepals, petals, stamens (male) and pistil (female flower). The pistil bears the female organ (stigma) while the stamen bears the male organ (anther). The anthers produce pollen, which is transmitted to the stigma. When the pollen lands on the stigma, it grows through the style and fuses with the ovum in the ovule. The fusion develops into a seed.

The process of pollen transfer onto the stigma is called pollination while the fusion of the pollen gamete and the ovum of the ovule, is called fertilization.

The male and female organs are not always in the same flower. In some crops, such as maize, the male and female organs occur in different positions on the same plant. In other crops, the organs are on different plants, such as in Papaya. The female organs of such plants receive pollen from different plants of the same species. Such plants are cross-pollinated. This also occurs in maize where the female organ (silk) receives pollen from various sources including the mother plant. Such crops are characterized by a high level of variability.

Some crops are strictly self-pollinated. In such crops both male and female organs are in the same flower. In self-pollinated crops such as groundnuts, the female organ will only receive pollen from the male organ within the same flower. Other crops have 3–25 % cross-pollination and are called semi self-pollinated. Self-pollinated crops such as wheat, groundnuts and soybeans have limited variation. Variation usually has to be created through crossing with other genotypes of the same species and variation expressed during segregation in the early generations or through induced mutations.

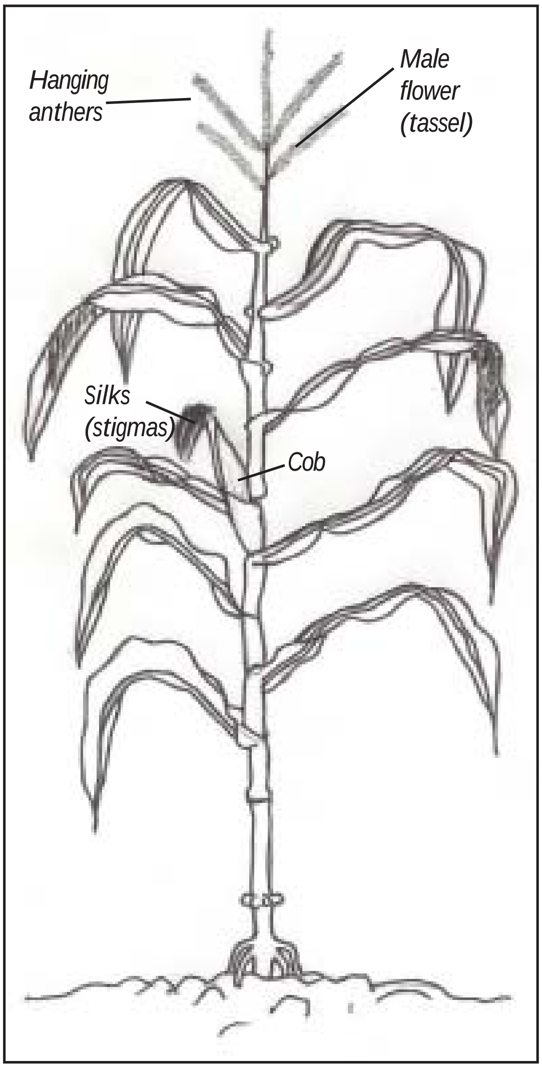
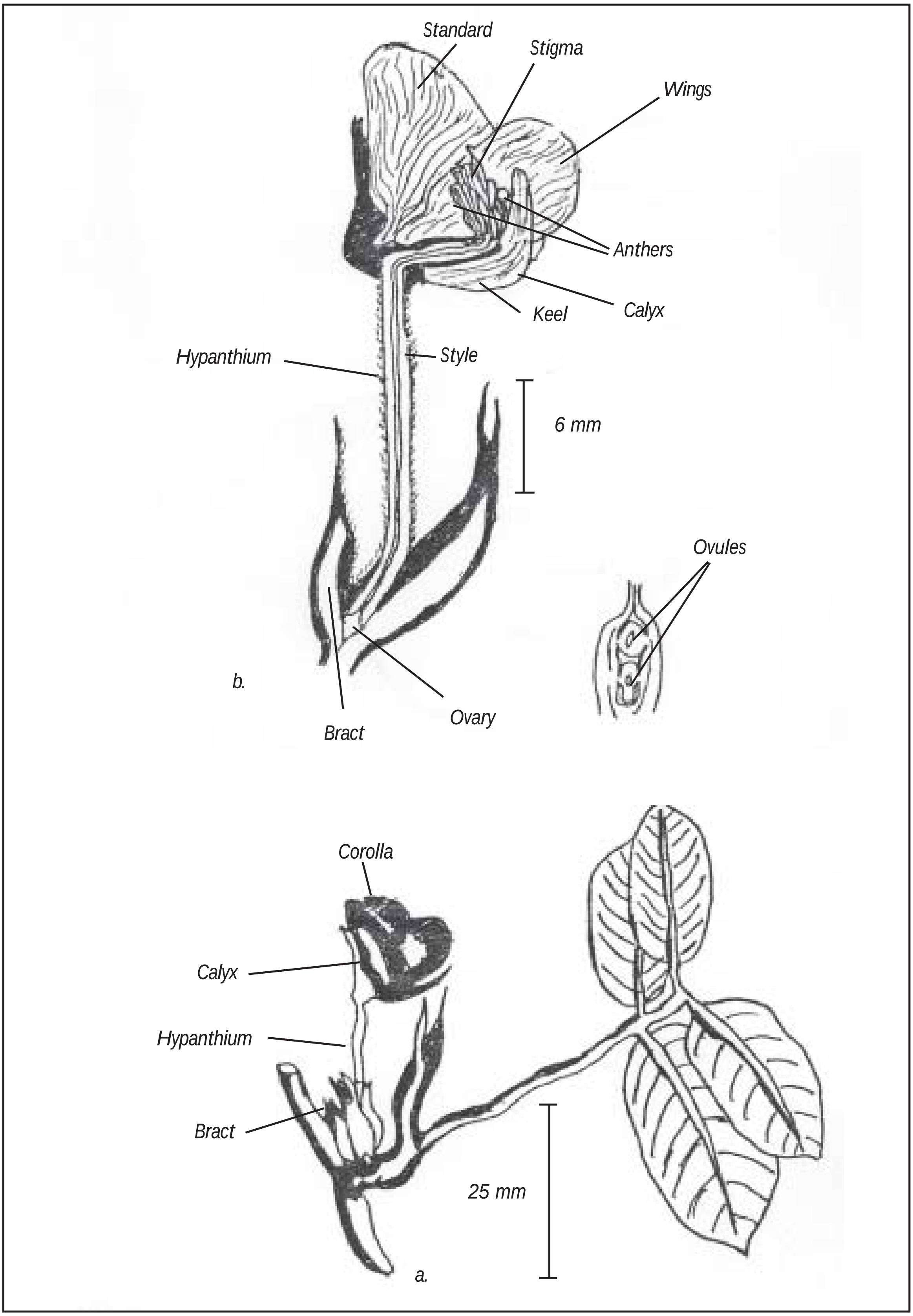



*Figure 1: Maize plant showing the male and female part of the plant's flower structure. The male part or tassel contains pollen while the female part has the silks which receive the pollen.*




*Figures 2a & 2b: Groundnut inflorescence with flower in leaf axle (2a), and longitudinal schematic drawing of the flower (2b), showing the anthers and stigma in the same flower.*

### III.1.4 Variation and Plant Breeding

Plants differ in many ways. They show variation in traits, such as maturity, height, seed coat colour, endosperm colour, presence of pigments, disease resistance, etc. There are, however, two kinds of variations: environmental and hereditary. Environmental variation occurs when plants of the same genetic make-up are grown in different environments. Such environments may occur in the same field, due to fertility gradients or soil type. These cause differences in growth, which may be mistaken for heritable genetic variation. Environmental variation is non-heritable and cannot lead to crop improvement.

Hereditary variation is a result of plants possessing characteristics of different genetic origin. Genetic variation is heritable and can be carried over from generation to generation. However, environmental and hereditary variations are not entirely independent of one another. There is usually an interaction between genetic and environmental variation. Breeding develops varieties through selection, involving a process of sifting through each genetic variation to select plants with the best combination of desirable characteristics, such as high yield, disease and pest resistance, good quality, etc.

### III.1.5 What is a Plant Variety?

A plant variety is an assemblage of plants with similar genotypes that may be identified among other varieties within the same species, by its structural features and performance. It is an agronomic unit familiar to breeders and farmers alike. New varieties are developed and tested by breeders and farmers. Hence, farmers choose the varieties appropriate for their farming systems from those varieties available.

### III.1.6 Variety Development and the Seed Industry

The majority of SADC countries have an integrated seed industry, which includes both formal and informal seed sectors.

The formal sector has well organized and structured systems of crop improvement, seed production, distribution and marketing, involving private seed companies, research and quality control.

The informal sector is characterized by localized seed production of local varieties or land races and recycled improved varieties. This involves the growing of a crop, part of which is saved for own use. As farmers select and save grains, tubers or roots from plants with the highest yields and resistance to pests and disease, they engage unconsciously in some form of crop improvement. Through these farmer selection activities, local land races can be modified and new varieties developed.

Small scale farmers can benefit from strong linkages with the formal seed supply system through Participatory Variety Breeding (PVB) and Variety Selection (PVS), which may build their capacity in the application of scientific plant breeding techniques.

## III.1.7 Conventional Plant Breeding Methods

The mode of reproduction determines the breeding method to be used in modern crop improvement. A thorough knowledge of the reproductive process is needed, that is, whether sexual, asexual or a combination of the two and the nature of pollination, whether self- or cross-pollinated. Table 1 gives a list of commonly grown crops in the SADC and their mode of reproduction.

**Table 1: Some Important Crops Grown in the SADC Region**

| Crop | Mode of Reproduction | | | |
|---|---|---|---|---|
| | Self-Pollinated | Semi Cross-Pollinated | Cross-Pollinated | Vegetatively Propagated |
| Maize | | | X | |
| Sunflower | | | X | |
| Sorghum | | X | | |
| Wheat | X | | | |
| Rice | X | | | |
| Pearl Millet | | | X | |
| Finger Millet | X | | | |
| Sweet Potatoes | | | | X |
| Cassava | | | | X |
| Beans | X | | | |
| Cow peas | X | | | |
| Bambara nuts | | X | | |
| Groundnuts | X | | | |

### III.1.7.1 Self-Pollinated Crops

The principal ways in which new varieties of self-pollinated food crops are developed are as follows:

- Introduction
- Selection from land races
- Hybridization and selection from the segregating generations

### III.1.7.1.1 Introduction

Introduction as a breeding method involves the process of taking food crop varieties grown in one environment to a different environment. The varieties are initially included in a yield trial if adequate seed is available. During the trial, the introductions are evaluated for their yield, disease and pest resistance and other important agronomic characteristics. After several multi-location trails which should include local check varieties, the best performing introductions may be released as varieties and recommended to farmers for production.

### III.1.7.1.2 Selection from Land Races – Mass Selection

The variety can be selected for uniformity by applying a mass selection method, where a morphologically heterogeneous variety or land race is available. All undesirable genotypes should be eliminated. This is done either by rouging off types in the field as the variety grows, or by selecting desirable types as they grow, bulking and harvesting them at maturity. This is what is termed "mass selection". Phenotypic characteristics such as plant height, ear characteristics, seed size, as well as phenological characteristics such as days to maturity, are used as selection criteria: the seed of selected plants is bulked to maintain the purity of the existing varieties or to generate a new variety.

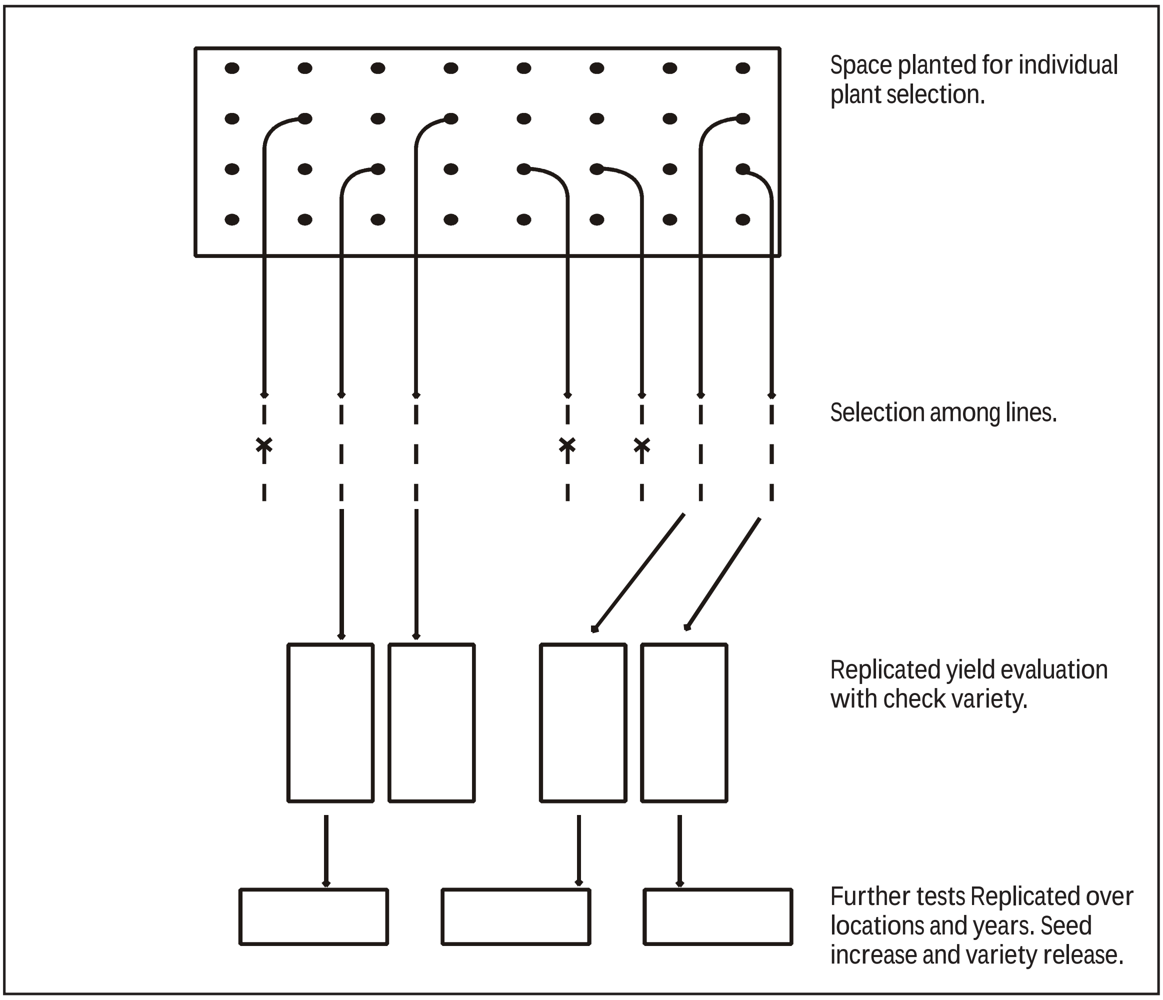



*Figure 3: Pure Line Selection Method*

### III.1.7.1.3 Selection from Land Races – Pure Line Selection

A pure line selection method can be used, if the objective is to exploit the existing variation in a variety or land race to develop other varieties. The general procedure of the pure line selection method is to plant a heterogeneous variety. Single plant selections are then made from it, based on the breeder's objectives. Seed from each plant is planted ear-to-row for comparative evaluation among the selected lines. The selected lines are harvested and seed from each line is bulked. Further evaluation of the lines could lead to selection of lines that can be released as varieties. A variety developed through this method will be uniform as far as physical characteristics are concerned. Farmers may observe off-types in their fields and develop a variety through this method. Figure 3 presents diagrammatically the pure line selection method in self-pollinated crops.

### III.1.7.1.4 Hybridization Selection from Segregating Generations

The need to combine desirable characteristics from other varieties into one variety is the norm in plant breeding. In hybridization, as many as two, three or four varieties may be cross-pollinated. The purpose of crossing is to create variation that could lead to the re-combination of desirable traits from the parental varieties used in the crosses. The choice of parents for cross-pollinating is based on the breeding objective. The varieties used in crosses are usually well adapted with high yields, disease and pest resistance, and other unique characteristics.

There are several methods used in handling the segregating progenies resulting from hybridization. Some of the selection methods are as follows:

- Pedigree selection
- Bulk population
- Single seed descent

### III.1.7.1.5 Pedigree Selection

Pedigree selection provides a record of the line of descent of all the lines in each generation. Pedigree selection begins in the $F_2$ generation, when there are maximum genetic variations from segregation. Single plants are selected on the basis of qualitative characteristics such as disease resistance, plant height, earliness, flower colour, etc. Single plant selection is done on the progenies of each selected plant in succeeding generations until the $F_5$ generation, when selection switches to selection of desirable families (Figure 4). This method has been widely used in the breeding of wheat and other small grain cereals.

### III.1.7.1.6 Bulk Population Method

The method of handling segregating generations using the bulk population method involves the growing and harvesting as bulks of early generations (Figure 5). With this method, selection is delayed until later generations, usually the $F_5$ or $F_{6,}$ during which single plant selections are done. The progenies of the single plant selections form lines for reselection among lines in succeeding generations.

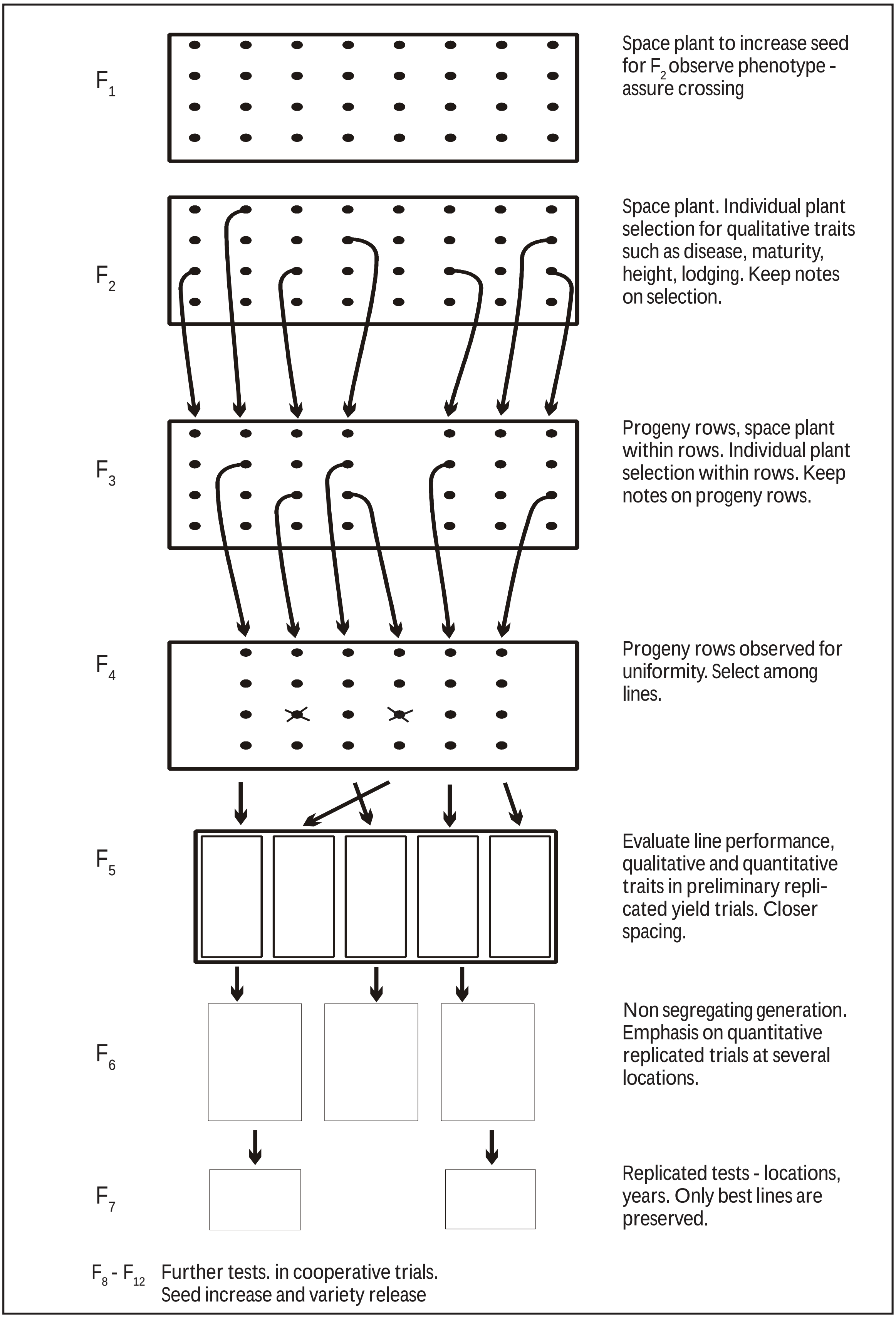



*Figure 4:* *Pedigree Selection Method*

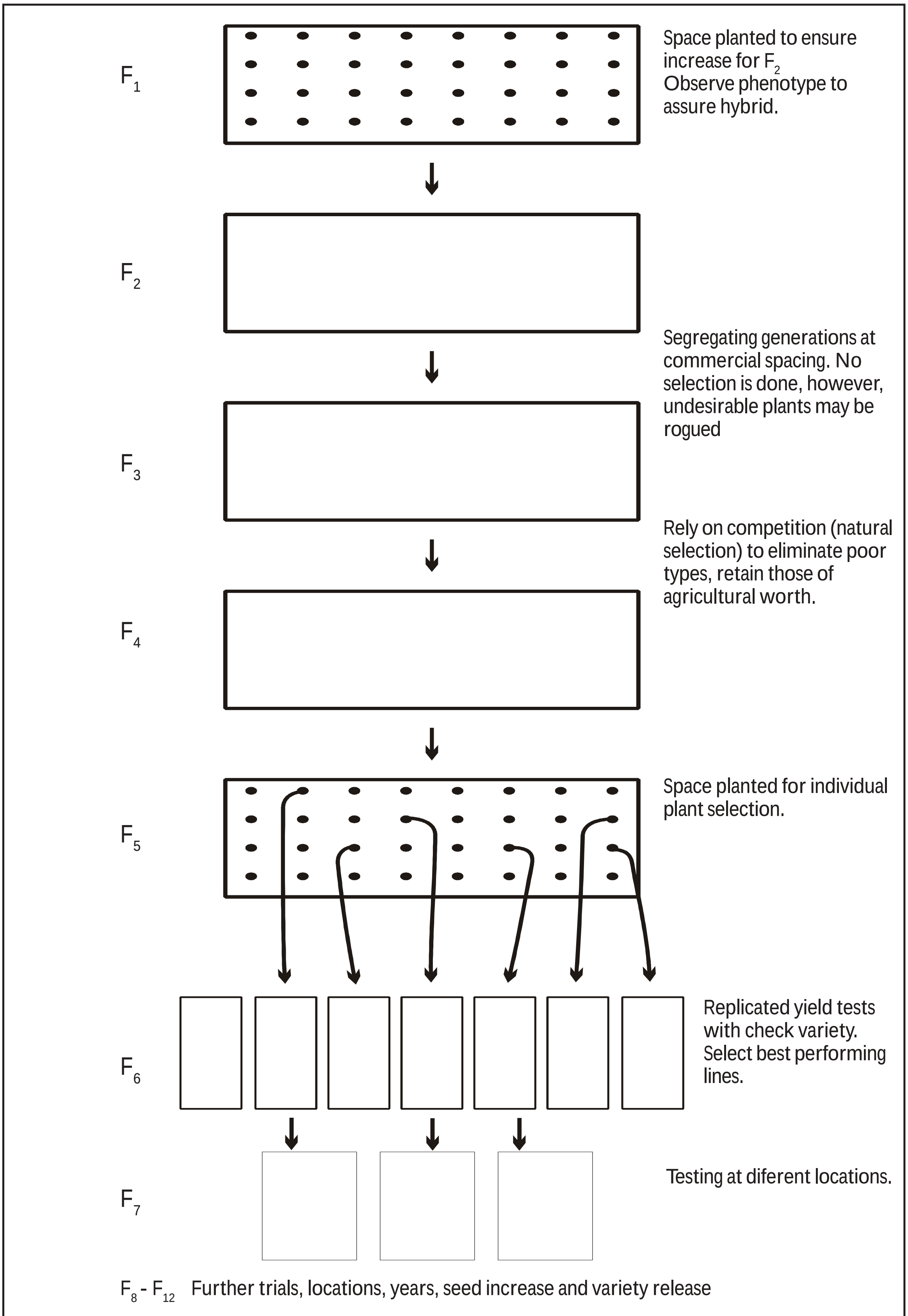



*Figure 5: Bulk Population Method of Handling Segregating Populations*

### III.1.7.1.7 Single Seed Descent

The single seed descent method involves planting the segregating $F_2$ generation and selecting one single seed per plant. The single seed selections are then planted and only one seed per plant is selected in succeeding segregating generations until $F_{5,}$ when the bulk seed from each plant is planted in individual rows for further evaluation and selection among lines (Figure 6). The single seed descent method has been used in small grain cereals such as wheat and barley. It has also been widely used in soybean breeding.

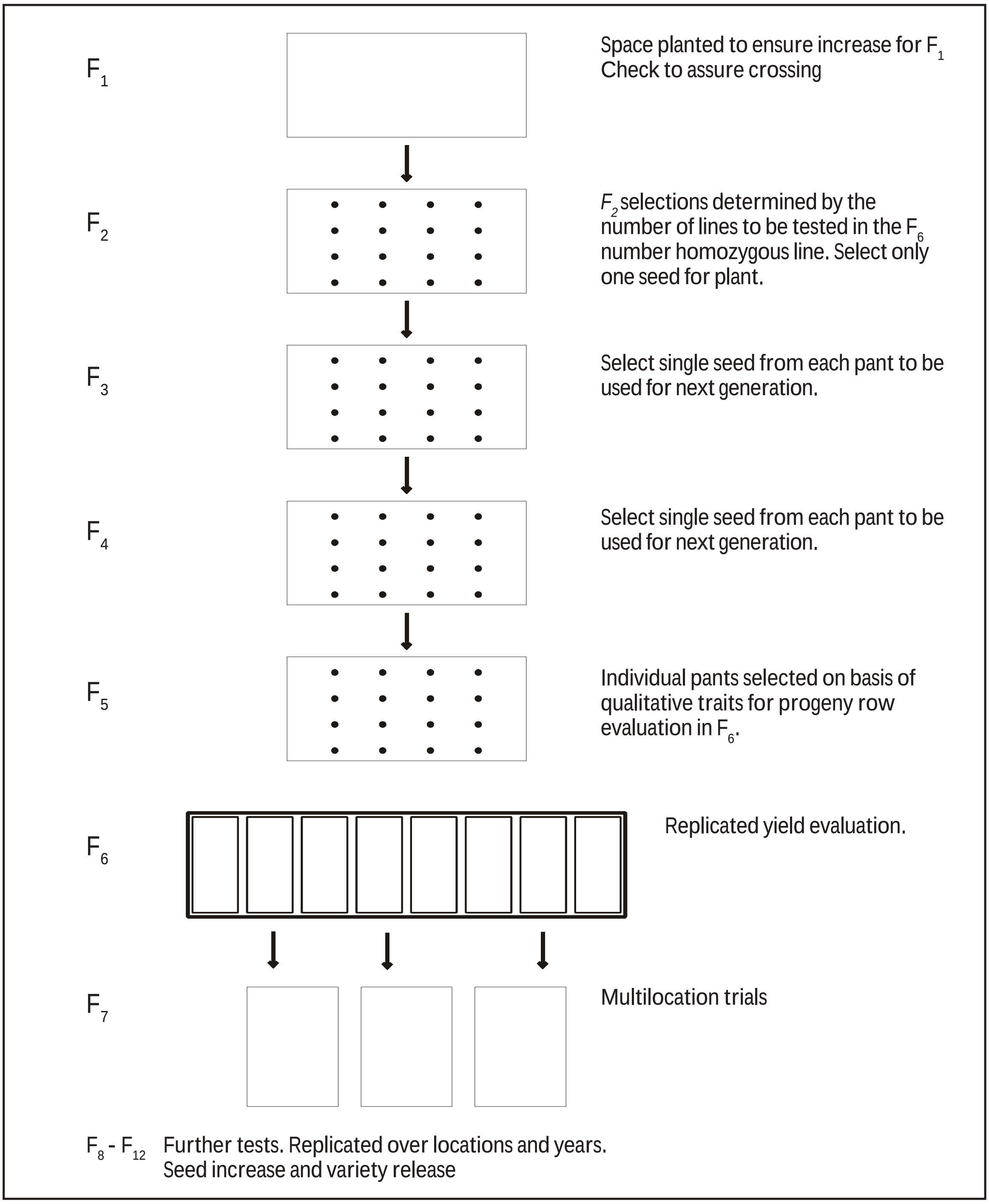



*Figure 6: Single Seed Descent*

### III.1.7.2 Cross-pollinated Crops

A cross-pollinated crop can be considered as constituting a reproductive community of sexual and cross-fertilising organisms which share a common gene pool. The gene pools constitute broad groupings as determined by gene frequencies of traits by colour, maturity, climatic adaptation, nutritional characteristics or other characteristics of special interest to the breeder. This out-crossing nature requires cross-pollinated varieties to be isolated from a variety of the same species, to maintain equilibrium of gene frequencies within each heterozygous population. Open Pollinated Varieties (OPVs) of cross-pollinated crops tend to be more heterogeneous than those of self-pollinated crops.

The principal methods for variety development in cross-pollinated food crops constitute three stages:

- Introduction
- Population improvement to develop open pollinated varieties
- Development of hybrid varieties

Only the first two methods will be discussed in this manual. Hybrids are best discussed with regards to the formal seed sector.

#### III.1.7.2.1 Introduction

The introduction and selection processes are the same as in self-pollinated food crops. Many good varieties from international agriculture research centres, such as CIMMYT have been introduced to the SADC region. The varieties are highly adaptive to different environmental conditions and meet the small scale farming communities' demands.

#### III.1.7.2.2 Population Improvement – Mass Selection

The mass selection breeding method is as discussed under self-pollinated crops. Plants exhibiting desirable characters are selected from the breeding stock of a cross-pollinated crop and at harvest their seed is bulked to constitute the next source population for selection (Figure 7). After several cycles of selection, the reconstituted population should be superior to the original population. This is because the process of selection and bulking of the seed to reconstitute an open pollinated population, increases the frequency of desirable genes and hence, desirable genotypes. Mass selection, however, has only been effective in selection of simply inherited traits. In the case of mass selection, when selection is made after pollination has taken place in the plant population, both superior and inferior plants provide pollen for the next generation. Furthermore, the effect of soil heterogeneity also introduces inefficiencies in selecting visually for quantitative traits based on an individual plant.

An improvement on mass selection is what is known as stratified mass or grid selection, which was proposed by Charles Gardner in 1961. With this method, the field in which the source population is planted is marked into grids or strata. One or two plants that outperform other plants within the grid are selected. In this way, seed is selected from plants distributed equally over the field. This method reduces the risk that differences in field conditions (soil fertility gradients or irrigation) would result in the selection of plants from only one side of the field. It has been reported that stratified mass selection improves the efficiency of mass selection (Gardner 1961). The improved population can be released as an open pollinated variety. Figures 7 and 8 represent the mass selection methods.

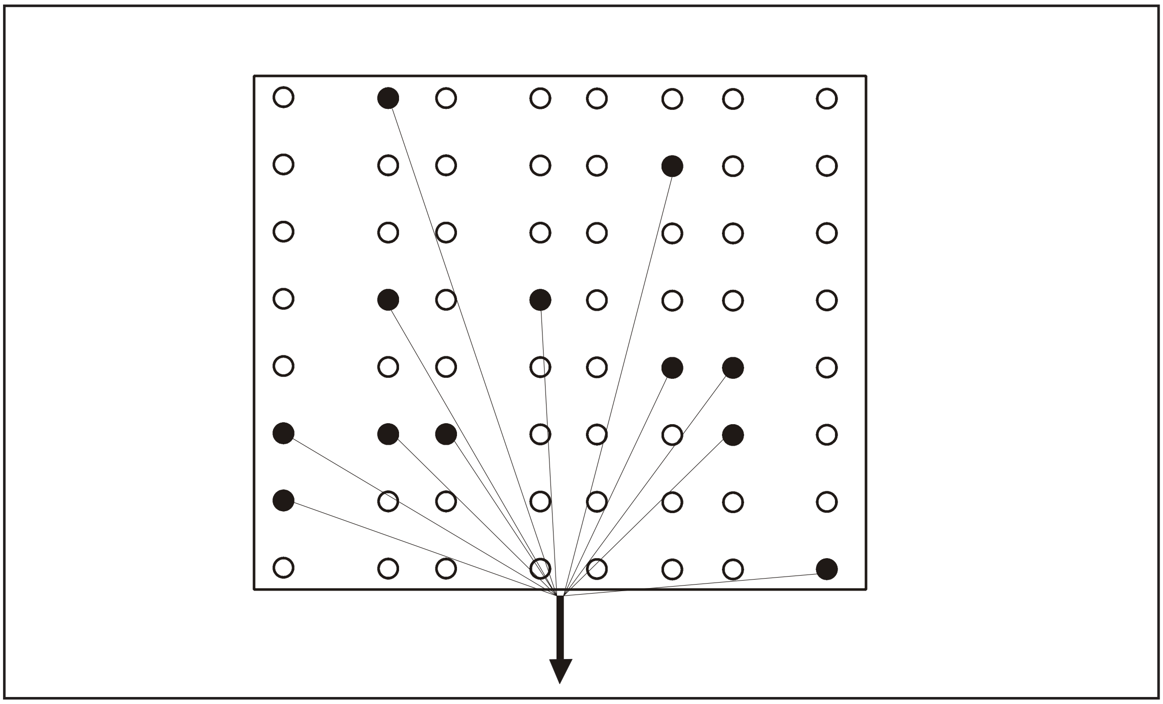


*Figure 7: Positive mass selection. Seeds from the best plants only are selected and used for next season's planting (Almekinders & Louwaars 1999).*

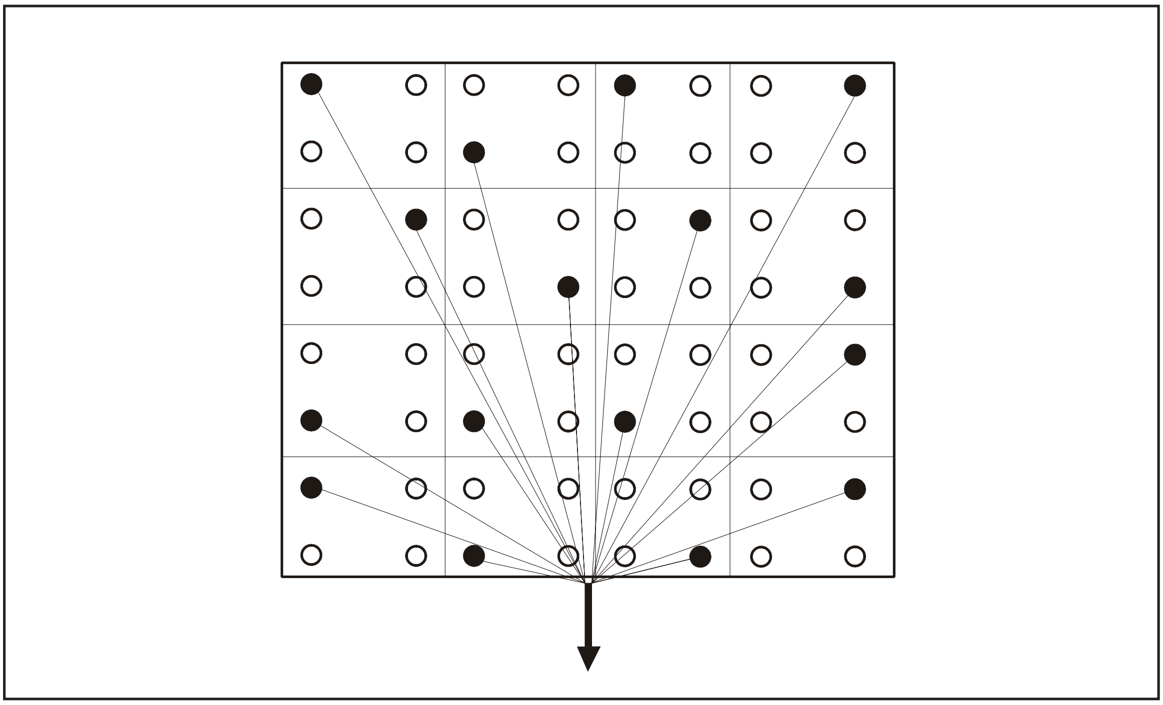


*Figure 8: Stratified mass selection or grid selection. Seed is selected from plants distributed equally over the field (Almekinders & Louwaars 1999).*

#### III.1.7.2.3 Population Improvement – Recurrent Selection

This is a powerful method for population improvement. It is a good method for improving the population in both qualitative and quantitative traits, due to the Progeny Test Component of this cyclic selection process.

In this system of population improvement, a number of plants with desirable characteristics are selected from the source population. These plants are selfed and part of the pollen is used to cross to a heterozygous testor variety. Yield evaluations in a progeny test are obtained from crosses of selected plants to a testor. The progeny test is conducted in the following year, during which time the selfed seed is stored until evaluations for yield have been made (Figure 9). The progeny yield test will indicate which selfed seed should be bulked and planted, in order to obtain all possible crossing among the selected plants that will constitute the next source population and start the cycle all over again. Recurrent selection has been widely used in maize and sunflower breeding. It has also been widely used in cassava breeding with cassava cultivars that flower and produce seed.

In cassava breeding, however, the method is modified. Cassava suffers from severe inbreeding depression such that selfed seeds produce very weak seedlings with a poor field survival rate. In cassava, the recurrent selection method involves continuous crossing of desirable genotypes to other cassava lines with desirable traits. This leads to continuous improvement of cassava cultivars through concentration of desirable traits in selected clones.

## III.1.8 Participatory Variety Breeding

Small scale farmers do engage in crop improvement of some sort as they maintain their local varieties. There is a great need for strong linkages to be formed between formal and informal seed supply systems, in order to involve small farmers in the plant breeding activities of the formal seed sector. The engagement of small farmers in plant breeding would build upon their capacity for crop improvement, as they interact and learn from trained plant breeders. This knowledge would enable them to improve local varieties and thereby household food security.

## III.1.9 Variety Assessment of Value for Cultivation and Use

A number of criteria are used to compare different varieties, when selecting a crop variety for cultivation and use. These include yield, pest and disease resistance, length of the growing season, taste and colour. The inputs required to maximize production may also be used as criteria for variety selection at the smallholder farmers' level, where resources are limited. For example, varieties may be selected on the basis of efficiency of soil nutrient utilization, such as yield under low nitrogen conditions.

### III.1.9.1 Yield Stability

A good variety gives consistent yields every season. Such a variety enhances the chances of predictable yields. Testing a variety for yield stability involves establishing performance observation trials across a number of locations over a period of time. This will also involve data collection and analysis, checking if the performance of the particular variety is consistent and better than established ones. Such data is sometimes required for a variety to be released officially for production. The procedures are as follows:

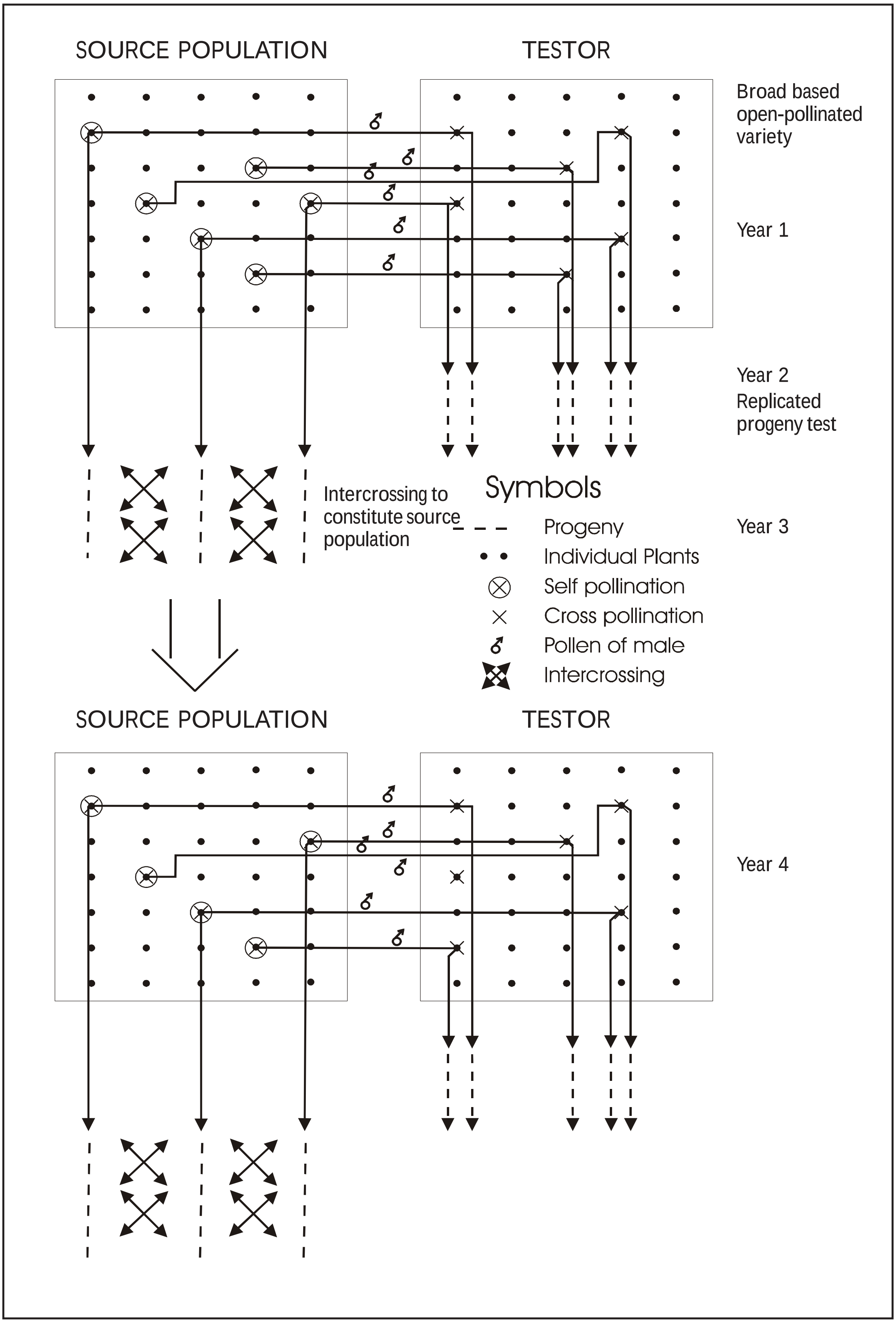



*Figure 9: Recurrent Selection Method for Population Improvement*

- Identify locations representing agro-ecological conditions across the country, etc.
- Plant selected varieties in 3 to 4 sites in each agro-ecological zone.
- Take records of all characteristics during crop growth and post harvest.
- Compare yields of the trials within each agro-ecological zone. This allows assessment of yield differences across agro-ecological zones, as well as yield variability within a particular zone.
- Comparison of yields across agro-ecological zones allows identification of suitable areas for specific varieties. It is also demonstrates the agro-ecological stability of the variety.
- Repeat trials over at least 2 seasons to test the effect of sites and years on variety performance as a measure of stability.
- Compare yields across seasons.
- Consistent yields demonstrate good yield stability across agro-climates and time.

### III.1.9.2 Palatability

The rate of adoption of a variety is determined by the palatability of its produce. Varieties should be acceptable to consumers. Community-based variety selection or development programs allow farmers to test new varieties for grain texture, palatability and taste. Under conventional breeding and variety testing programs, farmer participation in crop improvement also gives farmers the opportunity to test varieties for food and other uses. This approach, also known as Participatory Variety Selection (PVS), popularizes varieties before they are released. Procedures for the testing of palatability of new varieties are as follows:

- Supply farmers in the target areas with small quantities of seed and management information for unnamed varieties.
- Allow farmers to monitor crop development. Farmers can be advised to grow the new varieties next to their established or even their best local varieties.
- Farmers should be allowed to observe and record various characteristics of the new varieties. Breeders and agronomists can give support and advice.
- Allow farmers to harvest the plot.
- Allow farmers to put the varieties to different uses, such as processing, food preparation, brewing, tasting the various products from the seed.
- Allow farmers and the community to rate the different varieties used in the study for palatability.

This enables farmers to compare the new varieties with their local ones.

### III.1.9.3 Storability

The storability of seed or grain is essential for food security. Some crop varieties do not store well. For example some maize and sorghum varieties are so soft grained that weevil damage starts in the field. Such varieties will not be suitable for poor communities, which may not have the resources to afford chemicals for controlling storage pests. As a result, breeders and farmers strive to develop long life varieties, resistant to post-harvest storage pest damage.

The nature and oil content of the grain also determines storability. Some crop varieties such as soybeans store very well. However, some varieties have grain with leachy testa, which allows escape of materials from grain during storage. This attracts infestation by mites and other storage pests resulting in the loss of grain quality.

## III.1.10 Variety Characterization

A variety is identifiable by its unique characteristics. These are characteristics that differentiate it from existing varieties. Characterization involves identifying and documenting key characteristics that differentiate varieties. These characteristics may be phenotypic (morphological), agronomic or quality elements. The morphological features include plant architecture, flower structure, colour and positioning, nature of fruit and colour, and processing characteristics.

The differences in characteristics are mostly used in Distinctness, Uniformity, and Stability analysis (DUS). This analysis defines distinctness, uniformity and stability for registration, protection and identification of a variety. In countries where seed certification is applied, DUS or variety characterization is a prerequisite for certified seed multiplication. DUS involves recording and documenting all morphological and physiological characteristics of a variety. The procedure for characterization of varieties is as follows:

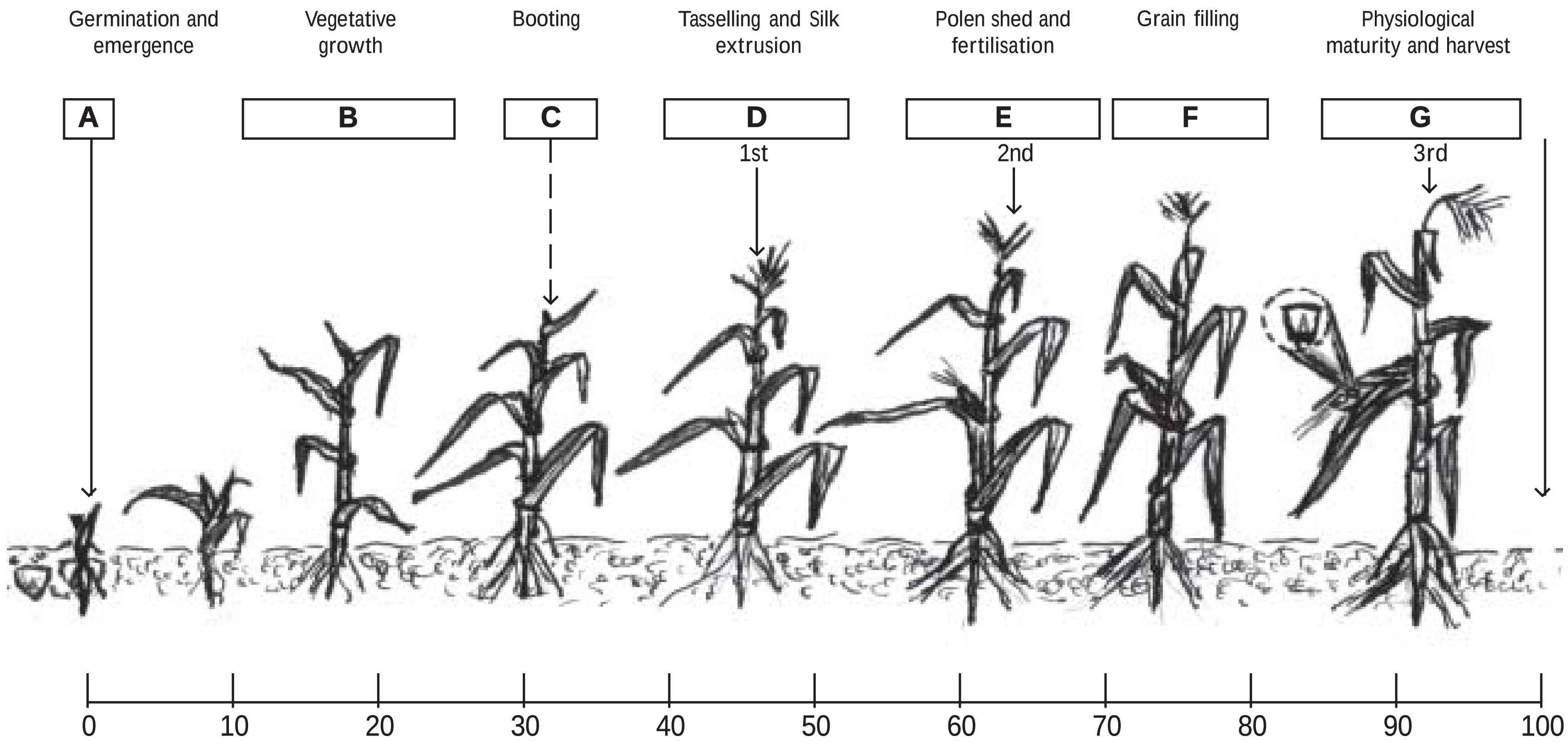
- Plant the variety in rows, applying the recommended management practices.
- Record date of planting and emergence.
- Record colour of seedlings, including leaves and stems.
- Record date and days of flowering, flower size and structure.
- Measure and record full leaf size, angle and length.
- Measure and record plant height.
- At maturity, observe and record grain size and colour, as well as conducting a nutritional assessment (for physiological characterization).
- For fruiting crops, measure and record fruit size, colour and shelf life.

Characterization of varieties provides producers with the necessary information to respond to consumer needs, as characteristics are catalogued and used for marketing purposes.

### III.1.10.1 Variety Architecture

Variety architecture is the morphological structure of a variety. It refers to the canopy shape and leaf arrangements of the variety. Thus, a variety may have an open or closed structure. Soybean varieties show significant differences in canopy structure. Some varieties have open canopies, while some varieties have been developed with a triangular open canopy. Varieties with triangular canopies have been designed to reduce mutual shading among leaves, hence maximizing photosynthetic rate and crop growth. Therefore, when setting out breeding objectives, it is important for the breeder to decide the type of plant architecture required for the conditions in which the varieties will be bred. In most cereal crops, such as maize, sorghum, millet, etc., plant architecture is determined by the leaf angle and leaf size. Narrow leaf angles allow most leaves to be exposed to sunlight, while large leaves increase the surface area for photosynthesis. Figures 10a, 10b and 10c below illustrate different plant types of rice.

## Maize Crop Growth Development Stages for Variety Characterisation




**A** – Plant in good seadbed as recommended, after first soaking rainfall.
Basal fertilizer can be applied as recomended for the plot
RECORD AS DAY ZERO AFTER 50% SEEDLING POPULATION EMERGENCE

**B** – Ensure good weed control and thin where necessary to one plant per station
If rains are good aply half of amount of AN (approx .150 kg/ha fertilizer after 20 days of vegetative growth.

**C** – After 25 days scout the crop for booting at least three times a week until tassels start emerging.
Rogue all plants that boot to early by 5-10 days if they are less than 1 percent of the population, if more than that, leave them and verify your opservation with other VEVO-trials.
Apply second AN dose

**D** – RECORD PERIOD FROM EMERGENCE TO 50% TASSELLING AND SILK EXTRUSION.
Note carefully time-lag or synchronisation between the two flowers extrusion.

**E** – RECORD PERIOD OF
1. FIRST POLLEN AND SHED, WHICH HERALDS THE BEGINING OF FERTILIZATION
2. CONTINUOUS POLLEN SHED IN THE POPULATION.

This is important for period of fertilisation, if too short it might impact significantly on grain yield.

**F** – Scout for pests and cobrot diseases.
If this characterisation is in a VEVO-trial, when 50 percent of varieties have flovered, it is time to arrange for a field day.
This stage will clearly delineate variability between similar crop varieties.

**G** – Record period of 50% physiological maturity (when black scar develops at the hilum)
Harvest at least 15-20 days after 50 percent psysiological maturity has been attained by the varietal population.

*Figure 10a: A tall conventional plant type of rice*

*Figure 10b: An improved high yielding, high tillering type of rice*

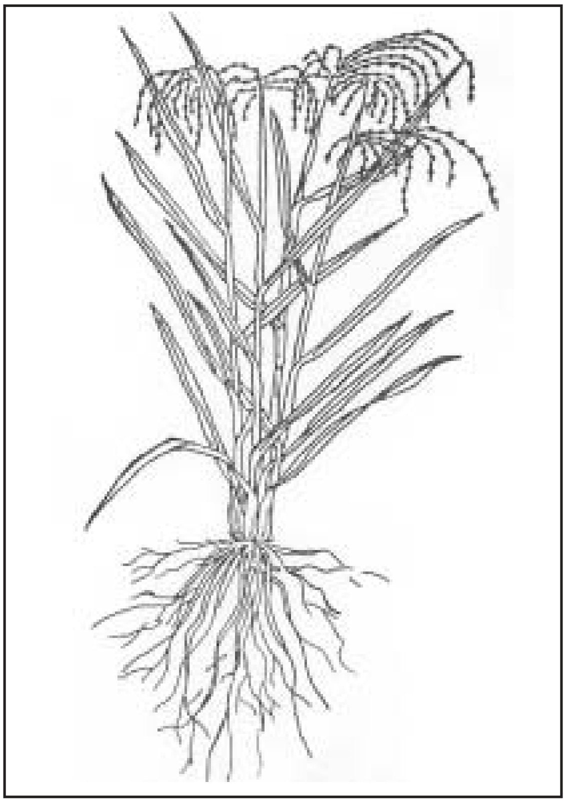


*Figure 10c: A low tillering erect leaf type with a high yield potential*

### III.1.10.2 Flower Structure, Colour and Positioning

Varieties may also be differentiated on the basis of flower structure. Flower structure, colour and positioning determine the mode of pollination. Sorghum has a closed flower which ensures 95 % self-pollination. In pearl millet, the flowers are open and the female organs are exposed to the air, allowing cross-pollination and less than 5 % self-pollination. In maize, the male flowers (tassels) are at the top of the plant to expose pollen to wind for transmission and pollination elsewhere. The female flowers (silks) are located in the middle of the plant (Figure 1). The flower structures can be used to manipulate the pollination system of the plant. Sorghum may be grown next to another sorghum crop, while pearl millet and maize seed crops require isolation.

### III.1.10.3 Physiological Maturity

Varieties reach maturity at different times. Some varieties are early maturing (short season), while others are medium to late maturing. The time of maturity determines when and where a crop should be planted. Long season types are planted early, while short season types can be planted later. When seed or fruit develops on the mother plant, it increases in size, due to inflow of photosynthetic material from the leaves. Movement of this material stops, when the seed or fruit reaches maximum growth or physiological maturity. In most cereal crops, such as maize, sorghum, etc., physiological maturity is accompanied by the development of a black layer at the hilum (Figure 11). The black layer is established when moisture content is between 35 to 45 %. Once the layer develops, seed can be harvested and dried. Seed must never be harvested before it reaches physiological maturity. Such seed will be of poor germination and vigour.

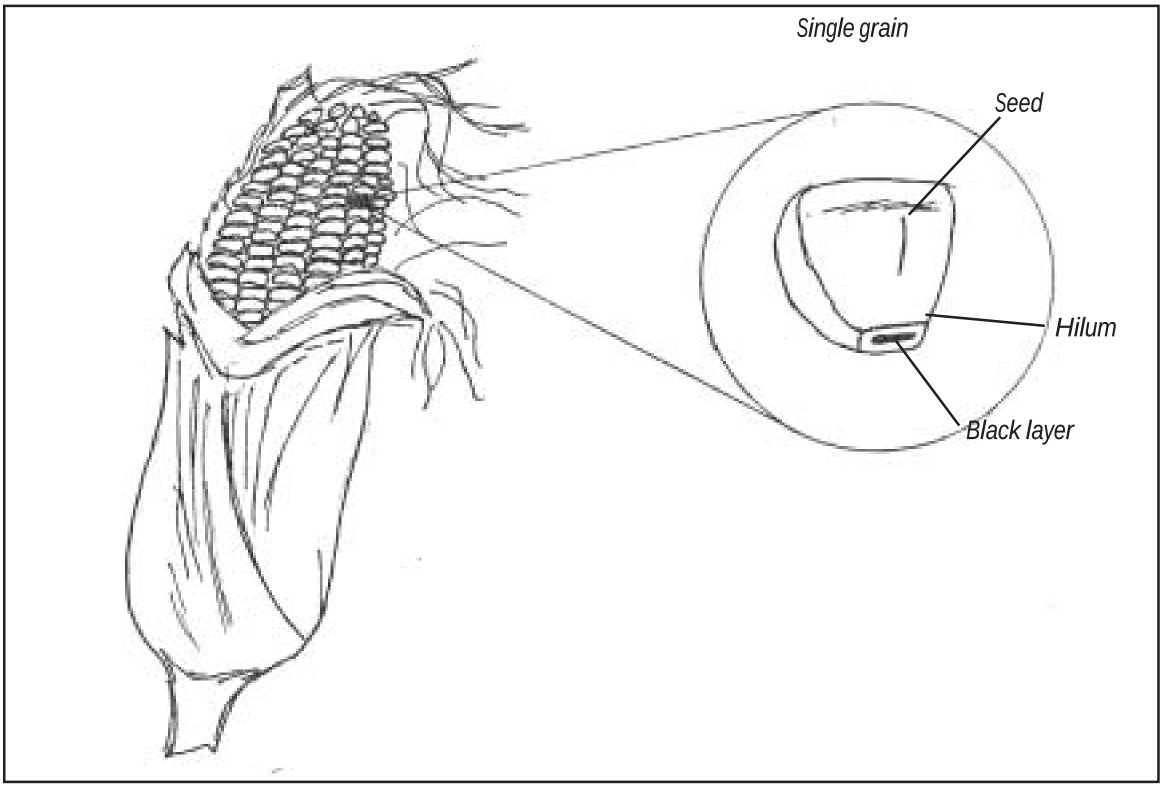



*Figure 11: A cob of maize and a kernel of maize with a black layer indicating physiological maturity*

### III.1.10.4 Fruiting Body Architecture and Colour

The type and nature of the fruiting body varies with the crop species. In maize, the fruiting body is the cob, while in sorghum and millet, this refers to the head. Pods are common fruiting bodies in most legumes. For maize, the number of rows and arrangement of grain on the cob differentiates varieties. Maize kernels are yellow or white depending on variety and intended use. Similarly, in sorghum, the heads can be closed or open, while the grain can be chalky white or flint.

### III.1.10.5 Processing Characteristics

The processing qualities of food crops vary with varieties. In sorghum, the grain colour is indicative of its processing requirements. White sorghum is mainly processed for food, while red sorghum is used for brewing. However, there are variety differences within each sorghum type. Some white sorghum varieties have soft seed/grain associated with poor quality food texture, while hard seed/grain is associated with good milling quality and food texture. Two types of grain, soft dent and hard flint types also characterize maize grain. Each type is associated with certain milling and food qualities. Most open pollinated varieties of maize have mixed grain types. Hard flint grain is generally preferred by women, as it does not break during pounding.

## III.1.11 Maturity and Household Food Requirements

As indicated in Section III.1.10.3, food crop varieties vary according to maturity dates. Some varieties are long season, while others are short to medium season. Long season varieties require up to 160 days to mature. In many cases, such varieties are planted early with supplementary irrigation. Breeding and multiplication of long season varieties is targeted for commercial farming with irrigation facilities. Short season crops can be planted early or late depending on the family’s food status. In cases where shortfalls are envisaged before the end of the full season, farmers are advised to plant early short season varieties. These will mature very early to secure household food needs before the end of the season. Farmers in marginal areas should always plant short season varieties of suitable crops.

*Figure 12: A farmer proudly demonstrates the different types of pearl millet in her crop, as can be seen from their distinguishing ear characteristics*

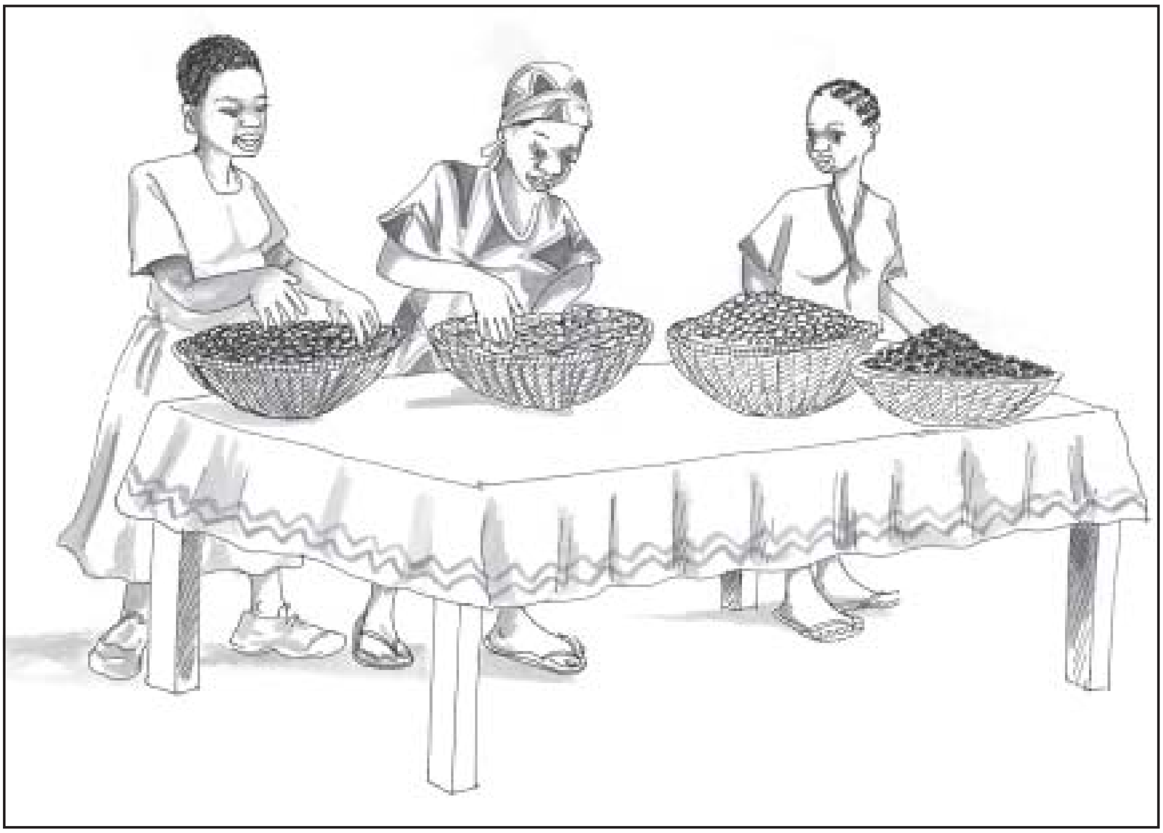


*Figure 13: Bean varieties characterized by variation in seed colour, size and shape*

Testing varieties for maturity is done through observation trials. Varieties are planted in a number of locations. A new variety is tested comparatively against established varieties. The maturity date is measured in days to physiological maturity, when the grain has developed a black layer at the hilum. Tested varieties are grouped into long, medium and short season types.

## III.1.12 Variety Maintenance

A variety is not a naturally occurring group of plants. A crop variety owes it existence to selection pressure, which restrict the variation in plants genetic pool to the levels set by the breeder and accepted by the consumer. Unless these pressures are maintained, natural selection among the plant population will lead to degradation of the variety. Thus, when multiplying the seed of a variety, precautions must be taken to avoid changes in variety characteristics through variety degeneration.

### III.1.12.1 Maintenance of Diversity

The maintenance of genetic diversity of local land races is also an important aspect of local seed supply. Farmers generally plant selections in their fields. Furthermore, during the planting time, they select the best grains from the best cobs or pods for seed. This practice can change the features of a variety drastically. It is important that farmers maintain the major features of the variety and avoid genetic drift by strict selection for local land races.

### III.1.12.2 Genetic Purity

The genetic make-up or genotype determines the existence of a variety in its form. Any genetic contamination through cross-pollination or physical seed mixtures will result in deviations from normal characteristics. Hence, the genetic purity of a variety must be maintained to retain the characteristics for which the variety was originally selected. Genetic purity of a variety constitutes the integrity of the variety genotype. This integrity must be kept and maintained.

### III.1.12.3 Self-Pollinated Crops

Simple mass selection may be used to maintain variety characteristics of self-pollinated varieties, when only a small degree of heterogeneity is observed, which may be due to chance out-crossing, mutations or physical mechanical seed mixtures of different varieties. A farmer can rouge out off-type plants to clean and maintain the variety. Another way would be for the farmer to select and bulk the seed of all true-to-type plants to develop a new variety.

However, when a self-pollinated crop shows wide variation of several characteristics, the pure line method of selection may be used. A minimum of 100 true-to-type plants are selected and the seed from each plant is planted ear-to-row the following season. The ear rows are then compared for uniformity; only the lines that are uniform and true-to-type are harvested for seed, in order to maintain the variety characteristics.

### III.1.12.4 Cross-Pollinated Crops

Three factors have to be borne in mind concerning the maintenance of cross-pollinated crops. These are as follows:

- Inbreeding depression
- Possibilities of genetic drift
- Requirement for isolation

Cross-pollinated varieties may suffer from inbreeding depression, if a small number of plants are selected to represent the variety and are grown in isolation. To maintain the cross-pollinated variety, at least 200 to 500 plants showing variety characteristics should be sampled for bulking.

Selecting a small number of plants may also result in genetic drift, i.e., a sudden drift in the characteristics of a variety.

Cross-pollinated crop varieties will cross-pollinate with varieties of the same species, if planted close by, a situation which often leads to variety contamination. For variety maintenance of cross-pollinated crops, various isolation methods have to be used.

### III.1.12.5 Isolation by Distance

The distance between the seed crop and any possible contaminant varies in crops. Cross-pollinated crops, such as maize and pearl millet require long distances of isolation, while self-pollinated crops like sorghum, wheat and cowpea require very short isolation distances.

However, isolation distances can also be determined by a number of factors, such as wind direction, natural barriers and planting dates. If the seed crop is in the windward direction of the possible contaminant, isolation distances are increased and vice versa. Presence of natural barriers, such as forests can also reduce isolation distances. Forests reduce wind movement and pollen transfer.

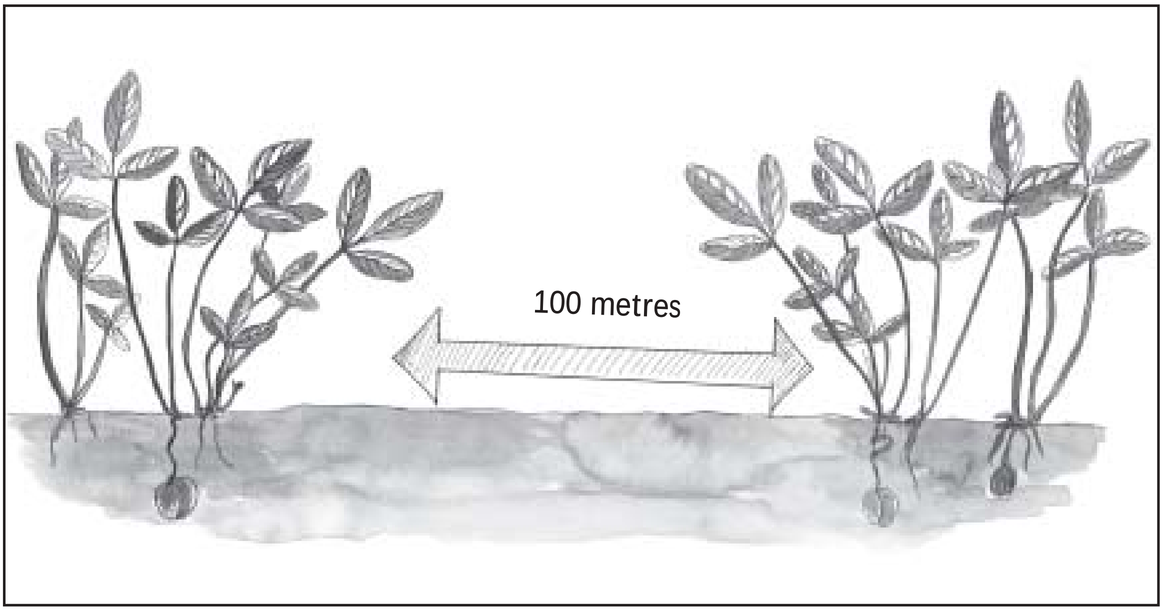



*Figure 14: Isolation for semi-cross pollinated crops*

### III.1.12.6 Isolation by Time

Seed crops can also be isolated from potential sources of foreign pollen by planting the crop earlier or later than the crop of the same species. The period of separation depends on the crop and projected weather conditions. It will also depend on the time taken for the crop to mature or its variety. However, a period of at least 21 days between planting will ensure adequate isolation. The advantage of time isolation is that more seed crops can be planted on the same piece of land. The procedures for time isolation are as follows:

- Identify the varieties to be multiplied and establish the number of days to flowering and time differentials.
- Plant the first seed crop (variety) under moist conditions.
- Plant four buffer rows of the first crop (variety).
- Let the first crop grow until booting stage
- Plant the second seed crop (variety) under moist conditions with four buffer rows.
- Monitor flowering of both crops.
- After flowering and pollination of more than 98 % of the first variety, remove any late flowering plants. These could be off-types.

Buffer rows are added to the edges of seed multiplication plots to increase pollen concentration (cloud) and reduce chances of contamination from foreign pollen.

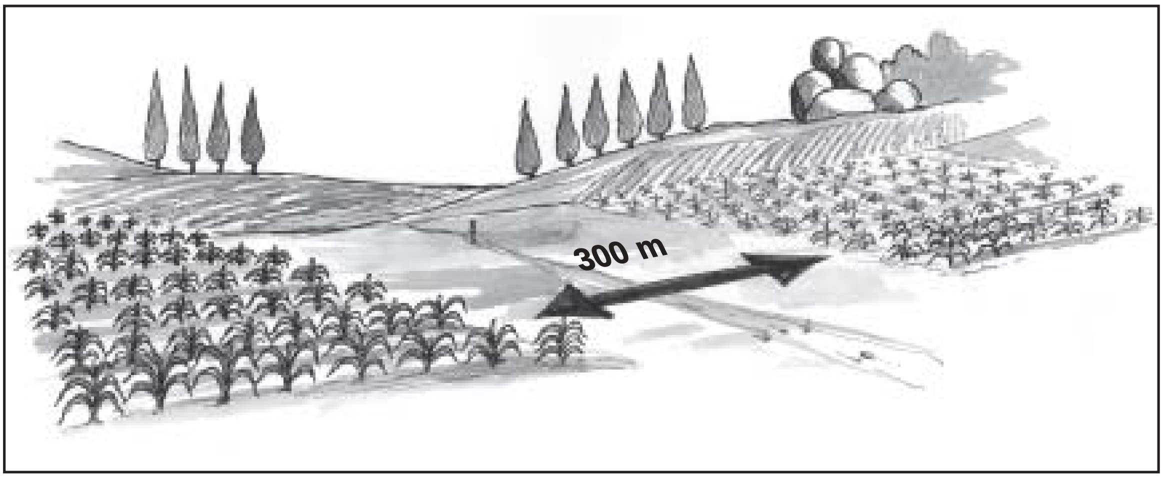



*Figure 15: Isolation for cross-pollinated crops with wind as pollination agent*

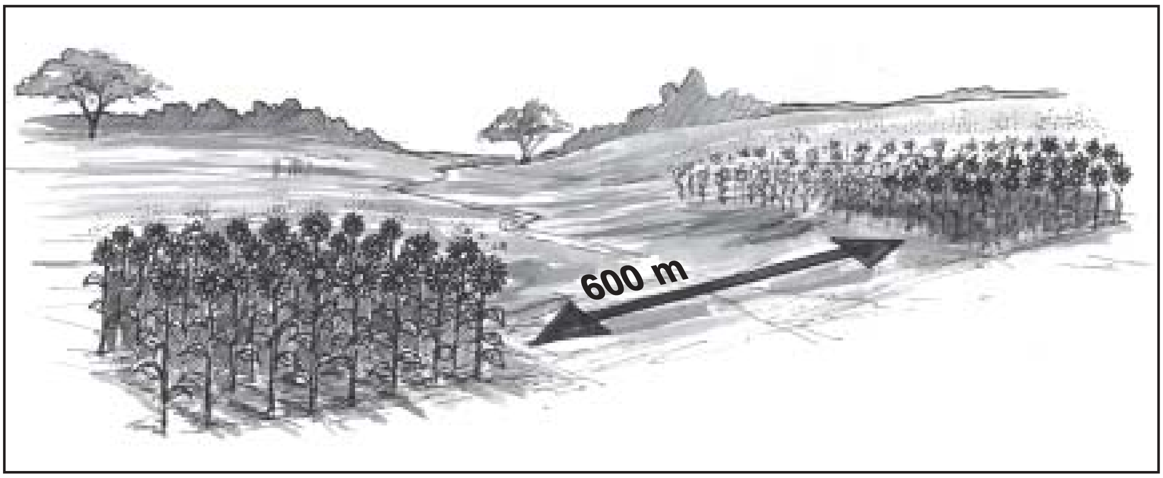



*Figure 16: Isolation for cross-pollinated crops with insects as pollination agents*

### III.1.12.7 Isolation by Time and Distance

Time and distance isolation may also be used to improve the genetic quality of seed during multiplication. This isolation involves a combination of the two techniques. In addition to planting seed crops at the recommended distances apart, the crops can be planted separately. This may be done for insect pollinated crops, such as sunflower.

### III.1.12.8 Seed Production Off-Season

In addition to seasonal seed multiplication, seed can also be produced during the off-season. In some SADC countries, most off-season production occurs in winter nurseries under irrigation. Much of the production is done in frost-free valleys. Off-season multiplication is mainly for parent seed (pre-basic and basic). The objective is to increase supply of parent pre-basic and basic seed for summer seed crops. However, bulking of commercial seed can also be undertaken in winter nurseries. These frost-free low-lying areas are also suitable for both open pollinated sorghum and maize seed multiplication.

### III.1.12.9 Variety Maintenance Procedures for Cross-Pollinated Crops

The maintenance of characteristics of cross-pollinated crops is not as easy as that of self-pollinated crops. Cross-pollinated crops require strict isolation from a crop of the same species as already discussed. There are also several procedures that are followed in maintaining the variety genetic purity of cross-pollinated crops. This section discusses some of these methods.

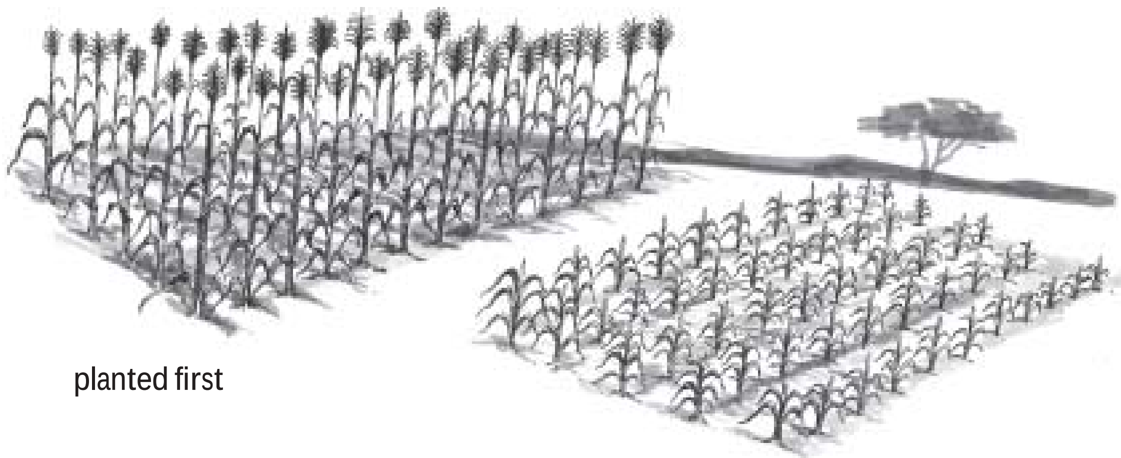



*Figure 17: Maize seed srop isolated by time*

#### III.1.12.9.1 The Half Sib Selection Method

This is an ear-to-row selection method; it is important for maintaining open pollinated varieties. The procedure is as follows:

- Select 200–500 plants that have the variety characteristics. At harvest, reselect the tagged plants, discarding those that have failed to show variety characteristics at this stage. Select only those plants with healthy looking ears or heads that are well developed and representative of the variety, though not necessarily the biggest.
- Plant the selected plants in ear-to row plots. The plants in each ear-to row are known as half sibs because they have the same mother parent but different pollinators. The rows may consist of 10–20 plants.
- Discard the poor looking and most irregular rows before they flower.
- Select the best plants or ears within the good rows, harvest and bulk the seed to reconstitute the open pollinated variety.

#### III.1.12.9.2 The Full Sib Selection Method

This method attempts to control pollen sources. Thus, two healthy looking plants from a variety to be maintained are selected and artificially crossed. The crossed ears, which could be from reciprocal crosses, provide the seed for the ear-rows for selection. The procedure is as follows:

- The crossed parents are observed during growth and at harvest: those that have shown undesirable characteristics by harvest time are discarded, while only those maintaining good traits are selected.
- The cobs from reciprocal crosses are observed for uniformity and other positive characteristics.
- Enough seed of the crossed parents is used to plant ear-to-rows. These seeds are full sibs sharing both parents.
- At least 250 of such rows are planted in a block.
- Remaining seed of these full sib crosses is mixed and planted around the block of lines to provide pollen.
- A first selection round is made when rows that are not true-to-type or too heterogeneous are removed before flowering.
- In order to avoid inbreeding and the consequences of inbreeding depression, plants in the best rows are de-tasselled to allow them to be fertilized by plants from surrounding rows, containing a mixture of full sib crosses.
- Seed is collected from the de-tasselled rows that appear sufficiently true-to-type of the variety at all growth stages. The seed is bulked to constitute the variety.

*Figure 18: Full sib variety maintenance of open pollinated maize varieties. Notice the covering of the ears of selected female plants, so that they can only be pollinated with pollen from selected male plants.*

## III.2 Background to Seed Multiplication of Food Crops

Seed multiplication is a technique and an art. It requires the seed grower to have an understanding of the technical issues pertaining to crop production and quality management. Seed multiplication involves planning and management.

### III.2.1 Planning Seed Production

Proper planning enables the production of the right quantities of seed for the farmer's own seed security needs and for seed exchange with, or sale to neighbours. It requires an analysis and understanding of the local community seed supply situation. When planning for small scale seed production, the following factors should be considered:

- Variety: - it must be the right variety for the farming area (variety identification).
- The quality of seed expected by the local farming community.
- Establishing the quantities required by the seed grower and an estimate of local community seed requirements.
- The capacity of the farmer to produce the quality and quantities of seed required by the community. There should be enough parent seed and land available for seed production.
- Establishing whether other farmers in the local community have the capacity to meet demand for local seed needs.
- Capacity for maintaining genetic purity in a certain variety.
- Availability of a community seed bank to store excess seed for farmer-to-farmer sales or exchange and seed entrepreneurship.

Thus, planning seed production involves identifying the variety, sources of parent seed, maintaining varieties, identifying the farmers and seed production fields, seed crop registration, quality control monitoring, harvesting, processing, storage and distribution.

#### III.2.1.1 Variety Identification

Seed multiplication has to involve a variety that is in demand by farmers, otherwise it will not be accepted. Thus, before any group promotes small scale seed multiplication, it needs to conduct a seed needs assessment survey to establish farmers' requirements, the relevant variety and potential quantities. Variety characteristics are also used during identification. The common characteristics in variety identification are days to maturity (early, early-to-medium, medium, medium-to-late and late), height (short, medium, tall), ear shape (conical, cylindrical), leaf shape and angle, colour of grain; and for maize, the colour of silk, grain type and cob placement. It is important to establish farmer preferences based on these characteristics and others that they may deem to be important. Once a variety has been identified, it must be maintained for sustainable supply of quality parent seed stocks.

#### III.2.1.2 Identifying Seed Growers

Seed multiplication requires committed farmers who appreciate the value of quality seed. The following criteria should be used, when identifying a seed grower:

- The seed grower must be a farmer of good repute and able to grow good seed crops, that other farmers in the community will purchase.
- The seed grower must have an appreciation of seed as different from ordinary grain crops.
- The seed grower must be able to invest more time and other resources on seed crops.
- The seed grower must comply with seed production parameters, especially when weather threatens quality.
- Availability of land: - the farmer must be able to spare part of the farm for seed production and the seed production area should be adequately isolated to multiply seed of open pollinated crops.
- Resource capacity: - the farmer must have adequate draft power to prepare suitable seedbeds for multiplication and enough crop management skills.
- The farmer must have the capacity for on-farm seed processing and comply with quality control requirements.
- The seed grower must be trained in small scale seed production.

The seed grower will be responsible for safeguarding the seed crop during active growth, as well as during and after harvest. At village level, the selection of seed growers should be

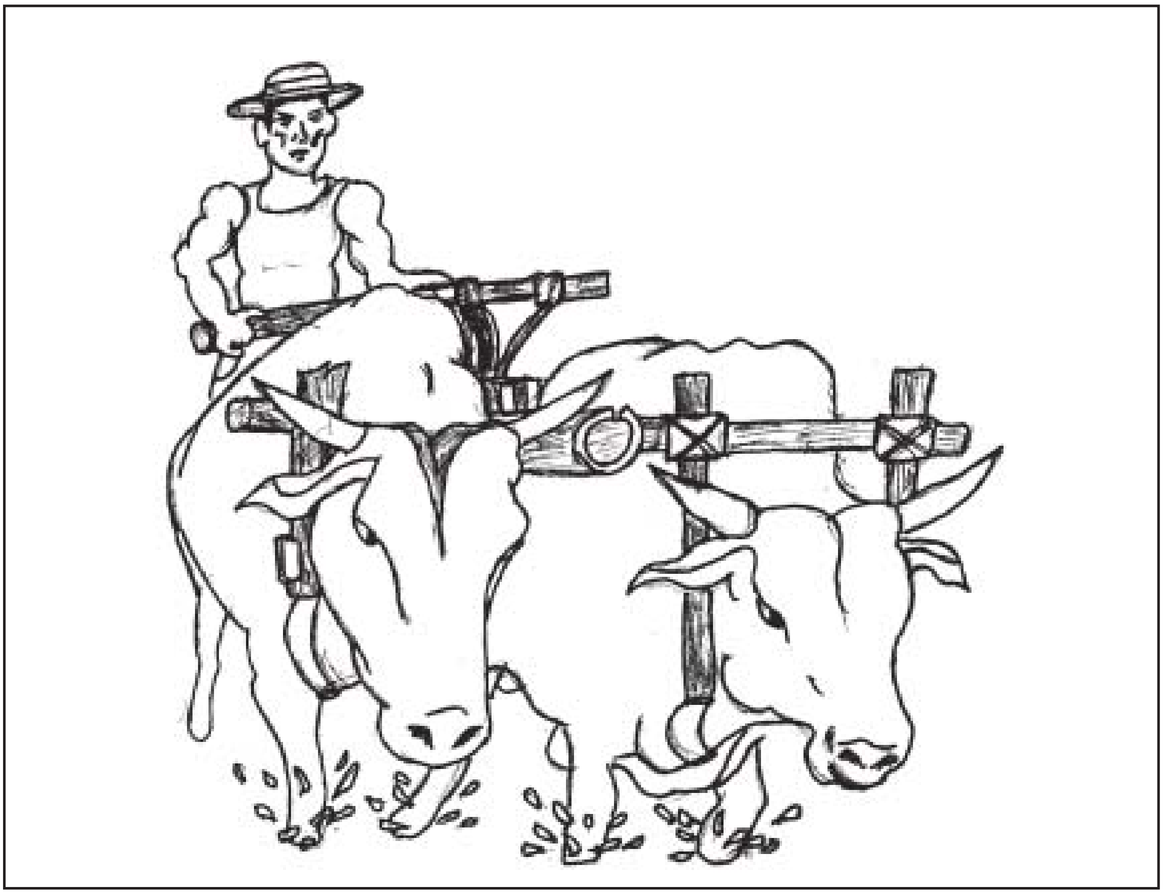


*Figure 19: Animal draft power is needed to ease field operations*

based on community consensus. The farmer must be ‘educated’ enough to appreciate the training needs for seed multiplication. Once a grower is identified, seed production may start. Seed multiplication begins with parent seed production.

### III.2.1.3 Parent Seed Production

Parent seed refers to both pre-basic and basic seed. Once a variety has been identified and maintained, parent seed should be made available for further multiplication. Production of parent seed is highly technical and requires adherence to certain practices. Multiplication requires adequate isolation, effective roguing of off-types and hand harvesting, cleaning and processing. A qualified seed production adviser or inspector must supervise the production of parent seed. Once parent seed is available, small scale seed multiplication may start.

Procedures for parent seed production are as follows:

- Identify farmer using the criteria as given above.
- Identify adequately isolated seed crop fields.
- Plant seed in rows.
- Monitor closely seed crop development.
- Remove unwanted plants, i.e., all off-type and diseased plants.
- Allow crop to be inspected at least four times during critical crop growth stages.
- Harvest the crop at a suitable time (physiological maturity).
- Seek advice from qualified seed production adviser (when necessary).

## III.2.2 Identification of Field for Seed Crop

High quality seed is achieved if agronomic practices used to produce it are appropriate. These practices cover the whole cycle starting from seed planted, site selection, seedbed preparation, soil and moisture management, weed, pest and disease management, seed conditioning and storage. The way each of these aspects are handled will affect all seed quality aspects:- genetic, analytical, physiological and sanitary, as well as amounts produced. Very often, the recommended practices for producing grain crops in specific crops either have to be modified, or followed more closely when producing seed.

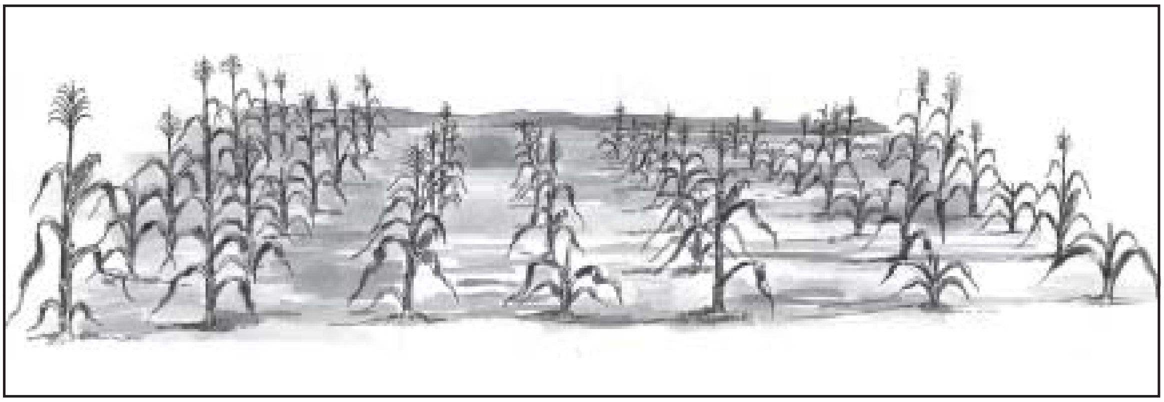


*Figure 20: Avoid sites where seed will not fully reproduce*

### III.2.3 Factors to consider when selecting sites for seed production

Any site chosen to grow seed crops has to meet some minimum criteria. The environment at the site has to allow the crop to reproduce, i.e. flower, set seed, and allow that seed to develop, fill and develop to physiological maturity. In some instances, climatic elements such as temperature and rainfall, as well as the photoperiod, prevent crop plants from setting seed. If reproduction is poor, this could favour plants with a skewed genetic make-up to flower in greater proportion, thus causing a shift in the genetic make-up of the variety. So, select sites where all plants fully reproduce, to reduce the risk of shifts in genetic make-up.

Since seed has to be free from pests and diseases as part of the quality requirement, and seed yields have to be optimized, the site identified should have low to nil weed, pest and disease pressure, depending on the crop type, seed category, pest and disease type.

It is difficult to distinguish off-types for roguing when crop growth is uneven. Consequently, sites on steeply sloping land, as well as those with poor drainage should be avoided since they create uneven and sometimes poor growth. Prefer those with high, evenly spread fertility.

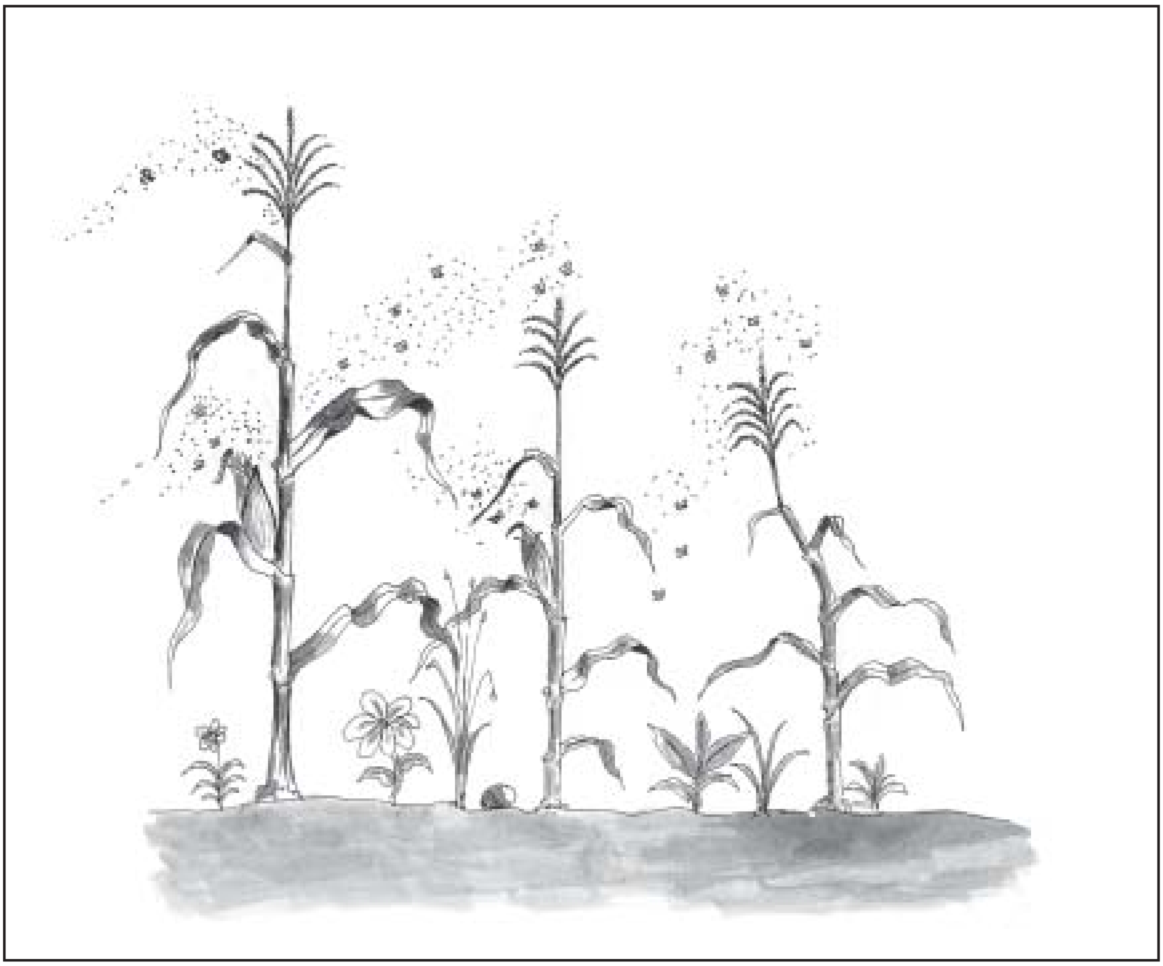


*Figure 21: Avoid sites with high weed, pest and disease pressure*

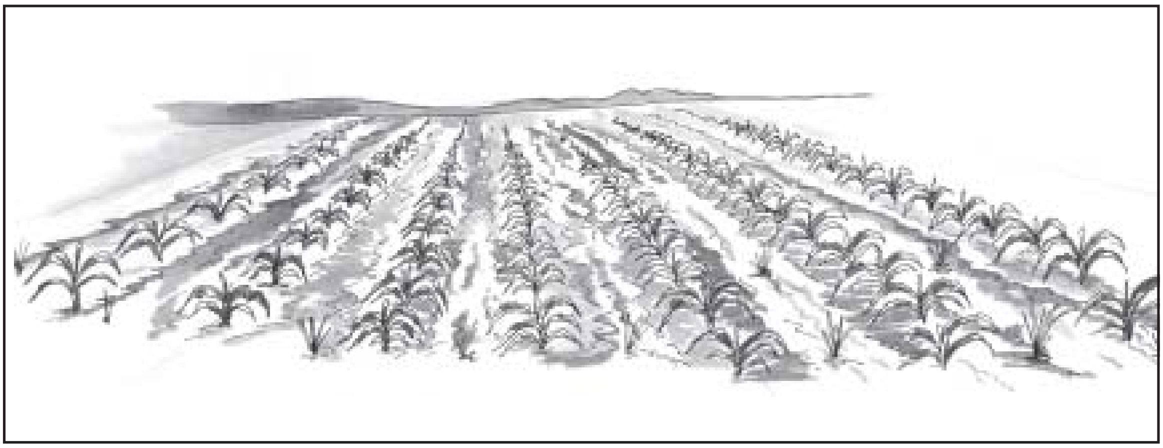


*Figure 22: Avoid swampy land*

Plots that previously hosted similar crops have to be avoided, to reduce the risk of contaminating the current variety with the previously grown varieties emerging from volunteer plants. Rotations will also prevent disease build-up. For example, Common Bacterial blight of common beans accumulates in the soil. Normally, field sites are given a 12 months break, but this has to be doubled for basic seed. Rotational considerations can, however, be relaxed if the variety is similar to the one previously grown, subject to other rotation requirements being met. Also, in instances where differences in varieties grown in rotation are very distinct, such as flowering stages and morphology, these differences would permit identification and subsequent roguing of off-types to prevent contamination.

*Figure 23: Avoid sites on sloping land*

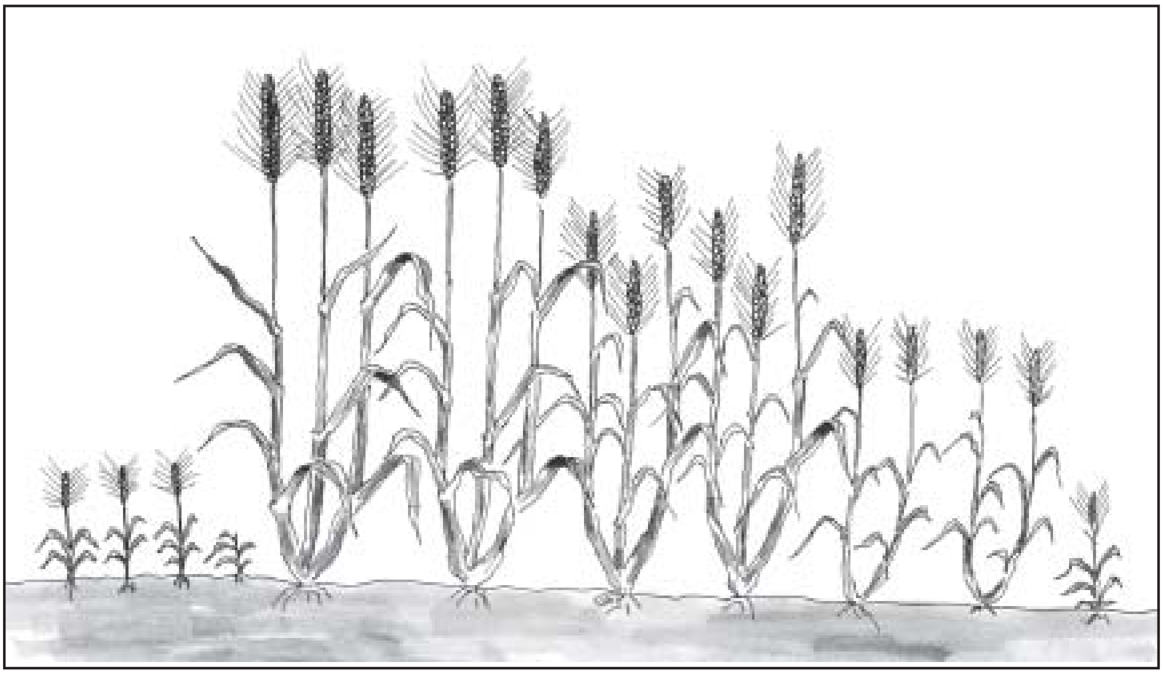


*Figure 24: Avoid sites with uneven fertility*

Contamination of varieties is also preventable if sites chosen are adequately isolated from potential contaminant crops. This prevents genetic contamination, physical admixtures, and spread of diseases. However, isolation distances may be reduced if other protection measures are instituted. For instance, many border rows could be planted around the seed rows. In cases were large fields are used as alternatives to large isolation distances, only the centre of the field is harvested for seed. Additionally, barriers such as windbreaks assist in reducing isolation distances. Livestock may carry contaminant pollen and seed, humans may steal,

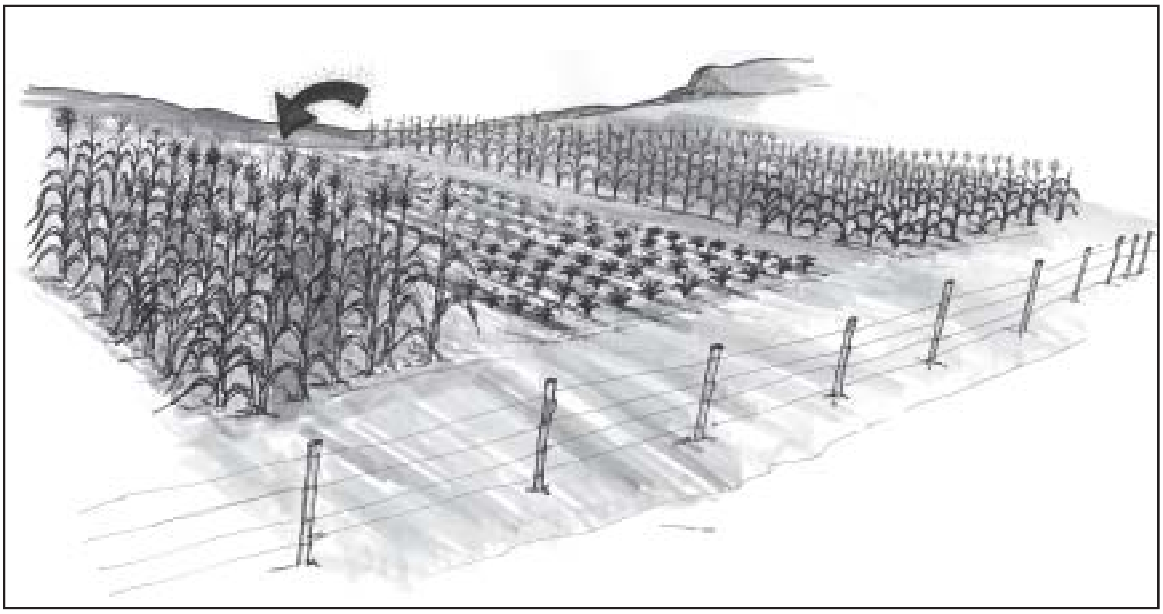


*Figure 25: Avoid sites close to contaminant crops*

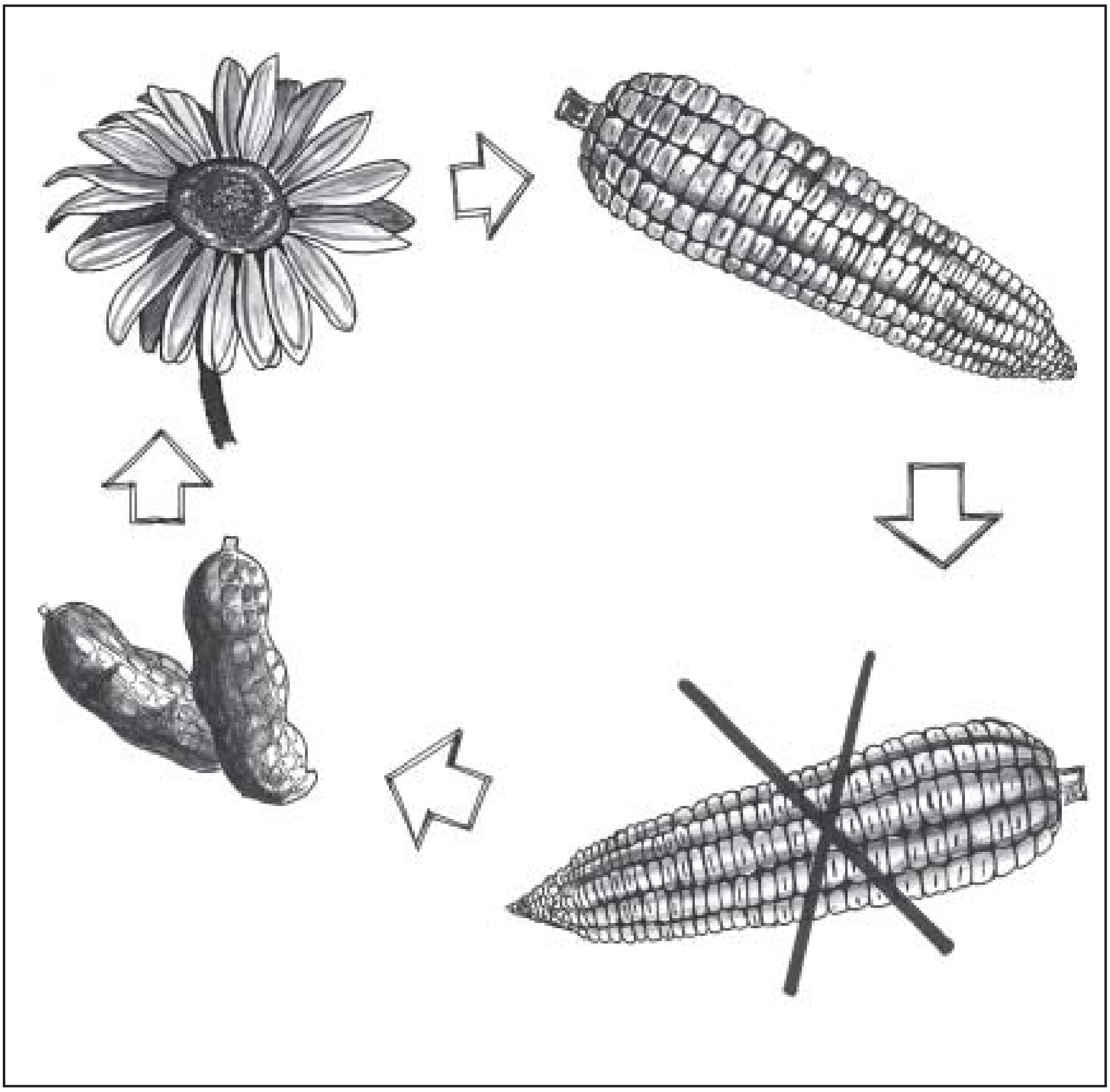


*Figure 26: Avoid sites that previously hosted similar crops*

and both may damage soil structure. Siting plots away from livestock and human tracks and sites close to seed stores are, therefore, further ways to reduce variety contamination, thus maintaining genetic purity.

Finally, choose sites that allow access for bringing inputs and moving seed harvests out.

### III.2.3.1 Preparation of the seedbed

Once a site has been identified, it is important to plough it early, probably one month before establishing the seed crop. Early ploughing will ensure that all residue rots down, allowing seed crops to grow well once planted. Weeds will also germinate and grow adequately in the intervening period, and these could be destroyed before crop establishment. Such early weed control practices thus reduce risk of contamination later.

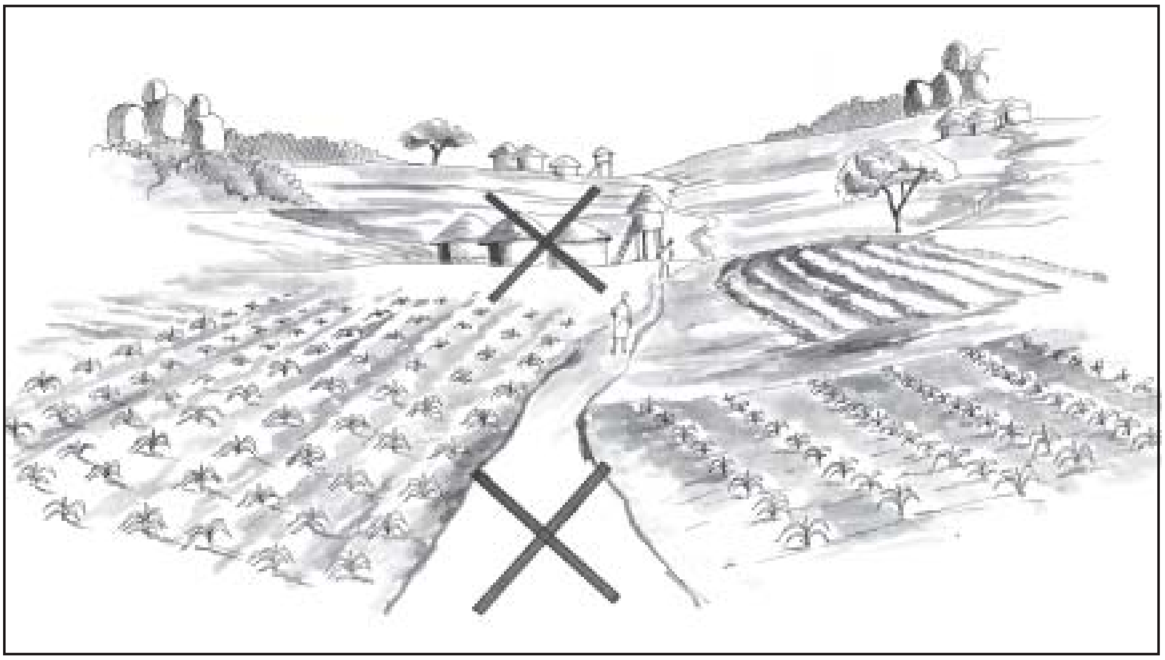


*Figure 27: Avoid sites close to tracks and stores*

Ploughing should be even, so that seed germination and growth of the crop is uniform, thus permitting easy spotting of off-types and diseased plants. Ploughing depth should allow adequate burial of crop residues and weeds. Disc and harrow to achieve fine tilth. Fine tilth increases soil-seed contact, and reduces failure of germination. Failure to germinate can also be reduced if minimum tillage is avoided.

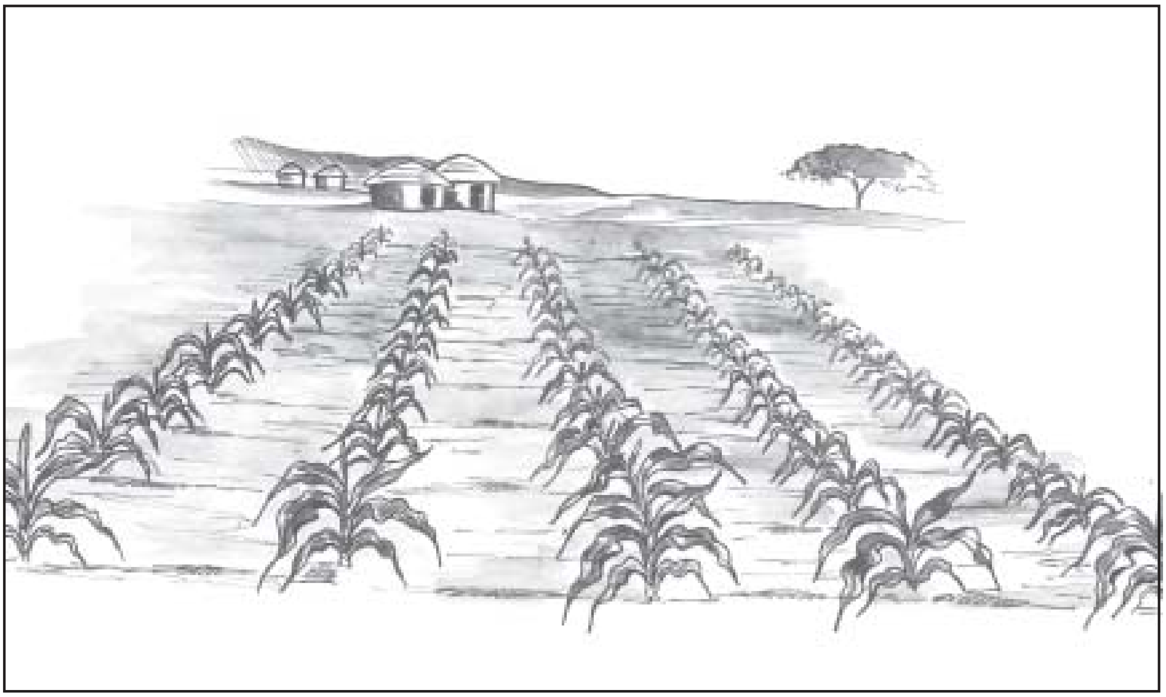


*Figure 28: Land ploughed early, about a month before seed crop.*

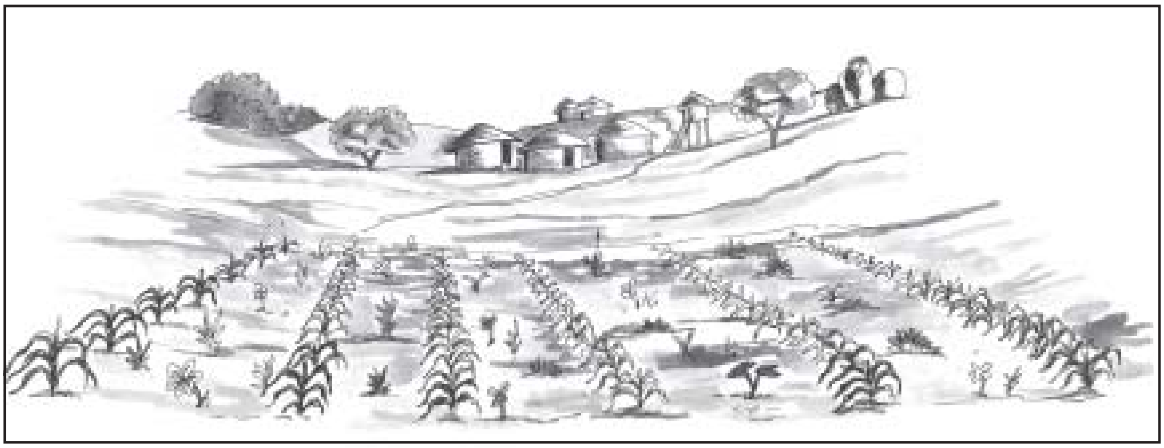


*Figure 29: Land ploughed late, immediately before seed crop*

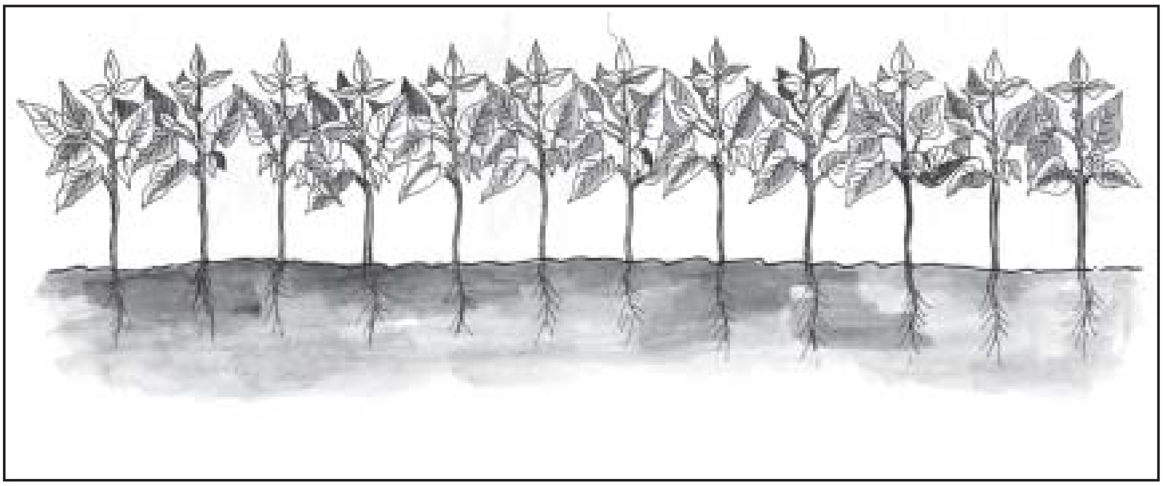


*Figure 30: Even ploughing depth*

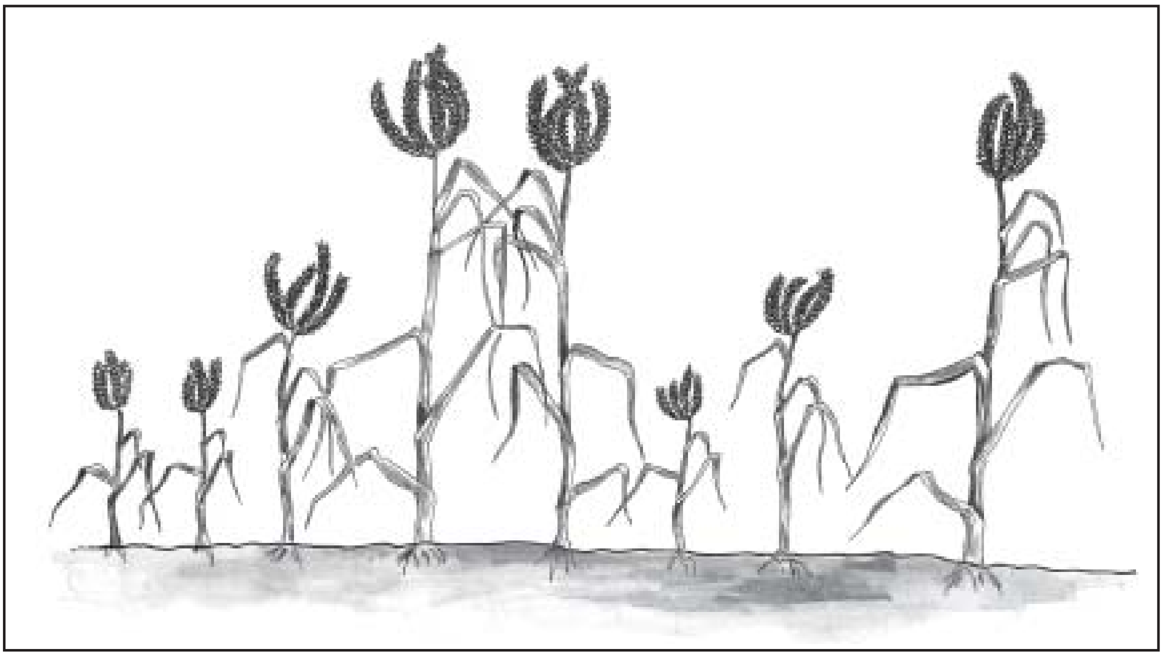


*Figure 31: Uneven ploughing deph*

*Figure 32: Fine tilth*

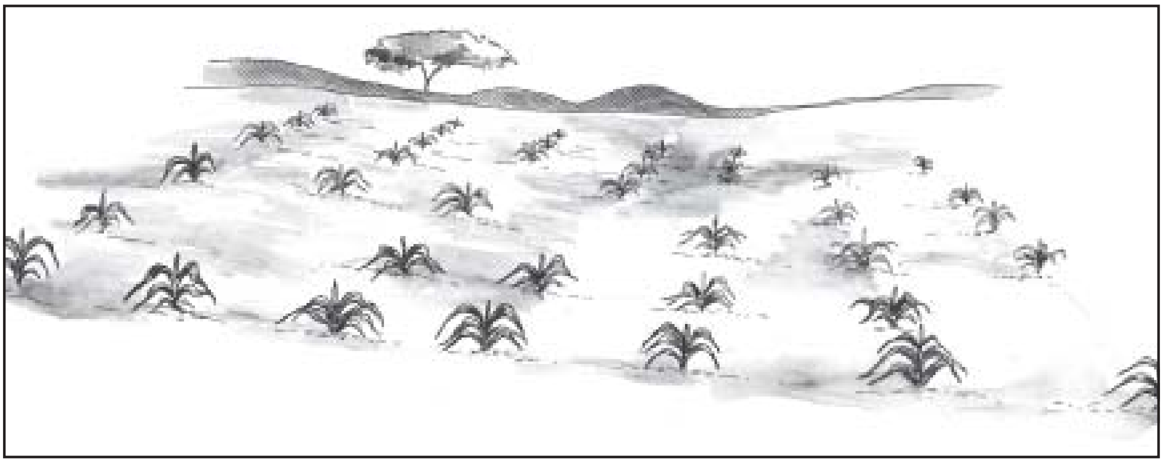


*Figure 33: Uneven tilth*

## III.2.4 Monitoring of Flowering

Flowering requires more attention than at any other stage of development during seed multiplication. Good and effective flowering management ensures:

- Complete pollination and good grain setting. Poor pollination often results in low seed set and yield. It also leads to production of a seed crop with variable seed sizes.
- Genetic purity of the seed crop.

Effective flowering management is achieved through monitoring of the flowering pattern of the crop. Field inspection ensures detection of off-types, volunteer plants and subsequent roguing of unwanted plants. Procedures for monitoring and field inspection are as follows:

- Visit the field regularly at booting stage: - this should be done preferably on a daily basis.
- Any plants that flower earlier than the estimated time to flowering should be destroyed.
- Estimate the percentage of flowering plants during every visit.
- For pearl millet and sorghum, all plants with ergot should be removed, put into a plastic bag, and burned.

## III.2.5 Physiological Maturity of Seed

Once pollination and fertilization have taken place, grain filling begins. This stage of development requires adequate soil moisture to ensure grain filling. Once grain filling has stopped, the seed is considered to have reached physiological maturity. At physiological maturity, a black layer develops at the hilum. This is a common characteristic in most cereal crops. Physiological maturity occurs when seed moisture content is 40–45 %. To establish the physiological maturity of seed, the following should be done:

- Select grain from a randomly selected heads or cobs.
- Remove the plug at the hilum.
- Check for a black layer (Fig 11).

Once the seed reaches physiological maturity, it is ready for germination. In some cases, the seed will germinate on the cob or head when moisture content is raised to more than 90 %. This occurs when the seed crop is exposed to incessant rain while in the field. Harvesting, therefore, can start when the seed reaches physiological maturity. It should be noted that if seed is harvested at physiological maturity at 40–45 % moisture content, it has to be dried artificially to 10–14 % moisture content, or moved onto a crib to allow natural drying out by the enviromental or artifitial warm air flow. The major activities to post-physiological maturity handling of the seed crop are as follows:

- Seed moisture content determination.
- If the weather conditions allow for natural field drying, the crop could be left in the field to dry to the required moisture content.
- If conditions do not allow for it, the crop should be harvested and dried artificially at controlled temperatures, or left on a crib and dried naturally by warm air flow.

*Figure 34: Farmers showing mature cobs of maize*

## III.2.6 Harvesting Seed

The moisture content of seed determines when the seed crop should be harvested. The seed must be harvested when moisture content is ideal. If harvested at high moisture content, it does not store well and loses quality more rapidly than if harvested at a moisture content of 12–15 %. Late or delayed harvesting exposes the seed to pest and disease infestation. This also reduces the storage life of the seed.

## III.2.7 Post-harvested Operations

### III.2.7.1 Drying

Seed is often harvested at higher moisture content than storage moisture. Harvested seed is left to dry to 10–14 % moisture content. Seed can be dried on cribs, mat or rock surfaces. The disadvantages of these drying methods are termite damage, pest infestation, livestock damage and contamination from grain left on crib or rock.

The procedure for drying seed on a crib is as follows:

- Construct a crib (with thatch roof) of 1–2 m above the ground.
- Apply used oil or ant kill on the supporting pillars to prevent termites climbing onto the crib and damaging the seed.
- Load cobs/heads loosely onto crib.

*Figure 35: Time harvesting date properly. Avoid harvesting when it is still raining as drying will be difficult.*

- Remove weeds and diseased heads or cobs.
- Leave to dry, checking moisture regularly. Ensure the crib is protected from rain and sun.
- Monitor the drying process, making sure there are no pests infecting the seed.

### III.2.7.2 Threshing

Once seed is dry to 14 % moisture content, the heads or cobs are threshed. Threshing can be done on the dry ground or a rock surface using sticks. Threshing can also be done on strips of wood arranged on a platform. Some farmers may use mechanical threshers. It is recommended that seed be threshed in gunny bags to prevent mechanical damage to the seeds.

Good quality seed is better shelled by hand especially for maize and ground nuts as mechanical devices tend to damage seed-grain.

*Figure 36: A thatched drying crib for cobs/heads of seed crop*

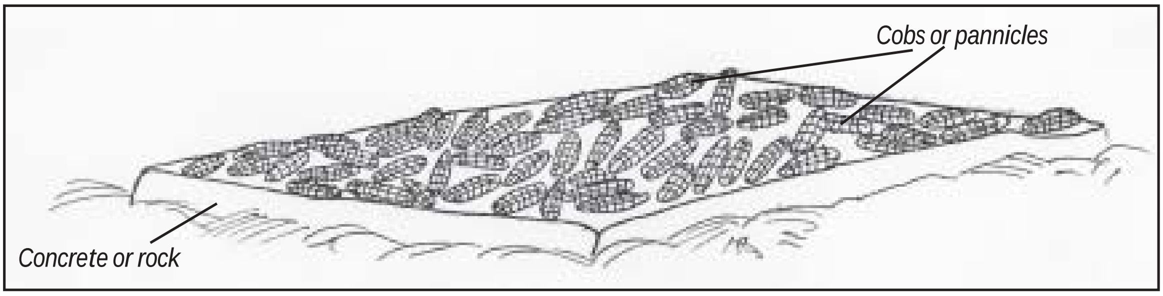



*Figure 37: A concrete slab for drying seed*

### III.2.7.3 Winnowing and Sorting

Winnowing is conducted to remove chaff, etc. from threshing. The procedure for winnowing and sorting is as follows:

- Select a clean surface.
- Use clean winnowers (free from other seed, soil, etc.).
- Winnow when there is a slight breeze in a consistent direction.
- Winnow slowly to allow separation of chaff and light seed.
- Place seed in sorting baskets or containers.
- Remove all broken, diseased and damaged seed.
- Treat and store seed in clean bags.

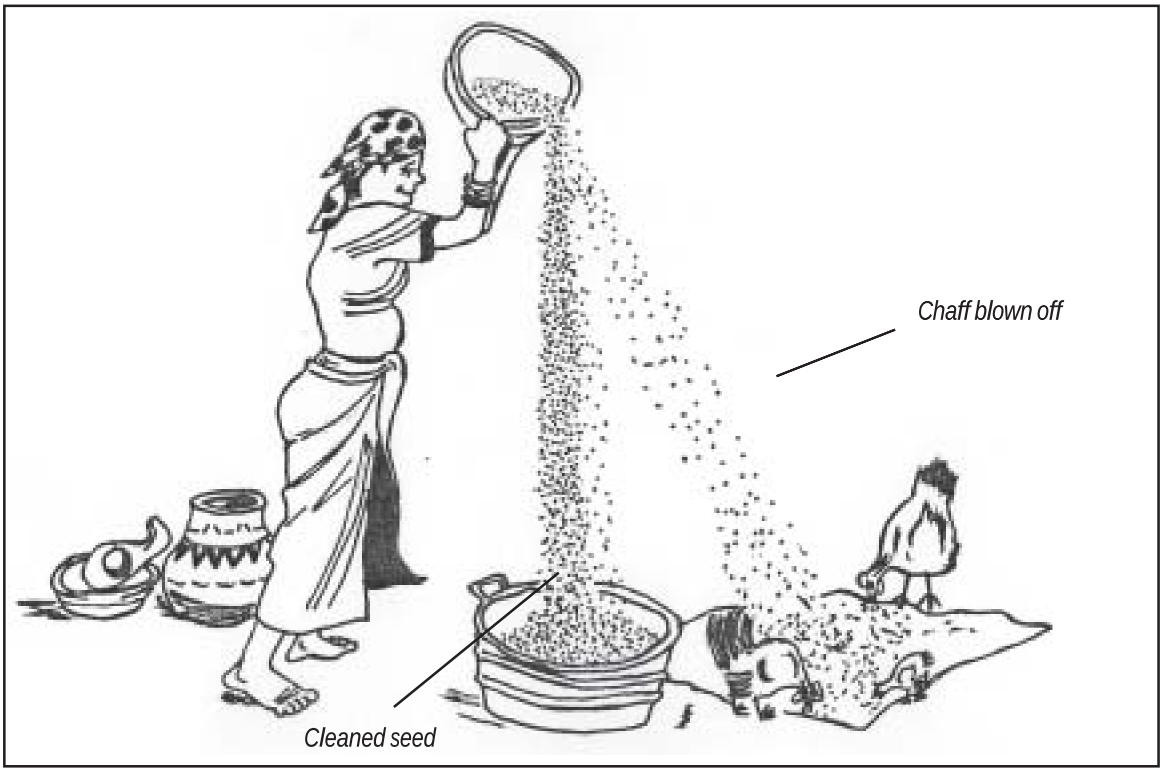



*Figure 38: A woman cleaning seed by winnowing*

### III.2.7.4 Seed Treatment

The objective of seed treatment is to control and prevent seed infestation/attack by pests and disease. The most common system of seed treatment for pests and diseases in the SADC region is seed dressing. In this case, the seed is treated either with a dry formulation, or wet-treated with slurry or a liquid formulation. On-farm seed production systems can apply both formulations, using a simple homemade rotating drum. The procedure to be followed is as follows:

- Equipment: rotating drum, required chemicals, etc. (Figure 39)
- Place clean seed in a rotating drum.
- Add dry dust, slurry or liquid formulation of the recommended amount.
- Rotate the drum for 30 minutes, checking that the seed is covered uniformly with chemicals.
- Remove seed into a bag or other storage container. If seed is too wet allow it to dry on a clean dry base (concrete, tarpaulin or rock).

Chemical can be poisonous: therefore, the following precautions must be taken when using chemicals:

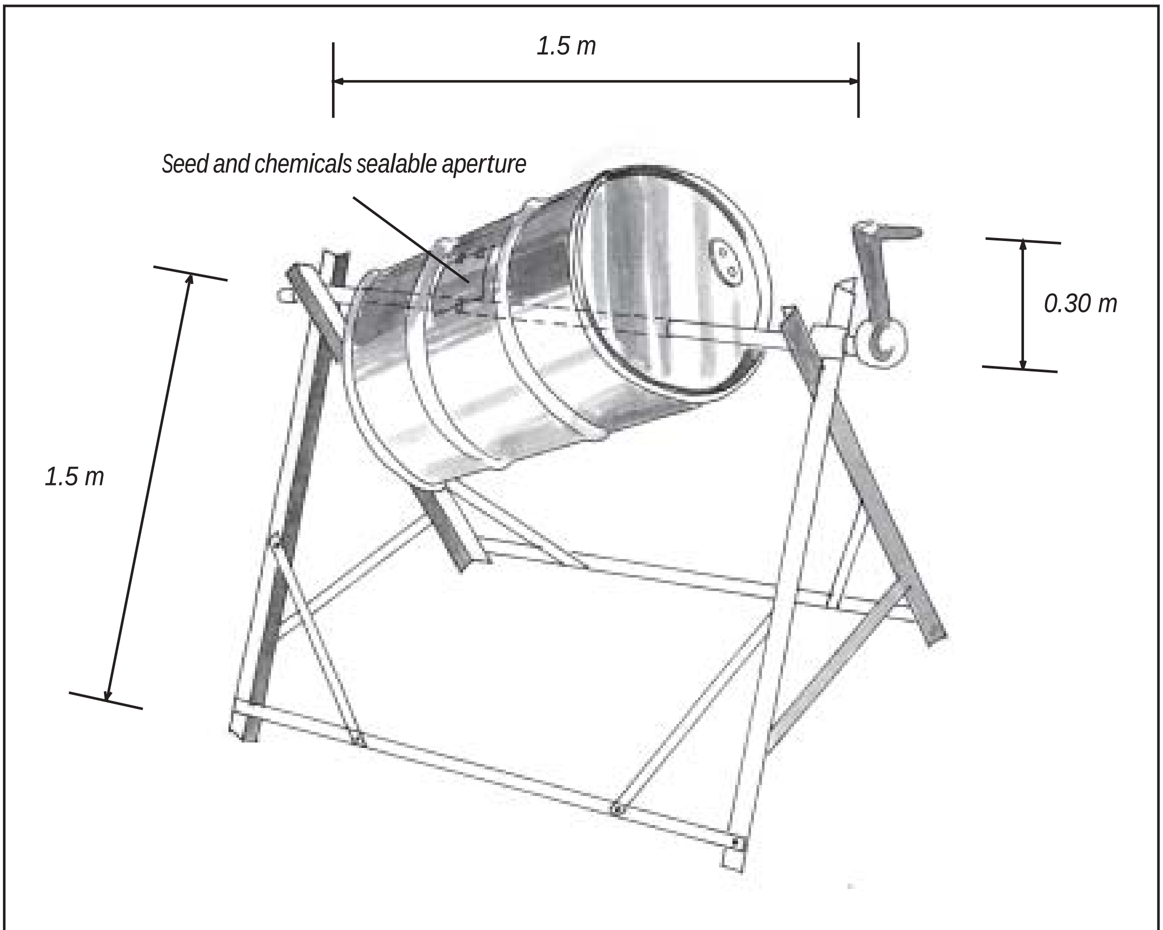



*Figure 39: A seed treatment drum*

- You should be trained in using chemicals.
- Follow instructions as given on the container.
- Check on the expiry date of the chemical when you buy it, as most chemicals lose their strength with time.

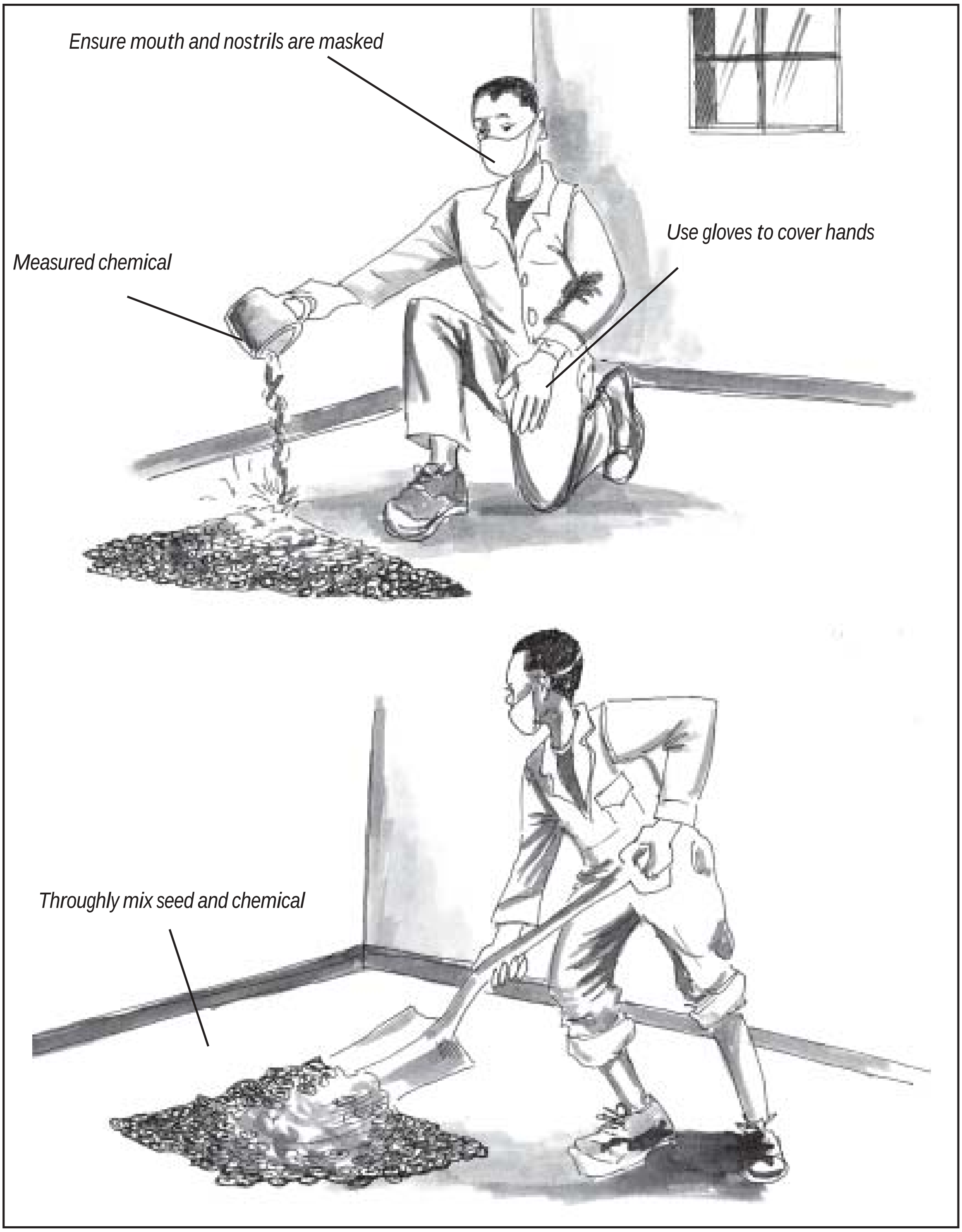



*Figure 40: Seed treatment using concrete floor and a shovel*

- Treated seed should never be eaten.
- Never eat or smoke when using chemicals.
- Use protective clothing when handling chemicals, i.e., gloves, noise mask or even protective glasses.

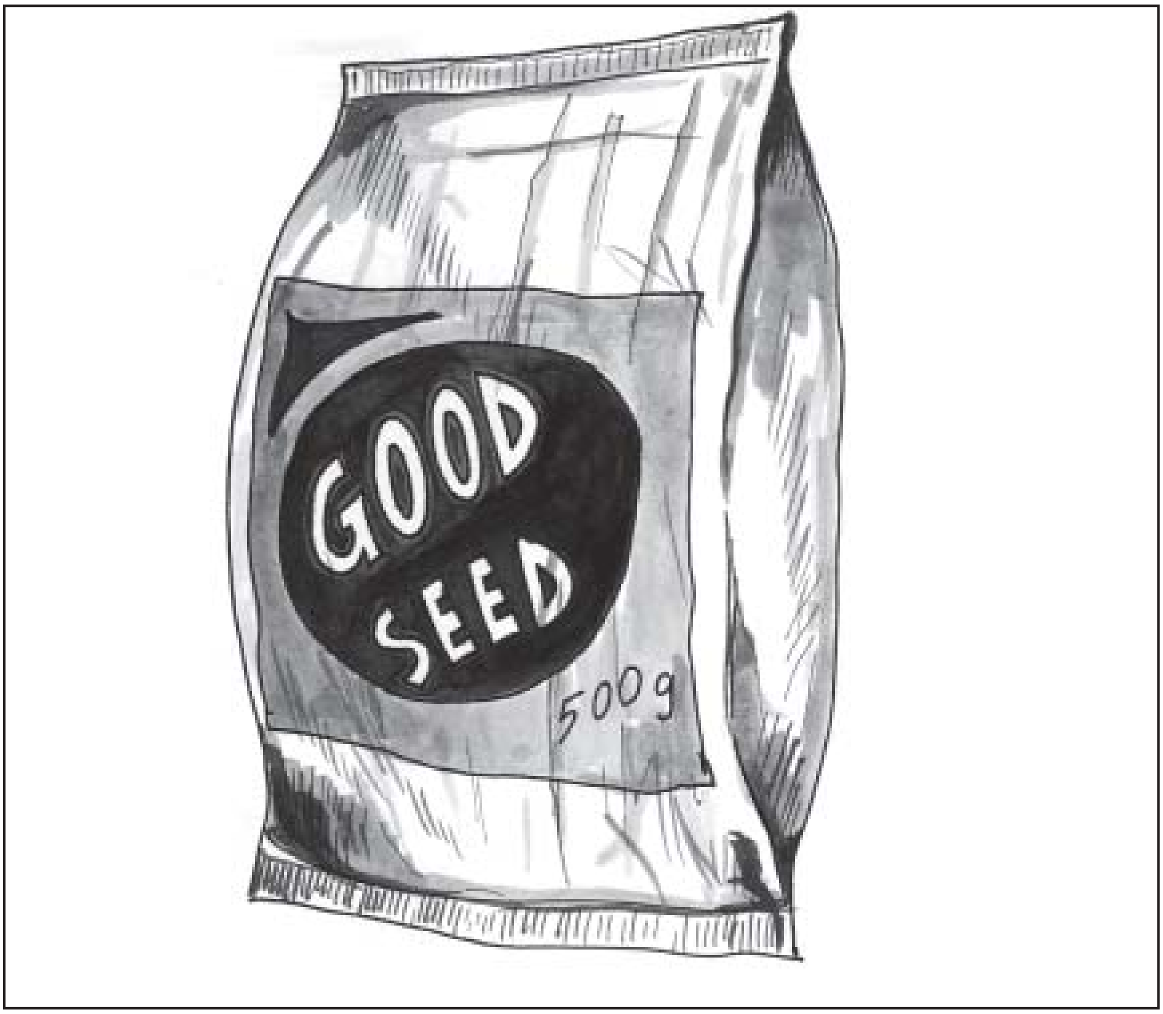



*Figure 41: Treated seed should be bagged or put into a storage container*

## III.2.8 Seed Quality

Seed is a biological unit whose quality reflects the type of crop to be harvested. Poor quality seed leads to poor crop establishment, growth and development and subsequent yield. The main seed quality parameters are genetic, physiological and physical.

- Genetic quality refers to genetic integrity of the genotype of the variety in question. Thus, any contamination from foreign pollen during flowering, pollination and fertilization causes loss of genetic purity.
- Physiological quality refers to ability of the seed to germinate, freedom from systemic pests and diseases, and having optimal moisture content. Poor physiological quality results in low germination rates and vigour.

- Physical quality is the freedom of seed from various contaminants, such as inert matter, disease spores, seed of other crop species and varieties of the same species.

### III.2.8.1 Why is Seed Quality Important?

When farmers purchase seed from any source, they expect the seed to germinate and give rise to healthy plants that interact positively with the environment. Good quality seed will also ensure better yields for the farmer. Good quality seed ensures healthy plants, while poor quality seed gives rise to sickly plants. Seed quality is important, because it affects crop yields.

### III.2.8.2 Elements of Good Quality Seed

Good quality seed:

- Has high germination rates
- Is free from noxious weed and other crop seed
- Is not damaged by insects
- Is free from disease and pests
- Is pure with all seed of the same variety and size

### III.2.8.3 Seed Quality Testing

The major quality components are tested and evaluated differently. However, before any seed quality testing is conducted, the seed must be sampled properly.

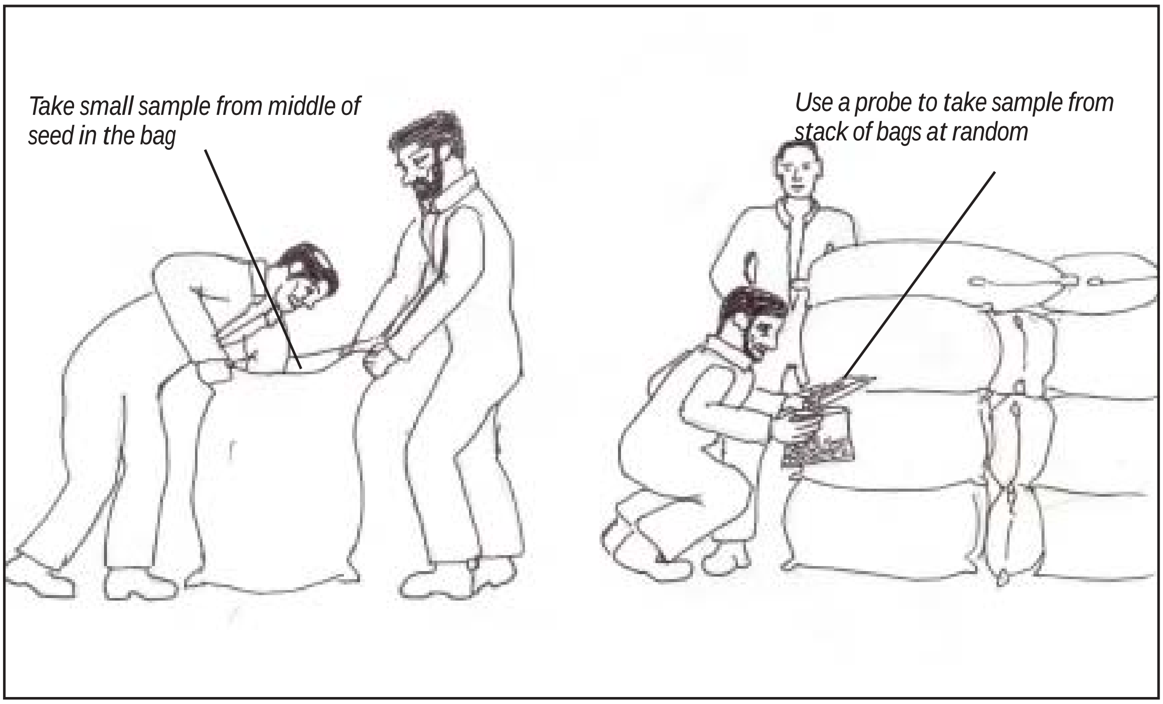



*Figure 42: Seed sampling using a sampling probe and hand collecting of small samples from open bags*

### III.2.8.4 Sampling of Seed Lot

Seed quality tests are conducted on a seed sample. The sample is representative of a seed lot. The size of the seed lot depends on the species and the size of the harvest. In some cases, the seed lot represents the total seed harvested.

The seed certification inspector does the sampling of a seed lot based on the seed certification scheme guidelines. However, anyone can sample a seed lot using the following procedures:

- Arrange bags in such a way that they are accessible for sampling.
- Using a sampling probe or hand, if bags are open, collect small samples of seed from each bag or randomly selected bags.
- Mix the small samples from the bags to form a composite sample, normally 1000g for crop seeds. In some cases, the composite sample may be too big to be sent to the laboratory.
- Take the sample to laboratory without delay.

### III.2.8.5 Registration of Samples

Once a sample has been drawn from a seed lot, care must be taken to:

- Retain the identity of the sample
- Avoid damage by pests
- Avoid exposure to variations in temperature and moisture

If a number of samples are drawn from the same source or different farmers as in the case of community-based production systems, the following information must be attached to each sample:

- Reference number
- Seed kind and variety
- Lot number
- Date sampled
- Date sample received by the seed certification agency

Once a sample is received, it goes through the testing procedures as described below.

### III.2.8.6 Testing Genetic Purity

Although field inspections and checks on seed origin ensure genetic purity, there is still need to verify the purity of the variety. This is done through pre- and post-control tests. Under pre-control tests, a sample of a seed lot intended for production of seed is planted in replicated plots. The growing plants are examined during the growing season. The plots are planted simultaneously with the seed crop. The results of the analysis will reveal the genetic purity of the variety planted for seed multiplication. The results will also show counts of other varieties, off-types and diseased plants. These results will assist in the management of seed multiplication, ensuring genetic purity of the variety.

In post-control plots, a sample from the harvested and processed seed crop is planted out during the next growing season. The purpose of the post-control tests is to check on the accuracy and effectiveness of the quality control procedures applied during the previous growing season. They also verify the genetic purity of the seed multiplied and distributed to the farmers.

### III.2.8.7 Testing for Physiological and Physical Quality of Seed

The physiological and physical qualities also determine the value of seed for planting. The physical qualities are referred to as analytical purity. The testing of these qualities is not restricted to registered laboratories, but can also be done by makeshift on-farm laboratories.

Seed quality standards list minimum requirements for germination and analytical purity. There is also minimum moisture content. These standards are contained in the internationally recognized Seed Certification Scheme and Seed Regulations adopted by each country. It should be noted, however, that seed testing laboratory results are not expected to show results for genetic purity, as these are done separately in the pre- and post-control plots.

### III.2.8.8 Testing for Seed Purity

Seed purity is tested for the species in the sample and includes all varieties and cultivars of the species, undamaged seed, seed in glumes, etc., as in sorghum, immature seed, (shrivelled, undersized or germinated seed), diseased seed and pieces of broken seed larger than half the original seed.

The objectives of purity analysis are to determine:

- The percentage composition by weight of the seed lot. The purity defined in the sample is a reflection of the actual status of the seed lot.
- The identity of the various species of seeds and other particles and materials constituting the sample.

When determining seed purity, the following procedure should be used:

- Take a working sample from the submitted sample, using the various methods given above.
- Weigh the working sample and record the weight.
- Separate the working sample into its components, namely pure seeds, inert matter and other seeds.
- Weigh the different components separately.
- Calculate the weight of the components as a percentage of the weight of the working sample.

### III.2.8.9 Definition of Inert Matter

Inert matter refers to:

- Material derived from seeds which may resemble seed
- Materials from other parts of the plant, i.e. leaves and stalks

- Dead insects, etc.
- Soil and stones

### III.2.8.10 Definition of Other Seed

These are seeds of other plant species, such as weeds and crops that are not part of the sample.

### III.2.8.11 Testing for Germination Capacity

The objective of testing for germination is to determine the maximum germination capacity of the seed. Germination results give an indication to farmers of how much seed may be needed to obtain good crop stand. It determines the planting rate, that is, how much seed should be planted per hectare or acre.

When testing for germination capacity, the following procedures should be used:

- Only pure seed should be used.
- Select randomly 4 x 100 (400) seeds from the pure seed sample.

The testing procedures for sorghum, millet and other small grain cereals, such as wheat, etc. are as follows:

- Plant seed on substrate into 4 equal groups of 100 seeds each. Seed can be planted in clean river sand or clean newsprint or toweling paper.
- Label each batch of seed planted.
- Incubate at 20–25$^{o}$C.
- Observe the seedlings after a specified period for each seed type.
- Take records of normal and abnormal seedlings. Normal seedlings should have well-developed roots, leaves and stems, while abnormal seedlings will have no roots and no leaves.
- Count the number of normal and abnormal seedlings in each batch of 100 seeds. Add totals of normal or abnormal seedlings. Divide by the number of seeds planted (including all batches). Multiply by 100 to get the percentage of germination.

### III.2.8.12 Substrates for Germination

Paper and sand are commonly used as substrates for seed germination rates to be tested. When using paper as a substrate, the paper should be of uniform moisture-holding capacity over its entire surface. The paper should be free of harmful chemicals and moulds. The paper should also be resistant to penetration by seedling roots. The procedure for using paper as a substrate is shown in Figure 43 below.

Sand is normally used for large seeds, such as maize and beans. Sand for germination should have the following characteristics:

- It should be able to hold sufficient moisture for the whole period of the germination test.
- It should be able to provide the correct balance between water and air supply to the germinating seed and developing seedling.

- It should be free of impurities, because they affect the germination of the seed.
- It should be sterilized, to prevent soil-borne moulds from affecting seed germination.

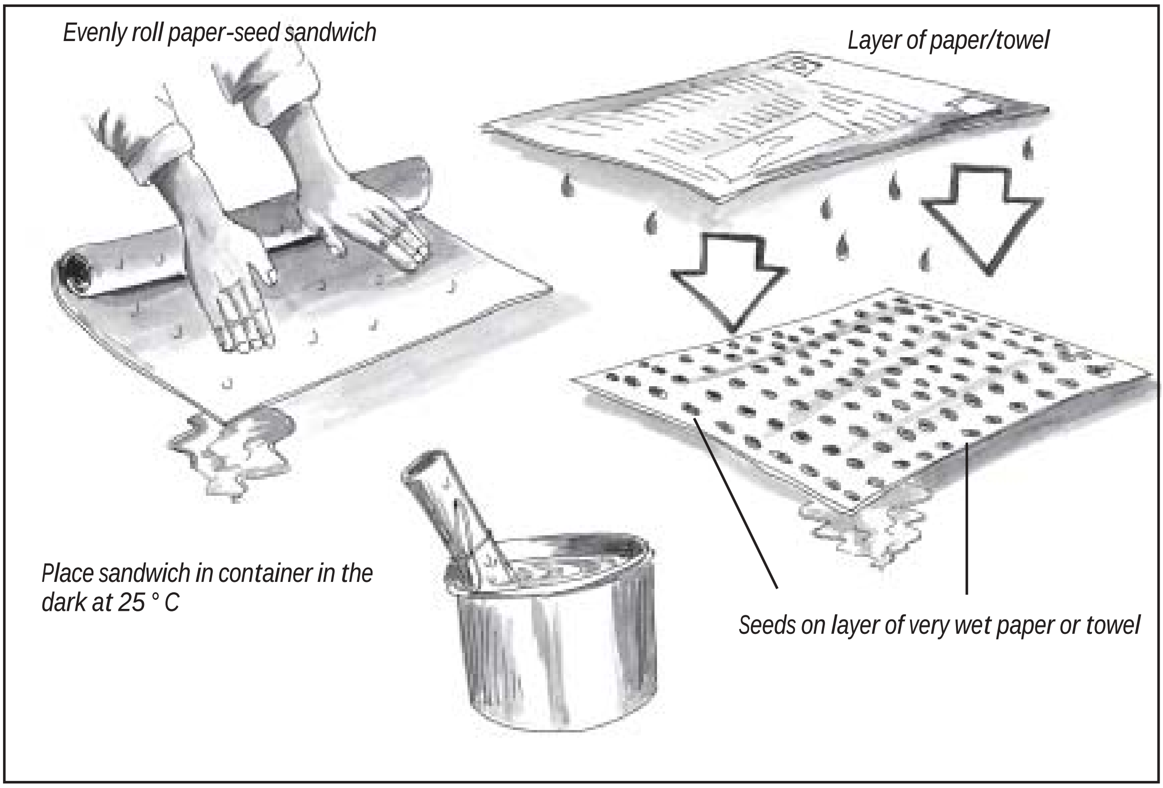



*Figure 43: Determination of germination quality using cloth and paper methods*

### III.2.8.13 Testing for Seed Health

Seed health refers to the association between seed and pests and diseases. Sometimes, seed fails to germinate into normal seedlings, because of infections from bacteria and fungi. Diseases associated with seed are seed-borne. Due to increased awareness of the importance of seed-borne diseases, most governments worldwide now require Phytosanitary Certification for imported seed. Pathogens can be transmitted by seed in three different ways, as follows:

- **Seed contaminants**: Inert material, such as soil clods, plant debris, and/or loose reproductive organs of the pathogens might act as carriers of the active or resting stages of organisms. Important pathogen organs that can be carried with seed are: fruiting bodies, telio and uredospores, nematode galls, chlamydospores and sclerotia.
- **Contamination of seed surface**: The seed coat and/or percarp can carry different pathogen organs. Different kinds of spores, fruiting, bodies and micro sclerotia are carried on seed surfaces. Even some viruses and bacteria can be transmitted this way.
- **Seed infection**: Infection may occur in the embryo and endosperm (systemic infection). Most seed-borne viruses and all loose smut pathogens fall into this category of transmission. Pathogen organs found in infected seed are:- dormant mycelium, chlamydospores, fruiting bodies, virus particles, bacterial cells, nematode larvae and micro sclerotia.

Seed health testing, therefore, is conducted to maintain clean germplasm for breeding programs; to predict field performance and subsequent disease development:- to determine whether seed treatment is necessary and prevent introduction of new pathogens in disease free areas. The blotter method is standard in seed-health testing and the tests can be conducted with the same equipment used for germination. Procedures for the blotter method are as follows:

- Plant seed in absorbent paper (blotter). Paper must be sufficiently moistened for the duration of the test.
- Place the blotters in petri dishes or clean food plastic boxes.
- Sow seed using uniform spacing that is consistent with seed size. Incubate dishes for a fixed time at 28°C. After the pre-determined incubation period, examine the seeds under a low-power stereoscope microscope for pathogens.

### III.2.8.14 Testing for Moisture Content

When a sample is brought into laboratory for testing, the moisture content is also determined. Recommended storage moisture content varies with crop species and ranges between 9 and 14 %. When determining moisture content, the following steps are taken:

- A sample drawn for moisture content must be taken to the laboratory and stored in a waterproof container.
- Weigh 100g of seed.
- Place the sample in porcelain crucible.
- Place in oven at 130°C for two hours. Make sure seed does not burn
- Remove sample and reweigh. Repeat process until mass does not change.
- Calculate the difference with original weight.
- The difference over the original mass x 100% represents the moisture content as a percentage.

### III.2.8.15 Testing for Seed Vigour

Seed vigour reflects the ability of seed to germinate rapidly, giving rise to healthy fast-growing seedlings. High seed vigour gives the seedlings a competitive advantage over weeds, etc.

## III.2.9 Seed Production Systems

When a breeder has developed a new variety, the variety must be multiplied and made available to farmers without delay. The production and delivery of good quality seed of improved and adapted varieties requires technical understanding of seed issues. The production of quality seed must be done under standardized conditions. To ensure quality of seed, the different stages of production must be supervised properly. Thus, during the production process, strict attention must be paid to the maintenance of genetic purity of the variety. There are three internationally recognized stages of seed multiplication. These are as follows:

- Pre-basic (Breeders') seed: this is normally multiplied in one generation under the supervision of the breeder. It is the source of basic seed. In some countries, basic seed is referred to as foundation seed.

- Basic (foundation) seed: this is multiplied under the supervision of the breeder or his agent. Standards applied in the production of basic seed must be those defined by the regulations of the country. Basic seed is used for the production of certified seed.
- Certified seed: this is seed produced either for further multiplication to 1st or 2nd generation seed in OVP only, or for the production of a commercial food crop. Uncertified seed can also be marketed as commercial or standard grade seed, but normally for OPV only..

### III.2.10 Seed Production Techniques

There are two major seed production systems: formal and informal. Under informal seed production systems, seed is not subject to strict and at times, mandatory quality control. Seed can be drawn from a commercial grain crop, cleaned and sold as "quality" seed. Recently, some organizations, such as Non-Governmental Organizations (NGOs), made improvements to the informal seed production system by:

- Relying on authentic sources of parent seed (basic seed) for further multiplication.
- Insisting on the application of quality control measures during and after multiplication.

However, informally produced seed is distributed within communities as home-saved and farmer-to-farmer seed exchange. The advantage of informal seed production systems is that seed or planting material can be made available without strict adherence to national regulations. In addition, it can be the basis for seed entrepreneurship development. Open and self- pollinated crops normally dominate the informal sector, and other crops regarded to be unattractive to the formal sector.

The formal seed production system abides by the regulations stipulated in each country. All seed crops are registered with the certifying authority of the country. Only registered varieties are multiplied for seed.

In both seed production systems, there are stages to be followed when producing seed. These include:

- Selection of varieties to be multiplied:- farmers' needs must be taken into account to ensure that all seed produced is marketed and sold. Thus, seed production must be demand driven. Selected varieties may be improved varieties (from research and development programs) or local varieties, such as land races.
- Selecting seed for planting:- to produce quality seed, seed of good genetic, physical and physiological quality must be planted. It must be of guaranteed quality.
- Selecting of site for seed production:- not all sites are suitable for seed multiplication. Only a site of suitable soil, free from noxious weeds and well rotated, to prevent volunteer crops that may contaminate the seed crop, must be selected for seed production.
- Land preparation:- care should be taken when preparing land for seed multiplication. Soil texture and particles must be even, to ensure uniform germination and maturity.
- Seed planting:- this should be done correctly, avoiding possible admixtures. Use clean containers all the time. Seed should always be planted in rows at uniform planting depth.

- Weed control and roguing:- all weeds must be removed, as they compete with seed plants for water and nutrients. Weeds tend to grow faster than crops and often overcome the seed crop, resulting in poor growth and development of the seed crop. Rouging helps to remove unwanted plants, which can be a source of both genetic and physical contamination.
- Controlling diseases and pests:- diseases affect crop growth and affect seed quality. Insect pests damage the seed, reducing physical quality and germination.
- Harvesting the seed:- all seed should be correctly harvested, avoiding admixtures and other forms of possible contamination. Seed must be dried to the right moisture content. The seed grower should avoid harvesting too late, as this may expose the seed to insect infestation in the field. In crops such as soybean, the seed may shatter, thus reducing the yield.

### III.2.10.1 Preconditions for Seed Production

Before seed multiplication is undertaken, a plan should be formulated. The plan should consider the following factors:

- Soil requirements for the seed crop to be multiplied
- Climatic conditions
- Farmers' requirements

### III.2.10.2 Soil Requirements

Seed must be multiplied in suitable soil conditions. Maize requires heavy to light sandy loams. These have a high water holding capacity. Maize requires soils that enable synchronization of male and female fertilisation gametes development during hybrid seed multiplication. Sorghum, millet, groundnuts, cowpeas, and bambara nuts can be multiplied in light sandy soils, as long as there is sufficient moisture.

### III.2.10.3 Climatic Conditions

Climate determines the type of crop to be planted. Seed multiplication for sorghum, millet and other crops should be multiplied in fairly dry climates, to reduce infection by seed-borne diseases.

### III.2.10.4 Farmers' Requirements

Farmers normally buy seed of crops and varieties they are familiar with. Varieties can be improved varieties or traditional varieties. Improved varieties must have been demonstrated for their productivity in field trials and accepted by farmers. Local seed producers should also liaise with their communities and establish the quantities of seed the community is likely to absorb. Production should be planned according to the seed needs assessment survey. Seed growers should be advised to always produce extra seed that will allow external markets and carryover stock of at least 20 % of the established community demand.

## III.2.11 Seed Multiplication of Self-Pollinated Crops

Seed of self-pollinated crops, such as groundnuts, may be re-sown for several generations. The procedure for seed multiplication is as follows:

- Obtain breeder or foundation seed.
- Identify the field for multiplication.
- Prepare the land suitably and make sure the land is isolated to avoid contamination from volunteer plants and mixing with seed from neighbouring plots, thus maintaining genetic purity.
- Prepare rows and apply fertilizer. Seed should always be planted in rows to facilitate removal of unwanted plants (roguing) and weeding.
- Plant seed in the rows. Always plant when soil moisture content is at field capacity.
- Cover the seed immediately with a 10mm layer of soil. This prevents birds from pecking at the seed, as well as protecting it from direct sunlight and high temperatures.
- As the seed crop grows, control weeds by hand or machine cultivation.
- Remove by hand all undesirable individual plants. The undesirable plants can be of the same varieties, but deformed or infected with disease or pests, and/or a different variety identified by its plant characteristics. When roguing, remove the entire plant and take it away. Roguing should be done before flowering, as cross pollination may occur through various agents, such as pollen-seeking insects and birds exploring the grain setting.
- Allow the crop to be inspected during active growth if necessary.
- Harvest the crop at about 40 % moisture content. If hand harvesting, do not leave crop in the field to below 40 % moisture content, as seed may be lost due to shattering or other factors when it is too dry. When machine harvesting, adjust machine correctly to avoid seed damage and losses during harvesting.
- After harvesting, process the seed accordingly. Seed must be processed on a clean base, such as a concrete floor or pressed ground. Avoid floors and ground with crevices, as seed of other varieties may be lodged in such areas. It is advisable never to process seed at the same time as similar varieties and other crops.
- Always use clean equipment, e.g. winnowers, bags, etc.
- Pack clean seed into clean bags.
- Store seed in a safe and cool storage place. Seed stored at room temperatures will keep longer and retain viability until the following planting season.

### III.2.12 Multiplication of Cross-Pollinated Crops

Seed production in cross-pollinated crops is more difficult than in self-pollinated crops. Seed of cross-pollinated species is replaced more frequently than in self-pollinated crops. They require more isolation. Cross-pollinated crops are associated with hybrids. However, synthetic and composite varieties have been developed from cross-pollinated varieties. Composite varieties are often referred to as open pollinated varieties. However, the most common cross-pollinated cereal crops in the SADC region are maize and pearl millet. Seed multiplication of these crops is conducted as follows:

- Identify the field or plot for seed multiplication, making sure that it is adequately isolated from plots of the same species. There is a minimum requirement for isolation of 400m for cross-pollinated crops. However, isolation distances can be reduced if the adjacent plots are planted at different times (time isolation) and if buffer rows are used (length of isolation will depend on the number of buffer rows). The more buffer rows the less the isolation distance. The isolation distance can be increased, where the crop is insect pollinated, such as in sunflowers, because the insects fly long distances.
- Plant seed in rows to facilitate roguing of off-types and unwanted plants.
- Add necessary fertilizer at planting to ensure optimal seed development and good yields.
- Monitor crop development, ensuring no foreign pollen contaminates the crop.
- Remove unwanted plants or off-types before pollen shed.

## III.2.13 Multiplication of Semi Self-Pollinating Crops

Semi self-pollinated crops should be treated the same way as self-pollinated crops. However, semi self-pollinated crops should also be isolated, to reduce any incidences of cross-pollination.

## III.2.14 Multiplication of Vegetatively Propagated Crops

Vegetatively propagated crops include the sweet potato, Irish potato and cassava. Stems are used in crop propagation in sweet potato and cassava, while tubers are used for propagation in the Irish potato. These crops are not subject to cross-pollination or genetic contamination and therefore remain pure after a number of generations. The main problems in seed multiplication of these crops are viral and bacterial diseases. Hence, extreme care must be taken when producing seed. The procedures for seed multiplication are as follows:

- Identify field or plot that has not been planted with a seed or commercial crop of the same species for a minimum of 3 years. This stops volunteer plants or bacterial diseases from the previous crop contaminating the current crop. Avoid areas with a history of viral disease outbreaks.
- Plant disease and pest-free stems or tubers. Stems from plants infected with a virus should be avoided. Nematodes infect potato tubers and such tubers should never be used for seed, as this spreads the pest to uninfected areas.
- Monitor growth and development of the seed crop. Weeds can harbour vectors, which transmit viral diseases. Hence, the seed crop must be cleaned, by spraying, regularly.
- For sweet potato and cassava, keep the crop in the field and harvest seed when needed. For Irish potato, harvest the seed crop, treat with a combination of a pesticide and fungicide and store in bags under cool conditions.

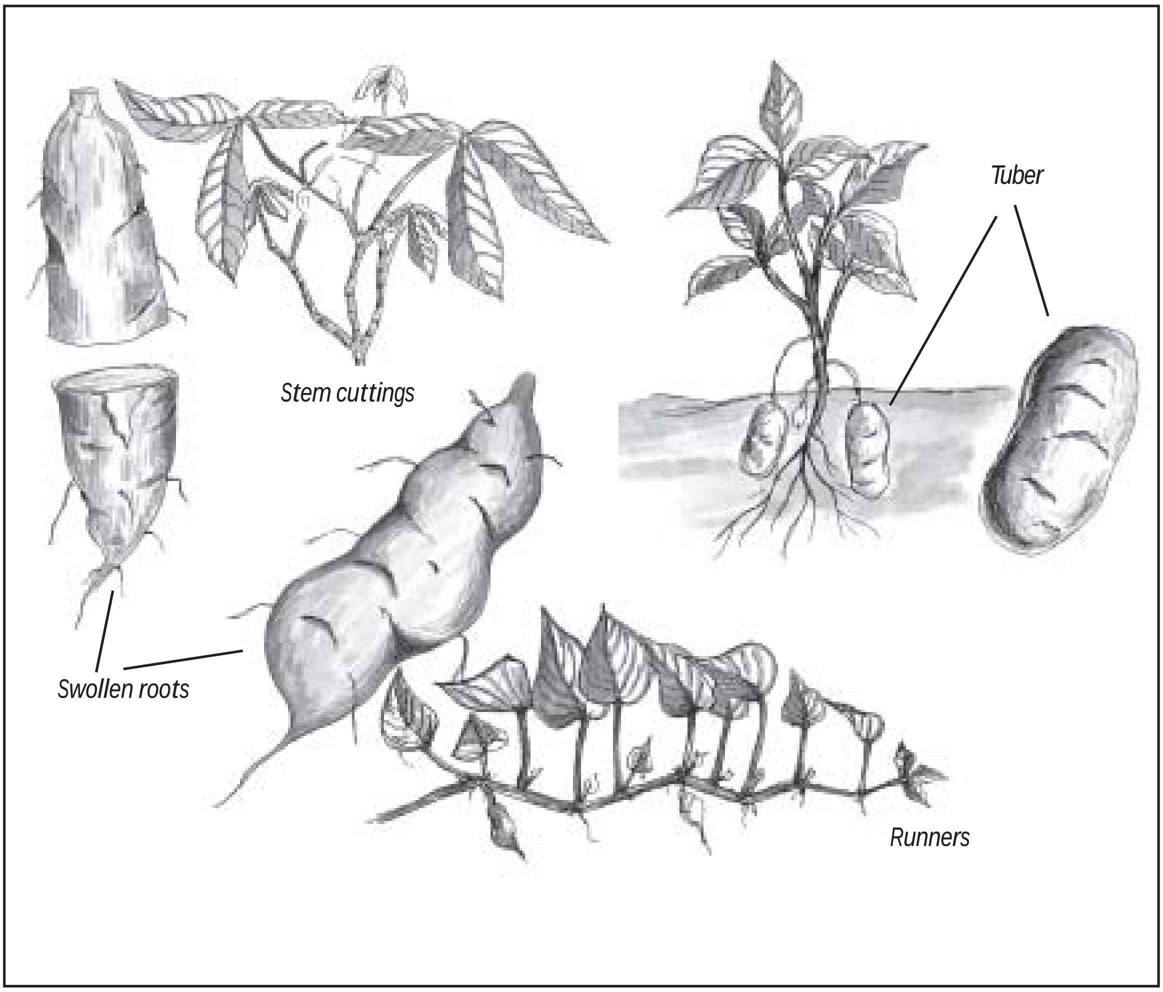



*Figure 44: Some popular vegetatively propagated crops in the SADC region*

## III.2.15 Off-season Seed Multiplication

Seed production is traditionally conducted during the growing season. In some cases, the seed produced is not enough for the following marketing season. As a result, seed is often produced off-season, i.e., during the winter/spring seasons. However, off-season production requires irrigation and is thus expensive. In most cases, therefore, only parent seed is produced during off-season. Off-season seed production is carried out as follows:

- Identify area for seed production. It must be an area where average winter temperatures are above 20°C, free from frost, adequately supplied with water for irrigation and accessible for associated seed activities.
- Plant breeder/parent seed in mid-June or after the frost period.
- Monitor crop during growth and development, controlling weeds and irrigating the crop as necessary.
- Harvest and process the seed before the next growing season.

## III.3 Agronomic Aspects

Successful production of crops in general and seed in particular, depends on how well the farmer practises sound crop management. There are many factors that contribute towards a healthy and productive seed crop. These include the genetic makeup of the variety, quality of the seed planted, soil and climatic conditions, and cultural or husbandry practices employed in crop production.

The manipulation of a crop's genetic makeup to develop improved varieties is achieved by plant breeders working in conjunction with other plant scientists and consumers. Crop improvement techniques have already been discussed in the Background to Breeding Food Crops (Section III.1). Through plant breeding, breeders are able to develop crop varieties with improved characteristics, such as:

- High yield
- Adaptation to varying environmental and soil conditions
- Disease and pest resistance
- Various other quality aspects

The quality of seed used to produce a seed crop also has a great influence on crop productivity. A farmer needs seed of good genetic quality, seed that is clean, viable, well developed and free from seed-borne diseases and that produces vigorous seedlings.

### III.3.1 Soil Fertility and Climatic Requirements

Soil as the crop production medium also strongly influences crop productivity. The soil stores moisture and plant nutrients essential for plant growth and development. The soil requirements of many seed crops differ little from those of the same crop grown for direct consumption. In general, the soil should have an adequate supply of mineral nutrients, some of which influence seed quality. It is a well-established fact that if a crop develops vigorously, it is more likely to yield abundant, plump, well-filled seed than a crop that is stunted and weak, due to poor soil fertility.

Concerning the nutrition of seed crops, nitrogen, phosphorus and potassium all play an important role. The essential plant nutrients are categorized either as “major” or “minor”. The major nutrients are needed in large quantities, i.e. 200–300 kg per hectare, while the minor or trace elements are needed in smaller quantities per hectare.

High seed crop productivity, therefore, requires soil with:

- Good structure and texture
- Good soil depth and good water holding capacity
- Good balance of soil plant nutrients
- An acidity range of pH 5.5 – 6.5

The climatic conditions, such as day length, temperatures, rainfall and relative humidity have to be optimum for crop production. Some crops are sensitive to low temperatures, others to high temperatures. For seed crop production, the farmer has to know the crop characteristics to determine whether the seed crop can grow in a particular environment or not.

The cultural or husbandry practices employed are aimed at manipulating the environment to suit the crop or in some cases, adapting the crop to the environment so that the crop can express its full genetic potential in yield and other characteristics.

**Table 2: Major and Minor Essential Plant Nutrients**

| Major | Minor |
|---|---|
| Nitrogen | Iron |
| Phosphorus | Manganese |
| Potassium | Zinc |
| Calcium | Boron |
| Magnesium | Copper |
| Sulphur | Molybdenum |
| Chlorine | Cobalt |

*Chlorine is often considered a minor nutrient element because although large amounts are taken up, only very little is essential for growth. Also note that carbon, hydrogen and oxygen which are major nutrient elements are not included as these are not added through fertilizers.*

## III.3.2 Seed Crop Protection

After crop establishment, the major husbandry practices required for good yield performance are those involving crop protection. If pests and diseases are allowed to attack crop plants, the result will either be reduced stand due to plants dying off, or curtailed plant development. Either or both of these situations will result in reduced yield and quality. In the case of diseases, some of them may be seed borne, a fact which would render the grain unfit to be used as seed. Good crop protection ensures that crop plants realize their yield potential and also attain good seed quality. Crop protection usually involves control of insect pests, plant diseases, nematodes, weeds, rodents and others. The principle is to keep each pest below its threshold level (injury level) and keep the seed crop clean throughout crop growth. There are well-defined control practices for the different pests.

Sound crop protection requires good knowledge of the pests (and diseases), especially their life cycles; knowledge of the type of injury they cause to the crop; knowledge of the crop's reaction to the injury; the pest threshold; the chemicals that are effective in controling it and their rates and time of application; and other aspects. One of the most challenging aspects of crop protection involves correct identification of an insect or weed at the different stages of growth, or of diseases at different development stages. Thus, sound crop protection requires considerable training. Other demands for pest control include use of correct concentrations of pesticides, appropriate application methods and safe handling of the agricultural chemicals. However, the seed grover may employ the services of research and extension to indentify exogenous problems and how to eradicate them.

### III.3.2.1 Diseases

One of the important constraints to high productivity is that of plant diseases. Plant diseases reduce plant productivity or kill plants entirely. The importance of a disease or the pathogen that causes it is determined by the economic losses it causes. A plant disease is defined as a series of invisible and visible responses of plant cells and tissues to a pathogenic micro-organism or environmental factor resulting in adverse changes in the form, function, or integrity of the plant. It may lead to partial impairment or death of the plant or its parts.

Plant diseases are directly caused by fungi, viruses and bacteria and indirectly by nematodes, various insect pests and poor nutrition.

Disease control is a very important aspect of seed production. That is the reason why the seed crop is inspected in the field at routine intervals to ensure that it is disease- and pest-free during the seed certification process of the formal seed supply system. The reason for this is because seed can be a very efficient way of transmitting plant pathogens in space (from place to place) and time (carry over from season to season), with the disease reappearing in the seedlings produced.

Some diseases are carried as seed-borne diseases, whilst others are perpetuated through poor field hygiene and lack of crop rotation practice. There are many diseases that infect cereal and legume crops. There are, however, a few principles that may assist in reducing disease outbreaks in smallholder seed production. These are as follows:

- Use of germplasm resistant/tolerant to prevailing major diseases.
- General crop hygiene, including use of effective crop rotation.
- Seed treatment with chemicals.
- Use of clean seed selected from a disease-free crop, especially free of seed-borne diseases.
- Regular scouting for disease infection to facilitate early control and roguing out of diseased plants if only a few are infected.
- Control measures aimed at populations of plants, rather than individual plants.
- Control methods should be aimed at protecting plants from becoming diseased, rather than curing them once they are already diseased.
- Control of insect-vectors that transmit viruses.
- Carry over of seed for only 2 to 3 seasons and then fresh seed needs to be sourced.

There are general approaches to management of plant diseases that a seed grower should be aware of. Ideally, a farmer must identify diseases in his/her crops and then apply control measures as appropriate. However, disease identification is very complicated, even with handbooks that have colour plates. It is reasonable, therefore, to suggest that farmers should follow prophylactic control measures recommended for each crop. They should at least make an effort to identify the major seed-borne diseases, since these may end up infecting their crops. Seed pathology is concerned with the recognition and control of seed-borne diseases. To do this, a complete understanding of the biology of pathogen is essential. This is problematic for the non-expert, as this is a specialist undertaking requiring laboratory confirmation, even when it is being done by experts.

For seed-borne diseases, it is important for farmers to work hand-in-hand with extension staff and other technical service providers so that all efforts are made to:

- Source seed free of seed-borne diseases for the seed crop or use treated seed.
- Identify correctly seed-borne diseases expected in the area.
- Put into effect prophylactic sprays for these diseases.
- Inspect regularly the crop and identify disease-free sections of the field.
- Only harvest those disease-free sections for seed to carry onto the next season as seed for commercial or seed crops.
- Hold regular sessions of disease identification at seed crop plots with relevant experts.
- Observe correct field hygiene.

### III.3.2.2 Insect Pests

Insect pests affect adversely growing plants and can even destroy whole plants at various developmental stages. They can reduce the plant stand or its productivity. Insects can also infest grain in the field or in the store. This results in loss of grain quality in terms of germination percentage and even nutritional value. For seed production, managing insect pests should be done, in order to:

- Achieve high yields
- To avoid grain being infested, i.e., preserve the seed quality

Principles of insect pest management in seed crop production are:

- Use of tolerant/resistant varieties: these are fewer than for diseases
- Sound field management, including effective insecticide application to crops
- Grading of un-infested seed for storage
- Systemic insecticide application to grain
- Storage in environment where insects have no access
- Rotation of crops of different species.

### III.3.2.3 Weeds

Most smallholder farmers realize that low crop yields are due to poor weed management and high weed pressure. Significant portions of cropped land may be abandoned when weeds overwhelm the crops planted. Weeding is one of the most labour-demanding tasks in any small landholding and is becoming a major constraint to this sector in sub-Saharan Africa, given reduced labour profiles because of HIV/AIDS pandemic affecting most communities.

A weed is any plant that grows where it is not wanted by man. Weeds include volunteer plants from the previous crop. Weeds vary in their aggressiveness to compete with crops.

They compete with crops for production factors:- water, nutrients, light and space. Weed control must be done in good time, before yield-reducing competition for production factors has taken place. The principle for good weed management or control is to keep weed pressure below the economic threshold (i.e. damage levels), not necessarily to keep the crop weed-free. This should be fairly achievable at the household level of seed production, since the seed crop field sizes involved are small, particularly in seed gardens. Another aspect of weed management that is important for the realization of good crop yields is controlling/removing the weeds before they seed. This will contribute to the reduction of the weed seed bank in the soil and ensure low weed pressure in future.

### III.3.2.3.1 Weed Induced Damage

Weeds cause several types of damage to crops, disturbing normal development of the plant and ultimately lowering its yield. These are:

- Competition for nutrients, resulting in nutrient deficiency symptoms in crop plants.
- Competition for water, resulting in stressed plants that do not grow well and may even die.
- Competition for light and space when weeds overshadow crop plants, they tend to grow very tall, slender and weak stems, resulting in easy lodging.
- Parasitic weeds, such as striga, suck out nutrients from plants resulting in sickly growth and development.
- Weeds can be alternative hosts to pests and diseases.
- Weeds harbour mice and other animals, such as porcupines which inflict heavy losses on crops.
- When well established and in close proximity to the crop plants, some weeds exude chemicals that affect crop growth adversely (allelopathy).
- Removal of weeds adjacent to crops often results in crop plant root damage, when pulling out and root pruning using an implement such as a hoe. This weakens the plant and exposes it to infection with disease pathogens in the soil.

### III.3.2.3.2 Weed Management

This should aim at effective weed control, preferably with reduced labour input. The main principle is to keep weed pressure below threshold levels and also to reduce the weed seed bank. Several considerations may guide the weeding operations:

- Preparation of seedbed after initial flush of weeds, to minimize weed population in the crop seedling stage.
- Weeding early to facilitate good early growth of seed crop and quick ground cover.
- Avoiding root pruning through implement damage or weed pulling.
- Being careful not to damage crop plants as this can result in disease infection.
- Selecting the most appropriate herbicides and applying as advised on the label.

## III.4 Handling Storage and First Aid for Pesticides

Pesticides include fungicides, nematicides, bactericides, insecticides and herbicides. Most of these can be poisonous to human beings and need to be handled and stored carefully. There are many cases of chemical poisoning on farms. The farmer needs to be taught about safe handling of pesticides, their storage and guidelines on first aid to victims poisoned by pesticides.

Pesticides are essentially poisons manufactured to 'kill' living organisms, e.g., plant patho-gens, insects, rodents and weeds. There are various categories of pesticides whose level of toxicity is shown by various types of usually colored signs, i.e. pictograms on the label, of the package or container.

This information is very important as it contains crucial information such as:

- How poisonous the pesticide is.
- The safety precautions recommended for that pesticide.
- The formulation of the pesticide, i.e., the active ingredient, its concentration and form (liquid, powder, dust, granules, etc).
- The pests to be controlled with.
- The application rates for each pest.
- The recommended application method.

## III.5 Seed Storage

Seeds are living organisms. All living things must eventually deteriorate and die. Seed deterioration is inevitable and irreversible. However, seed deterioration is not good for agriculture as it results in reduced viability and seedling vigour, leading to reduced plant stand. Seeds intended for planting are thus managed, to minimize their deterioration, i.e., to maintain their viability and vigour as high as is possible. Since deterioration is inevitable, even if slow, seeds for planting can only be stored for limited periods, if they are to be used before their quality declines to unacceptable levels. It is desirable to have seed with germination of 85 % or higher for most crops. Seed deterioration varies among seed populations: therefore, seeds of different crop types have differing storage potential. This also means that seeds of different crop types have different shelf lives. Factors that influence the lifespan of seeds include:

- Internal factors:- these include the physical condition (broken, cracked or bruised seed) and physiological state (e.g. degree of maturity or grain filling). Damaged seed or those not fully developed deteriorate more rapidly than undamaged and fully developed seed.
- Environmental stresses during seed development:- these influence mainly the physiological state of seed. Stresses such as mineral deficiency (inadequate soil fertility), water and very low or very high temperatures can impair the longevity of seeds. Seeds from plants that suffer such stresses may not be stored for long periods.
- Relative humidity and temperature:- the two most important factors that influence the lifespan of seeds are seed moisture and the temperature at which it is stored. The level of moisture in the air, seed moisture content and temperature of the storage environment influence the rate at which seeds lose viability.
    - High levels of moisture in the seed store or the seed itself often results in development of fungal infections that cause the seed to rot.
    - High temperatures cause more rapid deterioration through increased metabolism, particularly if the seed has high moisture content.

In formal seed production systems, seeds of most crop species may be safely stored for several years through careful control of temperatures and relative humidity. Such seed storage facilities are expensive and sophisticated. For community-based seed production systems, simple but functional approaches to seed storage are needed. The basic steps for successful seed storage for up to two years are as follows:

- Harvest seed as soon as it dries enough, so that it does not deteriorate in storage (less than 20-25 % moisture content). Timely harvest is important to avoid other problems, such as:
    - Pest infestation in the field. Both maize and grain legumes may be infested by pests in the field, creating a source that will multiply in storage.
    - Grain legumes may shatter if left for too long: this makes harvesting much more difficult and necessitates picking of grain on the ground.
    - Seed of both cereals and grain legumes lose quality if overexposed to the sun's heat once physiological maturity has been attained.

- Delayed harvesting of seed exposes it to danger of damage or loss by mice, livestock and other animals.
- Care should be exercised during processing. Only methods that do not crack or bruise the seed should be used. Unshelled maize or cowpeas should not be shelled in a sack using a stick. Such damaged seed either is not capable of germinating or will deteriorate fast.
- Take out seeds that are broken or damaged, not fully developed, infected with disease or pests. Only clean, undamaged, pest-free seed must be stored.
- Treat the selected seed with an insecticide, such as malathion (1 % dust) and a fungicide, such as captan. Only available and inexpensive chemicals should be used. If these chemicals are not available or affordable, traditional methods of treating seeds should be considered. These are effective for insect pests. The most commonly used ones are:
  - Mixing the seed with wood ash. The crystalline structure of the ash deters weevils and bruchids, which attack cereals and grain legumes respectively.
  - Putting leaves of *Tagetes minuta* (Mexican marigold) in the seed container. The smell of the leaves of this plant keeps the pests at bay.
  - Use of cow dung, either by smearing it on the walls of the storehouse or sides of a container, or spreading fine, dried cow dung on maize cobs.
  - Putting dried gumtree leaves in the storeroom or container.
  - Sprinkling finger millet hulls on grain.

*Figure 45: Improved traditional storage bin*

- Hanging maize cobs above fireplace so that the grain is coated with soot. This is good for short-term storage and is applicable to maize only.
- Storing the seed in a covered container in a cool place. Ambient room temperature in sealed clay containers can be effective for fairly long periods of storage that is, around two years. The seed should be covered with a layer of washed and dry river sand. Apply a layer of cooking oil or paraffin on top of the sand for longer storage.

To summarise, good quality seed can be obtained only if well dried (less than 12.5% moisture content), undamaged, fully matured whole grain is treated and kept in a cool, dry environment.

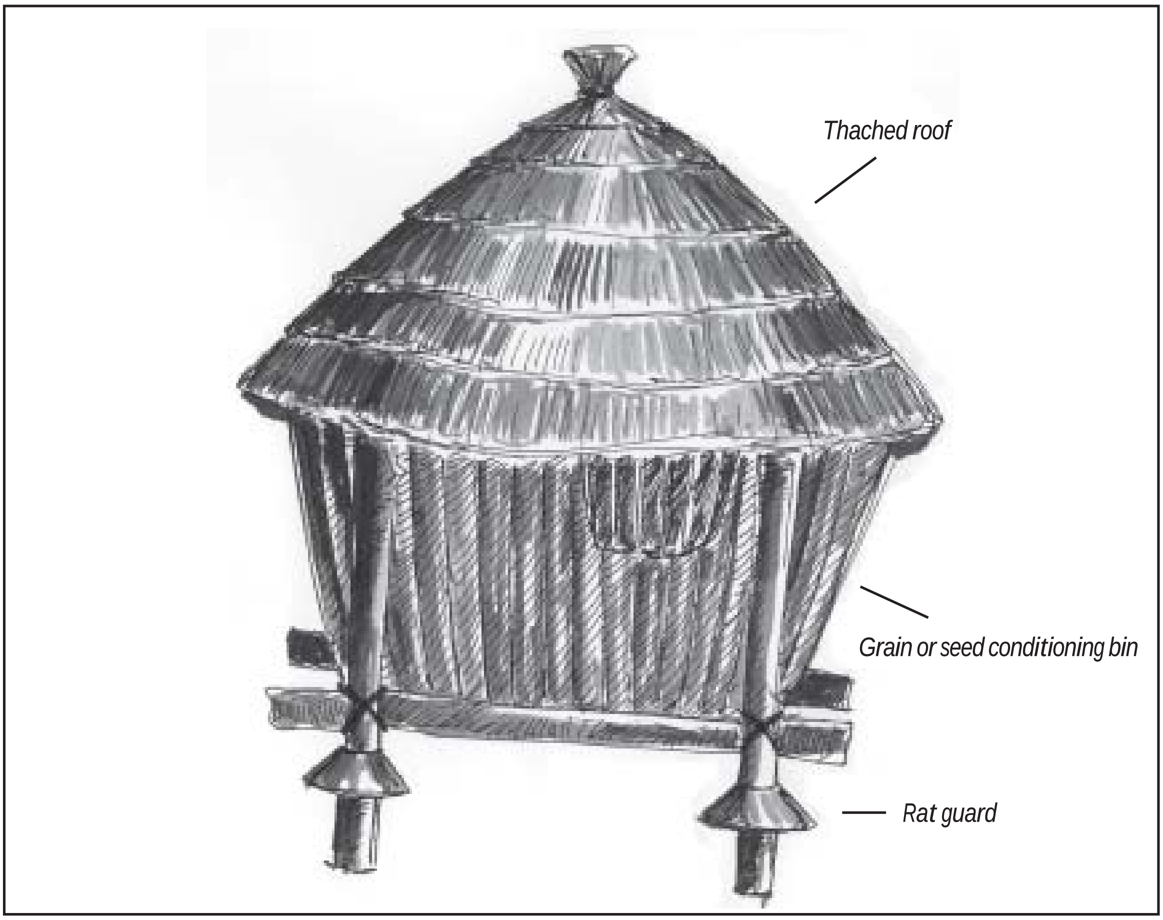



*Figure 46: Traditional storage bin on stilts with rat guard to prevent rodent damage to stored grain*

## III.6 Seed Gardens

Seed security can be defined as the sustained ability of all farmers to have sufficient quantities of the 'desired' crop and variety diversity of seed at the right time. This seed must be of high quality. The use of high quality seed is one of the important factors in increasing productivity of smallholder farmers. For example, the grain yield components for maize are: number of plants/hectare, number of cobs/plant, size of cob and shelling percentage. For cowpeas, they are: number of plants/hectare, number of pods per plant, number of seeds per pod and shelling percentage. Seed quality (germination percentage and seedling vigour) directly influences crop stand establishment, which is the primary grain yield component of crops.

In most SADC countries, smallholder farmers experience problems in acquiring seed of improved varieties, particularly for the traditional food crops, such as pearl millet, finger millet, sorghum, groundnuts, field beans, cowpeas, bambara nuts, as well as root and tuber crops. The majority of farmers use their own farm-saved seed from previous crops or buy retained seeds from other local farmers. Commercial seed companies have largely focused on producing seed of hybrid maize and high value crops, such as wheat and soybean. However, even when seed of improved varieties of the traditional crops is produced commercially, use of such seed by smallholder farmers is limited, due to various problems. These include high seed prices and large seed packs, lack of local seed traders (timely availability), and lack of organised seed entrepreneurship in farming communities.

This situation justifies the need for community-based local seed supply programmes in most countries in the region. One such approach for improving seed technology transfer to farmers is that of seed gardens. Smallholder farmer seed projects should be confined to traditional and improved varieties. Hybrid varieties can be left to the formal seed sector. Efforts in this direction by NGOs have gone a long way to alleviate seed availability problems, as well as increasing the use of improved varieties.

### III.6.1 The Use of Seed Gardens

The establishment of seed gardens by smallholder farmers enhances household level seed security. Seed gardens provide farmers with an opportunity to produce high quality seed that is ready for planting immediately after harvesting, without requiring storage facilities. Only excess seed will require storage. If well managed, seed from seed gardens should meet the grade of certified seed, or at least come close to it. Seed gardens offer the farmer with the possibility to produce adequate amounts of seed for the crop varieties of his/her choice. Seed gardens also provide the opportunity for extra training in husbandry of crops farmers choose to grow. If used effectively, seed gardens can achieve food security: that is, enough food at the household level and surplus for sale to raise cash, as well as improved livelihoods.

There are two scenarios in which seed gardens may be used:

- In areas of mono modal rainfall, the seed garden is established in the off-season (dry season) period so that seed is available at the beginning of the following rainy season.
- In areas of bimodal rainfall (e.g. around the equator), where there are short and long rain periods, seed gardens are best established in the short growing season to make seed available for planting in the main growing season.

In areas of mono modal rainfall, there is reduced disease incidence in the off-season, hence, enhanced likelihood of producing high quality seed. This is due mainly to reduced relative humidity. Also, since few crops are grown in this period, it is possible to achieve the required isolation distances for the different crops. However, the fact that few crops are normally grown in the off-season may also mean increased pest problems, such as rat damage and increased chances of livestock and wild animal damage. Another risk is low temperatures, which may cause delayed germination and slower plant growth. Frost damage may also occur.

In bimodal rainfall areas, seed gardens can act as an alternative or complementary local means of seed supply to main season production activities. In the short season, it may be necessary to irrigate the crops at the beginning and end of the season, depending on growth duration.

In both of these scenarios, adequate water provision and crop protection practices are necessary to produce high quality seed. Security is another absolute requirement. (Figure 47)

## III.6.2 Planning of Seed Gardens

Planning of seed gardens is critical as it influences whether the seed production activities will succeed or fail. The first major question is whether farmers establish a seed garden as a group or do it individually. Individual seed gardens have worked well in Zambia, but small groups, provided they can work together well, should also be able to run successful seed gardens. For a given community, the seed garden project should be planned communally under the local civic/traditional leadership. This is because the setting up and operation of the seed garden will involve utilization of common property, such as land, water, trees and grass. However, the planning of seed gardens requires that a few steps be followed:

- The first step is for farmers to select the crops and varieties they want to grow in the

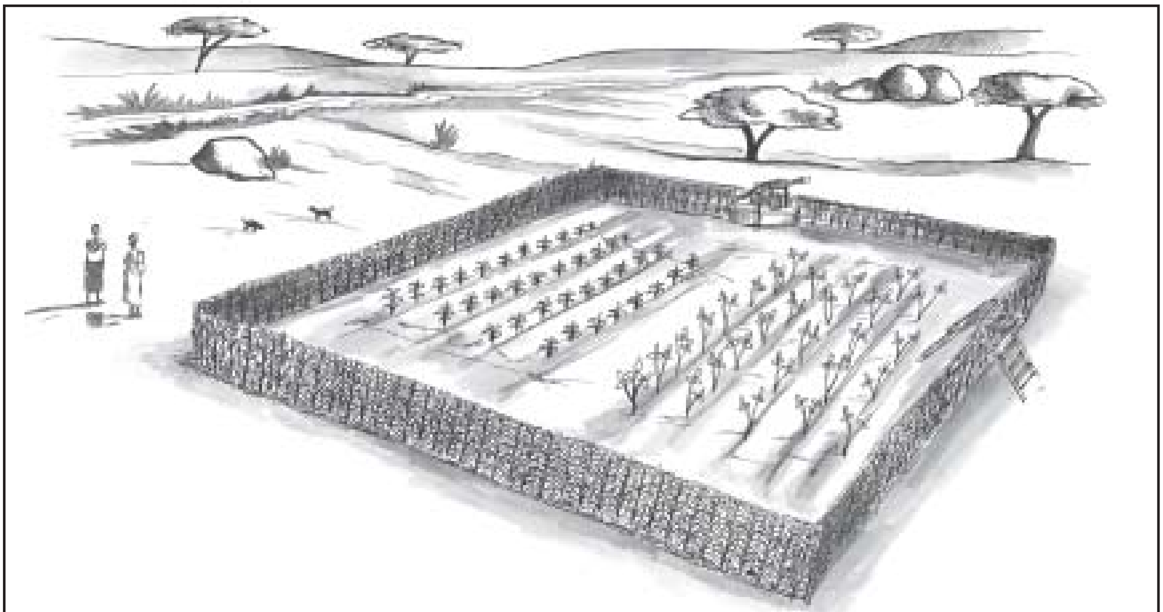


*Figure 47: Seed garden with a combination of live and barbed wire fencing. Note the source of water within the garden site.*

main season. Some farmers can select more than one variety for a given crop. The crops could include maize OPVs, sorghum, pearl millet, finger millet and grain legumes, cowpeas, field beans, greengram and bambara nut.

- Select or make sure these varieties can mature in the dry season or in the short rains, so that good quality seed is available at the onset of the main growing season. It is very important to facilitate timely planting in the main season.
- Source of basic seed should be established.

It is important to source good quality seed for use in the seed garden. Do not use seed of unknown quality in the seed garden.

### III.6.2.1 Size of Seed Garden

Generally, the seed garden must be small to ensure good management and adequate fencing. However, the size of the seed garden will vary depending on the area the farmer intends to grow in the main season and whether she/he intends to trade in seed or not. Several factors can influence the garden size:

- The size of arable land available.
- The access to draft power for field operations.
- Ability to fence the seed garden – it is more difficult to fence with poles and grass, than with barbed wire and pig netting.
- Amount of available water – this is critical since the seed crop requires adequate moisture to attain good yields and produce seed of quality. Water available from dams, boreholes, wells or streams must be properly assessed, as this will dictate the areas to be cropped in the seed garden. The water requirements of the intended crops must also be known. Technical assessments and advice on this aspect are crucial.
- Whether the seed garden is communal or individually owned.

### III.6.2.2 Availability of Water

The seed gardens have to be sited near a reliable water source so that labour required to irrigate the garden is minimal. The water must be adequate for the area to be irrigated throughout the crop's growth duration. The quality of the water must be suitable for irrigation. Sometimes, deep wells and boreholes in sodic soils yield salty water unsuitable for irrigation. Generally, water used to grow common vegetables is good enough for field crops.

### III.6.2.3 Location of Seed Garden

Location is critical for several reasons:- it must be near the irrigation water source; the location must be frost-free; the soil must be reasonably fertile to raise a good crop with only moderate fertilizer inputs; and it must be a safe place where crops can be easily monitored and chances for theft are minimized.

The nearer the seed gardens are to human settlements, the more likely it is for them to be managed well. It is ideal to cluster several individual seed gardens together. This improves security and may reduce the fencing demands of individual gardens, since some sides will be shared.

### III.6.3 Requirements of Seed Gardens

A good seed garden must have certain characteristics to ensure that successful and sustained crop production is achieved. The main aspects to consider are: the garden site, freedom from frost, garden fencing for protection against animals, and sustainable cropping patterns.

- The garden site:- the soil must be reasonably fertile and not too sloped, to avoid erosion. If the soil slope exceeds 3 %, appropriate conservation works must be done.
- Freedom from frost:- the site of the garden must ideally be frost free. Sites where frost occurs, no matter how mild, must be avoided. So the garden site must not be at the bottom of a valley and it should have a thatch hedge around it for protection against frost.
- Seed is a high value product that demands high levels of inputs in terms of management. Therefore, a seed crop should not be grown in a field that is not secure. The field should be well fenced, ideally with barbed wire and pig netting. Since most smallholder farmers have limited resources, a strong fence of poles and brush that cannot be penetrated by small livestock is suitable. In all cases, wherever possible, a thick thatch of grass all round the garden is recommended, to keep rabbits and members of the deer family out of the gardens. These can be devastating, particularly for grain legumes, such as cowpea, field beans and soybean. In Zambia, poor fencing structures have resulted in extensive crop damage by livestock. The Jatropha plant from cuttings planted during the rainy season established successful live fencing. In Zimbabwe, there are several tree species used for live fencing of riverine gardens.
- Establishment of a seed garden demands heavy investment in fencing and sometimes, in the development of water wells. Therefore, the management of the seed garden must ensure productivity for a long time. This can be done by practising effective crop rotation between off-season and in-season crops. The main aim of this will be to sustain productivity, that is, soil fertility, and to manage pest and disease levels.

Another requirement for the sustainability of farmer-based seed multiplication systems, such as that of seed gardens, is a reliable supply of quality parent seed material, as well as adequate technical back-up. This calls for:

- A good source of parent seed stock, preferably a public sector institution or NGO.
- Regular supply of parent material for all varieties so that seed can be retained over 2 to 3 years at most. This should maintain quality and limit disease build-up.
- Adequate technical back-up for effective seed multiplication and good quality standards.

## III.7 Participatory Training and Technology Transfer Concept

It has now been widely recognized among community development specialists and policy makers that developmental programs which involve the participation of target communities right from the start have a greater propensity to succeed than those which do not. It is recommended that initial participatory diagnostic studies be carried out in the target communities by developmental agencies, to gauge the communities' own understanding of the problems they currently face and suggestions on how these problems can be solved. Community participation, therefore, is needed at the initial problem identification stage, to develop appropriate intervention measures to solve these problems. Community participation is also needed during the implementation of the intervention strategies recommended.

The basic concept underlying the formulation of the participatory concept is that people decide for theselves what to do with their own lives. The local beneficiaries participate in all stages of project development, implementation and evaluation. This fosters a sense of ownership among the intended beneficiaries of the project, thus ensuring the project's success.

The training approach followed in this manual uses participatory training tools. The methodologies and training tools used herein are aimed at improving Small Scale Seed Production Projects in the SADC region, with greater attention paid to the primary stakeholders: that is, the peasant farmers themselves. This is encapsulated in a publication by the Farm Level Applied Research Methods for East and Southern Africa (FARMESA) Project (Anandajayasekam, P et al, 2001), provides an extensive and detailed discussion of some of the participatory technology transfer concepts used in this seed manual.

### III.7.1 Participatory Rural Appraisal

Participatory Rural Appraisal (PRA) is a methodology that involves a multidisciplinary team of community development specialists who interact with community members, in order to learn from and with the community members, so as to investigate, analyze and evaluate their problems and opportunities. This participatory technology transfer tool is a means of gathering different kinds of data that is important for identifying and mobilizing interested groups and evoking their participation, as well as opening up avenues for the group to participate in decision making, project design, execution and monitoring.

The central feature of PRA methodology is that it focuses on people, their livelihoods and inter-connectedness with ecological and socio-economic factors. The purpose of PRA, which is usually carried out at the problem diagnosis stage, is to provide the community with an understanding of their natural resources, their constraints, problems and opportunities. It helps community members to make informed and timely decisions and facilitates them in planning, implementing and monitoring rural development projects.

### III.7.2 Participatory Extension Approach

The role of Agricultural Extension Services is to act as a liaison service between research workers, policy makers and other support service providers and farmers. In this way, extension services play a dual role in providing innovative knowledge, as well as feedback.

With the realization of the need for pluralistic approaches in community development, the role of traditional public extension services is changing from that of teacher, to facilitator or catalyst for rural development (Hagmann,J et al; 1966). This changing role has been influenced by the recognition that farmers themselves are the only people who can make effective decisions on how to manage their farms within the many environmental and social constraints they face. In addition to the multitude of social and cultural factors affecting how they choose to farm. The Participatory Extension Approach (PEA) was developed on the premise of sharing learning experience between all stakeholders in a given programme.

The concept of PEA is an extension approach and concept that involves a transformation of the way in which extension agents interact with farmers. Community-based extension and joint learning is central to PEA. The extension service facilitates communication and information flow, in addition to providing technical back-up options. The extension worker coordinates and organizes knowledge acquisition from several sources. In addition, the extension worker documents farmer knowledge and experiences and produces simple guidelines for farmers. Thus, farmers build upon their management and problem solving capacity: a situation that requires a dual process of learning by practical field experience.

The characteristics of the PEA processes are outlined by the Zimbabwe Department of Agriculture, Technical and Extension Services (AGRITEX 1998). The main characteristics of PEA were outlined as follows:

- It integrates community mobilization for planning and action with rural development, agricultural extension and research.
- It is based on an equal partnership between researchers and extension agents, who can learn from one another and contribute their knowledge and skills.
- It aims to strengthen rural people's problem solving, planning and management abilities.
- It promotes farmers' capacity to adopt and develop new and appropriate technologies/innovations.
- It encourages farmers to learn through experimentation, building on their own knowledge and practices and blending them with new ideas, which leads to action reflection or action learning.
- It recognizes that communities are not homogeneous, but consist of various social groups with conflicts and differences in interests, power and capacities. Each group then makes its collective decisions and also provides opportunities to negotiate between groups.

The Participatory Extension Approach is not a "one time" discrete activity:- it is a cyclic process of learning which repeats itself with a different set of problems. There are four major phases of the PEA process. These can be outlined as follows:

- _Phase 1_: Preparing the community through social mobilization. This phase involves facilitating the communities' own analysis of their situation.
- _Phase 2_: This phase is concerned with community level Action Planning based on the activities of the first phase. This phase includes prioritising problems and needs, searching

for solutions, mandating local institutions and action planning.

- *Phase 3*: Implementation and trying out of farmer experimentation. The actual implementation involves mobilization of resources and implementation of activities. This step helps to re-evaluate local knowledge in the light of new techniques. During implementation, new questions and problems may arise for which the community should work out appropriate intervention measures.
- *Phase 4*: Monitoring and Evaluation (M&E) through sharing of experiences, ideas and self-evaluation. This phase consists of joint learning by sharing ideas and experiences, and by reflecting on the success and failures of the actions and experiments carried out. M&E includes a Mid-Season Evaluation and an End Season Evaluation. M&E leads to planning for the next season or Project Phase.

### III.7.3 Farmer Field Schools

Another participatory training method for farmers that has recently gained popularity is known as the Farmer Field School (FFS) extension method. This method emerged in Java in Indonesia in 1989. It has since spread to Southern and Eastern Asia and to India. In Africa, FFS methods have been applied in Kenya, Tanzania, Uganda, Zambia and Zimbabwe (Anandajayasekam, P. et al eds, 2001).

The FFS method is a practical approach to training, which aims at building up the technical competence of farmers on major aspects of crop and livestock production. The main assumption underlying FFS is that the participating farmers will acquire enough technical knowledge to test the various technological options available to them and in the process, be able to decide on the best alternatives for adoption. It is, however, absolutely essential that the facilitators of the FFS be technically strong and have a complete practical understanding of the subject matter being taught, albeit using non-formal educational methods. During the process, FFS provides a learning environment that attempts to build on the capacity of the group.

FFS training revolves around four basic principles, which are as follows, with special reference to seed production:

- Growing of a healthy seed crop through the use of improved varieties, efficient nutrients, water and weed management practices.
- Observing crops in the field regularly, to understand crop typology and its implication in seed crop production, and to determine management actions necessary to produce a profitable seed crop.
- Understanding biological agents and agro-ecological systems that conserve beneficial predators and parasites.
- Making farmers realize that they are experts in their own farming systems.

FFS training in seed production brings together farmers in groups to participate in hands-on intensive training in seed crop production, covering all aspects of seed production over the entire crop growth cycle. The principle is that in field schools, farmers and trainers participate equally in field observations and discussions, applying their previous experiences and new information from outside the community to reach management decisions on what action to take. The guiding principles for the field school learning process are as follows:

- All learning activities take place in the field during land preparation, planting and the growth cycle of the crop.
- All learning is based on the farmers' observations in the field. The observations form the basis for discussion and analysis by farmers who arrive at concepts they test and improve upon, through further field activities.
- Training is focused on the analysis of the crop agro-ecosystem. This analysis helps farmers gain insight into ecological interaction in the field. The combination of analytical methods, ecological insight and integrated management principles for growing a healthy crop, provides farmers with wider alternatives to choose from.
- Training lasts the entire cycle of the crop, so that farmers acquire a firm understanding of the relevant concepts for each stage of crop growth and how these impact on quality seed production.
- The curriculum is based on local conditions, problems and needs of participating farmers.

## III.7.4 Variety Evaluation, Verification and Observation Trials

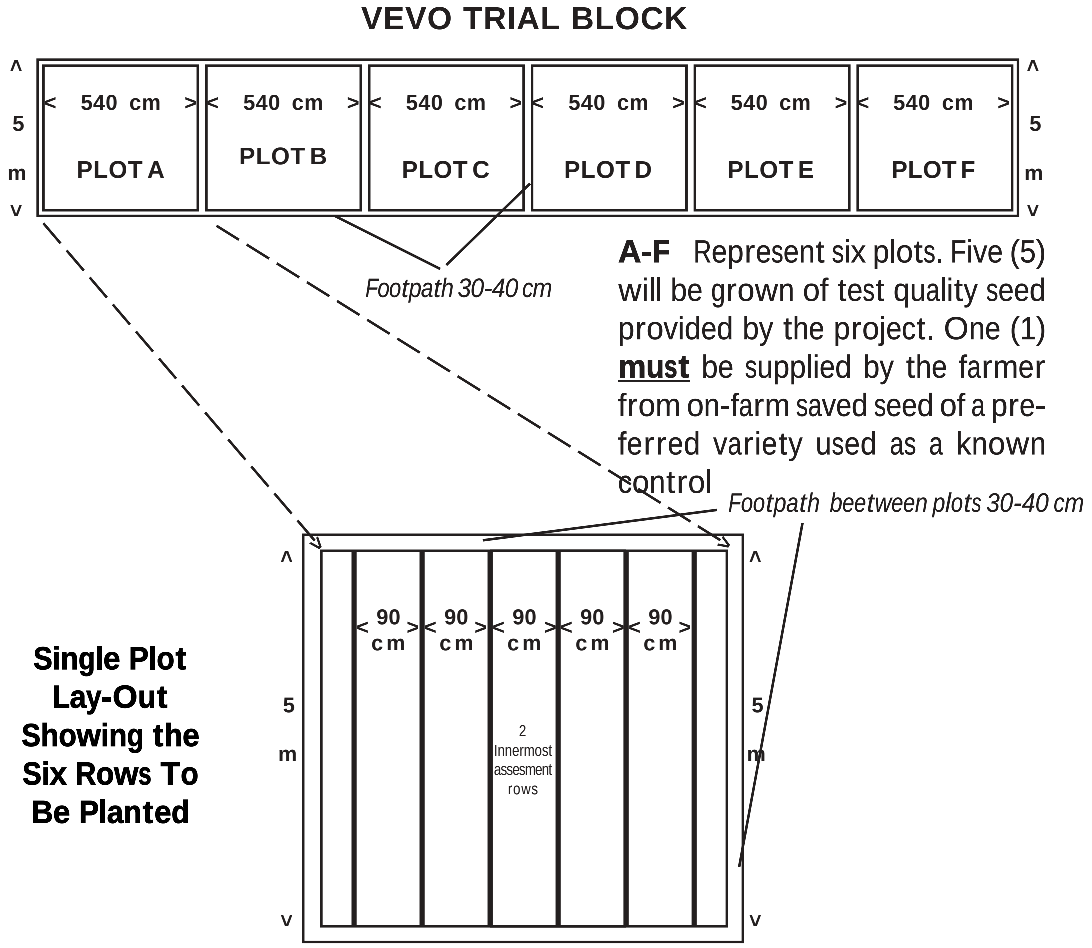
The use of farmer's fields and allowing farmers to carry out agronomic trials in their own environment is a powerful participatory training tool for skills and technology transfer to the farming community. The Variety Evaluation, Verification and Observation trials (VEVO) provide small scale farmers with the opportunity to acquire practical training in seed production (see Annex IV).

### III.7.4.1 The Use of Observation Trials

The VEVO trials can be an effective tool for the participation of smallholder farmers in the process of improving their access to quality seed of appropriate varieties of traditional food crops. Instead of only introducing what technocrats think is good for farmers, observation trials provide an opportunity for evaluation of germplasm in the farmer's environment, enabling them to observe the different cultivars, manage them and finally select those that best suit their needs and agro-environmental conditions. In this way, farmers participate in technology generation through evaluation of the germplasm. Consequently they will adopt varieties that they have tested and observed to perform well, particularly when they are tested at the farmer level of management and inputs supply, through the VEVO trials.

In this programme, the VEVO trials can serve several specific objectives, namely:

- As a tool to evaluate variety adaptation to farmers' agro-ecological conditions and sometimes, their management requirements. Specific measurements taken in these trials could include:
  - Yield performance of varieties, including yield components, such as shelling percentage.
  - Growth patterns of the varieties, observing phenological developmental stages, growth duration, harvest index, lodging, shattering, sprouting, disease and insect pest infestation in the field, etc.
  - Farmers' preferences given the yield performance and other variety characteristics, such as grain appearance. This is particularly important for grain legumes, such as cowpeas, field beans and bambara nuts.




**A-F** Represent six plots. Five (5) will be grown of test quality seed provided by the project. One (1) **must** be supplied by the farmer from on-farm saved seed of a preferred variety used as a known control

*FIFM variety evaluation and observation trial plot with a a farmer's crop*

The thick black lines are planted rows of the test variety

ü Only the **two-(2) innermost** rows are used for evaluating for all characteristics of the variety and seed-saving (but not recommended for open pollinated varieties). The other four (4) rows are discards to be used for testing other traits like taste, milling and shelling ration, processing, seed quality testing, training and storage

- To provide sites for Farmer Field School training for Small Scale Seed Production Programme facilitators and farmers. Aspects that can be used in the training are:
  - Developmental pattern and morphological differences of the varieties in the observation trial.
  - Variety genetic quality, e.g., evenness of plant growth and level of off-types and appearance of typical off-types.
  - Comparison of the growth characteristics, disease and insect pest levels with the local standard variety.

- Recording and collation of data on growth, yield and cultural practices.
- Recording environmental data, particularly rainfall.
- Field school activities develop farmer capability to manage their own seed plots later.

- Development of germplasm Geo Information System (GIS) adaptability maps: data from various observation trials is combined to develop maps, showing where particular varieties perform well. In order for this to be possible, the data from the individual observation trials must be:
  - Adequate, hence a certain minimum detail must be recorded during all observation trials.
  - Carried out properly such that data recording is accurate and consistent.
  - Planned properly, including training of participating farmers hosting the trials.
- Field days to demonstrate variety performance to a wider audience in a locality. The members of a group hosting an observation trial can invite several other stakeholders to field days, e.g., extension staff, health personnel, school teachers, NGO development workers, traditional leaders and other farmers. These field days can achieve several objectives
  - Promotion of best performing varieties.
  - Creating awareness of improved varieties available to farmers in the area, thereby creating a local seed market.
  - Encouraging other communities to participate in the programme.
  - Providing a forum for farmers to share ideas and experiences on the new technology.

Figure 49: Farmers visiting a VEVO trial plot during a Field Day

### III.7.4.2 Planning of Observation Trials

A trial is a systematic enquiry. Therefore, if an observation trial is not planned properly, it may not achieve the intended objectives. Planning of observation trials can be done at various levels:

- Facilitator level of planning with extension personnel, including development workers and plant breeders. This will involve:
  - Explaining the rationale of the concept of observation trials in smallholder farmer seed production.
  - Going through the technical aspects of production and quality assurance in seed production.
  - Going through the details for managing an observation trial, from objective through field layout, data recording and processing. It is important for facilitators to understand clearly all technical and social aspects of handling observation trials.
  - Detailed discussions on how to form and work with the farmer groups involved in the observation trials.
  - Selection of facilitators for the project, not all those involved in the above training may be comfortable with playing the facilitation role, or interested in the planned observation trials.
  - Selection of target communities, i.e., where there is need and interest in seed multiplication.
- Community mobilization to explain the concept to the targeted groups of farmers. This is a very important and sensitive stage which is critical to the success of the observation trials. Several steps should be taken, nemely:
  - Introduction of the project to local level authorities and seeking permission to work in their area. This often includes meeting traditional, civic and political leaders of the area. This mobilization is important for gaining community support and dispelling any suspicions about the project mission.
  - Defining and/or refining farmer target groups. This is necessary so that only relevant observation trials can be discussed and the appropriate farmers are invited to 'mobilization' meetings. Note that different farmers can be targeted for different crops in the same locality.
  - Meetings to explain the concept and to gauge interest in project.
  - Selection of appropriate crops to cover most aspects of knowledge, information and technology transfer consistent with farmers' socio-economic situation and expectations.
  - Selection of participating villages and farmers or farmer groups.
- Work plan preparation with selected participants, for a minimum of six observation trials per crop per village, to cater for randomisation. All members in a group must participate actively in the preparation of these work plans, so that each one of them understands the resultant activities. Furthermore, each work plan must be formulated in the village concerned. The specific activities can include:
  - Selection of variety preference and diversity.

- Selection of sites for observation trials. This must capture the diversity of micro-environmental differences and farmers must understand clearly these differences.
- Selection of the specific varieties for multiplication.
- Generation of information and knowledge systems related to quality seed production, particularly local management practices.
- Developing detailed trial outlines and going through them with the group. This should make the farmers understand what is expected of them. The outline must be well laid out, with the following subheadings:
  - Title
  - Objectives
  - Location
  - The varieties (treatments)
  - Management
  - Records
  - Training farmers on how to fill in the trial diary and rainfall figures.

### III.7.4.3 Requirements of Observation Trials

The observation trials must be separated, at least 0.5 to 1km apart, to capture the important micro-environmental differences and enable easy access of more farmers to the trials. Micro-environmental characteristics can include:

- Differences in rainfall (leeward versus windward positions where hills occur).
- Position on the catena (uplands, down slope, wetlands, etc).
- Soil type (e.g. clay versus sandy loam).
- Soil acidity and sodicity, etc.

There are some important aspects to fulfil if results from the observation trials are to be technically valid. The main ones are:

- All participants have to use the same seed rate and generation.
- Trials have to be established at the same time.
- Trial plots have to be of the same size and this should be as indicated in the protocol for each crop.
- The trials must be accessible. Only farmers willing to allow others to visit the trial plots need be encouraged to join the programme (i.e., those who are not superstitious). This is necessary if facilitators and farmers in the locality are to make individual visits or organize field days during the season.
- Each site must have a trial diary, in which observations and details of operations are entered regularly.
- Regular site visits by facilitators are a pe-requisite. At least one visit per week, during which the trial diary for each site is examined for completeness of recording. Discussions with the hosting farmers at the trial site are encouraged.

- Wherever possible, each site must have a rain gauge. Rainfall data is very important as the amount and distribution often influence crop performance.

### III.7.5 Strengths, Weaknesses, Opportunities and Threats Analysis

The analysis of a project in terms of its Strengths, Weaknesses, Opportunities and Threats (SWOT) is usually an integral part of the Monitoring and Evaluation (M&E) exercise in project implementation. To be effective, M&E, as well as assessment of the project impact on the target beneficiaries should be participatory, and an integral part of project planning and implementation. Before discussing the SWOT analysis, it is important to define M&E.

Monitoring refers to a continuous assessment of both the functioning of the project activities in the context of implementation schedules, and the use of project inputs by the target population, in the light of design expectations. Project monitoring is hence a process, which observes events connected to a project systematically and critically, in order to control the activities and adapt them to the existing conditions. Evaluation, on the other hand, is a much broader concept. In general, evaluation addresses project performance: that is, comparing achievements with expected outputs.

Having given a brief definition of M&E, we now can discuss the SWOT analysis and how it is used in the execution of a business enterprise or a community development project. The SWOT analysis assesses the Project's Strengths, Weaknesses, Opportunities and Threats. With regards to strengths, the SWOT analysis examines the project's superiority: that is, it determines what the project does better than any others in the industry and the source of this strength. Furthermore, it analyses whether the strengths are sustainable and how the strengths can be leveraged to the benefit for the project and ultimately its stakeholders.

Having examined and listed exhaustively the project's strengths, the project's weaknesses are also analyzed and listed exhaustively. The analysis of weaknesses determines the project's areas of vulnerabilities:- in particular in the project design and implementation strategies that may need strengthening or modifications.

The opportunities of the project are then examined. Opportunities are the project's critical potential success factors; those unique aspects of the project that are the foundations of the project's concept. These are also listed and finally, the threats to the project are examined.

The analysis of threats or challenges involves identifying the variables, which if changed unexpectedly, would have a radically adverse impact on the project's outputs. It is important to be cognisant of these threats and work towards minimizing them.

Once the SWOT analysis is done and all the components examined and listed, the final task is the selection of options that become the basis for actions to fulfil the desired future direction of the project. In short, what the project promoters and target beneficiaries want the project to achieve at a specified time in the future. This exercise involves developing an inter-related matrices that match the strengths, weaknesses, opportunities and threats. The matrix will reveal gaps in the project design and execution that have to be corrected to improve the project performance.

# Chapter 1V - Contents

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Training Manual on Small-Scale Quality Seed Production

# Chapter IV

## IV Planning and Implementation of Seed Production: Background on the Practical Guide

Who should use the practical guide? Why is it structured in the form of activities? How should the practical guide be used? This practical guide to local seed production systems implementation is targeted at:

- Technical and extension service providers, both in the public and private sectors, who will facilitate all the processes in local seed supply systems. These will include:
  - Crop breeding institutions and plant genetic resources conservatories
  - Crop agronomists and extension advisors with seed crop production knowledge
  - Small enterprise seed/grain commodity marketing advisors
- Farmer beneficiaries who will implement the processes involved in the development of local seed supply systems such as:
  - Community leadership and farmers' associations
  - Village agricultural crops producers
  - Volunteer village farmers willing to invest personal resources (land, labour and inputs) in agricultural crop development trials

### IV.1 Planning of Appropriate Variety Breeding, Seed Production and Multiplication

All the different steps for major crop breeding methods, seed production and multiplication are explained in the guide in a practical manner, which is easy to understand. Local seed supply systems often attempt to meet the seed demand for crop varieties that are adapted to locality specific, agro-environmental conditions. They need to be consistent with farming systems practised by 'indigenous' farmers, so as to meet their household seed, food and socio-economic requirements. It becomes immediately apparent that for the sustainability of such a programme, 'indigenous' farmers should be empowered to access the necessary skills and technology to meet their local seed demand independently.

Chapter III covers the main aspects of Participatory Variety Selection (PVS) and Participatory Variety Breeding (PVB).

Participatory Variety Selection is incorporated into Variety Evaluation, Verification and Observation (VEVO) trial plots (see Section III.7.4). In this regard, a farmer-selected variety, such as maize, competes with five improved varieties adapted to the same or similar agro-ecological conditions. The results obtained are verified over three crop cycles or crop agricultural seasons. The participating farming community then takes part collectively in variety ranking, based on their preferred criteria for:

- Value for food, social and economic use
- Stability of yield in the local agro-ecological farming conditions
- Adaptability to farming systems practised and to agro-ecological conditions prevailing

Based on this ranking, a number of varieties are selected for production by the farmers themselves, this speeds up the pace of adoption of improved varieties in their farming system. Participatory Variety Breeding may follow, if farmers have the technical capacity to undertake a planned programme of variety development, as outlined in Section III.1.8

### IV.1.1 Maintenance of Seed Stocks

In formal seed supply systems, plant breeding institutions maintain all breeding materials and/or germplasm in different collections. These collections are normally classified as:

- ***Base Collection*: ** This is a long-term collection used to regenerate the variety or lines required for reproducing a ‘lost’ variety.
- ***Active Collection*: ** This is used for medium-term variety genetic conservation or for further variety development.

**Table 3: Modified OECD Certified Seed Grade Classification Scheme**

| Seed Generation | Producer | Utilisation | Probable Quantity |
|---|---|---|---|
| **Foundation** | Breeder | Basic and Active Collection Maintenance, Variety Maintenance, Development and Production of Next Generation. | ± 50 kg |
| **Pre-Basic** | Breeder and/ or Breeding Institution | Basic Collection Maintenance, Variety Development, Genetic Purity Maintenance and Production of Next Generation. | ± 500 kg |
| **Basic** | Seed Supply Systems | Working Sample, Seed Bulking and Final Variety Purity Verification | ± 20 tons |
| **Certified 1st Grade** | Seed Supply Systems | Working Sample, Quality Seed Multiplication for Commercial Crop Production | ± 200 tons |
| **Certified 2nd Grade** | Seed Supply Systems & Food Crop Producers | Working Sample, Variety Seed Security Achieved and Increased Food Production | Seed to Meet Demand for Variety |
| **Certified Standard** | Food Crop Production | Food Security Concerns | Increased Food Productivity |

- ***Working Sample*: **This is often used during the first stages of crop variety seed multiplication and/or PVB programmes.

In this regard, crop variety breeders are custodians of the institutional memory of such breeding technology, without which a variety may be lost.

In peasant farming systems, such local expertise also exists. However, these farmer crop breeding systems are at a disadvantage in that breeding knowledge systems lack replication, as they rely on mental rather than recorded memory structures. In this context, local seed systems are initiated with the objective of restoring lost technology to a community, through tapping into formal institutional memory structures and thereby avoiding the long process of appropriate technology generation. For uniformity, this manual will follow the Organisation of Economic Co-operation and Development (OECD) seed classification scheme, as shown in Table 3.

This manual will concentrate on training for the development of replicable variety seed knowledge and information systems that can be transferred easily to communities. Through Knowledge, Information and Technology Transfer (KITT) systems, community crop varieties, seed technology and institutional memory structures will evolve.

## IV.2 The 3-Year Project Phase

It has been shown from past experience that a 3-year project phase works successfully in KITT systems for seed supply. During the three years, extension workers and intermediaries support and hand over activities to the farmer or farmer groups with begining of the second year, in order for the project to be successful and sustainable. Successful development and establishment of viable local seed supply systems is achievable, if implemented according to the guidelines, continued in the Local Seed Supply Curriculum Block I–III (Annex II). The activities have been designed to generate and enhance local information and agronomic knowledge pools at the farmer level. These activies are based on farmer varieties at interface with improved varieties (technology) of the same crop species in farmer-implemented, farmer-managed VEVO trial plots.

The objectives of this 3-year PEA to training in seed supply processes are as follows:

- Develop variety characterisation knowledge at farmer and facilitator levels, so that they understand easily the expression of plant traits. The expression of some traits in plant development is not affected by changes in the environment, yet other traits are highly affected and are therefore said to have a high genotype x environment interaction.
  - Traits such as flower colour and architecture (distinctive shape and form), or time differential in pollen shed and stigma receptiveness, or period of pollen shed, are examples of plant traits that are not sensitive to environmental changes. These traits are known as qualitative traits.
  - The expression of traits, such as yield, period between crop emergence and flowering, or period between fertilisation and grain physiological maturity, are greatly affected by stresses, such as drought, soil nutrient deficiency, etc. This can result in

## Duration Seed Program

YEAR 1 YEAR 2 YEAR 3 →

<u>Year 0</u>

- Planning for a Seed Program

<u>Year 1</u>

- Train the trainer by principal trainer beginning of season
- Month | 1 2 3 4 5 6 7 8 9 10 11 12 |
- up to 6 seasonal refresher courses for trainer by

  principal trainer

<u>Year 2</u>

- Beginning of season train the trainer refresher course
- Backstopping by principal trainer

<u>Year 3</u>

- Trainer advises in case of need seed grower

Seed Program Consultant:

- offers services to interested customer and if needed advises to find funding for program
- organises training (Venue, accommodation, transport etc.)
- secures services of subject matter specialists
- backstop's program through entire phase

a changed expression of such traits, due to a high genotype x environmental interaction. Traits which are sensitive to environmental changes are known as quantitative traits.

- Train farmers to identify and learn critical crop agronomic developmental stages important for:
  - Removal of off-types within a variety's seed crop, to enhance its genetic purity.
  - Detasseling or emasculating of all female lines before pollen shed, during breeding/ development of synthetic or open pollinated varieties.
  - Harvesting the crop 10 days after grain physiological maturity is reached, for controlled conditioning and processing of seed before onset of pest and disease infestation at field level.

As most of the target group of farmers may be illiterate, the 3-year training phase is important for creating seed supply knowledge and information systems that are based on the development of 'institutional memory' at the community level. This may enhance the sustainability of the programme if participants continue with the processes initiated during the training.

### IV.2.1 Concept of Seed Supply

Seed supply relates to the process of appropriate crop variety selection, variety development (variety genetic development and genetic integrity maintenance) and seed production, harvesting, conditioning, processing, physiological quality and physical qualitypurity testing, grading, treatment against pests and diseases, storage and packaging, marketing and distribution. In this regard, it is important that farmers are familiar with these activities, before embarking on the creation of local seed supply systems, which is often the ultimate goal.

## IV.3 Time Spreadsheet

The implementation of project activities in a 3–year time frame is summarised in the time spreadsheet indicating lines of responsibility for a given activity for each set of partners in a given agricultural season (see Annex I: Spreadsheet).

The rationale behind the time spreadsheet and why it should be used by the farmer is that it is handy and gives an overview of the activities whose outcome directly impacts initiation of subsequent activities for successful completion of the project. Since local seed supply systems are farmer based, it is imperative for farmer groups involved in such a project to be entirely familiar with the use of such a spreadsheet. This is based on the idea that it would be the farmers' responsibility to solicit stewardship for each activity, where they lack the capacity to complete it on their own.

The layout of this manual follows a functional approach based on a yearly work plan targeted at achieving specific results, as illustrated in the time spreadsheet (Annex I).

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Training Manual on Small-Scale Quality Seed Production

# Chapter V

## V Project Preparatory Phase: Training of Trainers

This Chapter has been designed for technical and extension trainer facilitators interested in participatory approaches to agricultural development, in collaboration with peasant farming communities. Preferably, such facilitators should have a fairly good background in food crop agronomy and should be drawn from the ranks of public or private agricultural sector intermediaries whose objectives include development of local seed supply projects.

Chapters III – IV give explicit and detailed background information on seed supply processes. This chapter attempts to synthesise such knowledge and information systems for the peasant[1] farmer level, through training. To appreciate the problems involved in developing appropriate training modules consistent with the target farming systems, it is necessary to define a few terms that are central to the discussions that follow. Bryceson (2000) defined *'peasants'* as constituting a distinct type of agrarian producers with the following four main distinguishing characteristics:

> **Farm**: the pursuit of an agricultural livelihood combining subsistence and commodity production.
>
> **Family:** internal social organisation based on the family as the primary unit of production, consumption, reproduction, socialisation, welfare and risk-spreading.
>
> **Community**: village settlement and traditional conformist attitudinal outlook.
>
> **Class:** external subordination to state authorities and regional or international markets, which involve surplus extraction and class differentiation.

A peasant's livelihood involves changing agrarian labour processes that are responsive to internal differences, such as climate, local resource variation and demography, as well as external stimuli, such as markets, taxation and other forms of state intervention. In this regard, peasant societies are best understood as societies moving towards or away from these four characteristics.

This gives a background to the development of the train-the-trainer course curriculum for seed supply systems that is solidly based on the creation of *'social capital'* (*Neuendorf 2003*). This simply means the establishment of trust relationships between various partners interacting with peasant farmers, to facilitate the development of common rules and norms pertaining to reciprocity and exchange of information. This would culminate in development of linkages and networking of social groups, such as farmers' associations, societies and producers' groups at the peasant farmer level under the guidance of agricultural re-

[1] The term 'peasant farmer' was preferred in the context of this manual, as not all smallholder farmers lack access to appropriate seed for their farming systems. Furthermore, not all resource-poor farmers have small land holdings

search and extension services. These groups would then constitute the primary local 'trainer' team comprised of peasant farmers and field extension service workers, in order for the PEA to develop local seed supply systems.

The design of these training curriculum modules integrates the requirements of trainer facilitators and those of peasant farmer participants in accessing seed Knowledge, Information and Technology Transfer (KITT) systems, as outlined in Annex III: Development of PEA to Local Seed Provision Systems.

The first train the trainer course is important, in that it covers the syllabus modules that would give prospective trainers a firm background in designing relevant work plans for developing local seed supply systems in their areas of operation.

The syllabus is summarised in Annex II: Local Seed Supply Syllabus. The induction training course would cover most aspects leading to sustainable development of local seed supply systems. Emphasis is placed on a hands-on approach to knowledge and information transfer, to encourage active participation of farmers with different literacy competence levels.

The entire syllabus, therefore, envisages training researchers, extension personnel and some farmers together for a minimum of three consecutive crop production cycles, to internalise a common technological and social framework for improving field crop productivity in a given locality. The syllabus is divided into systematically categorised modules, according to content area and methodology.

There are seven course modules that constitute the whole training syllabus namely:

- Introductory activities
- Social technology
- Variety characterisation and value for use and cultivation criteria
- Quality seed crop production, conditioning, processing and storage
- Variety purity maintenance
- Legislative seed framework at the interface with access to technology, distribution and marketing
- Local seed networks and exposure learning tours

The course is strong on practical field training (FFS), wherein visualisation, hands-on experience and observation techniques are used as the main tools for PEA in training, skills and information transfer. Essentially, social capital serves as a linkage point for knowledge and information transfer in local seed supply systems to peasant farmers and other consumers. Direct research–extension–farmer linkages are important to enhance face-to-face communication, thereby levelling the playing field, which is conducive for free flow of information as participants become acquainted with one another.

The training course, therefore, serves as a mechanism for empowering peasant farming communities through research–extension linkages in developing sustainable rural livelihood approaches, through improved crop productivity based on local seed supply systems. For the course objectives to be fully realised, it is important for extension and research personnel facilitating the programme activities to work with the same group of farmers for a period of no less than three consecutive agricultural seasons. Seed supply is a process and not a one-off event.

On completion of this course, each participant would have attained practical skills in KITT provision for sustainable local seed supply within their community. The curricula for different categories of local seed supply facilitators, be it farmers, agricultural technicians/supervisors, or national diploma/degree level personnel, may be designed from the summary syllabus presented in Annex II and expanded in the Training Curriculum (Neuendorf; 2003).

## V.1 Background to Breeding Food Crops

Crop breeding is a strategy often favoured by farmers as one of the possible means of increasing access to improved crop varieties. However, such an option may only be feasible if farmers and extension facilitators have been properly trained. Participatory Variety Breeding (PVB) processes for open- and self-pollinating varieties are explained in Section III.1.

## V.2 Background to Multiplying Food Crops

Food crop seed multiplication is outlined in Section III.2. Before embarking on such a programme, it is of great importance for farmers first to have easy and sustainable access to seed stocks of varieties with proven genetic superiority and purity. Second, it is important for mechanisms of variety genetic purity maintenance to be created to make available basic seed stocks for seed crop multiplication programmes. Third, as certain cereal crops considered to be staple foods are cross-pollinating, there is a great risk of seed contamination in peasant farming systems where crops tend to be grown together.

Given this background, it is important that communities are mobilised for developing local seed supply programmes with clearly articulated lines of responsibility to:

- Ensure good isolation of seed crops in crowded peasant farming systems
- Establish which varieties and what quantities are to be produced
- Know where and how the seed will be processed, packaged and distributed

## V.3 Agronomic Aspects

The agronomy of seed crops is not so different from that of ordinary crop production. This is described fully in Section III.3 and needs no further discussion.

## V.4 Observation Trials and Seed Gardens

The on-farm variety trials provide an opportunity for farmers to select the crop and variety biodiversity adaptable to their agro-ecological conditions, by using VEVO trials. Such trials, as elaborated in Section III.7.4, may also be used to check the variety's agronomic characteristics: these might also be used by farmers to produce seed in the off-season in seed gardens (see Section III.6), thereby making fresh quality seed available at the start of the main cropping season.

## V.5 Community Mobilisation

If demand for seed is clearly identified and the survey indicated the kind of crop diversity communities prefer, the project would need to select communities with whom to conduct pilot seed programmes.

The project would then need to mobilise the latter to implement seed supply programme activities. The mobilisation process involves discussing with the community the felt needs identified through the seed needs baseline survey. The project would endeavour to devise sustainable strategies for alleviating low food crop productivity together with the community. The communities have to be encouraged to suggest possible strategies that are consistent with their household food and economic security.

## V.6 Training Tools and RRA, PEA, FFS, VEVO and SWOT Tools

The key training tools for developing viable local seed supply systems are anchored firmly in Participatory Extension Approaches (PEA) and Farmer Field School (FFS) extension methods, whereby the extension services of an intermediary, be it public or private and/or NGO, lead the facilitation of implementation of all activities (see Section III.7). This is after a Rapid Rural Appraisal (RRA) has been conducted of the local seed supply situation in the area. A combination of PEA using the FFS method will be used. The FFS method is a practical approach to training which enables farmers to become their own technical experts on major aspects of crop and seed production. The FFS approach is based on the premise that the

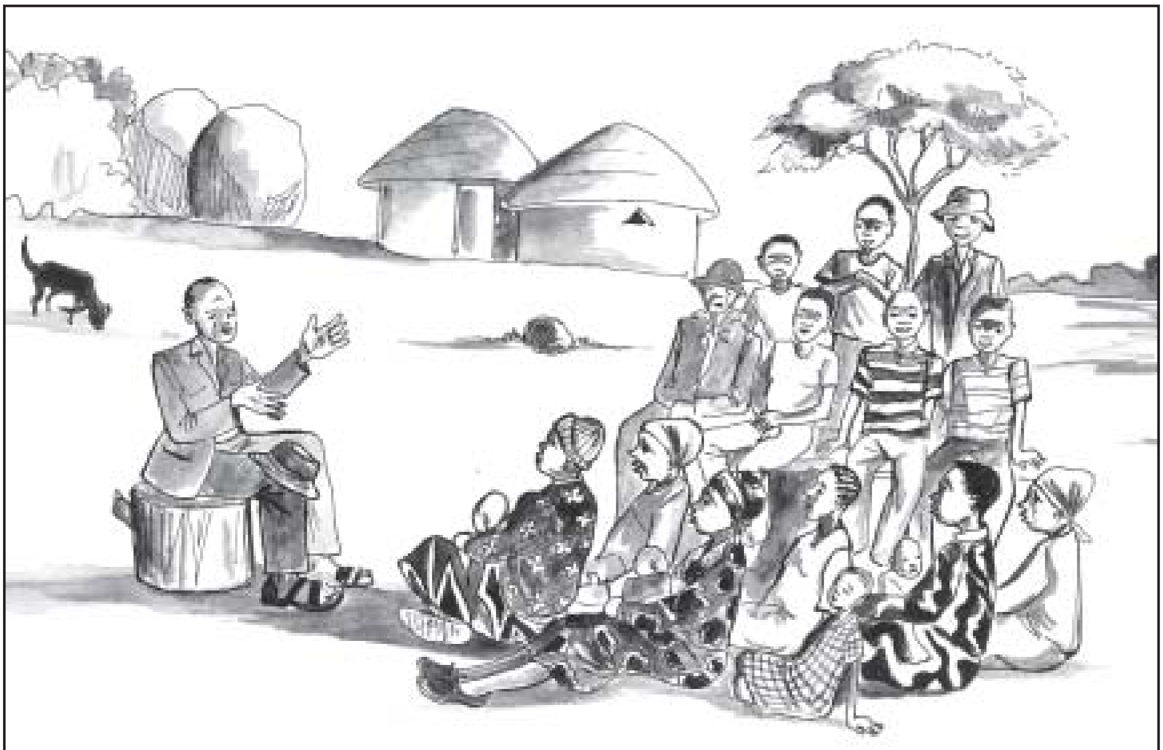

*Figure 34: Community mobilization for seed production*

*Figure 35: Use of drama in community mobilization*

participating farmers become researchers testing the various technological options available, during which process they are able to decide on the best means of adoption in their particular circumstances. Field extension services are at interface with peasant farming communities in most countries. In this regard, they form an important link between farmers and research or other service providers and are better placed to extend both knowledge and information systems to farmers, in particular where PEA take a leading role.

Since most peasant farmers find it difficult to follow agricultural manuals, VEVO trial plots are another major training tool for most practical aspects of seed supply processes (see Section III.7.4). Literally, the VEVO trial plot acts as a visible medium (book) from which the participants might go back to the plot, in order to:

- Review any technical messages that may have been given
- Observe for themselves the key plant development stages for ensuring quality seed production
- Compare variety development within and outside their own agro-ecological conditions

The VEVO trial plot is an invaluable hands-on training tool in that it empowers participants to compare new information with their own knowledge systems. In this respect, as the VEVO trials are Farmer Implemented and Farmer Managed (FIFM), farmers tend to adopt the knowledge, information and technology outputs they produce.

The social capital invested into community mobilisation gives the participants and other stakeholders the possibility to review programme progress using the strengths, weakness, opportunities and threat (SWOT) or challenges analysis, in order to institute corrective measures in activity implementation schedules (see Section III.7.5). Hence, the need for constant monitoring and evaluation of the programme for the following elements: relevance, efficacy, effectiveness and impact on the life-styles of the community hosting it. These underlying tools are essential for a sustainable programme to work effectively.

## V.7 Identification of Demand

Before designing any kind of seed supply project in a given area, it is best to conduct first an assessment survey in a given area. The seed needs baseline survey should be structured to give clear indications of the communities' perceived cause for household food insecurity. Further analysis should indicate clearly a definite demand for quality seeds of improved crop varieties.

## V.8 Defining Seed Demand

The seed security framework shown in Table 4 is a useful tool for identifying effective seed demand in a given area, subsequent to a food security baseline survey analysis. Furthermore, it is important not to lose sight of the fact that seed is often indistinguishable from a food security grain crop during data analysis. Good crop production for many farmers in both commercial and peasant agricultural farming systems is often dependent on farmer-saved seed from crops harvested during the previous season.

Often, it is possible to determine the type of seed demand for the community from the food security continuum. It is therefore imperative that before embarking on work plan development for a seed supply system in an area, the intermediary and farmers are sufficiently confident that they have identified the correct seed demand for the community, in order for the project to be relevant to the community.

*Table 4: Seed Security Framework to Enhance Development of Effective Seed Demand Problem Definition*

| Parameters | Food Security | Seed Security |
|---|---|---|
| Availability | Sufficient quantity of appropriate food stuffs are within reasonable proximity to the target communities | Sufficient quantity of appropriate seeds are within reasonable proximity to the target communities |
| Access | Members of the community have adequate financial or other resources to timely procure or barter for appropriate food stuffs | Members of the community have adequate financial or other resources to timely procure or barter for appropriate seeds |
| Utilisation | Food is properly used (processing, storage, nutrition, child care, health and sanitation practices) | Seed of acceptable quality (genetic, physiological and physical, and Phytosanitary) is used |

## V.8.1 Comparison of Available Varieties as Preconditions to Identifying Farmers' Needs

The question to be answered here is whether the farmers' actual demand for seed is being addressed or whether it is seed of a preferred variety that is being dealt with. Numerous studies have shown that peasant farmers undoubtedly aspire to gain access to improved varieties. However, once these varieties are obtained, the demand for seed of those varieties diminishes quickly.

Hence, when conducting the food needs assessment baseline survey, it is imperative for the intermediary to solicit co-operation from local community seed experts, to obtain samples of no less than 250 grains of the preferred crop varieties. If conducted before the start of communal seed fairs, this activity will help technological resource providers to conduct grain or root and tuber comparative analyses with germplasm in their plant genetic resources gene banks. Exact germplasm replicas may not be found initially, however, such will give indications of the genotype profiles of preferred crop varieties. With other agronomic information obtained from the survey, the technological provider can come up with four to six varieties with the same genetic profile as those submitted by the farmers.

These are the necessary preconditions for farmers agreeing to participate in community-based research trials. Another precondition may be community demand for the introduction of new technology to current farming systems, due to changes in agro-environmental conditions or the farming systems themselves. New technology, however, does not have to be too different from the preferred one that is consistent with household food, social and economic security.

## V.8.2 Tools for Combining Preconditions and Determining Needs

It has already been stated that food needs assessment baseline surveys, combined with preferred food grain sample collection, are some of the tools needed for defining the preconditions of programme formulation. It is best to combine these with the following:

- Unstructured community interviews, to understand community dynamics governing availability and access to germplasm at the local level.
- Follow-on surveys with an experienced plant genetic resources expert, to verify the information and food preferences identified in the first survey.
- Provision of unlabelled food grain samples identified as being similar to the genetic profile of the preferred variety, so that the community can sample and confirm that the technology is suitable and consistent with their needs.

## V.8.3 Finding Partners in Seed – Seed Sources

National Agricultural Research Systems (NARS) in public and private breeding institutes and/or regional International Agricultural Research Centres (IARCs) are sources of quality germplasm and other exotic plant genetic resources that could meet farmers' felt needs. Furthermore, these institutions have the requisite human resources for providing seed supply trainers.

Public agricultural or rural development services and those of NGOs interested in local plant genetic resources conservation or development often offer the programme external extension facilitators. However, in order for the programme to be sustainable, it is necessary for public national extension services to be involved from the beginning, as they have the direct mandate to facilitate agricultural productivity.

Local seed supply experts need to be identified and to become an integral part of the technical and extension facilitation service.

### V.8.4 Elaboration of Peasant Farmer Crop Breeder in the Village

In each community, one or two individuals develop skills in variety crop development, identification and collection of germplasm for improving crop diversification and productivity at the village level. The local seed supply specialist often selects and maintains crop variety biodiversity in special seed gardens, both during the summer and winter months. The concept of seed gardens as living gene banks originated from peasant farming systems.

In some communities, peasant farmer seed supply experts still exist and provide germplasm for most crops that are not considered to be of commercial value to the formal seed industry. Such expertise is invaluable in the development of participatory approaches to local seed supply systems.

## V.9 Background to the Planning Process

As illustrated above, it is important to determine explicitly the demand for seed of target communities, in order to determine the entry point for possible intervention strategies within seed supply systems. For instance, if the majority of farmers have access to quality seed of improved crop varieties, it becomes immediately apparent that a small scale seed production project would neither be viable nor sustainable.

However, should there be problems of access to improved varieties of appropriate crops the stage is set for planning of variety selection and seed production systems. If the problem only involves utilisation processes, it may be realistic to plan for variety improvement and breeding processes to improve the genetic purity of the varieties.

## V.10 Lay Out of Time Spreadsheet

### V.10.1 The Practical Use of the Spreadsheet

Annex I illustrates the work plan in the form of a Time Spreadsheet covering three years. The first section of the spreadsheet indicates lines of responsibility for each stakeholder in a local seed supply project. The second spreadsheet indicates the important activities to be elaborated on for developing viable local seed supply systems in a latter section. The second spreadsheet emphasises PEA to developing local seed supply systems, thereby enabling farmers to assume full ownership of the project, which is important if the project has to be sustainable. The purpose of Time Spreadsheet is further elaborated in full in Chapter VI.

*Figure 36: Women are custodians of crop biodiversity*

### V.10.2 Examples of Time Spreadsheets

The time spreadsheet work plan has activities planned to cover the whole year. This clearly indicates that like all agricultural programmes, seed supply is a process and not an event. To this end, it is important that the work plan be closely followed, as some timed activities fall in the critical path for development of viable local seed supply systems.

## V.11 How to Use a Time Spreadsheet

The timed spreadsheet work plan is the master plan, which every facilitator should refer to constantly in implementation of field activities. For instance, there are critical activities important for creating local knowledge systems, such as correct determination of the variety fertilisation period. This has implications for planning Participatory Variety Breeding (PVB) processes, selecting isolation strategies in quality seed crop production, and timing Field Days for exhibiting potential quality seed availability to the market.

## V.12 Seed Production Process as Laid Out in Work Plan

Seed production processes follow immersion training, entailing knowledge of how to recognise varieties, local information generation to determine variety performance, and sourcing of appropriate quality seed of the varieties to be multiplied. Seed production can only be viable if the stock-seed is of the correct quality and of known genetic purity.

It is recommended that seed production processes be attempted only by those farmers who participated at least for a full agricultural season in the implementation and analysis of results from VEVO trial plots, designed to generate the requisite knowledge, information systems and skils for local seed crop production.

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## VI Small Scale Seed Production Process Initiation: Activities in Year One

Annex I provides an overview of the main activities of a work plan spreadsheet for the entire programme phase: it summaries clearly the key activities to be implemented in the Local Seed Supply Programme. It is critical for trained facilitators to be at hand during this introductory stage, in order to spearhead implementation of all activities in the programme.

The critical activities for the initiation stage of small scale seed production are summarised in Year 1 of Annex I. This section explains the rationale for each activity of the seed supply system composed of integrated processes, such as variety selection, variety genetic purity maintenance, seed production and multiplication, harvesting, conditioning, processing (cleaning, grading, physical and physiological quality testing, and treatment), storage, distribution and marketing.

Some of the above processes, though integrated, may be conducted independently. Other processes, however, are dependent on the implementation of one or more of the other activities in the chain, before they can be carried out. In this regard, for successful and viable development of seed systems, clear lines of responsibility for each critical activity need to be agreed upon among stakeholders. In formal seed supply systems, certain organisations take responsibility for certain processes for which they believe to have the requisite skills to give them a competitive market advantage. In informal or local seed supply systems, often these lines of responsibility are not defined, either at individual or institutional level. The 3-year time spreadsheet work plan in Annex I formalises these lines of responsibility.

### VI.1 Community Mobilisation

This is a follow-up activity to the seed needs assessment baseline survey already conducted by the intermediary in a given community, to identify specific seed demand problems associated with reduced food crop productivity.

To initiate a community-based seed supply system, consultations with farmers would be a prerequisite activity, if the latter were to assume ownership of the programme. Community mobilisation for local seed supply systems would be the responsibility of the village leadership. Together with the project intermediary, community leadership would need to elaborate on the data analysed in the baseline survey. The objectives for mobilising the community would be to explain the programme and discuss with community members the following elements:

- Key factors responsible for low food crop productivity in the farming system and local agro-ecological conditions resulting in household food insecurity.

- Possible strategies for solving the problems identified.
- The role of each community member to invest in the solutions identified to enable sustainability of the proposed local seed supply programme.
- Introducing the concept of participatory approaches as a form of social capital invested by the community in agricultural development, whereby dividends would accrue to both the community and the individuals, enhancing sustainable rural livelihoods.
- Developing local community seed supply systems to empower farmers to control the yield performance of their crops, in order to meet requirements for household food and economic security.

### VI.1.1 Elaboration of Target Farmer Groups

Target farmer groups are composed of volunteer members of the farming community identified through baseline surveys as having strong felt needs for establishing local seed supply systems. Volunteers have been shown to be more effective in implementing activities based on participatory approaches to agricultural development programmes. Often, participatory approaches call for individual investment in time, labour, land and other resources. Selecting farmers who are not willing to invest their own resources often creates problems, to the extent that field trials are abandoned or instruction are not complied with fully. In this regard, the volunteer groups should constitute a representative sample of the farming community's preferred lifestyle and farming systems.

Each group is usually composed of 20 farmers with homesteads well scattered throughout a given village, in order to capture the farming systems and agro-ecological heterogeneity found within a given locality. In many peasant farming communities, five to six villages constitute a distinct farming community (Ward or Block) governed by a cultural oligarchy headed by a traditional chief.

## VI.2 Training of Trainers Sessions

The Train-the-Trainer (TtT) sessions are meant to be conducted regularly during the first two agricultural seasons. The timing of the key TtT sessions coincides with the crop agronomic development stages. For instance, many extension personnel cannot differentiate between pollen shed and fertilisation. Such crop development stages are often an expression of the *variety's genotype x environment interaction*, and require that they be demonstrated clearly to participants. In most pearl millet varieties, for example, the stigma matures days before pollen shed in the same plant. This phenomenon ensures a high level of out crossing rather than self-pollination in this crop. Spatial isolation is the most favoured isolation mechanism in quality seed production for varieties of this crop.

The trainers must have a clear understanding of the expression of all the important characteristics in a variety, as identified by the farmers in a particular farming community, as well as the implications of changes in these traits for quality seed development, before attempting to train the farmers in small scale seed supply. It is recommended, therefore, that a qualified breeder and/or agronomist be the trainer in all technical aspects of seed crop knowledge transfer.

The manual will be used as a master guide and each trainer will be required to know how to use it, as it charts explicitly how the project should be implemented to achieve specific objectives. However, this manual is complemented by a complete Training Curriculim for both trainers an trainees, which fully covers all training aspects in detail. (Neuendorf, O.ed 2003)

### VI.2.1 Usage of VEVO Plot Protocols

The VEVO protocol is the key field training manual, which elaborates in detail the rationale for most of the seed supply knowledge and information generation process through activity implementation detailed in the work plan (see Annex IV and Section III.7.4). The trainers would need to be taken through the entire protocol for each crop, in order for them to appreciate the importance of some activities, for example, Farmer Field Schools in variety characterization at flowering stage of the crop; these are essential for verifying variety purity of a given crop.

### VI.2.2 Specification of Small Scale Seed Production

Small scale seed production would range from 0.5 to 1 ha investment in land by a peasant farmer. A team of husband and wife without assistance from other family members can manage easily this size of land for any crop. Improved open-pollinated varieties preferred by peasant farmers under good crop management and favourable agro-ecological conditions, have a yield potential of over one ton for most grain crops. To increase the quantity without compromising the quality, it may be better for farmers to combine their seed production into lots. This assists in marketing seed as its probity may be more easily verified independently.

Some farmers have attempted to increase the land size of their seed crops and ended up compromising the quality, which is the basis for seed marketing. After investing so much in materials and time, such an experience may hamper development of local seed supply projects. Furthermore, crop management is far easier with a smaller crop than with bigger areas of seed crops.

## VI.3 Work Plan Sessions

Examples of work plans are presented in Annex I. These trace the scheduling of project activities and lines of responsibility, starting with the Project Preparatory Phase and ending in Year Four when farmers finally take over. Work plans indicate when an activity should be initiated and who is responsible for its implementation.

### VI.3.1 Discussion Objectives of Local Seed Supply Systems

This manual explains the rationale for developing sustainable local seed supply systems in any peasant farming system in the SADC region. It is anticipated that this will lead to the desired purpose of the project, that is; <u>peasant farmers in the region have improved and sustainable access to quality seed of appropriate varieties of staple food crops</u>. Once the purpose has been reached, the farmers will be sufficiently trained to manage and administer independently the entire program on local seed supply.

The key outputs to ensure the attainment of the project purpose can be summarised as follows:

- Training of trainers from intermediary extension services and farmer resource persons who will facilitate the implementation of all the activities of local seed supply programmes.
- Deciding how many crops to work with and exploring possibilities of accessing improved varieties of these crops.
- Selection of pilot project areas and developing strategies for equitable expansion of the project to cover the target area.
- Creation of institutional farmer structures to co-ordinate and manage the implementation of project activities at the village level.
- Establishing strong linkages with resources (technological, specialist training and financial) and other service providers.

The above would provide a clearer framework for discussing the five key results expected from a local seed supply project. It is essential that all players are entirely familiar with the provisions in the manual, as it sets out clear guidelines on how to link all the components for developing viable local seed supply projects.

### VI.3.2 Use of Work Plan

Work plans essentially constitute the master plan that gives a sequential guide on how and when to implement programme activities. They are often formulated as a time spreadsheet indicating those activities in the critical path for successful completion of a particular phase of the programme. Further work plans determine lines of responsibilities for implementation and financing of activities.

In this respect, work plans are used in a programme for:

- Costing and hence resource budgeting (time, human and financial)
- Monitoring and evaluation of activity implementation by all stakeholders

### VI.3.3 Elaboration of Activities on the Basis of Sample Work Plan

Table 5 below illustrates the key project activities in an agricultural season that would contribute to attainment of outputs, resulting in achievement of the project purpose. The sample work plan assumes that the target farmers expressed a need for access to improved technology (varieties).

The crop variety profile preference consistent with household food and economic security needs is known by the peasant farmers. The project objectives would be to:

- Identify improved varieties with an identical or similar genetic profile to that preferred by farmers.
- Access the requisite variety or variety biodiversity quality seed and train the peasant farmers in quality seed production and variety genetic purity maintenance.

The timed and resource budgeted work plan spreadsheet in Table 5 illustrates the sequence of activities that would contribute to achieving the above objectives in a single agricultural season. However, due to the complexity of attaining expert seed production knowledge systems in a single agricultural season, it is often necessary to enhance the training over two or three agricultural seasons.

The work plan identifies over 23 key activities that would need to be implemented if the desired objectives were to be realised. The shaded activities fall in the critical path for establishing viable local seed supply systems. Although most are self-explanatory, elaboration of some is necessary for full comprehension of their sequencing.

### VI.3.3.1 Stakeholders Consultative Meeting to Review Seed Demands in the Project Area

The stakeholders include the target farming communities and the supporting intermediaries interested in collaboration in developing local seed supply programmes. The consultative meeting would aim to establish the:

- Commitment level of each partner in the project in terms of resource allocation.
- Crop and varieties that the stakeholders would like to work with.
- Most cost effective and equitable strategy for launching pilot areas for activities to implement the seed supply programme.

### VI.3.3.2 Select Extension Co-ordinator for District Local Seed Supply Programme

In order for the programme to co-ordinate communication effectively between partners and field activity implementation, and conduct monitoring and evaluation, a liaison/co-ordination extension person is required. The responsibilities of such a person would be to ensure that all partners are debriefed constantly on project progress in order to facilitate timely corrective intervention by other partners, should the budgeted work plan start to indicate any drift from the target. This may happen, as the project is vulnerable to weather changes.

### VI.3.3.3 Train the Trainers in Project Planning Matrix, Use of Manual and VEVO Protocols

The train the trainer component in preparation for the project planning matrix (PPM) is essential for all project activities, extension and farmer facilitators.

Most extension services and farmers still use the traditional top-down strategy for knowledge and information transfer. However, as seed production processes are considerably different from general food crop production processes, very few facilitators have the technical capacity to train farmers independently. It is important, therefore, for a transformation in the training strategy in field schools to be taught to both facilitators and farmers.

### VI.3.3.4 Seed Acquisitioning for VEVO Trials and Seed Multiplication

For outputs of all VEVO trials to be comparable, it is necessary for farmer participants to be given seed of tested varieties that are of the same quality regarding generation cycle and genetic purity. Such seed is often accessed through crop breeding institutes or organisations in the National Agricultural Research Systems (NARS) or International Agricultural Research Centres (IARCs). The process of seed acquisition links farming communities to technology developers and providers. Such linkages are important in empowering farmers to gain access to new, improved technology independently.

### VI.3.3.5 Seed Distribution

Quality seed for VEVO trials and/or seed multiplication acquired by the project would need to be repacked into trial size packs by qualified technicians. The VEVO trial packages should be clearly labelled and arranged to meet the requirements of the variety diversity to be tested. The seed for seed crop production should be packed in quantities predetermined for expected crop size by the facilitator. (c.f. Annexes IV and V)

Seed should be distributed to all participants well before the beginning of the planting period. This is important as both time and space are often at a premium in peasant farming systems.

### VI.3.3.6 PEA Field School Training on VEVO Trials and Seed Multiplication Layout

Layout of VEVO trial plots for a crop will need to be demonstrated to all participants at field level. This should be a hands-on approach, giving each participant the opportunity to try this exercise for themselves to enable them to duplicate the process in their own fields. The rationale of the strategy should be elaborated to all participants as each plot represents part of a randomised replicated trial block. However, the randomised block should be represented by six plots planted in different fields by different farmers. The design aims to capture the micro differences in agro-ecological conditions and crop management techniques in a specific locality. This gives a clearer variety adaptability and yield performance profile.

### VI.3.3.7 Monitoring and Evaluation of all Trials and Progress Report

Monitoring and Evaluation (M&E) of activity implementation and crop development in VEVO and seed crop multiplication plots is an important component of project management. The most critical M&E exercises being those at VEVO trial establishment and at flower initiation in some of the varieties in the VEVO trials and seed multiplication plots. The former determines the critical period for gaining information on crop emergence, while the latter is important for variety characterisation training in VEVO trials and removal of plant off-types in seed crops.

Farmers can undertake these exercises and should liaise with extension services personnel who may conduct a verification M&E exercise on a sample of VEVO trial plots, before sending the report to the intermediary who may then notify the trainer whether there is need for a Farmer Field School or not.

### VI.3.3.8 PEA Farmer Field School Training Variety Evaluation, Characterisation and Verification (Crop Flowering Stage) / Seed Crop Off-Type Removal

During the field school, the trainer takes the participants to a selected VEVO trial plot. The criteria for selection of a good training trial for variety characterisation can be summarised as follows:

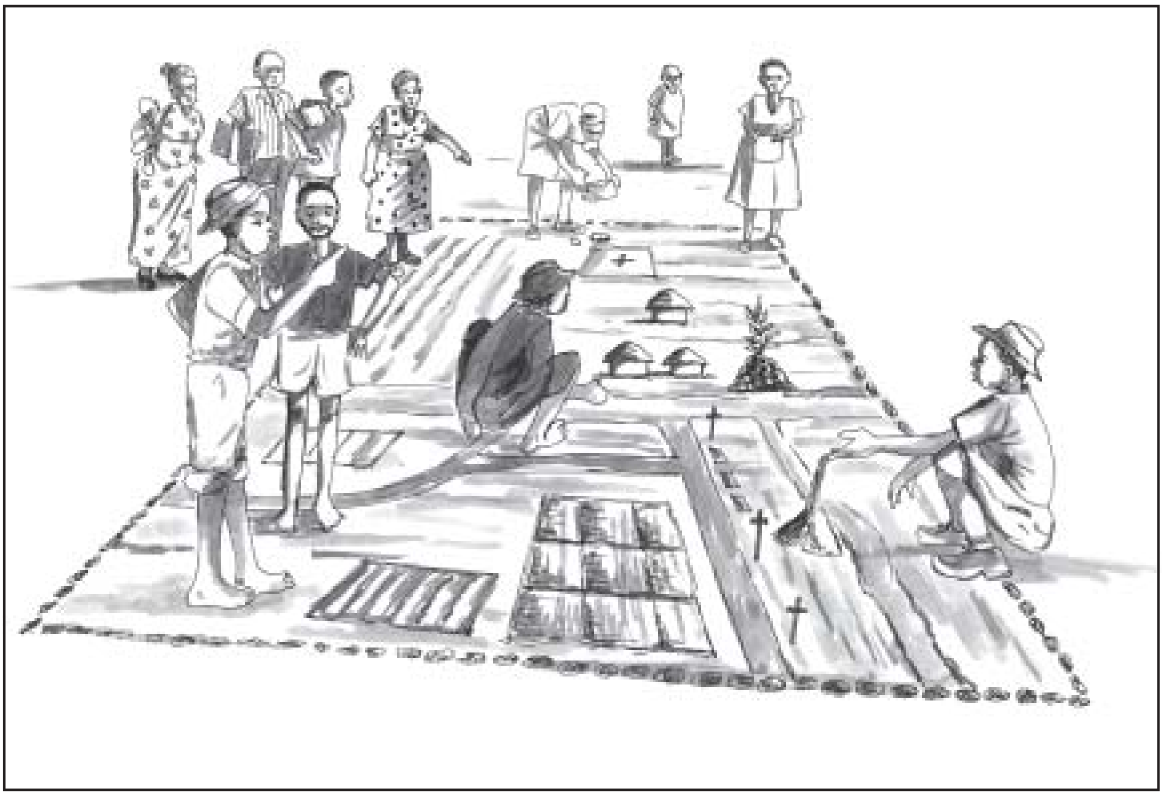

*Figure 37: Phases in conducting VEVO trials: decision making*

- The trial plot is easily accessible to most members of the community without damaging other crops in the vicinity, that is, the trial should be adjacent to a road or field path with the main crop framing it on three sides.


*Figure 38: Farmer removing off-type plants*

*Figure 39: Phases in conducting VEVO Trials: Management of the trial*

- At least one or two varieties are in full flower and some are starting to flower.
- Crop development in all plots is the same, showing no environmental stress.
- Crop husbandry in the VEVO trial plot is the same as that of the main crop.

The characterisation traits as described in Section III.1.10 have to be demonstrated to each participant, until the salient aspects of the trait are understood and can be duplicated by all participants. The following learning tools may be used:

- Plants in the plot may be considered as words
- Different varieties may be considered as paragraphs
- The entire plot may be considered as the page on which the words are written in paragraphs

Through PEA, the participants learn first how to identify and then read (note the trait) the words (that define a given variety). By doing the same for each variety in the VEVO trial plot, they begin to generate knowledge systems and skils on differentiating varieties based on qualitative traits, which are not influenced by changes in the environment, in addition to quantitative traits where the genotype x environment interaction effects are observable.

In quality seed crop production, the local knowledge systems generated for characterising each variety become invaluable in identifying quickly off-types that might contaminate the genetic purity of a particular variety. Variety verification, therefore, becomes important at flowering. Furnished with local knowledge and information systems, farmers can scout their seed crops easily for internal and external contaminants.

*Figure 40: Phases in conducting VEVO Trials: Field data collection and variety evaluation*

*Figure 41: VEVO Trial Plot. Note the clear labelling of varieties in the trial and accessibility of the trial plot.*

### VI.3.3.9 Local Seed Supply Participants Exposure Tours (Provincial and/or Regional)

Seed supply farmer groups learn a lot from exposure visits to other groups implementing similar projects in other districts or provinces, when they can exchange experiences with other farmers and observe the performance and management of seed related programmes in other areas.

This activity, although instructive, in that farmers respond better to the experiences of other farmers, tends to pose logistical problems. It works well where a network of local seed supply projects already exists.

### VI.3.3.10 PEA Field Days, M&E of VEVO Trials and/or Seed Multiplication Plots

This activity is a key community mobilisation activity where the farmers themselves assume responsibility for programme progress review. It provides the community with service providers, such as farm produce processors and commodity dealers to assess the quality and market opportunities available locally. It is a very good marketing tool to demonstrate the management and seed production technical skills that could be developed into contractual agreements.

*Figure 42: Field day visit: a groundnut seed crop*

*Figure 43: Field day visit: a sweet potato vine seed crop*

*Figure 44: Phases in conducting VEVO Trials: Variety selection based on field observations*

*Figure 45: Data analysis of VEVO Trials*

### VI.3.3.11 Farmer Field School Training in Crop Physiological Maturity Assessment: Second Variety Evaluation, Characterisation and Verification (Preparation for Harvesting)

This Field School is conducted like the one in VI.3.3.8 above, except that the medium for instruction would be the fruiting bodies and the seed grains that would need to be shelled to illustrate the differences. Physiological maturity is described in Section III.1.10.3. This trait is important for determining the period to maturity and harvest for the crop as different varieties tend to mature at different rates. Furthermore, the trait has great implications for seed quality.

### VI.3.3.12 Farmer Field School in Seed Crop Harvesting and Fruit Body Conditioning

Depending on micro agro-ecological conditions prevailing in a given area, this training session can be combined in one group with that for physiological maturity as described in VI.3.3.11 above. It is important for the fruiting bodies to be harvested no later than ten days after physiological maturity has been reached, to reduce the incidence of weevil and disease infestation of the grain.

The fruiting bodies should be put in well-aerated drying structures, such as cribs, and if possible protected from rodents and bird pests. Each crop requires different conditioning

*Figure 46: Cassava seed crop*

*Figure 47: Farmer proudly shows his mature maize cobs*

*Figure 48: Cassava seed crop ready for harvesting cuttings as planting material*

*Figure 49: Cassava planting material cuttings*

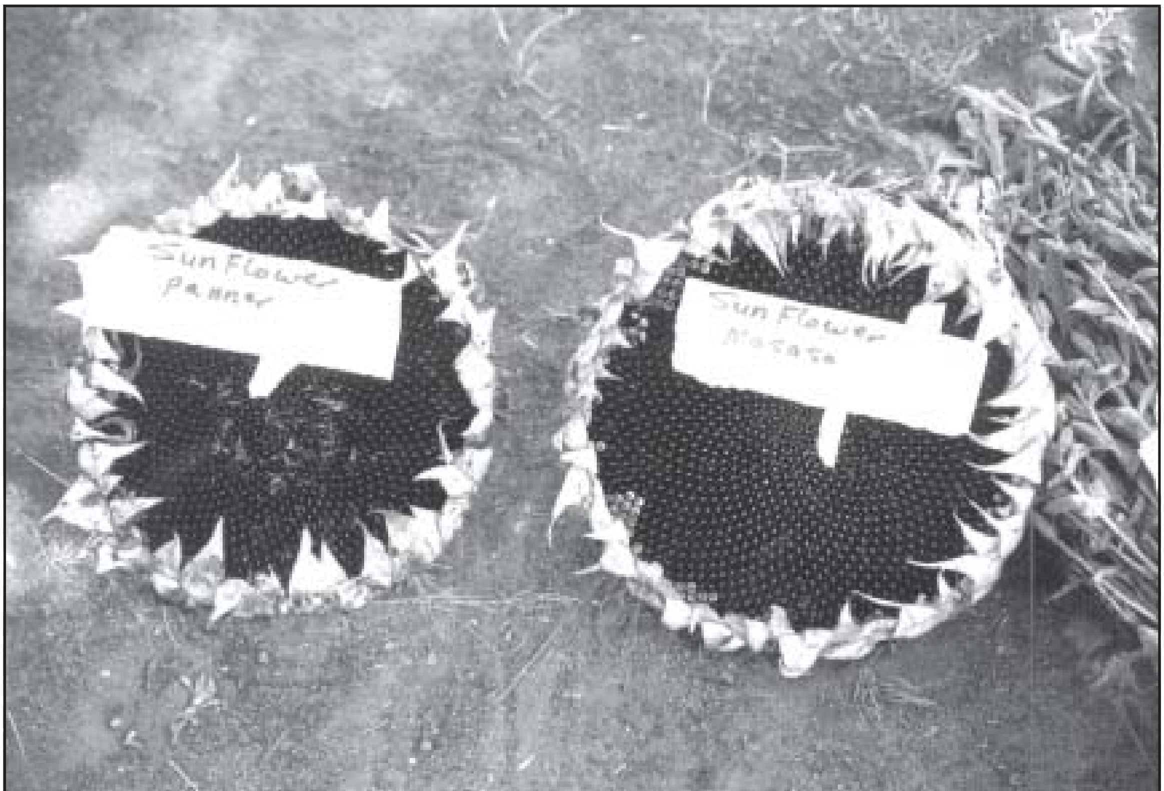


*Figure 50: Mature sunflower heads ready for threshing*

*Figure 51: Sorghum seed crop nearing maturity*

*Figure 52: Use of animal draft power in harvesting groundnuts*

processes that are illustrated below. However, the important factor is for conditioning to be performed in a shaded area, as direct heat might cause deterioration in the physiological quality of seed. In this respect, hot air drying is preferred for conditioning any type of seed rather than direct sunlight as a rule of thumb.

Seed should be conditioned to between 12–15 % moisture content before grain shelling. Determining these levels of grain moisture content is not very easy without a machine: however, as seed is not so different from grain, most farmers have local knowledge about determining the correct period for shelling.

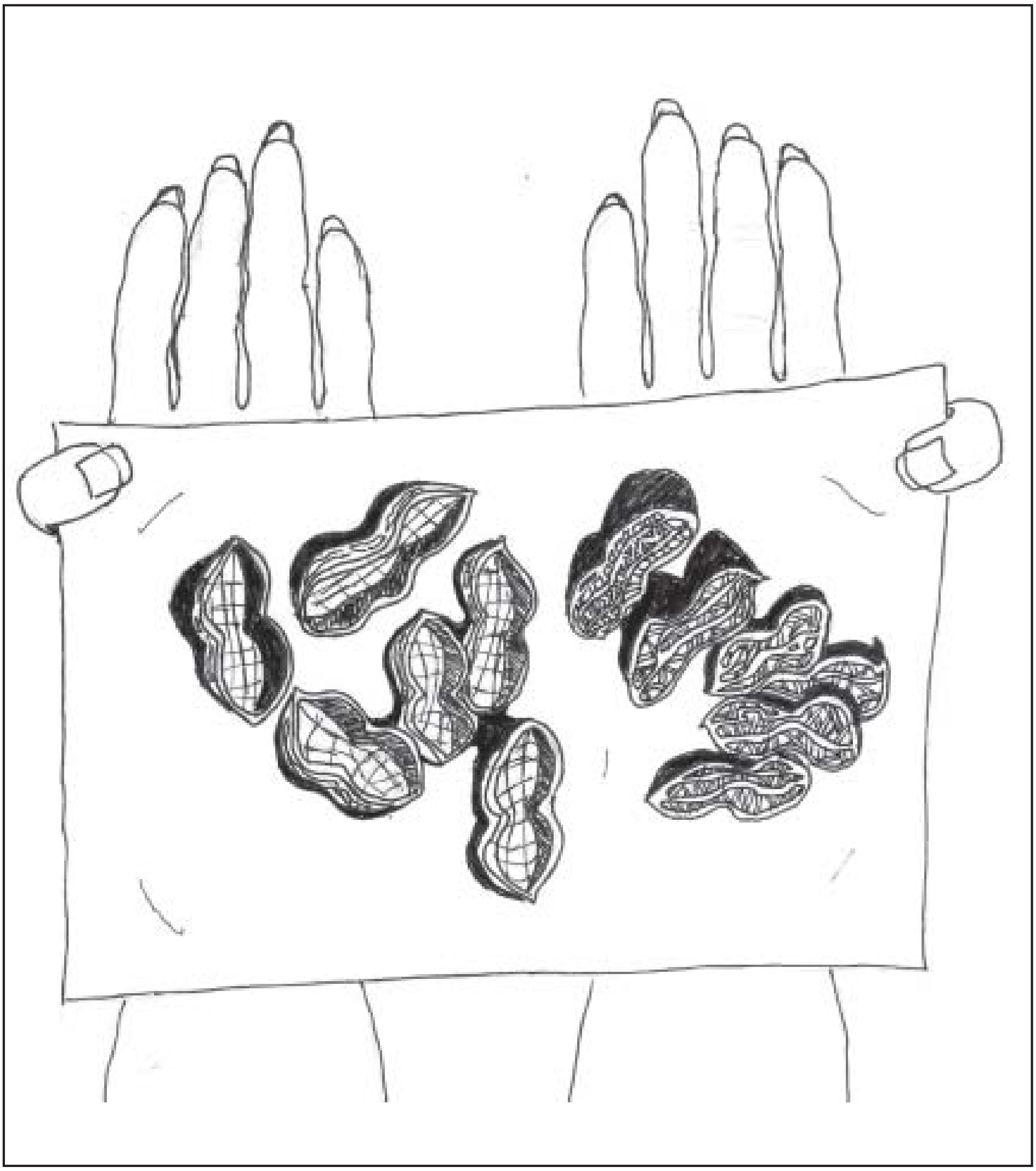

*Figure 46: Physiological maturity in groundnuts is exhibited by striations inside the opened pod*

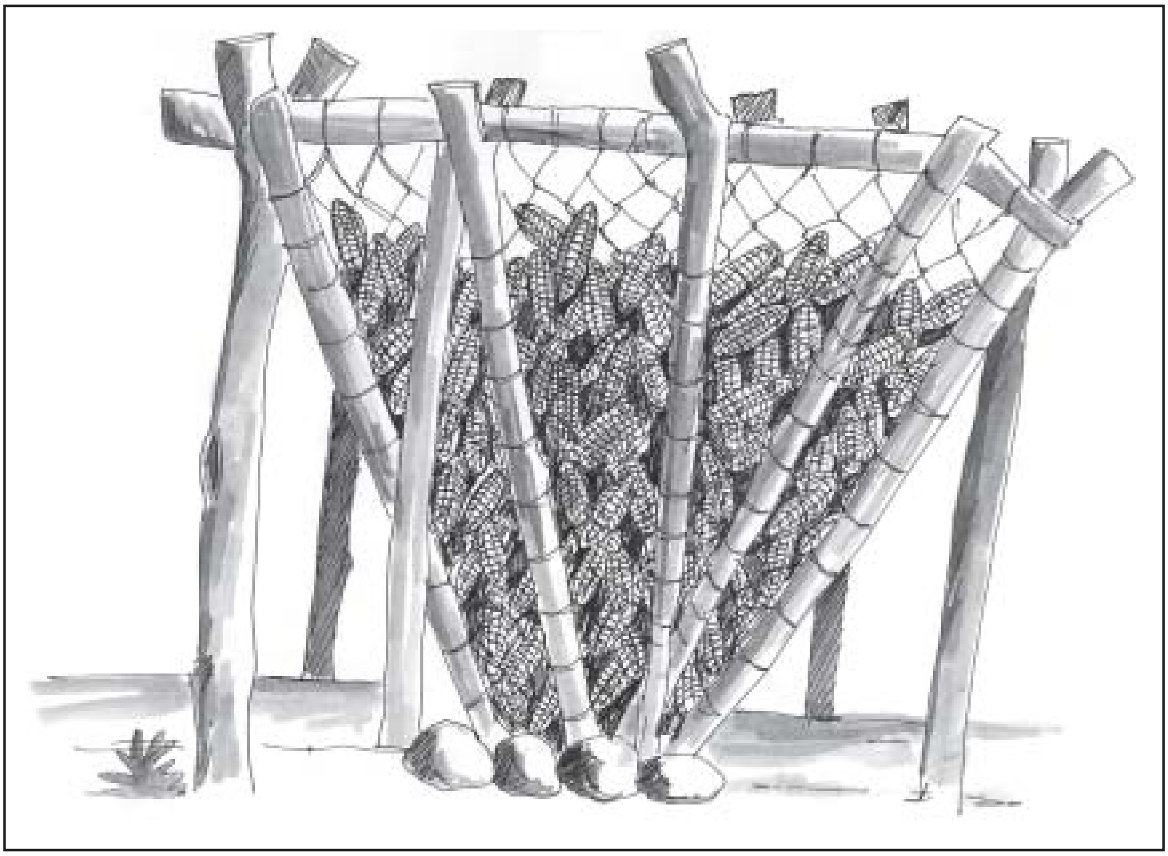

*Figure 54: Traditional crib for conditioning coarse grain cobs or panicles*

*Figure 55: Maize cobs hung out for drying*

## VI.3.3.13 Training in Seed Processing Selection of Good Fruit Bodies, Shelling, Grading and Seed Conditioning to 12 % Moisture Content

It is important that before shelling, only healthy fruiting bodies (cobs, panicles, pods and heads) are selected. Care should be exercised that in composite varieties all healthy and clean fruiting structures are selected for shelling. Farmers have a tendency to select only large fruiting structures: this poses a real danger of selecting out some genes that contribute to the variety's genotype, leading to genetic drift or loss of vigour due to inbreeding.

It is recommended that hand shelling be practised for seed grain processing, to avoid damage to the grains. Furthermore, before shelling, it is recommended that the fruiting body be divided into sections, generally accepted as those with the greatest probability for producing viable good quality seed grain.

However, for most fruiting bodies, it is easier to select seed after grading. Screens can be easily devised for grading the correct seed grain required for planting. Any seed smaller than the screen size may be used as food grain or stock feed. A number of manual screens are available or may be constructed easily, as illustrated in Figure 57.

Grading seed is important as it determines the following:

- Germination potential of the crop: seed of the same size and structure often emerges from the ground around the same time, provided that agro-environmental conditions are similar.
- Seedling vigour is similar which will result in a crop of the same stand and response to inputs, with implications for yield performance.

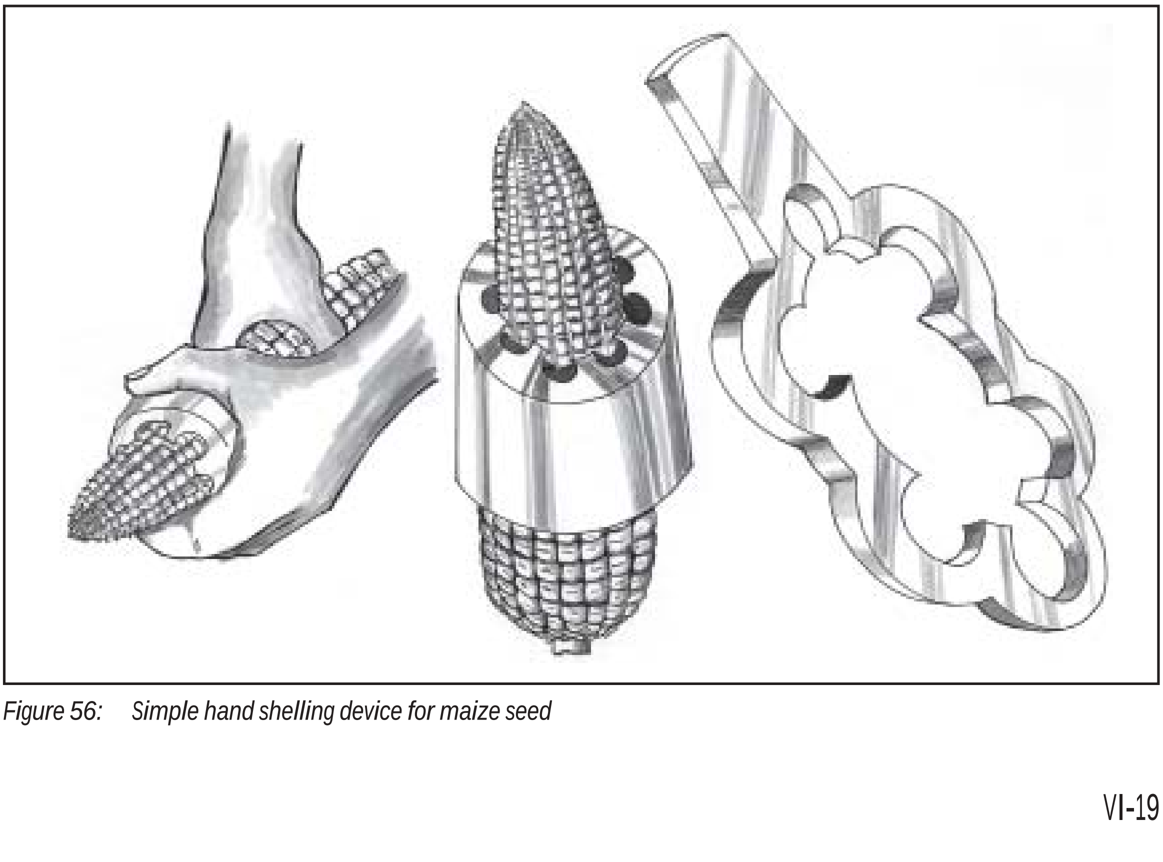

*Figure 56: Simple hand shelling device for maize seed*

### VI.3.3.14 Training in Moisture Content, Physical and Physiological Quality Determination and Short-Term Bulk Storage of Seed

After seed grading and manual selection for blemishes, it is important for the seed to be conditioned finally to moisture content of 12 % or below. This moisture content is easily determined at household level by using a tightly sealed transparent jam jar with a small amount of seed and ground table salt. The following processes are recommended:

- A handful of seed is put in a dry transparent jam jar or plastic bag with a pinch of dry table salt.
- The container with its contents is then tightly sealed and put in a very warm environment or in the sun for an hour.
- After an hour, the container with seed and salt is shaken and closely inspected. If the salt sticks to the sides of the container, the moisture content of the seed is above 12 %, it needs to be conditioned again.
- If the salt does not stick to the container or seed, the seed moisture content is equal or below 12 % and is ready for storage.

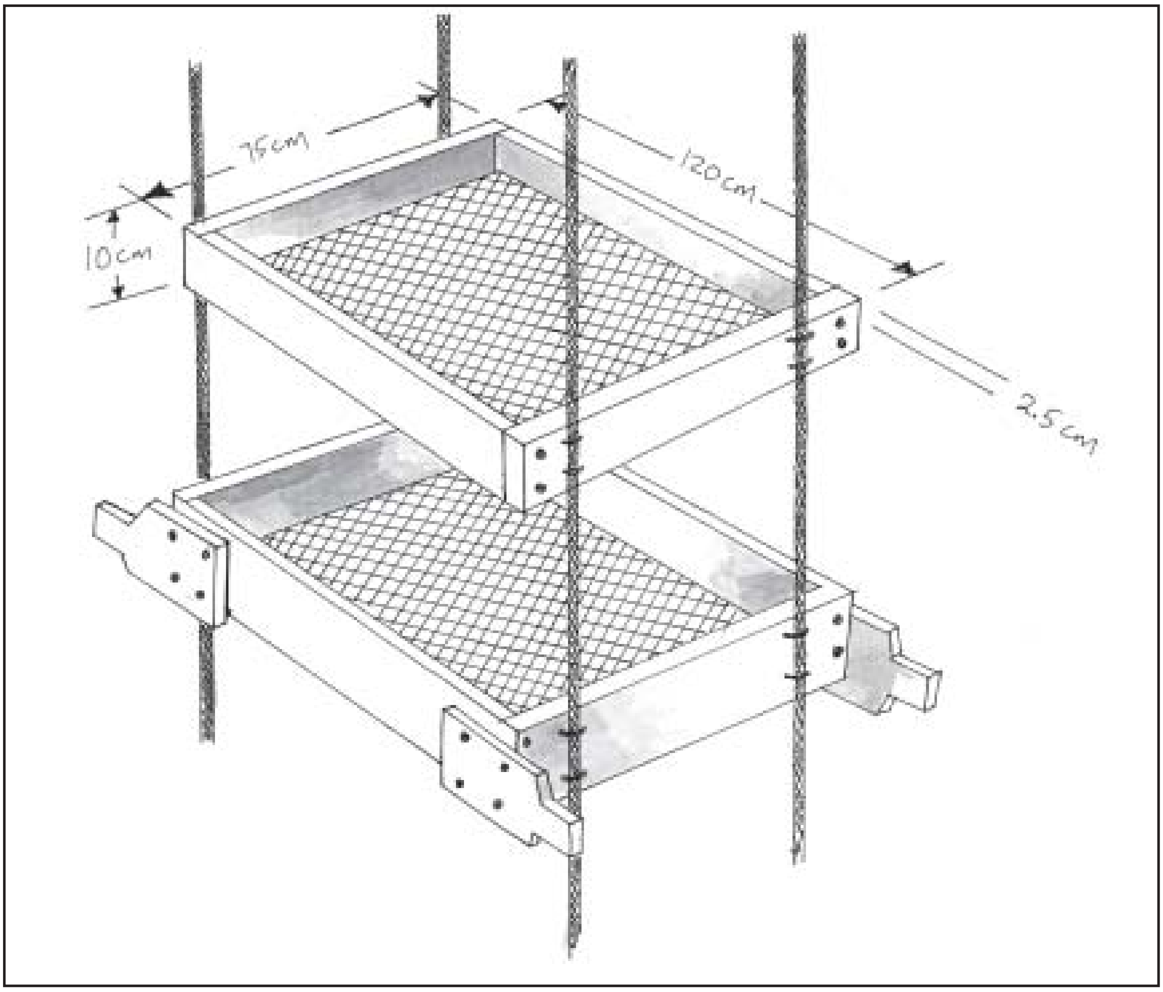


*Figure 57: Simple manual screens for different crops*

Seed stored at moisture content above 12 % will deteriorate in quality by loosing it viability or rot in less than 60 days.

Before storage, it is recommended that the seed be treated with a combination insecticide and fungicide mixture to prevent infestation with post harvest pests and diseases (Figure 61). There are a number of products on the market that are safe to use for both seed and food grain storage protection. The most effective seed protective chemicals are *actellics*. The advantage of such chemical compounds is that they can be mixed with grains in bags that can then be stored in traditional grain storage cribs.

Other effective pest control measures are very toxic and need to be applied in totally sealed containers. *Phostoxin* is a tablet that can protect grain from any pests with its fumes for long periods when correctly applied. However, once the container is opened and the fumes escape, the seed is immediately susceptible to attack.

Physical and physiological quality determines the suitability of grain to be considered as seed. After seed has been conditioned to 12 % grain moisture content, it is important for a sample of 1000g to be drawn at random from the entire seed lot. Samples are drawn from each bag with a probe from the centre of the bags. Samples may also be taken by hand, digging into the centre of the bag. The 1000g sample can either be taken to a seed laboratory or a village seed centre for seed quality determination.

Seed quality determination ensures that the seed user obtains a product with the following properties:

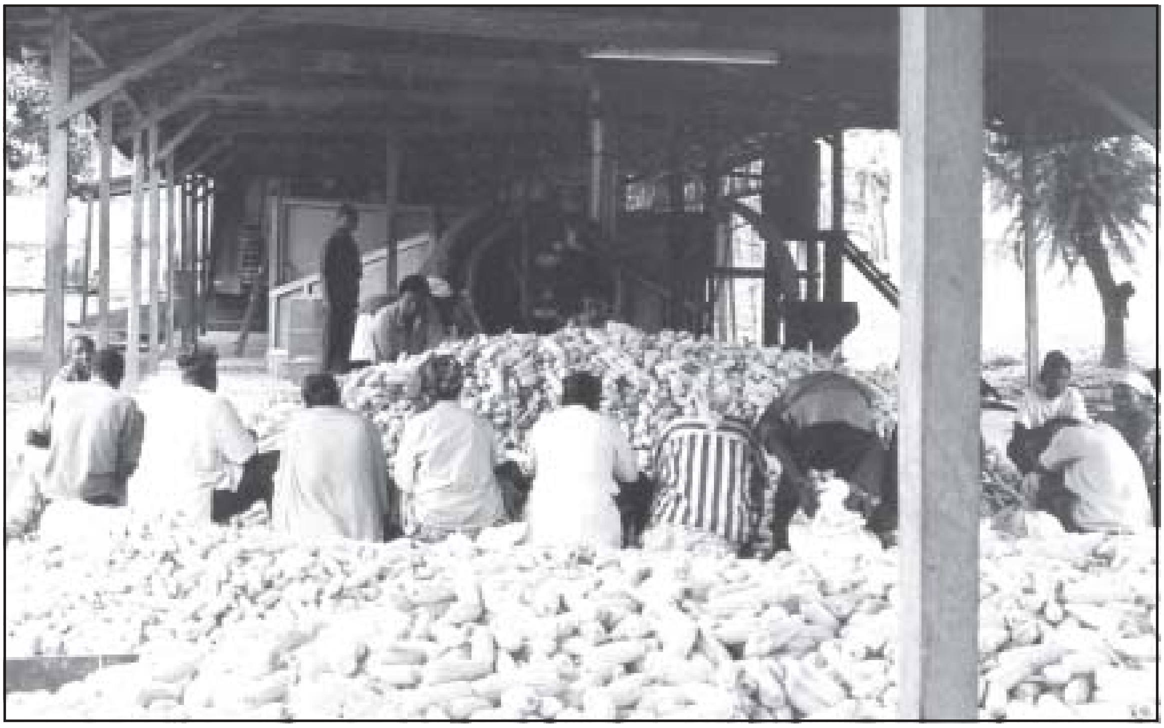

*Figure 58: Cob selection of maize seed: the cobs at the back have been selected for shelling*

*Figure 59: Seed shelling, cleaning, grading and packaging*

- Physical purity, that is, over 98 % full grain of the crop under test with no noxious weed grain in a sub-sample of 100g. Three samples are normally analysed.
- Physiological quality which analyses the germination capacity, vigour and health status of the seed.

To determine the germination capacity of the seed grain, a few simple procedures are followed. Four samples of 100 seeds each may be drawn at random from the 1000g sample. The seed samples are put in sterile inert material or substrate, keeping the seeds separated from each other by a distance of approximately 5mm, and then covered and moistened until the growth material is saturated with sterile water. Samples are then incubated in the dark for 5 and 7 days for cereals and oilseeds respectively. After the incubation period, each sample is assessed for percentage seed germinated and an average is calculated – this indicates germination capacity.

The structure and colouration of the plumule (shoot) and radicle (taproot) are analysed from the germinated seed. In good quality seed, these are normally straight and of around the same length, the tap root having good rootlets indicating high seedling vigour. The seedlings are colourless if developed in the dark. However, except for a greenish tinge on the shoot, no other colour should be evident elsewhere. Brown spots and/or fluffy growth might indicate seed-borne diseases.

*Figure 61: Application of seed treatment chemicals in the seed treatment drum. Note the use of nose masks to protect the farmer from inhaling the chemical.*

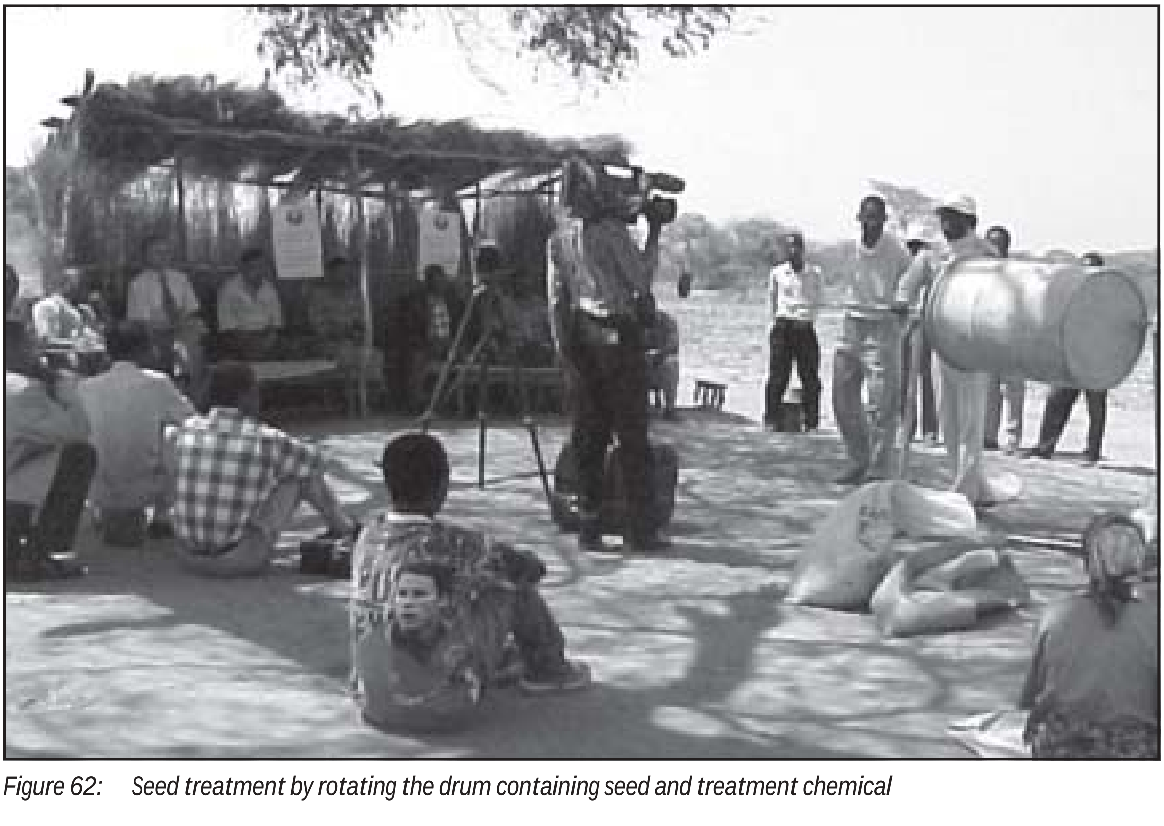

*Figure 62: Seed treatment by rotating the drum containing seed and treatment chemical*

*Figure 63: A seedling germination test using washed river sand as a substrate in raised trays*

### VI.3.3.15 Monitoring and evaluation (M&E)

This is an important activity. Monitoring and evaluation of project outputs is a means of verification of achievements. This tool is important in that all field players are fully familiar with the assumptions underpinning the project.

### VI.3.3.16 Planning For Seed Fairs and Trial Performance Data Analysis at the Farmer Level – Feedback Workshop

Seed Fairs are very important Participatory Rapid Appraisal (PRA) strategies for determining food crop utilisation in a given locality. These events, while yielding important crop genetic resource profiles preferred by farmers, at the same time, provide key information on crop and biodiversity gaps that need to be filled. Furthermore, such events enable partners in seed supply to get into contact with all sections of the community. In this respect, Seed Fairs become a community mobilisation activity whereby each family is required to showcase its crop farming produce (Figures 64 and 65).

The following guidelines normally ensure that Seed Fairs are open to the entire community:

- Farmers display their seeds at seed fairs for free.

- Each farmer can enter as many commodities as they like. However, judging is based on the appropriateness (adaptability) to the locality of the seed exhibited; biodiversity of crops and varieties on display; and uniqueness and aesthetics of the exhibits.
- Seed exchange or marketing is one of the key components of the event to help promote crop and variety diversity within the community.
- Any propagule or plant part that may be used to produce a plant of the same kind (vines, roots and tubers) or stores such propagules (fruiting bodies) can also be accepted as exhibits at a seed fair.

The rationale for accepting fruiting bodies, such as a whole tomato or pumpkin, is to allow farmers to keep their exhibits intact for home consumption after the fair. Seed Fairs constitute an advertising and marketing forum for local seed supply systems. It is easier to obtain seed from an exhibitor who is known to the client and is probably a neighbour, or one living in the vicinity whereby any mode of payment, including barter, may be accepted. Furthermore, the performance of the seed and its quality status might already be known to the customer from Field Days. This often reduces transaction costs required for proving genetic purity probity and seed quality that are a prerequisite for ‘quality declared’ and/or certified seed.

Displaying at Seed Fairs require that the exhibitor follow certain procedures. All exhibits need to be:

- Properly labelled, using both the local (vernacular) and the ‘formal’ variety name if it exists.
- Displayed in a single lot for each exhibitor, where possible, showing both the fruiting body and the seed in a container (plate, cup, etc.) and placed either on a mat or hung on a display stand (Figure 64 and 65).
- Easily accessible to the fair visitor walking around the displays.
- Marked only by number and not with the name of the exhibitor.

All exhibitors, including non-programme members, should be made aware of the rules for exhibiting, judging of displays and disposal of exhibits. Judges should be drawn from external technology and extension service providers, three members from the target farming community, and one member of the local extension facilitators for the programme. The judging criteria should be explained well in advance to all judges.

It is necessary to hold community briefing sessions wherein all the objectives of the Seed Fair and the judging procedure are explained and discussed openly. Farmers must not view this as a competition for winning prizes, but as a component of farmer-to-farmer seed knowledge, information and technology transfer (KITT). Furthermore, it is a showcase of the final product of the farmers’ local seed supply programme.

The key criteria used for judging exhibits at a Seed Fair are as follows:

- Appropriateness (adaptability) of the crops to the agro-ecological conditions prevailing in the locality (this might call for an interview of the exhibitor by the judges).
- Crop and variety diversity produced in one season from the farming systems.

- Seed quality – maturity status of the propagules, aesthetic quality of the display and health status.

Seed Fairs are designed to produce the following outputs:

Output 1: Enable peasant farmers in the area to share information regarding the performance of various crop varieties in VEVO trials and farmer varieties.

Output 2: Evaluate the crop and variety biodiversity available in a given geographic area and their adaptation to local agro-ecological conditions.

Output 3: Share skills and knowledge on how to produce a crop and/or variety for subsistence and commodity markets.

Output 4: Acquire information on quality seed sources (both availability and access) for preferred crops and/or varieties.

Output 5: Document local crop genetic resources inventory used by farmers for household food security: this contributes to data on seed sources as disaster preparedness.

Output 6: Document indigenous crop and variety genetic resources conservation strategies.

Output 7: Create an awareness of crop variety developments for increasing crop productivity in low input agricultural systems.

Output 8: Showcase for local seed supply systems' quality output for local and external markets.

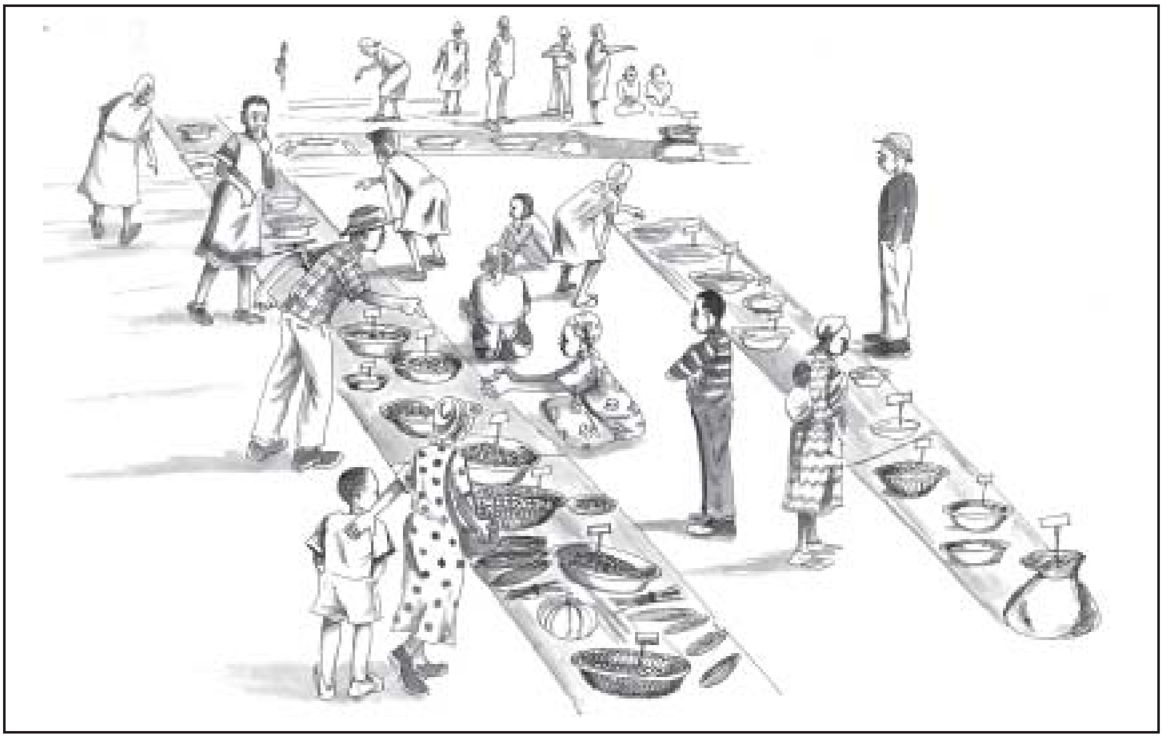

*Figure 64: Seed Fair: Note the arrangement of stands to allow ease of accessibility.*

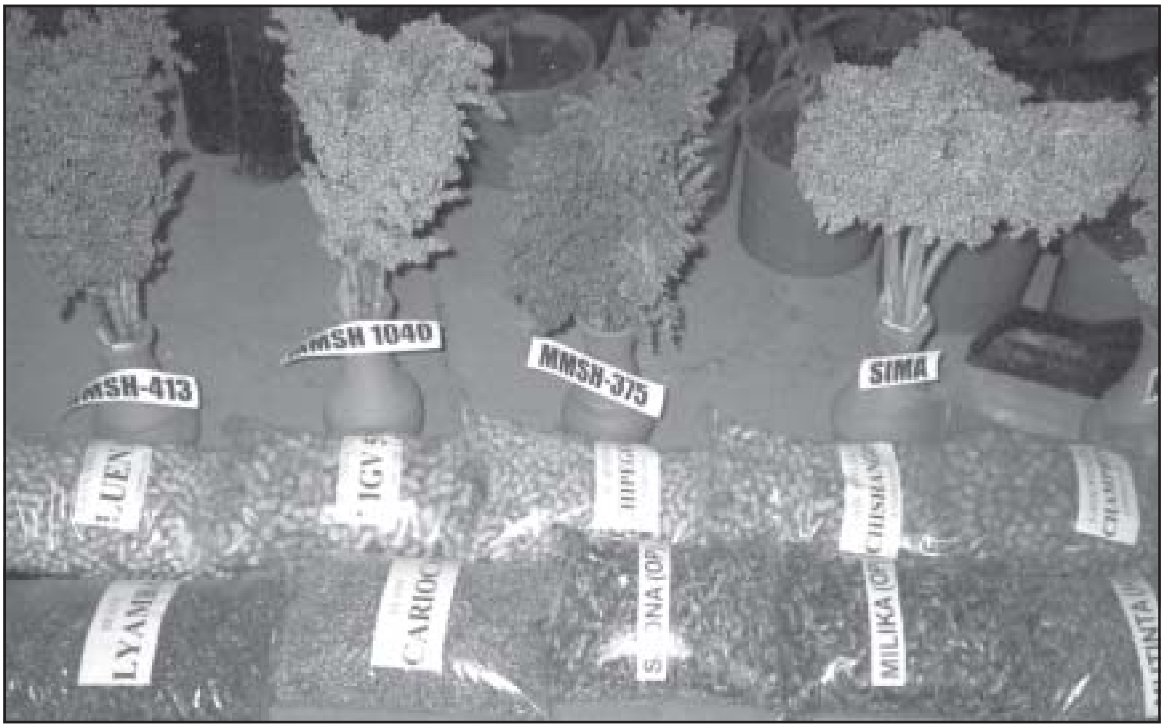


*Figure 65: Different types of sorghum, groundnuts and sunflowers displayed at the seed fair*

### VI.3.3.17 Planning and Selection of Seed Gardens/Winter Seed Production Sites

When planning for seed fairs, farmers often ask to verify the performance of seed of certain varieties as they need to bulk it for the following agricultural season. This presents opportunities for off-season seed production in frost-free areas. Off-season seed production often requires areas with adequate residual moisture to support crop development and/or areas accessible to irrigation facilities.

These small off-season seed crop production areas are referred to as Seed Gardens. The concept of winter bulking of seed was elaborated in Section III.6. It will not be described here in full, except where it relates to training participants in seed supply processes.

Once farmers have agreed on Farmer Selected Varieties (FSV) consistent with their household seed and economic security demand, local seed production during winter offers opportunities for timely seed supply to the community in the immediate following agricultural season.

Once good sites have been identified and prepared for crop production, basic seed of the preferred variety/varieties have to be accessed by the technology provider at least a month before the planned planting date. The other consideration is that for composites, the crop size must not be less than 250 plants and not more than 6250 plants for coarse cereal crop varieties. The former plant population is the minimum required to produce 8 rows to avoid genetic drift. The latter figure represents the largest crop population that can be produced viably with limited irrigation facilities in seed gardens. It is important that a minimum of 8 rows be planted for production of quality seed. This follows the rule that often the outer two rows are discarded in quality seed crop production as they are used as buffer rows.

### VI.3.3.18 Scientific Trials Data Analysis (Generation of Varieties' Adaptation and Yield Performance Information Systems)

Record keeping has already been mentioned as one of the key elements required for developing institutional memory at all levels of the seed supply programme partnership 'tree'. For the farmers, although not fully explained in the protocols, it is often useful to make pencil sketches of key characterisation features, such as plant architecture.

At the end of the season, it is vital that all the data relating to qualitative traits, such as the period between pollen shed and fertilisation, be clearly recorded for a minimum of six plots per agro-ecological zone. This also applies to quantitative traits, such as period between crop emergence to tasselling, flowering or determination of seed grain physiological maturity. Other data, such as the actual yield calculated from 10 fruiting bodies or 100 pods per plot per variety from the same number of trials in a single agro-ecological zone and expressed in ton/hectare, should be determined. An average value for each trait should then be calculated.

These average values grouped under similar agro-environmental conditions prevailing that season are sent to a biometrics department of the service provider, where they are subjected to statistical analysis. The technical service provider then determines the areas of adaptability, based on the test sites for each of the varieties from which accumulated variety performance information might be generated over time.

Such analyses are important for developing seed shortage alleviation strategies before, during and after a disaster for similar agro-ecological conditions at national and regional level. To this end, VEVO trial plots contribute to the following:

- Community, national and regional seed security policy formulation through linkages to technology service provision.
- Identifying sources of appropriate technologies similar or the same to that preferred by the target group of farmers, thus opening up trading opportunities for seed.

### VI.3.3.19 Training in Seed Crop Variety Evaluation and Genetic Purity Verification in Seed Gardens/Winter Seed Production Plots

To reduce time frame for verifying results obtained in summer implementation of VEVO trials, immediately after processing the seeds, or with new seeds, the process can be repeated in seed gardens off-season.

The advantages fior these are that:

- Farmer and community knowledge and information systems are enhanced
- Characterisation data is immediately verified and often augmented
- Key elements of quality seed provision, are more firmly retained by the farmers' memory banks

These knowledge and information systems will help farmers appreciate the concept of off-type plant identification and the need to remove them from a quality seed production crop. Peasant farmers are often averse to the concept of removing a healthy plant from the crop, if it promises a good yield. Hence, seed gardens enhance farmers' seed production knowledge, while at the same time, introducing them to the concept of seed multiplication with its attendant elements, as follows:

- Choice of land where a similar crop was not grown the previous season.
- Isolation concepts based on time and distance.
- Plant population of not less than 250 plants to avoid the risk of selecting out the genes from the gene pool within a composite, that contribute to the variety's phenotypic stability.
- Using variety agronomic knowledge systems to determine when to check for off-types, pests and diseases, and correct times for planning of harvest or marketing of produce.

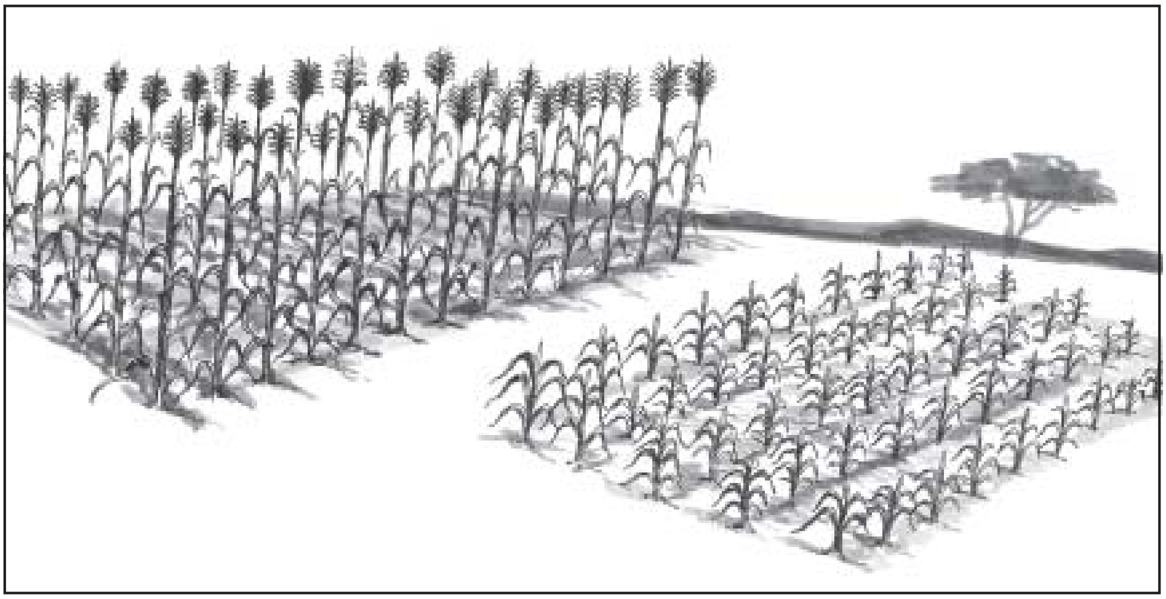

*Figure 66: Maize isolated by time*

### VI.3.3.20 End of Season Progress Review and Planning Meeting

The end of season progress review stakeholders' meeting should be based on SWOT analysis of the entire programme. For the review to be conclusive, it must review the relevance, effectiveness, efficiency and impact of each component of the programme explicitly.

If the participants feel that the programme is sufficiently relevant to achieving the goals as determined by the programme, it would then be time for planning the way forward. In planning, cognisance should be based on:

- Effectiveness of the message transfer strategy and how this could be improved.
- Efficiency as it relates to implementation of different components and how well each partner achieved their lines of responsibility.
- Finally, impact of the project at target farmer and community level for its continued sustainability.

Planning, including improvements and changes, would be easier after the above have been thoroughly explored.

## VI.4 Identification of Demand

Sections V.7 and V.8 discuss the Food/Seed security complex, which is summarised in Table 4. Identification of actual seed demand is best approached using a two-pronged strategy of structured baseline survey in the community and the use of Seed Fairs. The former is an analytical approach based on interviews of a large section of the target community, while the latter relies on observation the use of plant genetic resources inventory within the target community in a given season. The Seed Fair approach constitutes a continuous update of the food crop inventory underpinning food security and hence, the demand for crop and variety biodiversity.

## VI.5 Identification of Shortages

The food-seed Security continuum complex summarises in table 4 clearly illustrates the salient differences between seed demane and seed shortages.

Whereas most people use seed demand synonymously to seed shortage, this is conceptually wrong. With reference to table 4 section V8 it was shown that seed demand was more related to inaccessibility and/or failure to use available seed. However, in the context of seed security, seed shortages are a function of the unavailibility of crop seeds even when access or appropriate utilisation are in place.

In this regard, identifying seed shortages is far easier than identifying seed demand. The non availability of any seed class is quickly noticed as it impacts negativelly all wealth classes within a community or population resulting in non production of that crop. If such a crop experiencig seed shortages is a staple food, seed shortage, often result in a food emergency the following season.

Seed shortages often require central government intervention through direct importation of appropriate crop variety seed. Alternatively, central government would have to coordinate off-season seed multiplication of appropriate crops and varieties to off-set the seed shortages.

It is against such a bactrop that local seed supply systems assume a critical role. Often seed relief efforts, after natural or man-made emergencies supply in appropriate seed that could actually exacerate the crisis. Support of quality local seed provision systems even in neighbouring countries that network with affected countries seed systems often effectively ameliorate such shortages. This succesfully illustrates the nessesity for establishment of seed gardens within the framework of local seed supply systems development.

## VI.6 Description of Needed Varieties

Seed Fairs (see Section VI.3.3.16) identify locally available germplasm Through participatory rapid rural appraisal of local crops and varieties biodiversity inventory, and through consultative discussions with peasant farmers during Seed Fairs, it is possible to learn about the quantity and quality of seed still present in the active and working samples of the local seed supply system. Furthermore, the genetic profile of the varieties in demand may be ascertained through this approach.

It is possible for a good plant genetic resources specialist to identify potentially improved varieties conforming to the desired genetic profiles, by collecting 250 seeds for each of the preferred varieties with information from the farmers on the crop growth profiles and prevailing agro-ecological data.

With this information, it is possible to approach the National Agricultural Research Systems (NARS) and International Agricultural Research Centres (IARCs) for five or more improved open pollinated varieties of the same crop, with similar or the same genetic profiles. These are the varieties which are then introduced as new technology in the VEVO trial plots.

### VI.6.1 Usage of VEVO Plot Protocols for Farmers to Select Needed Varieties

The protocols for VEVO trial plots are a key hands-on training medium. The layout of the protocol (see Annex IV) traces all the key activities required to be undertaken by each player in training for local seed supply systems. The trials also allow the process of variety characterisation, seed processing and identification of farmer selected varieties (FSV) to take place. These activities are summarised in the work plan spreadsheet for Year 1 in Annex I. The protocol provides for six VEVO trials per crop per village, the plots being widely dispersed to guarantee that every member of the farmer group participates and contributes to variety local agronomic knowledge and information generation.

Crops differ in genotype x environment interaction in their phenotypic expression of important traits, such as yield performance and other quantitative inherited traits. Varieties included in the VEVO trials have to fit into particular farming systems in the prevailing specific local agro-ecological conditions. Normally, these farming systems are characterised by large numbers of location specific varieties in geographic regions of limited size. This emphasises the need for crop variety biodiversity to satisfy the demand for household food security in a given locality.

This kind of adaptation has been termed agro-biodiversity, which combines ecological and genetic diversity including heterogeneity of farm management aspects in peasant farming systems (Almekinders and Louwaars 1999) and their interactions at different rural wealth levels. The VEVO trials protocol design enables peasant farmers to:

- Generate information and knowledge systems on how to produce quality seed crops under prevailing heterogeneous farming practices and agro-ecological conditions in a given locality.
- Select appropriate agro-biodiversity to meet farmers' household consumption with regards to food, livestock feed, fibre, and market expectations for surpluses realised, or varieties grown particularly for the market.

At the community level, these VEVO trials achieve a replication of over 18 trials per crop. Such replications would yield scientifically significant results under reasonable crop agro-ecological production conditions. The 18 trials provide enough samples of the different micro agro-ecological conditions, coupled with the individual farm management systems of each participant. VEVO trials have a potential for resolving the appropriate variety demand complex for any given locality in one to two agricultural seasons. This would empower farmers to select knowledgeably the crop and variety biodiversity consistent with their household food and economic security lifestyles.

### VI.6.2 Implementation of Multi-Location Single Block Trials in the Programme Area

Single VEVO trial plots are Farmer Implemented, Farmer Managed (FIFM). As previously elaborated in the protocols, the farmer has only to follow the instructions on the layout of the plot. Farmers will need to be trained in the correct use of the protocol and in implementation of the programme activities. The FIFM is a participatory approach to conducting rural agricultural research. Therefore, although farmers are free to use their own crop husbandry methods for crop production, the programme needs co-ordination for it to achieve the desired results. Since all VEVO trial plots are in 'single' farming system, for them to achieve scientifically acceptable results, replication is a prerequisite and this is only achieved through VEVO multi-location trials in diverse micro-climatic areas in a number of villages within a district, province or region. The co-ordination of such a programme can be achieved under the direct supervision of trained extension personnel working with peasant farmer local seed supply groups.

## VI.7 Finding Partners in Seed – Seed Sources

A number of key partners usually collaborate to manage and administer the development of local seed supply system programmes. For sustainability of the project, it is necessary to define the role and responsibilities of each partner in the implementation of activities contributing to the results which achieve the objectives of the project.

### VI.7.1 The Community

The community represents the target group of peasant farmers who are the beneficiaries of the project. In this regard, the project ultimately belongs to this partner and it is therefore in the community's interest for the project to succeed.

The main role of the community is to facilitate the implementation of all project field activities, to participate and contribute the land resources for local activities. Furthermore, the community is responsible for the following:

- Co-ordinating linkages with sponsors and donors of the project.
- Ensuring that all community members are familiar with the key objectives of the project and therefore respond positively to requests made whenever there is a need. In particular, when called upon for assistance in maintaining isolation distances or time-frames in seed crop production, keeping livestock off the project activity sites and contributing to communal activities, such as Seed Fairs and Field Days.
  - Facilitating the formation of farmer seed supply groups in each village that will be responsible for the following:
  - Hosting VEVO trial plots every agricultural season; selecting pilot seed multipliers for the chosen crops and/or varieties; and being the repositories for village institutional memory on seed supply knowledge and information generation systems (data and information collection).

- Organising functions aimed at promoting the sustainability of the project, such as Project Progress Review Meetings with other stakeholders, Seed Fairs, Field Schools and Field Days, and meetings with commodity and marketing service providers.

## VI.7.2 Intermediaries

The intermediaries of the project are usually public or private institutions or NGOs involved in the promotion of rural development. These institutions often have an administrative and management section headquartered in urban areas and a rural extension service stationed within or near communities they work with.

It is often these institutions that conduct needs assessment baseline surveys on a number of rural livelihood support systems and administer any funding that might accrue to the projects from sponsors or donors. With resident field extension officers, the role of such institutions is to:

- Conduct needs assessment at community level using extension staff, and analyse the data to establish peasant farmers' needs, such as for food, health, water, education, etc.
- Assist communities in writing project proposals for submission to development agencies (donors and/or sponsors).
- Provision of extension facilitators to conduct PEA facilitation through training farmers in specific areas of interest to the project.
- Providing linkages with expert technology and service providers.
- Facilitate training programmes and farmer-to-farmer exchange visits.
- Develop community structures to administer and manage community based activities.

## VI.7.3 Technology Providers

In seed supply systems, there are technology (varieties) providers who have developed or might assist in developing crop varieties consistent with peasant farmers' expectations. In this respect, these institutions do not communicate directly with peasant farmers, except through extension services. However, given the advent of more participatory approaches to agricultural development, there has recently been a shift in interaction between technology providers (breeders and/or researchers) and peasant farming communities. It has been recognised that adoption rates of new technologies have increased, following direct linkages between farmers and researchers or research institutions.

The new role of research and breeders in developing local seed supply systems is to provide training to both farmers and extension facilitators in variety evaluation and verification. The researcher's responsibility is to:

- Facilitate generation of variety growth knowledge and information systems.
- Develop strategies for participatory variety breeding (PVB) when the preferred farmers' variety is not already on the shelf.

- Train participants to fully comprehend seed quality production concepts, as opposed to food grain production.
- Provide the programme with improved varieties whenever requested.
- Interact with the private sector, to contract trained farmers in quality seed production of those crops which are not in regular demand, but are important for subsistence farming either locally or outside the district.

Resources providing partners are in a peripheral position in local seed provision systems, due to the traditional structuring of agricultural development systems. It is important, therefore, that strong linkages be formed between farmers, researchers and other stakeholders. It is a recognised fact that extension services interact closely with both partners, therefore they offer the best bridging institution.

### VI.7.4 Private Seed Companies and Seed Commodity Dealers

Private seed companies have been known to offer commercial farmer-seed producers training in seed crop production knowledge and information services. Increasingly, this sector has shown interest in offering peasant farmer groups similar training for less commercial crops, such as OPVs and other marginal crops whose market is often eratic as it is mostly driven by relief agency demand.

Consequently, for private seed companies, economics of scale suggests that it might be more cost effective in terms of both human and other resources to develop seed supply capacity at community level.rather than be directly involved in seed produstion. This being more effective than being directly involved in seed supply processes for marginal or less commercial crops with ephemeral market demand. To this end, such companies favour to contract rural peasant farmers in seed crop production, in particular for OPV crop varieties and those seed crops whose demand is driven by relief seed supply.

The above is often true with seed and grain commodity dealers who deal in speculative markets and enter into loose binding contracts with peasant farmers to produce quality seed that could also be marketed as grain. Should the commodity entrepreneur fail to corner the market, the peasant farmers may dispose of the commodity on the local market, either as a seed or a food grain.

## VI.8 Decision of Seed to be Tested and Seed Source

Ideally, the decision on which varieties are to be tested is reached by all actors in the Small Scale Seed Production Programme. The varieties included in the Farmer Managed, Farmer Implemented on-farm VEVO trials are selected on the basis of their suitability to farmers' needs and adaptation to the agro-ecological conditions obtained in the test area. As already mentioned, Seed Fairs also play a very important role in providing a forum for identifying varieties to be tested. In the second year of the programme, the results of the VEVO trials accord farmers an opportunity to select suitable varieties (FSV) which are further tested in field trials.

### VI.8.1 Tools to Assist Decision Making Process

The stakeholders' consultative meeting must, without fail, reach a decision on whether the local seed supply programme's major objective is to supply quality seed to:

- The local community only, targeting household and communityfood security, or
- Meet household seed security and supply external markets to the target community.

While both choices offer the client or producer quality seed to produce a food crop, when the seed of staple food crops or other crops is deemed to be of national economic importance, most countries place regulatory controls on the marketing of such seed. Therefore, before embarking on quality seed crop production, farmers must be fully cognisant of the parameters that govern the distribution of their seed. This section will elaborate more on seed destined for the external market, as it covers both the food security and the economic aspirations of the target farmer.

### VI.8.2 Identification of Seed Sources

Table 3 indicates the types of seed that might be produced commercially or at local level, where they are available and what they are used for. The premise here is that the participating farmers and facilitators have already reached a preliminary variety ranking, through analysis of VEVO trial plot data and have chosen a preferred farmer selected variety (FSV).

For pilot quality seed crop production, the best quality seed to acquire is of the Certified Basic or Quality Declared Seed Class. This is often obtainable from either NARS or IARCs, or the Village Seed Supply Expert, if the varieties have already been subjected to verification of genetic purity test by an authorised institution in the country. The reasons for using this class of seed are as follows:

- The veracity of genetic origin of the variety can be traced back to the originator (breeder) of the variety, and if lost, there are good chances of developing the variety again.
- The characterisation traits are defined by the breeder and participating farmers through VEVO trials and can be cross-checked by an independent inspector for stability.
- If the quality of a seed crop produced by the farmers is good, three more generations of seed and crops can be grown without much genetic drift that would otherwise impact negatively on crop productivity.
- With good care, farmers can engage in variety genetic purity maintenance processes and therefore keep the variety within the community, without loss of vigour for around 10 years, which will enable them to seek other options for improving the germplasm (c.f III 1.12.a).
- Farmers can use this class of seed of improved variety to begin participatory variety breeding in later years.

### VI.8.3 Purchasing of Source Seed for Seed Crop Production

Source seed is best purchased from a crop breeding institution with a good reputation, whether private or public. It must be noted that basic seed may be twice the price of certified seed. At this stage of the programme, it is important to initiate immediately a cost recovery scheme through the farmer seed supply groups, in order to enhance sustainability of the programme after Year 3 of the programme phase.

It is important for the intermediary to train the farmers in the culture of investing in a premium product through its extension facilitators. This establishes the social contract which is a component of the Community Communication Module of the training syllabus in participatory approaches to the KITT systems to develop sustainable seed supply systems (see Annex II).

Any seed class purchased should bear the following information on its label:

- Seed certification certificate from an authorised institution
- Name of variety and the seed generation
- Lot number and name of producer
- Purity and germination analysis results and date when tests were conducted
- Mass of the seed

## VI.9 Formation of PEA Groups

A community is often too large for an intermediary to work with as a single unit effectively. To achieve efficiency and effectiveness in KITT, it is recommended that farmer groups be established in Pilot Project Areas. Farmer groups are more cost effective and easier to deal with when using the Participatory Extension Approach (PEA) as a Skills Capacity Building and Technology Transfer Tool among the participating farmers (see Annex III and also Sections III.7.2 and VI.3.3.10). It is then recommended that a community be divided into subunits of 15 to 20 households. Such sub-units are termed PEA farmer groups. This strategy ensures the following:

- Ease of implementation of a given activity as the number of participants would be of “class-room” size.
- A single community grouping composed of representatives from each group would create a forum of exchange of experiences with regards to agricultural development programmes.

The project’s functional structure actually borrows from community social dynamics and uses them to introduce innovations within any given community with high probability of acceptance and future adoption of the project’s messages.

## VI.10 Trial Sites Identification

A qualified and/or certified seed crop inspector is primarily responsible for approving any land selected for a quality seed crop production programme, if the seed produced is to meet the seed certification or quality declared standards of the country in question.

Once the farmer seed groups and facilitators have selected the seed production sites, it is *imperative* that a certified seed crop inspector be called in to inspect the site and map it into units of seed production (*seed units are all pieces of land that are grown with the same crop variety within 21 days of one another*). This inspection is critical for:

- Official recognition of the seed generation and for marketing
- Replication of recognised variety seed from the seed produced

However, for standard or informal seed grade, such inspections are not necessary. At the same time, proper labelling of the seed after harvest should be instituted to safeguard consumers from false claims. Quality assurance for local seed supply can be achieved through farmer to farmer field visit during the seed crops active growth

### VI.10.1 Isolation Principles

The concept of isolating seed crops is discussed in detail Sections III.1.12 and III.2.12. However, it is essential for the principles to be recalled. In quality seed crop production:

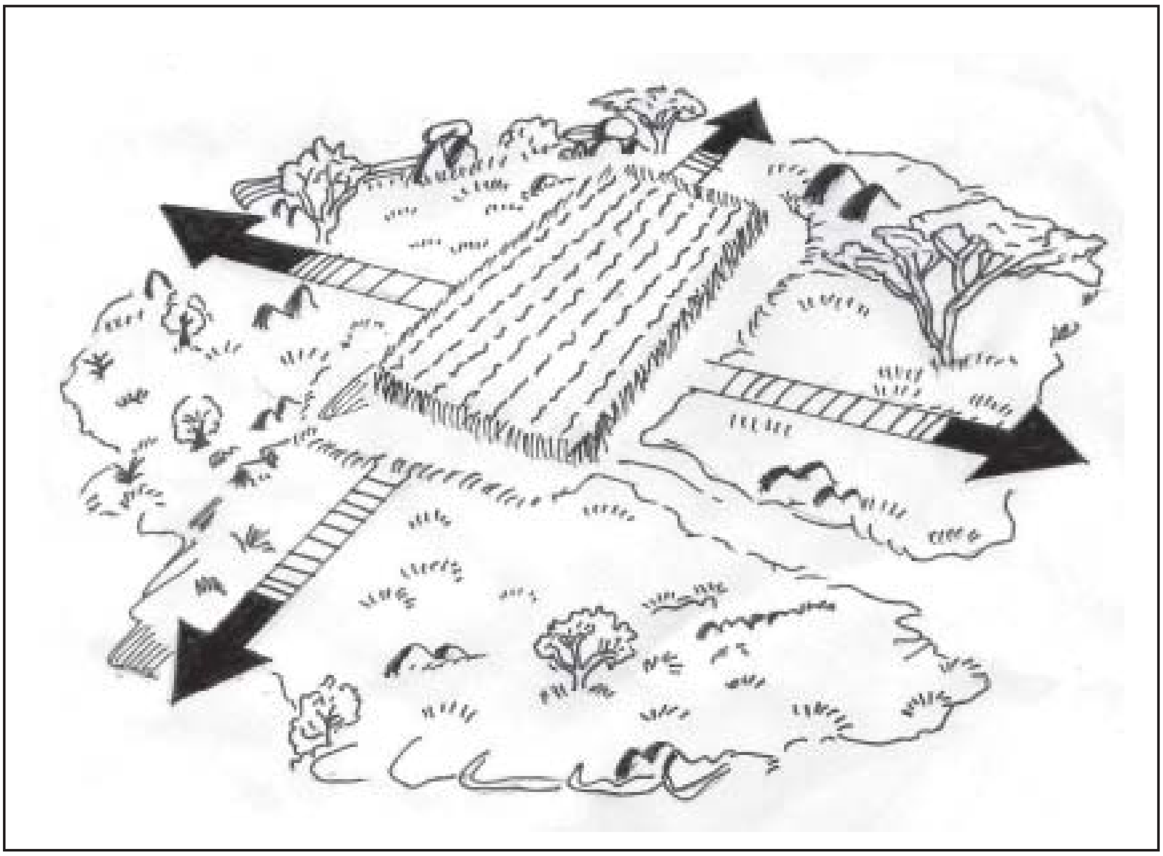

*Figure 67: Distance isolation*

The genetic purity of the variety must be preserved. Unlike in criminal law, if there is any doubt in variety genetic purity, the **crop is rejected** rather than given the benefit of doubt as in criminal law.

In this regard, the following factors are of key importance:

- The land where the seed crop is grown must be well separated from crops of the same species by the recommended isolation distance or time of fertilisation: this can only be established through VEVO trial plot generated data. Without full knowledge of the fertilisation dynamics of the crop varieties growing in an area, the only viable option is distance isolation
- Seed crops should not be grown on land where the same crop was cultivated the year before, even if it was of the same variety. This avoids problems of volunteer plants emerging within the seed crop and causing problems during removal of off-types.
- Seed crops should not be gap-filled should there be poor emergence as this causes serious off-type identification problems.

If not certain, a qualified agronomist or plant genetic resource specialist should be called in to identify suspect plants, including weeds near the seed crop.

## VI.11 Trials Sites Preparation

During land site inspection it is important to map all the seed crop units by area and time of planting including all neighbouring units. This is vital in seed gardens and time isolated crops if the neighbouring crop variety genetic profile is known.

Land preparation by use of either animal draft power or tractor should result in a well prepared seed bed that will allow even seedling germination. Land preparation also serves as a weed control method. It should be carried out at a time when it will result in maximum weed control for the seed crop.

Soil fertilization should be based ideally on soil nutrient balance analysis. Many public agricultural research stations in SADC countries offer soil analyses services at a modest fee. Optimum fertilization of the seed crop is important for good seed development and yield.

## VI.12 M&E Establishment of Seed Production Trials

The farmer group and extension facilitator participants are expected to monitor, evaluate and record correctly crop emergence, flowering, physiological maturity, harvesting and conditioning of the seed crop. At each of the M&E stages, it is fundamental for the certified seed crop inspector and seed supply processes trainer to be informed in writing of the crops' developmental stage. It is the responsibility of the extension facilitator to supervise these activities, while the seed supply farmer group is responsible for writing or communicating with the other stakeholders. This is an important training phase in quality seed production, as farmers are ultimately the owners of the programme. Reports have to reach the intended recipient at least two weeks before a critical seed crop inspection period, namely:

- Three weeks before flowering of the crop

- Two weeks before 50 % flowering of the crop
- Two weeks before physiological maturity of the crop

It is clear that such information can only be acquired by those community farmers who actively participated in the VEVO trial plot part of the programme. In this regard, they will have the requisite local seed supply knowledge and information systems to react timely to the requirements set out above.

### VI.12.1 Farmer Group Seed Supply Knowledge Evaluation

The pilot seed production programme offers both the trainer and the facilitators an opportunity to assess the impact of the KITT training curriculum Module III based on VEVO trials plots (see Annex II and III). The pilot seed production programme, therefore, provides training and enables farmer and facilitator participants to assess the development of local seed supply systems.

### VI.12.2 Participatory Evaluation Methods and Tools

Multi-location trials and the number of the VEVO trials make evaluation and recording of data a very difficult task for a single extension officer in a given area. Difficulties often arise from the fact that most trials reach the vital crop developmental stages at around the same time.

Therefore, it is necessary for the farmers and the village seed supply specialist to receive training in observation and proper evaluation of plant developmental stages. It is extremely important for every assessor to be familiar with the 50 % median ranking for determination of a trait occurrence in open pollinated varieties, as well as how to record their expression. In a self-fertilization variety, often the variety is over 80 percent homozygous, therefore flowering will occur at the same time.

The first year is fundamental for the training of all participants in correct observation, identification and recording of the main crop developmental stages. The Farmer Field School training aims at a participatory extension approaches to technical knowledge and skils transfer, enabling peasant farmers to record comparable data from their trials on their own. Therefore, VEVO trial plots must be established from crop variety seed of the same generation and from a single source if possible (see Sections III.7 and VI.3.3). This minimises areas of variance in statistical analysis of data from multi-location trial plot results.

### VI.12.3 Screening and Scouting for Diseases, Pests and Noxious Weeds

This aspect has already been discussed in detail in Section III.3.2. It is important to state that scouting for noxious weeds, pests and diseases in the seed crop should be carried out carefully by the community itself. This represents a departure from traditional farmer seed systems, where the seed crop is under the sole control of the Village Seed Supply Expert. Weeds should be removed speedily before the flowering of the seed crop and pesticides used to eradicate pests. Diseased plants should also be removed from the crop and burnt before they act as reservoirs for an epidemic. Collective responsibility for the seed crop helps to instil a sense of ownership of the project by the community and fosters development of viable local seed supply associations.

### VI.12.4 Background on Farmer-to-Farmer Extension

Farmer-to-Farmer extension approaches in rural agricultural developmental programmes are now recognised as being vital for effective adoption by communities of new messages and technology. As the facilitators speak the same language and have similar cultural backgrounds to their clientele, it is easier for them to impart knowledge and information using communication techniques that are quite comprehensible to their colleagues, although not necessarily understood easily by outsiders.

Furthermore, it is more cost effective to practise farmer-to-farmer extension methods, as it develops technical and knowledge skills at the local level, reducing dependence on external facilitators. A large number of farmers with sound seed supply knowledge and information systems, means that a greater proportion of the entire community will be more open to new ideas.

## VI.13 M&E of VEVO Trials in the Programme Area

It is the responsibility of the extension services of the intermediary organisation to monitor and evaluate regularly (M&E) the implementation of all programme activities in accordance with the Programme Phase Time Spreadsheet Work Plan (see Section V.11 and Annex I). M&E is vital for the VEVO programme, whose determinants (crops) exhibit significant genotype x environment interaction and are dynamic by nature, therefore varying from area to area and from district to district.

Hence, effective lines of communication between farmer groups and extensions service personnel should be established quickly. The main role of the extension would be to evaluate the data captured by the VEVO trial plot implementers, and to make the necessary modifications to the records, through discussions with farmers. However, during the first phase, M&E determines the following:

- Timing of all other events, in particular Farmer Field Schools and Field Days contributing to both local seed knowledge and information generation systems.
- Development of a culture within the participating group of farmers of the importance of constant observation (scouting), data capture and record keeping in quality seed supply processes. This has important implications for future local seed supply programmes as the information gathered could later be incorporated

### VI.13.1 Data Recording

Data recording is one of the key components contributing to the success of local variety knowledge and information generation systems. Such systems can eventually be used by technology providers to develop variety adaptability and performance maps at national and regional levels. These maps are invaluable to peasant farmers for developing local seed networks which may give access to appropriate technology and broader marketing opportunities for surplus seed. The VEVO trial protocols have data recording sheets, which must be used to capture the requisite information on various forms of crop adaptability and yield performance for a given locality (see Annex IV). Facilitators and farmer participants in development of local seed supply programmes should recognise the importance of recording all key information from the very beginning, as this is vital for successful implementation of all other activities related to seed supply processes.

The data sheet captures the main variety characterisation traits observed in a trial plot. It is important to record each of these traits, in order to analyse the local phenotypic expression of each variety in the trial. As explained in the protocol, critical data to record is the *date of crop emergence* rather than the date of seed planting (drilling) in a trial plot. Crop emergence defines the period which determines each subsequent crop growth phase. However, for data to be relevant in variety characterisation, each VEVO trial plot should be established on the same environmental time frame, for example first week of Novembar, in order to reduce environmental differences.

Other key information to record for variety characterisation is: days to flowering, flower colour, pollen shedding, stigma extrusion and/or receptivity and seed grain physiological maturity. These traits have been elaborated upon fully in Section III.1.10, where the traits characterising the crop and those differentiating the crop varieties are explained. Regarding VEVO trial plots, it is fundamental to record days to flowering, days to pollen shed, days of fertilisation and days to physiological maturity. Additional data that would contribute to knowledge development systems would be yield performance and average plant height.

The data recording sheet includes other information obtained from farmers, such as their variety preference ranking in the VEVO trial plot. Such ranking presupposes that farmers have crop ranking criteria that are consistent with their economic expectations and lifestyle. Depending on how wealthy peasant farmers are, ranking traits such as taste and yield performance versus stability, grain processing and storability, may have serious implications for farmer selection of varieties for value for cultivation and use (VCU).

From VEVO trial plot data records, all stakeholders may determine for themselves the following:

- Crop or variety biodiversity needed for local entry into the seed supply programme.
- Type of isolation strategy needed to produce quality seed crops for a given variety.
- Local institutions that need to be developed to manage and administer successful implementation of all activities associated with quality seed supply processes.

### VI.13.2 Statistical Analysis of Multi-Location Single Block Trials

At the end of the season, all agronomic data records for a single location (normally six single block trial plots) are averaged out and aggregated as a single randomised block design trial. This is despite the fact that they were not planted on the same day or given the same crop management and husbandry treatment. The rationale for this treatment of data is to capture the heterogeneous nature inherent in peasant farming systems, due to differences in community wealth ranking and locality specific micro-environmental conditions. Subjecting such data to regression analysis is not usually necessary, as the inherent heterogeneity in FIFM–VEVO trials cancels out the coefficient of variance normal in traditional block randomised block trial plots.

In this respect, VEVO trial plot analysis enables all participants to acquire basic mathematical skills for conducting multi-location single block trial data analysis. The results obtained are similar to advanced statistical analysis performed by biometricians. However, to verify the community/extension services analytical results, the same records are sent to technological service providers to be compared using advanced statistical analytical tools, in order to identify areas of agreement and/or variance.

To this end, by cross-checking with participants, including extension services personnel, the technology provider has the responsibility to modify both analytical systems to a point of convergence, without complicating the data analytical process beyond the comprehension of people with basic mathematical knowledge in averages calculation.

The protocols enhance farmers' capacity in monitoring and evaluation of crop agronomic development, in order to determine the timing of the following activities:

- External training intervention activities by either the extension facilitator and/or seed supply trainers.
- Holding Field Days or community and other stakeholder exposure visits to local seed supply activities.

## VI.14 Budgeting of Seed Production Activities

The development of local seed supply programmes, as illustrated in the Time Spreadsheet Work Plan (Annex I) has serious implications for human, financial and material resources. Ongoing public investment, either government- or donor-funded, will be required to ensure access to financial resources to kick start these activities.

Most services are provided at a fee, whether they are from private or public institutions. It is prudent, therefore, for a provisional five-year cash flow programme budget to be prepared and amended during the development of the programme to cover such costs as:

- Management and administration of programme
- Purchasing of basic seed stocks, seed packaging materials and seed processing equipment and infrastructure
- Facilitation of training, extension and seed supply services
- Farmer exchange exposure visits and network development
- Variety registration processes
- Quality declared seed inspections, sampling and seed testing

## VI.15 Technical Report to Extension Organisation

It is imperative that once all multi-location single block VEVO trials plot results have been analysed, a technical report incorporating the research–extension–farmer perceptions be compiled. It is the responsibility of the Intermediary to organise a local seed supply stakeholders' progress consultative review meeting at the end of the seed production season.

The objectives of such a meeting would be to analyse critically the management, administration and implementation of VEVO trials plot activities, based on the programme phase time spreadsheet work plan, as well as deciding the way forward in relation to the lessons learned in planning for the following:

- Winter seed supply programmes that may include variety evaluation and verification trials on characterisation parameters and pilot seed crop production-training processes.
- Subsequent rainy season programmes which would entail only VEVO trial plots or both VEVO trial plots and pilot seed crop production training processes.
- Elaboration of a budgeted time and resources spreadsheet work plan for any future local seed supply programme.

### VI.15.1 Information Exchange between Trainers, Extension Workers and Intermediaries

It takes time for all stakeholders to appreciate that seed supplies are a process, rather than event-driven. In this regard, the learning process is determined by the level of understanding and commitment by each partner to the programme.

It is essential that all service providers undertake a SWOT analysis of their involvement in facilitation of the programme phase activities. Often, modifications in either administration or management of the programme will be necessary, due to differences in the competence level in understanding of seed supply processes and PEA by each service facilitator.

The timing of this consultative meeting should be a few days or weeks after the planning meeting to facilitate better co-ordination of the implementation of planned activities and to draw realistic operational budget lines. However such meetings should be timed to allow good lag-time between the meeting and implementation of planned activities.

## VI.16 Seeding and Planting

The broad agronomic aspects of seed crop production have been adequately covered in Sections III.2 and III.6. An exhaustive discussion of crop specific agronomic requirements, such as plant spacing, seed rate, fertilizer application rate, rotation, pest and disease control, etc. is beyond the scope of this manual. This information is readily available from National Agricultural Research Systems and other technology providers.

It should be emphasised, however, that the seed crop should be:

- Planted the same day or if this is not possible, within 48 hours at the most, to avoid problems in determining the date of crop emergence except where dry planting is practised.
- Given an optimum balance of inputs application to favour seed set rather than vegetative production.

## VI.17 Seed Crop Husbandry

Seed crop husbandry as already emphasised is a very important component of seed supply processes. This is true for seed production, either in the main season or in seed gardens in the off season.

### VI.17.1 Pilot Seed Production Trial Management and Seed Crop Husbandry

The management of seed crop production involves the M&E tools already mentioned. It is the responsibility of farmer and facilitator participants to report on the status of crop emergence to the trainer and seed inspector. The trainer should be in a position to determine the correct crop variety development agronomic stage for PEA Field Schools from average periods calculated during data analysis of the VEVO trial plot results, as well as correction of any variation in heat units of impact on crop development.

### VI.17.2 Selection of Participants for the Pilot Seed Crop Production Programme

Seed production and supply is a process rather than an event. It calls for a lot of patience, skills development and willingness of participants to invest in time to learn and work with others, energy to monitor and evaluate crop development constantly, as well as financial resources. Many volunteers literally ‘mushroom’, when implementating seed crop production compared to those involved in the tedious VEVO trial plot process. It is strongly recommended that the best farmers who excelled in all aspects of VEVO trial implementation be the first to be engaged for this pilot seed production phase of the programme.

This process might prove difficult in the social and cultural dynamics of the community. However, it is vital that the extension facilitator brings to bear the lessons to be learnt from community training for transformation processes. Those community members who are not already part of the seed group should not be selected for implementing this stage of the programme.

In the first stage, not more than five farmers should be involved in the Pilot Seed Crop Production Scheme (Annex V). The crops used in seed production should be taken as community seed supply training tools where all Field Schools and Field Days will be conducted. Therefore, every volunteer must agree to these terms before programme initiation.

### VI.17.3 Screening and Scouting for Diseases, Pests and Noxious Weeds

The importance of maintaining good seed crop health status to achieve optimal physiological quality in seed cannot be emphasised enough. Screening and scouting for disease and pests are important activities during seed crop production. Some of the diseases are systemic, that is, they infest every part of the plant and hence may spread to other plants and crops and subsequently into thee seed itself

The pest/weed complex often transmits serious disease epidemics, where the weed acts as a reservoir of the disease, while the pest is a carrier and transmits the disease, often a virus, to the crop. It is important, therefore, to screen crops for any noxious weeds and diseases that can develop from a single plant infestation into an outbreak of a disease epidemic in the entire seed crop.

Scouting for pests and weeds is vital for eradication of potential sources of seed contamination which can affect the physical purity and physiological quality of the seed. It is essential for seed crop producers to familiarise themselves with these diseases, pests and weeds (see also Section III.3.2).

### VI.17.4 Seed Crop Production and Supply Processes of Farmer Selected Varieties (FSVs)

Training in quality seed crop production and supply processes are often reserved for the second year phase in developing viable local seed supply systems in areas with one major rainfall season, or in areas without irrigation, or in areas that are susceptible to frosts. However, if the foregoing constraints can be avoided, that is, if the area is frost-free and has irrigation facilities or a bimodal rainfall season, pilot seed crop production and supply process can be initiated in seed gardens (see Section III.6).

## VI.18 Variety Characterisation

Characterising a variety simply means identifying a combination of traits that are unique to that variety and are controlled by either one of a few alleles or by many alleles, a situation which determines the sensitivity of the trait to changes in the environment (see also Section III.1.10). For a true variety, that is a hybrid or a variety of a self-pollinated crop plants or asexually produced plants, such traits are distinctive, uniform and stable (DUS). For open pollinated varieties of most crops, it is also possible to establish the DUS criteria for synthetic and composite varieties if certain genetic standards are applied. This section will elaborate on these traits in more detail as they constitute the basis for training participants in all aspects of quality seed supply processes that ultimately contribute to quality seed production and supply.

It should be understood clearly that all determination of trait expression is considered from the date of crop emergence from the soil, rather than the day the crop seed was planted in crops propagated from ‘true’ fertilized seed..

## VI.18.1 Observation as a Tool in Variety Characterisation

Many participants fail to appreciate the fact that seeing is different from *observation*. While the former is often passive and does not need any thought or judgement, and is often subject to illusionary perceptions; the latter needs input, that is, a thought process leading to a judgement based on previous knowledge systems.

Participants need to use their observational skills, often developed over time, in variety characterisation. It is for this reason that this manual emphasises observation as a tool for enhancing knowledge development capacity.

## VI.18.2 Inflorescence Emergence, Positioning, Structure and Colour

The plant flower is the repository of genetic components that culminate in the development of seed. Flowers or the inflorescence of most plants are the main distinguishing and unique organs used to differentiate one plant species from another, or find areas of similarity which place two or more species in one genus. It is logical, therefore, when dealing with variety characterisation, to target what most participants are familiar with, rather than go for exotic traits such as genetic mapping. In this respect, participants will need to be aware of those characteristics that remain constant whatever the environmental conditions, as well as those that are affected by environmental changes.

The mode of flower emergence from the sheath, its position on the stalk or rachis and its morphology under normal circumstances are genetically controlled and remain constant. In this respect they are useful traits for characterising a variety. The morphology and position of the sexual organs, such as the pistil and stamens, are also genetically controlled and therefore useful traits for variety characterisation.

Flower colour is not often a reliable trait to use as this might change with:

- Flower age
- Light and heat intensity

## VI.18.3 Plant Morphology

For open pollinated varieties, whole plant morphology is often not uniform. However, in asexually produced, self-pollinating and hybrid varieties, basic plant morphology is uniform among plants within the variety. The number and position of leaves, nodes, flowers and fruiting bodies are constant and therefore easy traits for peasant farmers to recognise and use as reference point for characterisation .

## VI.18.4 Fruiting Body Morphology and Colour

The shape, form and colour of a variety's fruiting body and grain are often very distinctive and are some of the useful traits that can be used to characterise some varieties, in particular, hybrids, self-pollinating and asexual types. This trait is often difficult to use with open pollinated composite varieties, although more stable in synthetic varieties.

### VI.18.5 Physiological Maturity

Physiological maturity is a very important trait used to determine the variety's maturity profile. Although the period between fertilisation and grain physiological maturity is influenced by genotype x environmental interaction, this trait is important for determining the correct timing for harvesting seed in local seed production programmes. There are useful observable indicators of this trait:

- In grain, the point where the grain is attached to the fruiting body will often show black or dark discoloration, if broken with a finger nail. (Figure 11)
- In crops that produce pods, if the pod is broken open, the areas that the grain came into contact with usually have dark or black lines. (Figure 46)

### VI.18.6 Processing Characteristics

Grain processing profiles have been used by peasant farmers as one of the traits to characterise varieties for their value for use and cultivation. This is a trait women farmers are good at determining. This trait is often valued deferently in peasant farmers' lifestyles and commercial utilisation, for example peasant farmers tend to prefer flint grained maize yet commercially the dent type grain is preferable. Flint grain does not easily break during pounding, which is valued by farmers in food processing. However, in commercial milling, hard grain damages machines, a feature not too popular in business.

### VI.18.7 Value for Cultivation and Use (VCU)

A variety Value for Cultivation and Use (VCU) relates to the variety's adaptability to the agro-ecological conditions where the farming systems are practised. This is coupled with the range of uses the household might have for the variety's plant products. Farmers select varieties subliminally or consciously according to criteria related to VCU (see also Section III.1.9).

Household food security at the peasant farmer level is achieved normally when the farmer has enough food reserves to last the full year, without having to look for food from external sources. To this end, most farmers rely on crop and variety biodiversity to meet their household food security. The correct mix of crops and/or varieties relies on information systems derived on assessment of VCU.

### VI.18.8 Maturity in Relation to Household Food Requirement

The variety maturity profile determines how quickly the variety can fulfil household food needs. Depending on the landholding of each household, in addition to agro-ecological crop growing conditions, different options are open to farmers to ensure household food and economic security. For instance:

- In dry land farming systems with a single rainfall period it might be necessary for the farmer to grow variety diversity of the 'staple' to meet food security. In this regard:
    - A short season maturing variety will provide food for the mid-season hunger period and would cover about 0.20 of the farm land.

- A medium season variety will provide food for the following few months in readiness for the main harvest and would cover about 0.30 of the farmland.
- A long season maturing variety will provide food for the remainder of the year and contribute to the main harvest that will be subject to long-term storage and would cover about 0.50 of the farmland.

The staple crop variety would be inter-cropped with some leguminous and/or pulse crops to complete the nutritional aspects of food security.

- In areas with a bimodal type of rainfall, the peasant farmers' options vary with agro-environmental conditions.
  - One of the rainy seasons is normally longer than the other, which suggests its suitability for production of the main harvest of the staple crop variety.
  - The short rainy season might be used for growing short period maturing crops that will carry the family over to the major harvest.

In this regard, such farming systems are characterised by crop and variety biodiversity to accommodate the heterogeneous nature of the agro-ecological conditions, under which farming systems are practised.

- In farming systems with irrigation facilities, food crop production is possible throughout the year. Such farming systems are characterised by smaller land holdings than the first two above. In this case farmers have an option of growing:
  - Crop biodiversity at different times of the year to meet their food security, ensuring that storage profiles of the selected varieties can carry the harvest throughout the year.
  - Variety diversity to meet the food and economic security demand.

## VI.18.9 Yield Stability

Regarding short- to long-term maturing varieties, peasant farmers often prefer those crop varieties that have a high tendency for yield stability rather than only high yield. Yield stability refers to when a variety's yield performance under different agro-environmental conditions does not vary drastically. The variety ensures a yield, except when there is total crop loss due to prolonged adverse weather conditions.

This is different from a crop variety that only gives very good yields under specific agro-environmental and crop husbandry conditions. If these change slightly for the worse, the farmer might not harvest anything, despite reasonable crop development.

The demand for household food security means that most peasant farmers select a variety that offers reasonable yield performance combined with yield stability, due to the vagaries of the agro-ecological conditions the crops may be subjected to.

## VI.18.10 Storability

Storage of the harvested crop plays a very important role in selection of varieties that underpin household food security. The storability of the fruiting bodies, grain, roots and tubers determines whether a variety is given a large crop area or not.

A combination of the maturity profile of a variety and its storability determines whether it will be selected as the household major food security commodity or not. In growing a variety for breaking the hunger cycle, storability might not be an important characteristic, as the harvested products are processed into food as soon as they reach the preferred food conditioning standards. However, for household food security, long-term storage with little loss due to pest and disease infestation assumes a very critical role. In this regard, peasant farmers tend to select long season varieties with good storage profiles that contribute to the bulk of their household food security, as they are processed for food for longer periods.

### VI.18.11 Palatability

Palatability is a subjective variety trait, yet it is used as an important tool during Farmer Selection of Varieties (FSV) for VCU. The best results are achieved through participatory food processing meetings, which are part of the community mobilisation effort to support the programme.

This test involves bulking all the produce from the same variety in all VEVO trial plots into one lot. The bulk from all VEVO trials is processed for food and tasted by a cross-section of community members. According to their preference, each variety is ranked for use as a food product. These palatability tests are conducted with a bigger sample taken from larger observation trial blocks the following season, until the variety with preferred taste for the majority of the community members is selected.

The palatability tests are important in selecting varieties for preparation of different types of dishes that add to the need for variety biodiversity in peasant farming systems. For instance, varieties that are good for food production are not necessarily good for brewing or preparation of wines. Furthermore, not all oilseed crop varieties have the same oil expression potential.

### VI.18.12 Uniformity and Stability of Fruiting Body for Market Penetration

Distinctiveness in taste and/or colour, uniformity in morphological characteristics, stability in yield performance, and morphology of the crop from a given variety, has important implications for cost effectiveness in commercial marketing of farm produce. This is the basis of success of hybrid crop varieties: the quality potential of a given variety is predictable and can be verified by independent institutions.

Peasant farming systems also need varieties that are stable and uniform, if they are to penetrate commercial markets. They must supply crop produce with predictable:

- Yield performance, period maturity profile and distinctive taste and processing qualities.
- Uniformity in size and colour of the processed product.
- Stability in any quality needed by the market.

It is easy to meet these quality standards for hybrid varieties and self-pollinated crop varieties, provided the variety genetic purity is not compromised. This is not easy to maintain in open pollinated varieties, due to the heterogeneity in its genotype and whose maintenance might easily be compromised through inadvertent selection processes during harvest.

## VI.19 Monitoring of Variety Booting

The period from planting to flowering is an important variety characteristic. It determines the earliness or lateness of maturity in a variety. The maturity period of a variety is so important to farmers that in some countries in the SADC like Zambia, all the released maize varieties are assigned numbers that indicate their maturity periods. The flowering stage of a variety is also used in roguing off-type plants from a seed crop.

### VI.19.1 Assessment of 50 % Flowering Stage of Participants' KITT Performance

In composite or synthetic crop varieties due to the genotype mix of the variety, there is often a tolerance of 5 to 10 days between the first and last flowering dates of the plant population in a seed crop. Any plants which fall outside these percentile ranges are considered off-types and are rogued out. Therefore, all plants flowering 5 to 10 days too early or too late must be removed from the crop, before the certified seed crop inspector arrives to inspect the crop. Such genetic anomalies are common in open pollinated varieties but should not exceed 2 % of the crop population. The Farmer Field School will concentrate on farmer knowledge of pollination and fertilisation dynamics with participants called upon to identify these traits by the trainer. At this stage, it is imperative for the seed crop inspectors to inspect the crop and satisfy themselves of the variety's genetic purity.

Such formal inspections, as already mentioned above, are necessary for Quality Declared or Certified Seed. For Truthfully Labelled Seed or Standard Grade Seed, this may not be necessary as such seed would be destined for the community and not for external markets.

At plant flowering stage, it is an opportune time to enable seed supply farmer participants to exhibit their knowledge in seed crop production through a community Field Day, when stakeholders in seed processes within the district are invited to participate. This farmer-to-farmer extension of agricultural development knowledge sets the stage for acceleration of PEA to development of local seed supply systems by local personnel. The trainer and extension facilitators only backstop this farmer-to-farmer extension by expanding on key aspects that may have been overlooked or misrepresented by the farmers.

### VI.19.2 Removal of Off-Types at Vegetative Stage

This is the best stage to observe variety morphology. The instructor will revise the obvious morphological features that characterise the variety, with farmer and facilitator participants contributing their observations from lessons previously learned. At this juncture, the instructor should allow the participants to point out those plants they perceive to be off-types and what their fate should be. Comprehensive discussions should ensue on the advantages and disadvantages of removing off-types. The importance of this phase is that the farmers must gain confidence to remove the whole plant regarded as an off-type from the field to avoid re-growth. This lesson is vital for quality seed crop production, as peasant farmers are most reluctant to destroy a healthy plant from a crop. Furthermore, all plants exhibiting susceptibility to diseases and pests should be removed at this point before pollination.

At this stage, it is time to call for official inspection of the crop by a certified inspector if the product is destined for marketing at a later stage. The inspector needs to come when all crops in the seed crop unit are at the pollination stage of flowering. The inspector needs two to three weeks' notice to undertake this exercise.

## VI.20 Field School Training

Farmer Field School (FFS) Training involves using the field and the growing crop in a trial or observation plot as tools for information generation or transfer, that help participants acquire the requisite knowledge for producing a quality harvest. The FFS training is conducted *in situ* on the farmers' crop or in trial plots. This follows a hands-on approach, whereby each aspect that is critical for the lesson is illustrated on a plant and/or crop, with farmers trying out immediately and demonstrating their ability to duplicate the lesson individually. This method of training is fully participatory, with every member in a group taking part in the execution of tasks and passing on lessons learned to other group members. Hence, this falls under participatory extension approaches (PEA) to training (see Section III.7).

Appropriate local information and knowledge systems are a prior requirement for developing local quality seed supply systems. It is also important that all potential seed crop producers be familiar with:

- Crop variety diversity preferred for food and other economic considerations by their community or neighbouring ones.
- The agricultural environment, both biotic and a-biotic (general local weather patterns over a decade, soil types, pests and weeds profiles) for successful production of a harvestable crop.

Such information could be gathered from local farmers, hence, the need for community mobilisation where information may be cross-checked. To capture this information, it is necessary to have VEVO trial plots, which are widely distributed over a given area within the community. Such trial plots in a given village/community should reflect local agronomic development and yield performance for each variety in the trial, when exposed to varying environmental conditions produced by farming systems favoured by the community. This exercise would generate locality-specific knowledge on how to handle each variety for optimum seed yield performance.

## VI.21 Field Days

Field Days may be termed community exposure events in the agricultural development programmes undertaken in the locality. These events are often organised by farmer groups with the following key objectives:

- Sensitise the community to the performance of various varieties under trial, as its members ultimately constitute the seed group's clientele for any marketable produce.
- Explain the processes involved in production of quality seed and quality food produce to the community. The importance of this step is that production of quality seed requires good community relationships, if contamination between seed crops and

food crops are to be avoided. Further, this is important for pointing out that purchase of quality seed each season ensures good yield.

- Invite the community to participate in the variety selection process, using their own criteria which are consistent with their social and economic needs.

In order for such Field Days to be effective exposure events, they should be timed to coincide with VEVO trial plot crop development, illustrating explicit differences between varieties. Hence, there should be two Field Days: the first one when over 50 % of the varieties in the trial are in flower and the second one when two or three varieties have reached physiological maturity (see also Sections VI.3.3.9 and VI.3.3.10).

## VI.22 Organisation of Exposure Visits

Exposure visits are based on the visit-observe-learn principle from contemporaries engaged in activities that you are engaged in. However, in the case of exposure visits, this principle is extended to a Field School experience normally involving members engaged or intending to implement PRE approaches to local seed provision systems.

The exposure visit would normally involve Field Schools to;

- Demonstrate how to establish community structures that underpin the implementation of local seed provision systems at village and community level
- Conduct relevant and effective VEVO-trials in a single village and how such trials are used to generate and capture relevant data for FSVs
- Plan and implement quality seed production fields and demonstration of the combination of small seed plots to create a recognised seed production unit amenable to quality seed registration and inspection
- Study strategies in local quality seed processing, packaging, treatment and storage
- Maintain at local level genetic integrity of FSV basic seed

The intended objectives of such a visit would be for the hosts to:

- Verify the relevance, efficiency, effectiveness and impact of project implementation strategies at community level
- Demonstrate the field implementation of R-E-F linkages in information and technology transfer for community memory development to enhance informed FSV during VEVO-trials
- Illustrate the creation of institutional structures at community and services provision level that would engender both viability and sustainability of local seed provision systems, such as;
    - FSV registration and release
    - Determination of seed demand both locally and in external markets
    - Creation of local seed production and distribution networks

Such exposure visits entail a lot of preparatory work at both hosts and visitors levels. Ideally such visits should be planned for at least two months in advance for the above objectives to be fully realised. However, if only one or two objectives are the focus of such a visit, its best for the visiting group to enquire from the intended hosts when it would be possible to undertake the visits with the intended objectives clearly defined.

*Table V Food and Seed Security Continuum Complex*

| Parameters | Food Security | Seed Security |
|---|---|---|
| Availability | Sufficient quantity of appropriate food stuffs are within reasonable proximity to the target communities | Sufficient quantity of appropriate seeds are within reasonable proximity to the target communities |
| Access | Members of the community have adequate financial or other resources to timely procure or barter for appropriate food stuffs | Members of the community have adequate financial or other resources to timely procure or barter for appropriate seeds |
| Utilisation | Food is properly used (processing, storage, nutrition, child care, health and sanitation practices) | Seed is of acceptable quality (genetic, physiological and physical and Phytosanitary) |

## VI.23 Training on Physiological Maturity, Cleaning and Moisture

The subject of seed quality including elements determining the proper physiological maturity of the seed crop and seed conditioning is discussed in detail in Section III.2.8.

### VI.23.1 Assessment of 50 % Seed Grain Physiological Maturity Stage of Participants' KITT Performance

Physiological maturity is critical for determining the optimum harvesting period of a seed crop, to avoid post-harvest infection and contamination. The farmer and extension participants will have to show their competence in determining this stage of crop development. The trainer is necessary to guide this process, so that the farmers become competent in its absolute determination. At this stage, the certified seed inspector should be called in to monitor seed crop harvesting as shown in the protocol (see Annex IV and Section VI.3.3).

The seed crop will need to be harvested and conditioned as elaborated in Annex V.. The participants should follow the processes introduced here during the VEVO trial pilot programme. The extension facilitators often know enough about harvesting and processing to be able to undertake assessment of this activity. Care should be taken to harvest and condition all the quality seed crop section separately from the discards (fruiting bodies selected out from the harvest).

As this process has implications for food crop yield performance, it is important that Farmer-to-Farmer extension be included in this activity with a Field Day. This would broaden knowledge about grain quality enhancement through avoiding field crop grain infestation by post-harvest pests such as weevils, and diseases such as fungal moulds - *Suchas Diploidias sp.* and *Fusarium sp*. These post-harvest infestations usually occur subsequent to physiological maturity and can be reduced through proper conditioning of fruiting bodies and grain.

### VI.23.2 Seed Grain Cleaning

Winnowing in a draughty area is the most common and effective technique used by peasant farmers to separate grain from chaff. It is preferable that seed be allowed to fall on a plastic sheet where it is winnowed repeatedly, until clean grain remains. This technique is preferred for seed grain processing, rather than the mechanised seed elevator option used by commercial concerns which is too expensive at this level of operation (Figure 22).

### VI.23.3 Sorting and Grading Seed Grain Types

Peasant farmers often select seed bearing fruit bodies with seed grain they consider good for replanting. This process entails the selecting out of fruiting bodies with seed grains, which contain some of the genetic traits conferring the true characteristics of the preferred variety. This is the main cause of variety genetic drift, resulting in a crop having entirely different characteristics from the source seed crop, in particular for OPV and semi-self fertilizing crops. However, in self-fertilising crops such selection is inconsequential.This, is prime reason why farmers need to buy “certified” seed after tho or three generations in OPV or self-polinated crops

To avoid this, all shelled seed from fruiting bodies deemed to be clean and with the desired morphological characteristics should be blended into one sample. The seed grain sample, depending on the crop and/or variety, are then sorted and graded by a tilted metal frame with different sizes and shapes of holes. First, seed is graded into the preferred size that has potential for producing vigorous seedlings. The second screen separates good seed by shape. The seed shape is important for machine planting, but if mechanical seed planters are not to be used, this second grading is not important. Seed grain is sorted out to remove damaged and/or diseased and stained grains.

### VI.23.4 Grain Moisture Content Determination

More than any other crop production process, whether for seed or food, grain moisture content has serious implications for survival of the commodity harvested, and falls in the critical path to success of the seed/food security complex programme. In this respect, it is fundamental for farmers to understand fully its implications for food and seed security and to be trained in its determination.

To avoid post-harvest deterioration of grain through disease and moulds that cause rot and physiological heat build-up, all grains must be stored at grain moisture content of less than 12 %. If seed grains are stored at moisture content that is higher than 12 %, it is guaranteed that they will deteriorate in both physical and physiological quality, rendering them useless.

In food grain such diseases could produce aflotoxins, which have serious human health implications that may lead to death.

Hence, once grain has been processed, it should be conditioned further to remove all residual moisture using either of the following methods:

- Laying it on a clean dry surface, such as plastic or flat rock, in a well-ventilated place which is warm (temperature of less than 40ºC) rather than in direct sunlight, particularly in the tropics. If left in direct sunlight, the surface used to put the grain on must be raised and porous so as to allow free movement of air through it.
- Putting the seed in a cylindrical and slowly rotating drum and letting a steady stream of dry warm air pass over it for at least 6 to 12 hours.

Grain samples are taken at random and tested for moisture content. However, it is easier for peasant farmers to use simple, easily available and accessible tools for this process. The device will not give the participant an exact grain moisture reading: all it does is to assure the farmer that the seed has attained good grain moisture content for optimal storage (see also Section VI.3.3.14). To construct a 12 % or less grain moisture content household tester, the following may be used:

- Either a completely dry transparent jam jar that can be sealed tightly, or a transparent small plastic bag that can be sealed by knotting or tying
- Completely dry ground table salt or sodium chloride
- Put a pinch of salt and about 100 seed sample together into the container.

To train farmers in the use of homemade grain moisture devices, let each participant follow these steps:

- Place each sample of dry and new seed grain into two very dry transparent sealable containers
- Put into each of the containers a quarter teaspoon of granulated dry table salt with 100 seeds
- Seal the containers tightly and place them either in hot sun or near a fire and leave for up to 15 minutes or more
- Shake both containers with the seeds and salt and observe
- If the table salt does not stick either to the seed or container, the grain has moisture content of 12 % or less. This grain is ideal for storage as seed or food for long periods
- If the salt sticks either to the seed or container, the grain has moisture content of over 12 % and is not good for storage and needs further conditioning.

This process is easy, available, accessible and very accurate. All farmers will add value to their grain commodity marketing strategies by aquiring this skill, where grain is considered at a premium when its moisture content is below 12 %. This technique is more useful for cereal crop grain moisture content determination ratther than pulses or oilseeds.

# VI.24 Harvesting and Conditioning

Seed processing involves a number of aspects: most of these are discussed in detail in Chapter III and Section VI.3.3. In this part, guidelines for seed processing will be given, focusing on cereal crops. However, mention of other crop types will be made to illustrate points of departure from the processes involved.

## VI.24.1 Correct Timing of Seed Crop Harvesting

Two weeks after the crop has reached grain physiological maturity, it is ready for harvesting. Harvesting should not be delayed unnecessarily, in particular for those crops with fruiting bodies in the ground, such as groundnuts and bambara nuts: if left in the ground, they have a tendency to germinate in the pod if the soil is moist. For pulses and other legumes bearing pods, timely harvesting may reduce loss through pod shattering in the field.

If the seed crop is to be hand-harvested, the following steps should be taken:

- For cereals and pod legumes, the larger part of the plant stalk should be cut together with panicle, cob or pod.
- For pulses and oilseeds with fruits in the ground, it is better to pull the whole plant out when the soil is still soft. Groundnuts should be pulled out when the grains start germinating in the pods, even if physiological maturity has not yet been entirely established. (Figure )

## VI.24.2 Conditioning of Fruiting Bodies

Many farming communities no longer know how to condition grain properly. Extension facilitators must train and demonstrate to farmers how to construct conditioning structures and how to condition seed bearing fruit bodies, such as groundnuts.

Farmer participants should practise these techniques in their groups through PEA under the extension facilitator's close supervision. This is another reason why the pilot seed production programme should be kept small: community collaboration and effective communication in developmental programmes enhance greater diffusion of knowledge and information systems.

### VI.24.2.1 Warm Air Aeration Techniques

This is the traditional method used by peasant farmers to dry grain before threshing. The principle is simple, in that it uses naturally dry, warm air to dry the seed slowly to around 18–20 % grain moisture content, when the seed is still attached to the fruiting body.

It is important to stack maize pyramids in the field with seed stakes that are well-separated from the discard stacks. The stacks should be loosely staked to allow free air circulation. For seed crops, however, it is better to remove the cobs from the stalks and pile them onto a raised, inverted cone(crib) or open top structure constructed out of wooden stilts, covered with chicken wire or reed mesh. (Figure 54)

These stilts allow free dry aeration from natural air or air convection from cooking fires which farmers use. Raised stilts are ideal for conditioning most grain crops from cereals to legumes and pulses. The heat and smoke from the burning firewood both conditions and prevents pest and disease infestation of the grain. Conditioning in this way is best maintained for two to three weeks before seed processing.

Most oilseed grain is best aerated in wooden trassel-shaped frames with the fruiting bodies facing the outside and leaves and stalks on the inside of the frame. However, it is better if such trassels are also kept in well-aerated covered shelters.

#### VI.24.2.2 Hot Air or Heat Seed Drying Techniques

These techniques are best used for rapid conditioning of seed grain or food grain. The process involves forcing a stream of air into a perforated drum which is kept rotating to allow air to pass through the grain. This system, however, is not recommended for oilseed grains as the heat alters the physiological condition of the grain. On the other hand, this is a very safe and fast method for conditioning cereal seed grain to the requisite 12 % seed grain moisture level, ideal for physiological and physical testing of seed.

For small quantities of seed, often for household seed security processes, fruiting bodies are best conditioned in traditional firewood burning kitchens. The maize sheaths in this process are peeled back and used as ties to the eaves, while panicles are just pushed into the eaves using the stalks.

### VI.24.3 Processing

Once the seed grain is considered sufficiently dry to about 20 % grain moisture content, it is safe to process seed by threshing the grain off the fruiting structures. There are important activities to be undertaken for the seed supply process. Farmers normally have local knowledge about this, but they still need to be trained, as they tend to select seed grain and/or fruit on the basis of size only.

#### VI.24.3.1 Fruit Body Selection for Seed Grain

For seed supply, all seed fruiting bodies need to be selected by removing infected or stained fruit bodies from the stake. Small fruit bodies should not be removed from the pile, except for deformed ones. This process is best undertaken on a flat surface covered with a plastic sheet or made from cement.

#### VI.24.3.2 Trimming of Fruiting Bodies

Cereal fruiting structures, such as cobs and panicles selected for grain shelling, need to be trimmed. The trimming process as described below needs to be explained:

- Remove small and uneven seed grain at the ends of the fruiting body. The former normally has fewer nutrients to support vigorous plant growth after crop emergence. The latter often has longer dormancy than other seeds and delays in germination, causing uneven crop emergence and hence problems in DUS characterisation
- Leave seed grain of the same morphology type which conforms to grain characteristics for a given variety, i.e. grade the seed.

### VI.24.3.2.1 Shelling Seed Grain

Threshing of seed grain by peasant farmers is traditionally performed by hand. Panicles are often threshed on hard flat surfaces to separate the grains from the stalks. The grain is then swept together and put into baskets or bags.

For pulses and aerial pod bearing legumes, such as pea and beanlike seed types, the stalks bearing pods are put in bags. The bags are then threshed with long thin staves to separate the grain from seed.

For maize and groundnuts, shelling used to be done laboriously by hand. This was done for maize, as threshing failed to dislodge seed grain from the cob. However, threshing of groundnuts tends to damage the seed. Separating the seed from the pod or shell of bambara nuts poses the greatest problem. This often requires gentle pounding of the shelled grain in a mortar with a large pestle.

Simple hand or mechanically driven machines for seed grain shelling for panicle crops, such as maize and groundnuts, have now been developed. Participants need to be trained in the correct use of these machines by the manufacturers’ representatives.

## VI.24.4 Storage of Seed Grain

At this stage of the pilot seed production process, not all aspects of seed production will have been covered. The other topics are covered in Years 2 and 3 as described in Chapters VII and VIII with the completion of the training process. This part will deal with short-term seed or grain storage (see also Sections III.5 and VI.3.3.14).

Farmers know through experience, the amount of seed they need per season for their farming activities. The rule of thumb is that a farmer needs to store twice the amount of seed required per season to cover for the risk of crop failure. The storage requirements for household seed security are 40kgs, 10kgs, 30kgs and 100kgs for maize, sorghum, rice and groundnut seed/ha respectively.

Groundnut seed is best stored in the pod. However, other grain seeds are best kept as grain. If seeds are sealed hermetically (free from external air) in a plastic bag or bottle they can maintain their quality for over five years. However, such technology is not easily available or accessible to peasant farmers: therefore, other strategies must be used to preserve seed quality. This includes seed treatment which is the subject of the next section.

## VI.24.5 Seed Grain Treatment

If sealing the seed hermetically is not feasible, it is recommended that peasant farmers store seed grain in airtight containers, preferably earthenware or plastic. The seed should be covered with 2cm of river sand that has been baked for at least two hours to sterilise it. *Soil must not be used as a substitute.* River sand should be soaked with paraffin or cooking oil. This procedure will keep seed free of pests and diseases for at least two years. For long-term storage, the above procedure will work for up to ten years, if the container is sealed either with plastic or hot beeswax, after oil application.

In Section III.4, chemical treatment of seed is elaborated on, so this technique is not dealt with here. However, farmer participants must be reminded that no chemical is totally safe. It is imperative that when using this method of seed treatment protective gear be used always.

## VI.24.6 Seed Physical and Physiological Quality Analysis

For all certified, standard grade seed or any class of seed destined for the external market, it is compulsory in most countries to have such seed to be analysed by a government approved and registered seed testing station or institution for crop seed physical purity and physiological quality, according to the International Seed Testing Association (ISTA) guidelines. This organisation has set up benchmark seed quality standards which are internationally recognised and act as a template for establishing national seed quality standards. The ISTA guidelines are important for international seed trade.

Seed destined for external markets or for producing other classes of seed need to receive a seed quality analysis certificate from an approved agency. It is important, however, that before seed of any class is stored, its physical and physiological quality be ascertained. This is critical for determining the seed planting density for crop establishment.

Peasant farmers and extension facilitators need to learn the rudiments of seed quality analysis, in order to enable them to make informed decisions regarding seed purchase from either informal or formal markets. This is in line with the Field Schools PEA to training in the determination of genetic purity of the variety involved in seed production. These two activities will empower farmers to conduct effectively all aspects of '*farmer certification*' of seed supply processes, comparable in efficacy to those of formal government approved systems.

This will ensure that farmers will have confidence in:

- Their local seed supply systems to deliver quality seed of selected varieties comparable to any in the world.
- Their ability to enter into seed capital generation programmes, either on their own or in partnership with formal seed supply systems, on contract.

## VI.24.7 Seed Sampling

This aspect of seed quality analysis is covered in Sections III.2.8.4 and VI.3.3.14 and an illustration of the sampling techniques is given. The process is as follows:

- A sample of one kilogram of seed, for example of coarse grain cereals or oilseed, is drawn from the seed lot at random with a seed sampler, which is probed into bags and small samples are taken from each bag until the right quantity of the seed sample is drawn.
- For home testing, small seed samples are drawn by hand from bags at random until the correct sample quantity is drawn.

## VI.24.8 Crop Seed Purity Quality Analysis

The sample is divided into two sub-samples. The first is stored for re-testing and variety genetic purity grow-out testing. The second sub-sample is further divided into four portions, where the four seed portions are spread individually on a clean surface and assessed for the percentage by mass of pure crop seed, chaff, weed and other crop seeds. Each of the separate entities is assessed for its mass, which is converted into a percentage of the total portion mass. Good quality seed should have a crop with seed purity of 99 % without noxious weed seed or fungal resting structure, such as sclerotia commonly found in groundnut and sunflower seed. If the seed is of a lesser purity but without noxious weed seed or fungal resting structures, farmers are advised to clean it out again. However, if noxious weed seed and disease contaminants are recorded, the entire seed lot is rejected and the grain recommended for alternative uses (see Sections III.2.8 and VI.17).

## VI.24.9 Seed Physiological Quality Testing

The four samples from above are blended together and four hundred whole seeds are selected at random for physiological quality analysis. From the same seed portions, 100 pure seed are separated out at random. These 100 seeds are used for physiological quality analysis explained in the following part.

Vigour testing involves taking 100 seeds from which four seeds are placed in a straight line on ten wet sheets of newsprint, an old newspaper will do, placed on a hard surface. A standard 23 x 12 cm brick is placed gently on the seed with one of its edges. The newsprint is watered to saturation point daily. After 5 to 8 days, the germinated seedlings will lift the brick as they grow if they are of good vigour. Weak seedlings fail to lift the brick. This seed characteristic was used by peasant farmers in former times to shatter rocks, as seeds were poured into rock fissures and water was poured in to start the germination process. As the seeds germinated and seedlings grew, the force they produced was great enough to shatter the rock.

Alternatively, four very clean plastic trays made from rectangular soft-drink plastic containers are filled with baked and sterilised river sand. Each tray is then planted with 100 seeds at a depth of two-and-a-half their size. The sand is watered to field capacity and the trays are kept at room temperature, which may range from 15 to 25ºC. Seeds of different crops with good vigour emerge from the ground in the following time spans:

- Cereal seed emerges from the soil in 3 days
- Pulse seed emerges from the soil in 5 days
- Oilseed emerges from the soil in 7 days

Two days after seedlings emerge the sand is washed off them. The seedlings are then spread out on a clean surface for observation. Good seedling vigour will be represented by a straight shoot and tap root of equal length and size.

Testing seeds for germination capacity and seed health is discussed in Section III.2.8. However, the home-based system is based on the technique described above. Assessment for each seed type is done 2 and 4 days later than for the crop type as follows:

- Cereal seed emerges from the soil in 3 days, 1st and 2nd assessments at 5 and 7 days respectively. Germination capacity range of 90–100 % being considered good quality seed.
- Pulse seed emerges from the soil in 5 days, 1st and 2nd assessments at 7 and 9 days respectively. Germination capacity range of 85–100 % being considered good quality seed.
- Oilseed emerges from the soil in 7 days, 1st and 2nd assessments at 9 and 11 days respectively. Germination capacity range of 75–85 % being considered good quality seed.

Alternatively, paper or cloth roll towels can be used to test germination and seed health quality instead of plastic trays. (c.f Section III 2.8.12)

## VI.25 Harvest Data Collection, Processing and Analysis

Once seed quality has been assured, seed weight is taken and recorded. The percentage of quality seed processed is recorded and analysed as a percentage of total harvest of the seed crop. The yield data can provide useful information on how well the test varieties are adapted to the agro-ecological conditions of the pilot seed production areas. This information is useful in seed marketing. Apart from that, the yield data can be used to delineate the agricultural area into clusters of agro-ecological similarities as discussed further in Section VI.25.1 below.

### VI.25.1 Agro-ecological Analysis

The records from multi-location VEVO trial and Pilot Seed Production Programs, if implemented in the same agricultural season, may be used to initiate statistical analyses of zones of adaptation for each of the varieties tested. The analysis starts with the characterisation of agro-ecological similarities across variety test sites within the program or similar programs, using the same varieties but facilitated by different intermediaries. Such records include geographical data on rainfall, minimum and maximum temperatures and the length of the growing season. This data will delineate varieties as short, medium and late maturing, as well as areas suitable for photo period sensitive varieties (those varieties affected adversely by changes in light intensity during summer and/or winter, such as some maize and sorghum varieties). That is why there are winter and summer varieties of some crops.

Experienced biometricians who can then generate variety performance maps are best left to perform these analyses based on Geographic Information Systems for the region or country. Such maps are invaluable tools for planning commercial seed production enterprises for crop varieties with a wide geographic adaptation, but with a limited local or national market. With the knowledge and information derived from regional VEVO trials based on replaceable (open pollinated or self pollinating) improved technologies (varieties), local seed supply systems can exploit such synergies in agro-ecological conditions to develop marketing seed networks.

## VI.25.2 Seed Supply and Marketing

Statutory instruments that often make it difficult for practitioners in local seed supply to penetrate formal seed markets regulate quality seed supply of commercially important crops, such as maize, rice and groundnuts in most countries. These statutory instruments regulate:

- Seed production which has to originate from certified or quality declared seed
- Seed processing which specifies parameters for physical and physiological purity and validity of such quality standards
- Seed supply which specifies parameters of the quantities of seed that can and cannot be sold without a licence from an authorised seed controlling institution
- Seed storage and packaging which specifies how and where seed may be stored and packed for the market.

### VI.25.2.1 Seed Packaging for Sale

At local seed supply level, for most countries seed grain can be packed in hermetically sealed plastic bags in quantities not exceeding 2 kg per bag. This quantity of seed can be sold legally by farmers, whether certified or not with a licence. Seed of heavier masses than this may only be sold by a licensed seed commodity dealer. A number of easy-to-use seed package sealing devises are now available in most commercial grain processing concerns.

Seed is best treated just before packaging. However, care should be exercised that the grain moisture content is returned to below 12 % before packing, as already discussed above.

### VI.25.2.2 Seed Package Labelling

For probity, it is a prerequisite that all seed supplied be 'labelled truthfully' with the following:

- The name of the registered variety, if certified or approved as an official variety for use as an agricultural commodity
- The correct mass of seed in the package, as this is important for the consumer to determine the planting rate
- The treatment use to protect the seed from pests and diseases which have implications for health of the user
- The name of the packing company, the quality status, and in particular, the purity and germination capacity, as well as the seed lot number registered with the quality determination institution.

This information assists the consumer and seed controlling institutions in tracing the origin of seed, should any problem arise. This is critical for maintaining good seed standards and averts development of disease epidemics that might impact negatively on crop productivity.

The above parameters add a premium to seed supply processes which single households can often ill afford to invest in. Due to this constraint, community technology mechanisms (see Module II, Annex II: Overview of the Training Curriculum for Developing Local Seed Supply Systems), suggest that such investment at local level might best be done through farmer seed group associations or co-operatives.

### VI.25.2.3 Seed Package Storage

Seed supply requires that the commodity supplier reserve one-and-a-half times the seed required by the market to off-set increased demand, as often, peasant farmers are more inclined to react to changing situations, rather than plan exhaustively for their requirements. Furthermore, there are dangers of environmental or human disasters that might disrupt peasant farming systems, which have a tendency to increase demand significantly to projected calculated sales in the first year of food crop production.

## VI.26 Elaboration of Seed Garden Concept

Seed gardens have long been a feature of the ‘farmer seed system’ that have always been an integral component of peasant farming systems where seed is selected from the food crop. Usually, women were more adept at seed selection than men. However, when it came to variety development, crossing and mass selection of varieties for adaptation to particular agro-ecological conditions, men appeared to be better suited for this component of seed supply systems. In short, the gender division of responsibilities in seed supply suggested that men were more concerned with variety breeding and crop development, while women were more involved in seed supply processes that involved production, conditioning, processing, seed grading and selection, storage and distribution. Therefore traditionally, seed gardens had the following functions:

- Variety adaptation evaluation and development of a test site.
- Important *in situ* plant genetic resources ‘live’ conservatories (gene banks).
- Variety genetic purity verification grow-out test sites.
- Seed bulking of a selected variety in isolation and during the off-season under close management.

It is clear that seed gardens have always functioned as indigenous agricultural crop research centres for communities, from which varieties were developed and ‘village foundation and pre-basic seed’ was produced. Hence, there were areas of crop knowledge and information exchange that had to be managed closely and with restricted access. In this regard, they had to be small so as to be managed easily by a few individuals.

### VI.26.1 Use of a Seed Garden

In present day local seed supply systems, seed gardens are still used for the same purposes as described above, although with slight modifications. The main modifications being that their use has been extended to include:

- Hosting of Field Schools and Farmer Field Days for training farmers, in particular, in aspects of participatory variety breeding processes.
- Variety characterisation of those traits that are not easy to grasp in one session, such as period of pollen shed in a variety and determination of the 50 % median ranges used in establishing ‘mile pegs’ in crop development stages, especially in cross-pollinating crop composites or synthetic varieties.

- Training farmers in seed processing aspects, such as conditioning, selection and grading of seed and seed dressing after harvest, in preparation for the seed production and supply phase in the development of local seed supply systems.

## VI.27 Seed Garden Site Identification

Seed gardens need not be elaborate. However, availability and access to reliable water sources and protection of the site from pests, in particular wild animals, are critical for situating and establishing seed gardens. Furthermore, good agro-environmental conditions for crop development are another prerequisite (see also Section III.6).

In the rainy season, seed gardens are best established next to the homestead where they can be managed and monitored closely. This site is important for monitoring changes in crop environmental conditions, as the farmers might be in a position to intervene by irrigating or draining the crop during water stress conditions. Furthermore, the variety x environment interactions may be strictly controlled to suit whatever trial objectives the farmer is targeting. For instance, in seed bulking, variety genetic purity verification, or plant genetic resource conservation, it may be necessary to save the germplasm at whatever cost. However, for variety adaptation testing to agro-environmental conditions, it may be prudent for the farmer not to intervene, so as to evaluate the impact of particular environmental vagaries on various aspects of the variety's agronomy.

In winter, water becomes a critical factor in locating seed gardens. In this regard, it is necessary for the farmer to be assured of water availability, access and rights of utilisation, as in most cases, such areas in peasant farming systems are under the jurisdiction of village community administration and not the farmer's property. Since fencing of the area, which may deny access of the land to other farmers, may become an issue, permission may have to be granted for use of such land for off-season seed crop production.

## VI.28 Seed Garden Site Preparation

Site preparation is dependent on the threat of damage from animals and access to water. Therefore, the garden needs fencing and has to be in an area where similar crops were not grown the previous season to minimise pest, disease and weed infestation (Figure 32).

## VI.29 Seeding and Planting of Seed Garden

The most important factor in seed crop production for composite or synthetic, open pollinated varieties is that the plant population should not be less than 250 plants, planted in no less than 12 rows. This is critical in seed production of any generation, to avoid genetic drift and/or erosion by reduction of the gene pool that constitutes the genotype of the variety.

In the main, the plant population in seed gardens is not determined by environmental conditions, in particular water availability, as this is a controlled input through irrigation or drainage, whether in the rainy season or in the off-season. Optimum seed crop plant densities obtained from technology providers can be used for seed gardens.

In winter, it may be advantageous to increase the plant density by 5 % to reduce the chilling effect of the air on the crops, as the middle section of the crop will be shielded.

## VI.30 Seed Garden Seed Crop Husbandry

Land preparation in seed gardens follows the trend for vegetable garden furrowing, with beds prepared to accommodate two rows of the variety at most. The furrows are used to run in the water for irrigation. The soil texture is left with small granules and levelled to allow for even water distribution and hence even crop emergence.

Fertiliser must be applied before seed planting. Intercropping with a different crop species, often with diverse agronomic needs or soil fertility enhancement characteristics, is encouraged, as this may add synergistic complementarity to both crops through:

- Weed suppression and better water retention, for example, a cereal crop intercropped with a legume or pulse crop
- Pest and disease suppression through different species exclusion.

The seed crop fertiliser regime is determined by the soil type: recommendations for this are discussed in Section III.3. However, it is more important for seed crops for compound fertilisers with potassium and phosphorous components to be used.

## VI.31 Seed Garden Site Irrigation

Rivers and *dambos* (perennial wet areas where boreholes may be sunk) offer the best water sources for irrigation in peasant farming systems. Although flood irrigation facilities have been introduced in some areas by national water boards in recent years, their use for seed gardens is not known.

In some cases, small gardens have been established around homesteads where they are irrigated by wastewater from the kitchen and bathroom. Such seed gardens are normally used for plant genetic resource maintenance, especially for root and tuber crops grown in small seedbeds.

During vegetative growth, it is important that crops should not be subjected to water stress as this might impact on both fertilisation and seed filling.

## VI.32 Organization of Information Exchange

Seed gardens are part of the local seed supply system. Therefore, the Time Spreadsheet Work Plan for the training in phase one of the programme, applies. However, in the first year phase, some of the second year phase activities of seed supply processes should be attempted, depending on the number of seed gardens established in a single community, assisted by one team of facilitators.

The most important activity would be a repeat of the VEVO trials, however, with fewer entries as the emphasis will be on verification of information already captured, as well as enhancement of variety characterisation knowledge. In this regard, information exchange linkages should be established during the implementation of the field stage of the seed gardens.

If the trainer is convinced that the participants have gained enough seed supply knowledge and information to proceed to pilot seed production, seed gardens can also be used to generate information on specific variety agronomic performances under local conditions.

### VI.32.1 Review of the Process

If the seed gardens are established within the same time frame as the main rainy season of Year One of the programme, the programme review process at the end of the season would cover this part. However, if seed gardens are established off-season, a further SWOT analysis of implementation of off-season programme activities would need to be conducted, in addition to determining the correlation between variety defining information of the rainy season, due to possible genotype x environmental interaction, in particular heat unit impact.

## VI.33 Organisation of Seed Fairs

The organisation of Seed Fairs was discussed in Section VI.3.3.18. The timing in the first year phase of the local seed supply programme is governed mainly by need to compare the following:

- Genetic profile of the varieties in VEVO trials, in addition to germplasm preferred by farmers but no longer performing to their expectations.
- Determination by plant genetic resources experts of the food crop and variety biodiversity that could be important for the target community's household and economic security, and thus need evaluation for seed supply processes.
- Showcasing the product of the programme activity to the community for their final evaluation.

In the light of these factors, only products from the main rainy season activities would be of interest. The reasons being that:

- Varieties that go into the second class for both pilot seed crop production and VEVO trials would be identified during the Seed Fair.
- For pilot seed crop production in the second year phase of the programme, varieties for seed production need to be determined quickly to give enough time to source seed of the correct class and for selecting the participants and inspecting seedbeds.

Therefore, during the first year phase of the local seed supply programme, Seed Fairs are best held immediately after harvest of the main crop season. Seed garden products may only be considered, if harvested at the same time.

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## Training Manual on Small-Scale Quality Seed Production

# Chapter VII

## VII Process Continuation and Farmer Exposure: Activities in Year Two

Local seed supply processes follow a training programme that is based on the KITT model syllabus, which emphasises field-based participatory training approaches. The second main agricultural season's programme is a continuation of that process, but concentrates more on Modules VI and VII introduced in Annex V.

## VII.1 Community Mobilisation / Community Technology

Parts of this module have already been discussed in Chapters V and VI. In this section, the emphasis will be on developing seed supply systems subsequent to the initial training programme which focused on VEVO trial plots implementation and results analysis.

### VII.1.1 Elaboration of Target Farmer Groups

Lessons learned from the first year phase of the programme prepare the partner for selecting, during consultative discussions, the target group of farmers to work with, in order to achieve the desired objectives which may be summarised as follows:

- Pilot training in seed production and supply processes.
- Continuation of VEVO trials, with emphasis on verification of FSV biodiversity and variety, as well as agro-ecological conditions characterisation defining variety adaptation performance for developing germplasm mapping, that is important for marketing and distribution.
- Strengthening farmer seed groups' institutional capacity building in communication systems.

All of the above objectives are vital components for developing logical, viable and sustainable frameworks for local seed supply systems. These are summarised in the TSSWP for the second year phase results, the use of which is the same as elaborated in Sections VI.6 and VI.14.

## VII.2 Work Plan Sessions

The work plan for this phase including the lines of responsibility for each partner in the programme, are described in Sections V.12 and VI.3. It cannot be over emphasised at this stage, that local community institutions should be engaged by the intermediary to start assuming more responsibilities for running the programme, if sustainability is to be achieved. Farmers should start to purchase seed inputs for seed production.

### VII.2.1 Identification of Available Varieties

For food crop production, seed should be sourced from off-season local seed supply systems, either from seed gardens or larger irrigated plots from the year one phase of the programme, if enough seed was harvested and processed.

However, for all VEVO trial and pilot seed supply processes, only the basic seed class should be used; the rationale for this is explained in Sections V.7, V.8, VI.3.3, VI.6.1 and VI.6.2. The intermediary should have planned for availability of seed by the first field school sessions of the TSSWP for the first year phase. This time is necessary, as technology providers do not usually keep large quantities of working samples of basic seed.

### VII.2.2 Use of Protocols

This stage of field training and M&E activities should be left to a trainer or a set of trainers with very good knowledge in all aspects of seed supply processes, from breeding to seed supply. The trainer should also be familiar with the characteristics of the varieties used in implementation of pilot seed crop production and supply programme. The VEVO Trial Plot and Pilot Seed Crop Production protocols are self-explanatory (see the protocols in Annexes IV and V). The trainer and extension facilitators would have reviewed their use during the train-the-trainer courses in the preparatory and first phases of the programme.

The extension facilitators should endeavour to train farmer seed groups in the use of the protocol and their rationale at least two weeks before the beginning of land preparation. Past experience in implementation of seed supply activities has suggested that farmers do not use the protocol, due to difficulties with literacy. However, PEA should teach farmer participants the importance of collaboration between group members or family members in all aspects of activity implementation. It is fundamental, therefore, that records be kept for knowledge and information systems generation and transfer. Furthermore, whoever writes the records need not be the owner of the plot, but could be any member of the family or community.

It is important that farmers use the protocols for crop and trial management record keeping. This enhances their capacity for seed supply knowledge and information generation, which may be shared with other stakeholders. The latter may have the technical expertise and capacity to delineate crop variety geographic adaptation zones, either locally, nationally or regionally. This is an important aspect for local seed supply network development.

The records from multi-location VEVO trial and pilot seed crop production schemes, if implemented in the same agricultural season, are used to initiate statistical analyses of zones of adaptation for each of the varieties tested. The analysis starts with the characterisation of agro-ecological similarities across variety test sites within the programme or similar programmes, using the same varieties but facilitated by different intermediaries. Such records include geographical data on rainfall, minimum and maximum temperatures and the length of the growing season. This data will delineate varieties as short, medium and late maturing, as well as areas suitable for photo period sensitive varieties (those varieties affected adversely by changes in light intensity during summer and/or winter, such as some maize and sorghum varieties: this is why there are winter and summer varieties of some crops).

Experienced biometricians who can then generate variety performance maps are best left to perform these analyses based on Geographic Information Systems (GIS) for the region or country. Such maps are invaluable tools for planning commercial seed production enterprises for crop varieties with a wide geographic adaptation, but with a limited local or national market. With the knowledge and information derived from regional VEVO trials based on replaceable (open pollinated or self-pollinating) improved technologies (varieties), local seed supply systems can exploit such synergies in agro-ecological conditions to develop marketing seed networks.

## VII.3 Identification of Demands

Consultative community meetings, through Field Days, Seed Fairs and Seed Gardens will have largely defined the variety biodiversity demanded by the target farming community, for variety verification studies and training in seed supply processes. Consultative meetings would have eliminated those varieties that were not adapted fully to their agro-ecological farming conditions and the service providers would have added the modified germplasm profiles from samples gathered at Seed Fairs.

## VII.4 Identification of Shortages

The preconditions necessary for continuation of local seed supply systems are determined by the need for their sustainability. These could be summarised, as relating to the following (see also Section V.8):

- Knowledge gained through Seed Fairs of crops and variety diversity preferred by farmers
- Farmer seed groups' willingness and self-motivation to learn about seed supply processes
- Availability of locally recorded information on variety adaptation and performance from VEVO trial plots
- Availability of qualified and competent trainer facilitators in seed supply systems
- Availability and accessibility to relevant and appropriate varieties
- Potential number of farmers who would want to use the seeds from varieties produced from local seed supply systems. This might call for a rapid appraisal community survey on seed demand.

## VII.5 Description of Needed Varieties

Variety assessment for its Value for Cultivation and Use for household food and economic security respectively is discussed in Sections III.1.9 and VI.18. In the second phase of the programme, it is important that such tests are repeated for verification of results and for adding to the data base results on new varieties introduced to VEVO trials, after removal of those found inappropriate during the SWOT analysis of the first phase programme results.

## VII.6 Finding Partners in Seed – Seed Sources

During the second year phase of programme implementations, seed supply systems take centre stage. This is important for creating linkages between research, extension and farmers for the development of knowledge and information systems, leading to market penetration and processing of technology generation. The extension facilitator is the focal point for these linkages, as often technology information and knowledge transfer needs to be transformed appropriately, in order for farmers to understand it fully. It has been observed that technology providers often lack the necessary PEA tools to communicate effectively at the peasant level.

As already mentioned, seed processing calls for investment that is beyond the technical and financial capacity of peasant farming communities (see Sections III.2.8, VI.3.3 and VI.18.6). Economics of scale dictate that the market for less commercialised crops, such as pulses (bambara nuts), and cereals (sorghum and pearl millet) is limited and tends to be localised. The development of Regional Variety Adaptation and Performance Maps would open up opportunities for viable commercial exploitation of some of these crops by experienced market players. It is then the duty of technology providers and extension facilitators to bring such information to the attention of seed commodity enterprises. From these collaborative ventures, a linkage between private seed commodity dealers and farmer seed groups might be developed.

It is important, however, that farmer seed group representatives be part of the negotiation process, in order for them to gain business negotiating acumen. In this respect, training in knowledge of seed control regulatory frameworks would need to be given to farmer groups. Such knowledge is critical for the understanding of the intricacies of seed supply at the formal level. Government institutions should take a leading role in this training aspect.

Farmers should be initiated in seed supply processes in the first Train-the-Trainer course for the second year phase of the programme. Enhancement programmes in small scale business enterprises should be introduced immediately as part of this community technology module (see Annex V). Such training can be provided through public or private sector facilitators; this would have to be introduced as a cost in the Logic Framework for year two of the programme phase.

## VII.7 Decision on Seed to be Tested and Seed Source

The intermediary should purchase basic seed for this programme immediately after the end of the first year phase programme review meeting and consultative work planning session. The seed should be distributed to each participant by extension facilitators and the local seed committee, together with the relevant protocols, either for VEVO trial plots or seed crop production.

## VII.8 Trial Sites Identification and Preparation

During the first year programme phase, it is important that farmer seed groups identify potential seed garden and seed multiplication sites with assured distance or time isolation parameters, as described in Sections III.1.12 and III.2.12. At this stage, the farmers, together with the community, should be in a position to determine the nature of the introduction of seed crop production and seed supply processes they intend to follow. However, for all seed crop production, the site must be isolated sufficiently, with well-drained soil, and not sown with a similar crop the previous season.

It is important to note that whatever class of seed needs is to be produced, the quality aspects of seed crop production and supply processes cannot be compromised (see Section IV.1.1). However, due to problems in seed availability from the formal sector, it is best that the local seed supply system plans, during this phase, to engage in variety genetic purity seed production processes. To this end, the seed crop production sample protocol in Annex IV must be followed as part of the Training Modules III and IV (Annex V). The training programme should follow this protocol closely, in order for farmers to have both availability and easy access to basic quality seed and first generation quality declared seed classes at the local level. Hence, site selection for variety genetic purity seed production would require stricter isolation conditions: it may be advantageous to apply both time and distance isolation principles in a seed garden rather than in a field.

VEVO trail plots during this phase of the programme should be sited where they are easily accessible for observation by large sections of the population, i.e. near the main crop. However, they should be:

- At the edge of the crop and near a footpath, as this would serve as a form of control
- Grown under the same agronomic treatments as the main crop and sown not later than two days subsequent to the sowing of the main crop.

### VII.8.1 Land Cultivation and Preparation

Land preparation for VEVO trial plots, Seed Gardens and pilot seed crop production has already been discussed in year one in Section VI.30. To capture data better and meet seed requirements, the areas for VEVO trial and seed multiplication trials may need to be scattered widely within the community.

## VII.9 Multiplication Site Identification and Preparation: Sections III.2.2, VI.10, VI.11, VI.27 and VI.28

This is element of seed provision has been adequatelly covered in previous sections. Therefore there is no need to repeat it, but it is important that this step is followed in this phase of seed multiplication.

## VII.10 Organisation of Exposure Visits

Farmer seed supply group exposure visits to similar local seed supply programmes or research centres within the district or outside help participants learn the following:

- How to manage and administer implementation of activities and co-ordination of community mobilisation activities from other farmer counterparts, enhancing transfer of relevant and appropriate information.

- Aspects of crop variety identification through characterisation and techniques for identification of off-types in open pollinated varieties from professionals.

Such visits, although not mandatory, are important for exposing farmers to the challenges faced by similar groups and the ways in which these challenges were solved. Often, these visits provide farmers with benchmarks that they can use to compare and evaluate the efficacy and effectiveness of their own implementation strategies. Thus, planning and financing of such activities at the community and intermediary level should be conducted early in the season.

## VII.11 M&E Establishment of Trials: See Section VI.12

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.12 M&E in Programme Area: See Section VI.13

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.13 Budgeting of Seed Production Activities

During the preparation for the TSSWP for the second year of the local seed supply programme, the need for resource budgeting is discussed (see Section VI.14). It should be stressed that during the budgeting stage, the farming community must be involved, in order for them to learn about and appreciate the costing of such programmes. Such an approach will enable farmers to scale the size of programmes according to their human and material resources.

The facilitators draw up an assessment of what is required for each component of the programme. The stakeholders' consultative meeting is concerned with allocating cost centres and lines of responsibility for these costs and/or activities.

## VII.14 Technical Report to Extension Organisation/NGO: See Section VI.15

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.15 Seed Crop Husbandry

The soil and climatic requirements and crop husbandry practices for growing a seed crop is more exacting than that for a commercial crop. Essentially, the seed multiplication area should have a suitable climate that favours flowering, seed set and ripening. In addition, the land should have fertile soils with optimum acidity levels for the particular seed crop. The other important consideration is the cropping history of a particular piece of land. Ideally, the land should be rotated in such a way that disease, weed and insect pest build-up is minimized or avoided. Seed crop husbandry practices, therefore, are aimed at providing an optimum growing environment for the seed crop that will ensure quality seed production (see also Sections III.2.10, VI.17 and VI.30).

### VII.15.1 Scouting and Control of Diseases, Pests and Weeds

The importance and rationale for protecting seed crops from disease and pest infestation has already been discussed in detail (see Sections III.3.2 and VI.17.3). In this part, seed crop producers should be reminded that scouting for these disease-causing agents is paramount, to enable corrective measures to be instituted by farmers, before seed quality is compromised.

In quality seed crop production, if diseased plants constitute less than 0.1 % of the crop population, they are considered to be off-types and should be removed. However, if disease and pest infestation is higher than 0.1 %, external intervention through disease and pest control measures must be introduced very early on, before an epidemic sets in.

### VII.15.2 Organic and Integrated Pest Management

Peasant farming systems often rely on organic rather than non-organic crop husbandry management systems, due to the cost factor. These farmers have sophisticated organic pest management systems but they do not take disease control measures, apart from removing diseased plants.

The most effective form of integrated pest management is to spray the whole crop with an organic pesticide, as well as removing all infected plants and burning them, irrespective of disease incidence. The rationale for this is that while some pests, such as red locusts or armyworm, can cause serious crop loss, other insects only cause minimal damage to plants: however, they transmit diseases, such as leaf hoppers which carry viruses. Therefore, it is best to eradicate all pests, in addition to diseased plants.

Crop rotation and inter-cropping plant species may be one of the best organic integrated pest management systems: it works on the principle of reduction in pest pressure on crops of the same species or crops that are attacked by the same pest. Section III.3.2 provides some useful information on the dynamics of pest/crop interaction.

## VII.16 Monitoring of Variety Booting: See Section VI.19

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.17 Field School Training

PEA for training farmers and extension facilitators using VEVO trial plots in crop variety is intended to build the capacity of farmers to:

- Identify off-type plants and remove them.

- Characterise and verify data collected the previous season, in addition to recording characterisation traits of new varieties during flowering and physiological maturity stages.
- Determine the optimal time for seed crop harvesting, conditioning and processing strategies.

This has already been described in Sections III.7, V.6, VI.3.3 and VI.20 and will not be repeated here. However, the trainer must draw attention to traits that may have altered if compared to previous results obtained in the first phase programme, due to changes in variety genotype x environmental interactions. This should be backed up by comparisons made with traits that are not sensitive to environmental changes. Correct recording of important information should be emphasised further and participants should be encouraged to assume a leading role in pointing out relevant traits during Farmer Field Schools and Field Days.

Training sessions for seed crop production and processing are discussed in detail in Sections III.2 and VI.3.3. However, it should be repeated that the portions for each class of seed should be harvested, processed, tested for physical and physiological purity, stored and packaged separately (as explained in Annex IV: VEVO Protocol). If using the same equipment for testing, higher class seed (see Table 3) should be processed first to avoid contamination.

## VII.18 Field Days: See Sections III.7.4, VI.3.3 and VI.21

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.19 Harvesting and Conditioning: See Sections III.2 and VI.24

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.20 Harvest Data Collection, Processing and Analysis: See Section VI.25

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.21 Identification and Preparation of Seed Gardens

Once Farmer Field Schools and Field Days on seed grain physiological maturity have been conducted, it is time to plan for off-season quality seed crop production, in particular, seed for variety genetic purity quality maintenance. This is best implemented in Seed Gardens which are well isolated from crops of the same species, particularly for cross pollinating plants.

The rationale and choice of seed garden sites is discussed Sections III.6, VI.26 and VI.27. It is for the farmer seed committee to decide which class of seed is to be produced in the off-season.

## VII.22 Seeding and Planting of Seed Garden: See Sections III.6 and VI.29

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.23 Seed Garden Seed Crop Husbandry and Irrigation: See Sections III.6, VI.30 and VI.31

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VII.24 Marketing Seed Products

Subsequent to harvesting and processing grain from all VEVO trial plots to 12 % moisture content, 20kg grain of the same variety collected from several different participants should be blended together. The grain is then sent for the following tests:

- Milling quality processing in an approved and registered facility.
- Evaluation of each variety's potential for multi-purpose utilisation as food, confectionery and industrial commodities in a food processing laboratory.

Such tests are important for determining the range of marketing opportunities the community needs to explore, to add value to the crop varieties they would invest in. It is the responsibility of the intermediary and extension facilitators to develop linkages between farmers and institutions providing such services to empower communities to consult service providers independently, should there be a felt need.

### VII.24.1 Official Registration and Listing of Needed Varieties in the National List of Approved Varieties for Use

There are statutory requirements for local seed supply systems to be able to market FSV seed of specified crops in most SADC countries. It is the responsibility of the technology service providers and trainers to educate stakeholders about these statutory requirements, in particular the target farming communities.

After the second year of VEVO trial plots and one season of pilot seed crop production, farmers may be encouraged to grow a limited area of their FSV for food production. This will give the stakeholders an opportunity to observe the performance of farmer-selected varieties before they are grown on a larger scale or marketed. They will also need clearance from the Plant and Crops Genetic Resources Control Authority, as described in the next section.

### VII.24.2 Limited Variety Clearance from the Plant and Crops Genetic Resources Control Authority

If crossed with a crop that is already adapted to the region, new germ plasma may contain genes that have deleterious effects on local germ plasma productivity, due to disease and pest interactive dynamics. Therefore, during the course of the second year phase of the programme it is important that:

- Samples of 1 kg each of these FSV are submitted for genotype profiling.
- Officials from the Genetic Resources Control Authorities are notified of the location where all new exotic germ plasma is being tried out, to enable the authorities to conduct M&E inspections whenever they feel it is appropriate.

This limited clearance is essential because without it, in some countries if the crop is on the controlled list, those in charge of the programme can be prosecuted and the crop destroyed.

### VII.24.3 Application for Official Registration of FSV

Official registration of crop varieties is often a prerequisite in some countries. This requirement is necessary for protection of the genetic purity of all varieties in the country. Plant Variety Protection Rights may be used for verification of originality of the germ plasma when compared to similar crop varieties. The breeder will need to supply authorities with the following information:

- Designated market name of the variety
- A precise and scientific description of the variety
- The variety's genetic purity characterisation traits during active growth
- The variety's agronomic growth characteristics under different agro-ecological conditions.

There are prescribed quantities of samples that need to be submitted for registration. The process often takes a whole year. Therefore, data from VEVO trials and pilot seed production plots should be sent to the intermediary for inclusion in the breeder's data during the application process.

In some countries, official registration means that the variety is restricted further in its production by including it in the Seed Certification Process. This implies that all seed produced for local and external markets must be certified. The legal requirements for seed marketing are covered in Chapters X and XI under Commercialisation and Marketing in the Informal Seed Sector.

### VII.24.4 FSV Listing on Recognised National or Regional Varieties for Use

In some countries, it is mandatory for variety seed that will be sold or used for agricultural crop production to be on an Official List of Varieties Approved for Use. In general, this applies to crop commodities that are traded commercially, with the following objectives:

- Limit the proliferation of crop biodiversity on the market or in the commercial food processing industry, as this might affect the DUS of the processed food, due to differences in the food taste and processing profiles of the commodity.
- Plan more efficiently for national food security, by using varieties that adapt to a broad geographic area and have a known yield performance based on agro-ecological conditions.
- Both variety registration and listing have implications for development of sustainable local seed supply systems, whether household, community or nationally based. While registration is important for all types of seed security systems, variety listing only becomes important in external marketing of seed commodities.

Thus, local seed supply systems must develop strong research–extension–farmer linkages, which can facilitate best the creation of national and regional variety adaptation and performance maps (see Section VI.25). With such tools, it becomes easier for local community seed programmes to make informed decisions about the scale of their investment in seed supply processes for a given FSV.

## VII.25 Organisation of Information Exchange

Subsequent to the Seed Fair and farmer–extension analysis of programme implementation and collation of results and records, a farmer/community consultative meeting should be held to chart the way forward for the local seed supply system.

The following suggestions should be put to the stakeholders:

- Further training needs in the basics of quality seed supply and marketing, based on experiences learned during implementation of the programme phase activities.
- Whether to extend the programme or not, to include Participatory Variety Breeding (PVB) activities in the next phase.

A concise report of all activities, highlighting the challenges faced during implementation, as well as a summary of the VEVO trial records with recommendations, should be dispatched to the intermediary's administrative offices for distribution to stakeholders. These records constitute a major linkage point between farmers and researchers for exchange of information, and need to be fostered.

### VII.25.1 SWOT Analysis of Implementation of Second Year Quality Seed Supply Programme and Work Plan for the Next Phase of the Programme

A stakeholders' SWOT analysis for the consultative programme progress review and planning meeting is conducted, as discussed in Sections III.7.5 and VI.3.3.23. The planning session should concentrate, in particular, on an exit strategy for the intermediary level of stewardship[4], in order to reach the community level. To this end, the intermediary should assist in developing strong community mechanisms to cope with programme management and administration, in order for the programme to remain sustainable. The structures that will need to be planned for are as follows:

[4] Stewardship concerns provision of management, support services and financial investment for all programme activities.

- Development of local seed supply systems association to organise all the logistics of the programme.
- Creation and development of a seed processing and certifying inspectorate at both extension facilitator and farmer seed association levels.
- Establishment and strengthening of local seed supply systems networks and linkages with service providers, in particular, technology providers in germ plasma, seed processing and seed marketing.

During this phase, the intermediary should provide backstopping support only, in addition to supporting the provision of training in PVB activities. Otherwise phase three of the TSSWP in Annex I remains as it is.

## VII.26 Organization of Seed Fairs

The second year local seed supply programme phase sets the stage for sustainable development of local seed supply systems in a given community. Seed Fairs are a very important component for developing such a sustainable system, as for the first time, farmer seed supply groups and associations, together with the community would be responsible for organising this activity, with the assistance of extension facilitators. The objectives of the Seed Fair are described in SectionVI.3.18, but here, farmers would be showcasing for the first time:

- Products from the local quality seed production and supply programme to potential local and external market players.
- Crop biodiversity grown in the target area that might assist plant genetic resources experts in understanding the agro-ecological conditions that determine the food crop genetic adaptation profile.
- Seed knowledge and information systems to potential partners in seed supply processes.

# Chapter VI1I - Contents

# Chapter VIII

## VIII Handing Over Process: Activities in Year Three

The handing over process involves the complete transfer of all cost centres and lines of responsibility to the communities engaged in the development of local seed supply systems. This process is only possible if all aspects of VEVO trial plots and quality seed supply processes for years one and two have been covered fully, in particular, the following:

- FVS and its accompanying components of correct data capture and record keeping
- Requirements for quality seed supply at the farmer seed association level
- Variety maintenance of genetic quality purity at seed production and storage level.

The above components fall in the critical path for sustainability of local seed supply systems and by the second year phase of the programme, the intermediary/extension and service provision systems should have created the necessary linkage frameworks to enable communities to proceed independently through Modules VI and VII of the training syllabus (Annex II) This aspect is elaborated succintly in the complementary curriculum publication to this manual (Neuendorf O. 2003)

### VIII.1 Community Mobilisation / Community Technology

In the context of this manual, community mobilisation and community technology involves Training-for-Transformation, in order to empower community members to develop sustainable rural livelihood approaches. This training would include the following:

- Creation of effective social structures for managing and administering projects.
- Collaboration in investment in appropriate infrastructural development that would be impossible at the individual family level. For example, the equipping of a seed processing and quality testing centre for bulk seed destined for the external market.
- Contracting of specialist services for advising and training the community in income generating projects.

This form of training is critical for maintaining the momentum for developing local seed supply systems. It will need to be initiated at least two months before the start of the third year of the local seed supply programme activities.

### VIII.1.1 Discussion of Objectives of Local Seed Supply Systems

Generally, peasant farmers are very interested in gaining access to new varieties. However, once these varieties have been obtained, the market for them diminishes quickly. Small numbers of farmers may be forced to look for seed each year because of drought or poverty. But these poorer households are likely to be the least inclined to purchase high quality seed at premium prices. Given the choice, they are more likely to obtain grain from neighbours for use as seed.

Hence, the major objectives of local seed supply systems would be:

- Select appropriate FSV consistent with farmer household food and economic security
- Produce quality seed locally to meet household seed security

At the same time, it is important to note that promotion of seed production as a cash crop requires a clear marketing plan. In this respect, small scale seed crop production does not have the critical mass market potential at the local level to make it cost effective. Such economics of scale have already been referred to as being one of the factors leading to inaccessibility of germplasm. Given this scenario, two new objectives for local seed supply become apparent:

- Development of national and regional local seed supply programmes networks that will be involved in conducting VEVO trials using the same varieties, so as to generate variety adaptability performance maps to give broader geographic entry for the seed.
- Harmonise the regional seed supply legal control framework to create a larger market for seed produced from the informal sector, which often leads to the critical amount needed for meeting limitations of economics of scale.

## VIII.2 Work Plan Sessions: See Section VII.2

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VIII.3 Identification of Demand: See Sections V.7 and VI.4

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VIII.4 Identification of Shortages

Community technology involving farmer-to-farmer consultative meetings at the local level can be used to substitute expensive surveys to determine farmer needs at the end of the second year phase of the programme. The following aspects should be considered:

- Shortages, in particular, at the household level may be identified through quality seed availability at community level and farmer-to-farmer seed exchange dynamics during Seed Fairs of the second year phase of the programme.

- Seed needs will certainly be linked to accessibility of appropriate varieties still not available as defined by the dual phase VEVO trial results, which points to continuation of the programme.
- Preconditions for launching the third year phase of the programme will be determined by some of the following factors:
  - Selling seed to the local or open market.
  - Meeting the seed control regulatory framework conditions for local or regional crop production.
  - Creating the necessary conditions for developing local seed supply system networks that would lead to the critical amount of seed demand, in particular, if the regional seed supply regulatory framework is favourable.
  - Securing assurance of availability at all times of crucial seed sources for basic and foundation seed.
  - Having the right infrastructure for establishing links to key stakeholders in seed supply systems.

## VIII.5 Description of Needed Varieties: See Sections VI.6 and VII.5

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VIII.6 Seed Sources: See Sections III.2.1.3, V.8.3, VI.7 and VII.6

This has already been elaborated on in the section cited. The reader is therefore referred to consult that elaboration.

## VIII.7 Decision on Seed to be Tested and Seed Source

Ultimately, different quality standards may need to be established for different markets:

- If seed is desired for the formal market, stricter standards of quality declared seed may be justified.
- If it is destined for the village market, the sale of less expensive common grade seed may have to be allowed.

However, the decision on the seed to be tested will be reached after the SWOT Analysis of Implementation of the Second Year Quality Seed Supply Programme and Work Planning for the Next Phase of the Programme has been conducted.

## VIII.8 Budget Review of Seed Production Activities

The budget implications introduced in Sections VI.14 and VII.13 and Table 6 suggest that preconditions for developing the third year phase will play a greater role. The profitability of the programme gauged against the costs of transaction at both the producer and consumer level need to be examined closely. This budgeting will include cost centres involving:

- Construction of seed processing facilities and engaging in production of quality declared seed
- Collaboration and contracting out of some local seed supply activities of the programme to seed commodity entrepreneurs.

Stakeholders must think about this very carefully, without losing sight of the need to select preferred varieties through VEVO trials.

### VIII.8.1 Identification of Financial Sources Needed for Seed Production Activities

The programme for sustainability must generate a viable cash flow for programme activities and identify clearly where the money for each activity will come from. Seed production, whether at household or commercial level, has a cost element that must be accounted for. In this regard, programme stakeholders will need to identify the investment agency and consult it before the beginning of the programme.

The intermediary will need to assist the farmers' seed association in developing its capacity for conducting financial negotiations on the open market.

## VIII.9 Trial Site Identification and Preparation

Trial site identification is conducted by the farmers' seed committee, extension facilitator and approved by an officially registered inspector, if there is a need for external marketing of the seed.

Changes in crop management practices need to be made if there is an expectation of achieving a premium price for seed. Without such a premium, the justification for purchasing higher quality source seed, farming isolated fields, applying manure and drying the seed crop, is reduced. Neighbouring farmers seem prepared to pay a premium to gain access to new varieties. However, it is much less likely that any significant number will pay a premium price for 'higher quality' seed of varieties they already own. Correspondingly, most seed producers demand external assistance in marketing their seed crop and such partners need to be satisfied with crop husbandry aspects.

### VIII.9.1 Choice of Site

The VEVO trial sites are decided by the number of participants growing the same crop that are willing to invest in this activity. However, for seed production there are a number of preconditions that will determine site selection:

- Isolation is very important, in particular, for variety genetic purity maintenance and seed for external marketing
- Official inspection and seed unit requirements

## VIII.10 Multiplication Site Identification and Preparation

The elaboration and usage of VEVO trial and Seed Crop Production protocols is covered in years one and two of the local seed supply programme (see Annex IV). Due to seed quality control regulatory aspects, it is important, however, that all participants continue to improve efficiency and accuracy in record and data capture. Furthermore, VEVO trial plot protocols offer local and external trainees of quality seed inspection a good training manual in the practical aspects of crop variety genetic purity differentiation.

### VIII.10.1 Definition of Role of Each Participant

This phase of the programme is crucial for sustainability of local seed supply systems, as it sets the stage for exit of the intermediary, in order for community seed supply associations to assume full responsibility for all administrative and management aspects. It is important for the success of the programme for each participant in the programme to know their exact role (see Section VI.7).

#### VIII.10.1.1 The Intermediary

The role of the intermediary has already been discussed in the manual, but for this phase of the programme, they would play more of an advisory and supportive role, rather than a pro-active one. In this respect, the intermediary needs to monitor and evaluate very closely the training and development of local capacity building in management and administration of seed supply processes.

#### VIII.10.1.2 Community Seed Supply Associations

This local management and administrative structure was planned for at the initiation of the programme to take over eventually from the intermediary, in order for its continued sustainability.

The community seed supply association should be composed of peasant farmer group members who are dedicated to the success of the seed programme, as it calls for self-motivation and willingness to invest both time and resources. The association members should participate in some field activities of the programme from the beginning, so as to understand the dynamics of the processes that govern development of viable local seed supply systems.

#### VIII.10.1.3 Farmer Seed Groups

Local participants for programme activities implementation are drawn from each village. It is important that a group be composed of no less than ten and no more than twenty peasant farmers from each village.

The rationale for this group size is that six group members will participate in VEVO trial plot implementation for each crop in the household food complex. In peasant farming systems, normally three crops are used to meet the household dietary food nutritional needs. In this respect, eighteen farmers would participate in trial implementation, the other two concentrating on local administration of programme activities. Furthermore, the two remaining members constitute the reserve pool of trainees, when the seed group starts concentrating on quality seed production and reduces the number of VEVO trial plot implementers in the third year phase.

### VIII.10.1.4 Extension Facilitators

The role of extension facilitators is explored fully in Sections III.7 and VI.7: their role here does not change, except that they would be co-ordinating and conducting more and more of the training activities by this stage. In particular, the following:

- Monitoring and evaluation of crop agronomic development stages with farmer participants
- Training in determination of 50 % crop grain physiological maturity, harvesting and conditioning, seed grain processing
- Co-ordination of seed crop quality inspections by approved inspectors as already discussed above
- Backstopping activities associated with seed knowledge and information systems transfer and dissemination, such as organisation of Seed Fairs, Farmer Field Schools and Field Days and Farmer Exposure Visits, in collaboration with Farmers' Associations.

Extension facilitators must be aware of changes in the development of the programme, as they normally have the mandate to spearhead agricultural development.

### VIII.10.1.5 Technology Service Providers

At this stage of the development of the local seed supply programme, a number of service technology providers will be necessary to facilitate the integration of all components required for the smooth functioning of local seed supply systems.

***Training Component:*** The training component will be subdivided into a number of parts involving:

- Breeder trainers who will facilitate Field School training in quality seed supply processes covering variety maintenance, characterisation and selection processes in VEVO trials and seed crop production plots, and if there is a felt need in PVB and selection processes.
- Registered Seed Crop Inspectors who will be involved in all aspects of seed certification processes, if there is a felt need for producing Quality Declared Seed. These facilitators will also be involved in training of extension and farmer local seed supply facilitators to become qualified and registered seed crop inspectors. This will enable local seed supply programmes to certify legally their own seed, thereby reducing transaction costs.
- Plant and Crop Genetic Purity Control Inspectors who will facilitate the registration and listing of FSV as national variety control statutory instruments, often required as a precondition for commercial marketing of seed**.** Trainers in construction and equipping of quality seed processing facilities and other infrastructure can be commissioned from the same national public institution to assist seed associations in meeting the correct national standards for seed supply, distribution and marketing.

***Technology Providers:*** There are a number of technologies needed to sustain the viable development of local seed supply programmes activities.

- Basic seed is the major component of improved technology (varieties) needed for initiating seed supply systems. This class of seed is provided by breeders from NARS or IARCs to produce the next generation of seed. However, the same class of seed can also be obtained from local seed variety maintenance plots or PVB programmes, for self or open pollinated varieties of crop germplasm preferred by farmers.

- Seed processing, packaging and testing equipment can be purchased from reputable seed equipment enterprises. Alternatively, the same equipment can be constructed locally. Such technology is a precondition for quality declared or certified seed. Farmers are trained in the use of this equipment by quality seed testing institutions.

**Service Providers**

- IARCs and NARS are often needed to provide identification of farmer varieties through genotype profiling subsequent to Seed Fairs. This service is vital for improving productivity of varieties affected by genetic drift through repeated seed production without careful isolation. Even if the exact variety may not be reproduced, some of the lost traits are often recovered.

Agricultural Commodity Entrepreneurs whose role would be to collaborate with local seed supply and crop grain producers in marketing and quality processing, packaging and distribution.

## VIII.11 M&E Establishment of Fields

Agro-climatic characterisation data as per protocol, yield performance and seed processing data is collected and recorded for analysis by the seed farmer groups and extension facilitators. Once all the data has been collated, it is sent for further national and regional sequential retrospective pattern analysis, exploiting available long-term multi-environmental VEVO trials conducted over the years.

## VIII.12 M&E in Programme Area

The national and regional sequential retrospective pattern analysis provides an opportunity and an objective basis for stratification and grouping of trial sites. The former is based on site similarity according to agro-climatic and variety yield performance.

This analysis is important for delineating agro-ecological domains of crop varieties, which are then mapped. Such mapping assists each local seed supply system to gauge potential market size for each of the crop varieties they wish to produce for the market.

With such information at hand, it is easier for the Community Farmers Seed Association to make decisions to invest in variety:

- Registration and Listing
- Quality Declared Seed Supply
- Construction of Seed Processing and Bulk Storage Facilities
- Own Certified and Official Registered Inspectors

### VIII.12.1 SWOT Analysis and Planning for Next Phase of the Programme

The stakeholders' SWOT analysis consultative programme progress review and planning meeting is conducted, as explained in Sections III.7.5 and VI.3.3.23. However, as the workshop will be dominated by the community seed farmers' associations for the first time, emphasis should be placed on how to enhance sustainability of local seed programmes through appropriate analysis of challenges and threats.

Another important issue worth tackling will be the linkages between local seed associations and the institutions that control seed supply and variety registrations for the fourth year phase of the programme.

The planning session for the fourth year phase of the local seed supply programme will be influenced by preconditions for meeting seed demand. However, as household seed security will still dominate the community dynamic, the use of VEVO trails should be encouraged by underlining that links with service providers should not be broken, in order for there to be continued sustainability of the programme.

## VIII.13 Seeding and Planting: See Sections III.2, III.6 and VI.16

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.14 Seed Crop Husbandry: See Sections III.2 and VI.17

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.15 Monitoring of Variety Booting: See Section VI.19

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.16 Field Days: See Sections III.7.4, VI.3.3 and VI.21

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.17 Harvesting and Conditioning: See Sections III.2 and VI.24

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.18 Harvest Data Collection, Processing and Analysis: See Section VI.25

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.19 Identification and Preparation of Seed Gardens: See Sections III.6, VI.29 and VII.21

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.20 Seeding and Planting of Seed Gardens: See Sections III.6 and VI.29

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.21 Seed Garden Seed Crop Husbandry and Irrigation: See Sections III.6, VI.30 and VI.31

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

## VIII.22 Marketing Seed Products

This has already been adequately addressed in the section cited. However, it is essential that they be followed if the implementation of quality seed supply be success fully realised.

### VIII.22.1 Farmer Exchange Exposure Visits

Farmer exchange visits during this phase are vital for developing links between local seed supply programmes for the creation of seed networks. Such networks are important for identifying logistical problems of seed distribution to distant markets. Furthermore, such networks might lead to collaboration in sharing activity implementation costs in seed production if the programmes are engaged in similar VEVO trials (see also Section VII.25).

### VIII.22.2 Identification of Markets

There are three kinds of markets open to local seed supply systems: markets for household seed security, markets for community seed security and markets for national seed security. The commercial formal seed market often caters for the third market, leaving the former two open for exploitation. The household seed market is often satisfied after the first or second season, hence, the community and international disaster seed markets still remains open for exploitation.

The regional relief seed market has sustained a number of informal quality seed programmes. However, the production of seed for the relief seed market is a risky proposition. This market can be highly lucrative if environmental or manmade disasters continue, but will disappear if there are no such disasters (or related emergencies). However, in general, identification of markets for local seed supply systems requires:

- Planning capacity at the community seed association level.
- Collaboration with commodity dealers to facilitate distribution logistics.

## VIII.23 Seed Fairs: Organisation of Information Exchange

The Seed Fair in the third year phase is another opportunity for farmer exchange exposure visits and finalising logistics for local quality seed supply networks. It is important, therefore, that the Farmers' Seed Association plan visits for its delegates to as many of such Seed Fairs as possible.

Local seed supply associations should take this opportunity to discuss the following:

- Results of the professional analysis of the VEVO trials data.
- Collaboration in implementation of seed multiplication programmes, whereby each association agrees to produce the variety best suited to their agro-ecological conditions, in addition to exchange of those seeds preferred for their crop and variety biodiversity.

## VIII.24 Finalization of Handing Over Process

At the end of the third year development phase of local quality seed supply systems, the intermediary's stewardship should be withdrawn. The community farmers' seed association should assume control of all aspects of programme management and administration, only consulting the intermediary for advice and backstopping on difficult aspects, such as variety registration and contract evaluation.

### VIII.24.1 Implementation of Local Seed Supply Systems through Farmer Seed Groups' Associations

All activities planned for the third year of the local seed programme will be managed directly by Farmer Seed Groups' Associations with the intermediary only playing an advisory role. This phase is critical for training and empowering local farmer structures in management and administration of agricultural projects, which are often influenced by a number of unpredictable variables, such as the following:

- Changes in the environment and the market
- Participant and service provider behavioural dynamics
- Contractual obligations with commodity dealers

- Negotiation skills, in particular with other network members and farmer participants
- Legislative framework in seed supply systems

The implementation of programme activities for the third year phase is illustrated in the TSSWP. The farmers' association will have to monitor and evaluate the programme progress review periodically and make crucial amendments to time frames for implementation, if necessary. Due to land pressure, it might be advantageous for seed of cross-pollinating seed crops to be grown in seed villages. Such decisions can only be taken by the community.

A seed village refers to a village in which all peasant farmers decide to grow one crop variety with the same class of seed, even if some of the crops may not be used as quality seed. The rationale for this is that it obviates the need for great isolation distances, particularly for quality seed for the market and variety genetic purity maintenance. At the community level, such a strategy may contribute to reliable crop rotation, as each village produces a different seed crop.

It is important that decisions about seed processing be made early in the season, in particular, if it has to be contracted out.

All the above activities are summarise in Annex 1, where elaboration has not been supplied in this chapter, section references are given in the Annex 1 Activity Column (*Insert*) to avoid repeating what has already been exhaustively explained previously.

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Training Manual on Small-Scale Quality Seed Production

# Chapter IX

## IX Breeding Multiplication and Production: Activities in Year Four Onwards

## IX.1 Work Plan Sessions

This will be the first work planning session when the Community Farmers' Seed Association will assume full control of the management and administration of local quality seed supply systems in the area, but still with full facilitation by agricultural extension. At the same time, as new aspects of the seed supply process may be added, it is important for invitations to be forwarded to the following:

- Intermediary technical personnel to advise on new training aspects
- Personnel from NARS and/or IARCs to offer guidance on how best to approach new concepts in seed supply
- Seed and grain commodity processors and distributors to offer guidance on quality standards for the market

### IX.1.1 Elaboration of Objectives

The objectives of the programme henceforth will be guided by the need for achieving sustainable rural livelihoods through participatory approaches in agricultural development. The main objectives may then be defined as follows:

- Research continues to take the centre stage, through VEVO trial plots and Participatory Variety Breeding (PVB)
- Sound community-based seed supply management structures for developing linkages with other stakeholders in the seed supply sector are established.

The following sections have been exaustively discussed. Please refer to them for successful completion of the programmes.

IX.2 Identification of Demand: See Sections V.7 and VI.4

IX.3 Identification of Shortages: See Sections V.8 and VIII.4

IX.4 Description of Needed Varieties: See Sections VI.6 and VII.5

IX.5 Seed Sources: See Sections III.2.1.3, V.8.3, VI.7 and VII.6

IX.6 Decision on Seed to be Tested and Seed Sources: See Sections VI.8 and VIII.7

IX.7 Budgeting of Seed Production Activities: See Sections VI.14, VII.13 and VIII.8

IX.8 Trial Site Identification and Preparation: See Sections VII.8 and VII.9

IX.9 Multiplication Site Identification and Preparation: See Sections III.2.2, VI.10, VI.11, VI.27 and VI.28

IX.10 M&E Establishment of Trials: See Section VI.12

IX.11 M&E in Programme Area: See Section VI.13

IX.12 Seeding and Planting: See Sections III.2, III.6 and VI.16

IX.13 Seed Crop Husbandry: See Sections III.2 and VI.17

IX.14 Monitoring of Variety Booting: See Section VI.19

IX.15 Field Days: See Sections III.7.4, VI.3.3 and VI.21

IX.16 Harvesting and Conditioning: See Sections III.2 and VI.24

IX.17 Harvest Data Collection, Processing and Analysis: See Section VI.25

IX.18 Identification and Preparation of Seed Gardens: See Sections III.6, VI.29 and VII.21

IX.19 Seeding and Planting of Seed Gardens: See Sections III.6 and VI.29

IX.20 Seed Garden Seed Crop Husbandry and Irrigation: See Sections III.6, VI.30 and VI.31

IX.21 Marketing and Information Exchange: See Sections VI.32 and VII.25

# Chapter X - Contents

# Chapter X

## X Commercialisation of Small Scale Seed Production

## X.1 Introduction

Commercialisation of small scale seed production refers to the evolution of the informal seed industry to a point where it integrates fully with the formal seed sector. In this way, the national seed industry becomes an integrated sector including both formal and informal seed systems. Hence, commercialisation of small scale seed production presumes the attainment of a certain stage of growth and development of the sector, whereby it begins to produce large quantities of quality seed of improved varieties to meet more than the local demand. That is, enough seed is produced for trade with other districts in the country and even for export to neighbouring countries, using various delivery systems. The informal seed supply can reach a stage where it equals or even surpasses the formal sector in providing quality seed for national and cross-border seed trade. However, for the local seed supply system to grow and mature to such a stage, some basic preconditions need to be fulfilled.

One fundamental precondition for the commercialisation of the small scale seed sector is peasant farmers' awareness of the merits of using improved seed. This requires that in the business of small scale seed production, improved seed as the main agricultural input needs to be promoted continuously, so that peasant farmers become receptive to this message and thereby provide a large market for seed that is essential for the commercialisation of the sector.

### X.1.1 Basic Requirements

Some of the basic requirements for commercialisation of small scale seed production may be discussed under two categories, depending on the target seed market. Commercialisation of small scale seed production may be for national seed security and as the industry subsequently develops, for cross-border trade. This section discusses some of the basic requirements for the growth of the informal seed sector for these two broadly defined markets.

## X.2 Commercialisation for National Seed Security

### X.2.1 Government Recognition of the Informal Seed Sector

Government agricultural policies need to recognise the informal seed sector's potential capacity to contribute to national seed security and its role in the development of this subsector in general, in order for its growth to be successful.

Government seed policy should not only recognise, but also promote the development of the local seed supply system. The emergence of government- and donor-funded small scale seed production programmes as a contribution to poverty reduction in the SADC region attests to the importance of the informal seed sector for seed security. The formal sector is comprised of private seed companies which tend to concentrate on hybrid seed production. This provides an opportunity for the local seed supply system to satisfy a niche market that has not been addressed so far by the formal seed sector: that is, provision of seed and planting material that is self, cross or vegetatively propagated. The recognition of the informal seed sector through legislation and provision of an operational framework may thus strengthen the local seed supply system, leading to its eventual commercialisation.

## X.2.2 Training in Small Scale Seed Production

As already discussed in this manual (*Chapter III-VI*), seed production is similar to crop production in many respects. However, seed production requires training, because in addition to the common practices associated with crop production, seed producers are concerned with field isolation, plant spacing and fertilization for seed production, water management, pollination, harvesting time and methods of drying, storage and quality control.

Small scale seed programs should continue recruiting and training peasant farmers in seed production for the commercialisation of small scale seed production. It is only when a great number of peasant farmers have been trained in seed production and entrepreneurship that the opportunity arises for production of large seed stocks for commercial trade.

## X.2.3 Seed Regulations

The provisions for seed regulation in most countries are enshrined in the Plant Varieties and Seeds Act. This act refers to the official release procedures for varieties and arrangement for seed quality control, as well as the organisational framework required for seed sector development.

The Plant Varieties and Seeds Act should include the recognition of the importance of both formal and informal seed sectors in the delivery of seed, in order for the latter to be commercialised.

### X.2.3.1 Seed Certification

Seed certification is a quality control system for seed production, aimed at protecting the consumer from poor quality seed. It is often an instrument of the Seeds Act or Statute. It is controlled by an official organisation, which in most cases, is a government organisation.

The seed certification scheme also contains the minimum standards acceptable for seed production, harvesting, processing, distribution, and marketing. Thus, certification involves the following aspects: regulated variety maintenance, field inspections, seed sampling and testing for germination, moisture content, seed-borne diseases, physical and analytical purity and labelling of seed packs.

In countries where the informal seed sector has been fully integrated into the seed industry, the Seeds Act provides for the certification of seeds produced by this sector. In Zambia, certification of seed from the informal sector follows the guidelines of the certified seed scheme. The class of Quality Declared Seeds (QDS) refers to seed certification in the informal seed sector. It involves a number of quality control aspects and is produced from formal sector foundation seed which is supplied every year. Released varieties are the main ones used for this class of seed.

The quality control aspects included in the QDS definition are as follows: isolation, field inspection, seed conditioning, seed treatment and packaging. Production of certified seed by the local seed supply system is essential for commercialisation, as consumers will have confidence in the quality of the seed they are buying. This will promote both internal and external seed trade.

Labelling of seed bags is an essential part of a successful seed enterprise. Labels must be both advisory and instructive. Labels must contain the following information:

- Name of variety
- Name of producer
- Germination percentage
- Purity percentage
- Season of production
- Serial number to trace the farmer who produced the seed
- Recommended region of production
- Recommended agronomic information (date of planting, fertilizer rates, etc.)

### X.2.3.2 Legal Requirements of Varieties (Refer to Section VII.24)

Some crop varieties are a product of research and development. Financial investment is needed to develop such varieties. As a result, variety breeders or owners have to recoup their investment through acquisition of legal ownership, licensing multiplication and distribution, in addition to charging fees for variety use. Such fees are referred to as royalties. Farmers, therefore, must know the origin of varieties before multiplication and distribution. The major sources of new varieties are the government (public sector), private sector and international agricultural research centres.

Government varieties are public goods, so no royalties or fees are normally payable for their multiplication and distribution. However, access must be requested for so that responsible institutions can make available breeder or foundation seed. Government varieties are mainly for sorghum, millets, cowpeas, bambara nuts and/or open pollinated sunflower and maize.

Varieties from international agricultural research centres are also regarded as public goods. Access must also be requested to make available breeder and/or foundation seed.

Varieties from the private sector cannot be accessed freely. Breeders own such varieties and intend to recover the cost of producing the varieties. Multiplication of such varieties requires permission from the breeder. A fee charged per unit of seed produced and sold often accompanies the permission.

### X.2.3.3 Regulatory Framework for Variety Registration and Ownership

According to various forms of national legislation on seed production and distribution, varieties for commercial seed multiplication need to undergo prescribed testing and registration for ownership. Testing involves evaluation for value for cultivation and use (VCU) and distinctness, uniformity and stability (DUS). DUS is necessary to ensure that the variety is new. DUS also verifies the following: first, that the variety is different from any existing one on the market; second, that it is uniform for concise description and identification; and third, that it is genetically stable. This ensures that the variety retains its originality. When a variety undergoes DUS tests, it is also subjected to nationwide testing. This is a VCU test to assess the agricultural value of the variety. In this evaluation, the variety is compared to existing varieties and tested across a wide range of agro-ecological conditions to assess the adaptability of the variety. Once tested adequately and established as distinct, uniform and stable, the variety is recommended for release through a Variety Release Committee (VRC).

### X.2.3.4 Variety Release Committee

In some countries, the VRC is a legal body established through an act of parliament. In other countries, the committee does not have legal status but is empowered by government to make decisions on varieties to be released on the market.

The VRC is a multi-sector committee which reviews the DUS and VCU results and the recommendations thereof. The committee consists of breeders, millers, oil expressers (for oil crops), farmers' representatives, extension services personnel, commodity brokers, and representatives from university faculties of agriculture, etc.

If the committee is satisfied with DUS and VCU data, it recommends the variety for release. The variety is then registered for multiplication according to national regulations and standards. However, farmer varieties can also be registered for seed multiplication. Such varieties may not be subjected to DUS analysis. Hence, they cannot be registered for plant breeders' rights under international law.

### X.2.3.5 Plant Breeders' Rights

Plant Breeders' Rights are provided for under an act of parliament. The law ensures breeder ownership and protection of the variety. The purpose of granting such rights is to enable breeders to recover the costs of developing the variety through charging royalty fees. However, the kind of royalty fee charged is a matter for the breeder and farmer, seed dealer or company to settle. Hence, any person wishing to multiply and distribute the variety for commercial marketing must seek authorisation from the variety breeder. The breeder is often referred to as the holder of the variety and is required to maintain the variety in its true form. The holder may also be required to issue licences for multiplication and distribution of the variety. However, farmers who save seed for own use are exempt from the requirement to obtain prior permission. Permission to use the variety for ongoing research is not required either. This implies that farmers who may wish to multiply varieties for commercial marketing must seek information on the following:

- Whether the variety is registered for plant breeders' rights or not

- The conditions or terms of these rights
- The owner of the rights
- The source of parent seed for the variety

Governments introduced special legislation to provide for the protection of breeders' rights. One such legislation is the Plant Breeders' Rights Act. The Act legalises the protection of the variety and anyone breaking this law is subject to prosecution. The Act is an international requirement under the International Convention for the Protection of New Varieties of Plants (UPOV). Hence, national legislation must be compatible with the Convention.

### X.2.4 Decentralisation of Seed Quality Control Services

Some countries in the SADC region have decentralised seed quality control services. This is important for commercialisation of this sector. Zambia's seed policy, for instance, promotes the decentralisation of quality control functions and encourages participation of the private sector in seed quality and certification, through licensing. At the same time, however, the government continues to strengthen its role in monitoring and regulating these services.

The decentralisation of quality control services, such as setting up satellite seed testing laboratories in provincial centres and the licensing of public and private inspectors has increased opportunities for local seed supply systems, by enhancing the availability of supportive seed services.

Other countries, in their recognition of the informal seed sector, have introduced an official logo for the seed sector. The official logo has also provided the opportunity to integrate the informal seed system into the formal retail seed business for accessing bigger markets.

### X.2.5 Support to Local Seed Security

All farmers require that the seed they want is made available in sufficient quantities at the right time and at the right price. In order to improve seed security, some seed programs promote community seed banks as part of the support given to seed production and supply at the household and community level. Small scale seed production programmes should explore possibilities for construction of inexpensive seed storage sheds to improve availability of quality seed at the community level. In districts that have government-owned sheds, ways of using them could be explored. Community seed storage sheds will lead to commercialisation of small scale seed production, in that seed could be produced and distributed to storage sheds in different districts and made available to farmers.

### X.2.6 Linking Informal and Formal Seed Systems

Seed programmes should link seed producers to larger seed and grain markets for farmers. This will assist in creating adequate demand to allow for sustainable seed crop production. Seed programmes could be linked to seed companies which would in turn absorb excess seed produced by the informal seed sector. There have been cases where seed companies have won tenders to supply seed to donor organizations for seed relief. In such cases, companies could enter into contracts with the informal seed sector to produce seed for seed companies. Such mutually beneficial linkages between the formal and informal seed sectors could lead to the commercialisation of small scale seed production and integrate the two seed systems into a viable seed industry.

### X.2.7 Organisational Set Up of the Small Scale Seed Production System

As mentioned above, the informal seed sector is not as organised as the formal sector. Hence, in order for the former to develop into a successful cottage industry, there should be financially viable organisations linking it to an apex body that promotes the growth of this sector. In the SADC region, some countries have promoted the development of seed associations, whose mandates are to facilitate seed production and marketing. In Zambia, the informal seed sector is organized into District Seed Growers' Associations. These Associations are further affiliated to the Zambia Seed Trade Association (ZASTA) as the apex body promoting the growth of the overall seed industry.

## X.3 Commercialisation for Cross-Border Trade

In order for the small scale seed production system to develop to a stage where it is involved in cross-border trade, seed policies and regulations in the SADC region need to be harmonised. The harmonisation of seed policies and regulations within SADC has the potential to encourage the development of a viable cottage seed industry in the region, as well as cross-border trade. Seed can be transported from regions with surplus to regions with deficits, thus leading to the growth of the seed industry in general and a concomitant growth of the informal seed sector in the sub-region.

# Chapter XI - Contents

## Contents - Chapter XI

Training Manual on Small-Scale Quality Seed Production

# Chapter XI

## XI Seed Marketing

### XI.1 Introduction

Farmers need quality seed to be available at the right time and place and at the right price. This seed must be for the required crop and of sufficient quality. Seed supply is achieved through effective marketing and distribution agents. Thus, the purpose of marketing is to provide farmers with high quality seed of the recommended varieties at competitive prices.

### XI.2 Seed Marketing

Seed marketing by Small Scale Seed Enterprises would involve the following:

- Distributing or selling of parent seed to seed growers. Such growers act as extension agents by demonstrating the varieties they grow, allowing other farmers access to their fields for observation.
- Harvesting and processing the seed. Farmers can be exposed to harvesting and processing procedures to allow them to appreciate the efforts invested in producng quality seed and hence the prices charged.
- Making the seed available to farmers in accordance with specific requirements, such as packaging and seed treatment. Farmers buy seed that gives them confidence in the crop they will then cultivate in the field.
- Selling seed to farmers at prices that are commensurate with the quality of the seed. However, seed should not be overpriced or else farmers will resort to other sources, thereby affecting the viability of the small scale seed enterprise.
- Ensuring provision of seed to farmers at the right time, place and required quantities.
- Advising farmers on how to improve production through use of improved seed. Farmers will appreciate and buy seed from a supplier who provides them with technical support in the production process. Thus, small seed producers could compete with large seed companies if they demonstrate the advantages of improved seed to their neighbouring farmers.

However, when marketing seed the following aspects must be considered:

- Accessibility of farmers: this will enable a seed producer to develop a strategy to reach all farmers in the area.
- Types of crops and varieties: farmers may buy seed of the varieties that are close to their traditional types.
- Cultural practices: small seed production systems would normally focus on small grains and be located in the production areas of these crops. Hence, seed must be for crops which can be produced according to existing cultural practices.

- Resource capacity of the farming community: there is no need to produce and distribute expensive seed, if the community does not have the requisite buying power. Production must be based, therefore, on crops that do not require expensive certification procedures, as these will also make seed very expensive.
- Use of retail outlets: there must be retail outlets willing to support the small seed enterprise by selling the seed to farmers without exorbitant mark-ups.

## XI.3 Methods of Seeds Marketing

While large scale seed companies may access mass media for seed marketing, small scale seed enterprises do not have the resources to use such channels. There are simpler and cheaper ways of getting seed information to farmers. Some of the methods that can be used include field demonstration days, seed fairs and community radios.

## XI.4 Field Demonstration

The small scale seed enterprise plants a field with a number of new varieties of different crops. Surrounding farmers and retail agents are invited to a special day once the crops have matured. Visitors are taken around the field and allowed to ask questions, express views on individual varieties and select preferred varieties. Seed enterprises can use such an event to assess popularity of varieties and establish the market potential and seed demand. Procedures for organising a field day are as follows:

- Identify varieties suitable for the market
- Plant the varieties in rows at various locations/sites accessible to the target market
- Apply minimum crop management systems as used by the target market
- Allow the crops to grow to maturity
- Invite farmers in the area and retail shop owners
- Guide visitors through the field and ask for comments on any of the seed varieties
- Invite visitors to choose varieties
- Hold field demonstrations at various sites on different days, unless the seed enterprise has enough personnel to organise it on the same day.

## XI.5 Seed Fairs

Seed fairs are becoming an effective way of informing farmers about seed sources, varieties and crops available in their areas. Seed fairs involve both farmers and seed suppliers, including home-saved seed activities. Seed fairs are organized as follows:

- Identify a central and common market place known and accessible to all farmers and seed suppliers in the area.
- All small seed enterprises come together and agree on a suitable date, preferably a weekend. Surrounding farmers must also be informed, in case they have home-saved seed of unique varieties, which they may want to sell to their neighbours.

- Invite senior community leaders and government officials
- Organize the tables and demonstration materials in rows so that displays are in full view
- Invite all seed suppliers to display their seed in acceptable containers or packages of their choice
- All legible materials should also be in the local language as well
- Invite all farmers in the neighbourhood
- Allow farmers and other visitors to walk through and choose what they want
- Potential sources of seed must also be displayed

## XI.6 Seed Packaging

Packaging can be very costly for small seed enterprises. Hence packaging must be relatively inexpensive but good quality. Most small enterprises use double-layered printable brown paper. The paper is cheap and waterproof. The double layer insulates seed and keeps it at a constant temperature.

Seed must be packed in small packages of 1 to 2 kilograms. Small amounts of 5-kilogram packs can be made available for a small group of farmers who can afford to buy them. Seed packs must be sufficiently labelled with correct information and the key requirement is that labelling is done in English, as well as in the local language.

## XI.7 Extension and Advisory Services

Seed demand depends on effective extension services. This facilitates introduction of new seed varieties. Small seed enterprises must use existing extension services effectively to reduce the cost of marketing, by capitalising on events promoting food productivity. Such days include farmers' price days. Farmers often come in large numbers to such events.

## XI.8 Legal Requirements for Seed Marketing in the SADC Region

Most SADC countries have marketing legislation to protect both buyer and seller. There is a section in the seed law, which stipulates the rights and obligations of all players in the seed industry. In each country, the government has retained control of quality control services to ensure impartiality and objective decisions during quality control procedures. The law also stipulates minimum quality standards for seed entering the seed market. In some cases, the law specifies the packaging material type and sizes. For inter-country seed marketing and sales, there are standard regulations for each country. However, although germination and purity standards vary across countries, there are minimum set standards that are discernable throughout the region. These standards must be followed.

# Annex I - Contents

## Contents - Annex 1

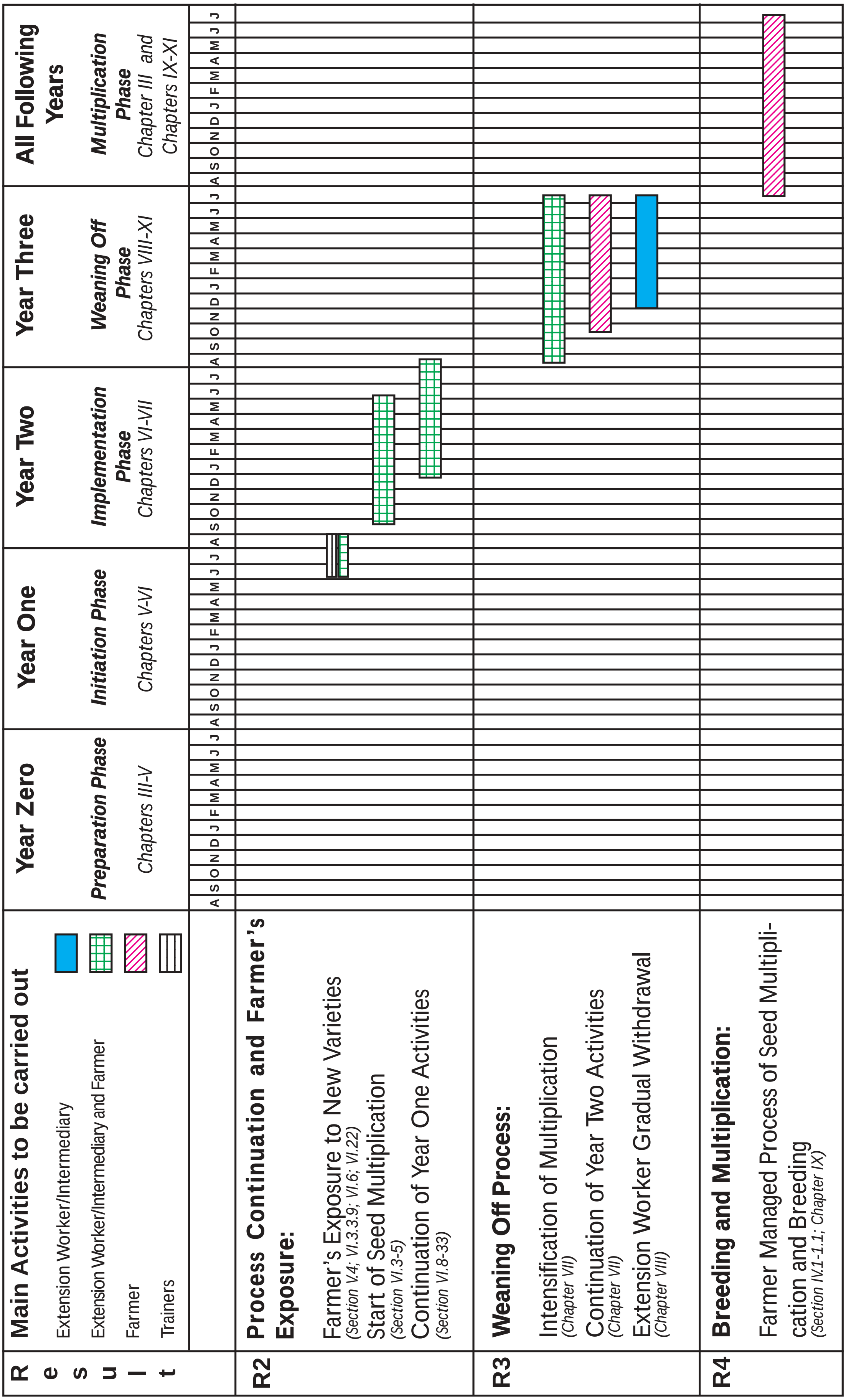
Training Manual on Small-Scale Quality Seed Production

# Annex I

| Result | Main Activities to be carried out | Year Zero | Year One | Year Two | Year Three | All Following Years |
|---|---|---|---|---|---|---|
| | Extension Worker/Intermediary<br>Extension Worker/Intermediary and Farmer<br>Farmer<br>Trainers | ***Preparation Phase***<br>*Chapters III-V* | ***Initiation Phase***<br>*Chapters V-VI* | ***Implementation Phase***<br>*Chapters VI-VII* | ***Weaning Off Phase***<br>*Chapters VIII-XI* | ***Multiplication Phase***<br>*Chapter III and Chapters IX-XI* |
| | | A S O N D J F M A M J J | A S O N D J F M A M J J | A S O N D J F M A M J J | A S O N D J F M A M J J | A S O N D J F M A M J J |
| **R0** | **Training of Trainers:**<br>Enable Extension workers and Intermediaries to Teach the Farmers *(Ch III-V)* | | | | | |
| **R1** | **Small Scale Seed Production Initiation:** | | | | | |
| | Initiation of Seed Production Process *(Section III.2-III.2.1.5; V.2)* | | | | | |
| | Problem Identification *(Section V.8.1-8.2; VI.4-5; VIII.4)* | | | | | |
| | Introduction of New Varieties *(Section III.7.3-7.4.3; V.4)* | | | | | |
| | Monitoring and Evaluation of Varieties *(Section III.1.10; VI.12-13)* | | | | | |
| | Implementation of Seed Gardens *(Section III.6; VI.27-31)* | | | | | |
| | First Seed Fairs *(Section VI.33)* | | | | | |

# Annex I

Training Manual on Small-Scale Quality Seed Production



## Preparation Phase, Training of Trainers

**Result R 0:**

*Training Phase: Training of Trainers*

Legend: Extension Worker/Intermediary; Farmer; Extension Worker/Intermediary and Farmer; Trainers

| Activity No | Activity | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Preparation Phase, Training of Trainers** | | | | | | | | | | | |
| A 0.1 | Background to Breeding Food Crops *(Section III.1.1-1.1.12; V.1)* | | | | | | | | | **Previous Year** | | | |
| A 0.2 | Background to Multiplying Food Crops *(Section III.2-2.15)* | | | | | | | | | | **Previous Year** | | |
| A 0.3 | Agronomic Aspects *(Section III.2-2.2.3.2; V.3)* | | | | | | | | | | | | |
| A 0.4 | Observation Trials and Seed Gardens *(Section III.7.3-7.4.3)* | | | | | | | | | | | | |
| A 0.5 | Community Mobilisation *(Section III.7.3; V.5)* | | | | | | | | | | | | |
| A 0.6 | Training Tools and PEA, SWOT, RRA Tools *(Section III.7-7.5; V.6; VI.3.3.6-8)* | | | | | | | | | | | | |
| A 0.7 | Identification of Demand *(Section V.7; V.8-8.2; VI.4)* | | | | | | | | | | | | |
| A 0.8 | Identification of Shortages *(Section V.8.1-8.2; VI.5; VIII.4)* | | | | | | | | | | | | |
| A 0.9 | Background to the Planning Process *(Section V.9)* | | | | | | | | | | | | |
| A 0.10 | Lay Out of Time Spread Sheet *(Section VII)* | | | | | | | | | | | | |
| A 0.11 | How to Use a Time Spread Sheet *(Section III.1.1-1.1.12; V.1)* | | | | | | | | | | | | |
| A 0.12 | Seed Production Process as Laid Out in Work Plan *(Section IV.2-3; VI.3-3.3)* | | | | | | | | | | | | |

## Year One, Initiation Phase

**Result R 1:**

*Initiation Phase: Small Scale Seed Production Process Initiation*

Legend: Extension Worker/Intermediary; Extension Worker/Intermediary and Farmer; Farmer; Trainers

| Activity No | Activity | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Year One, Initiation Phase** | | | | | | | | | | | |
| A 1.1 | Community Mobilisation *(Section V.5; VI.1-1.1)* | | | | | | | | | **Previous Year** | | | |
| A 1.2 | Train the Trainers Sessions *(Section V.2-6.2)* | | | | | | | | | | | | |
| A 1.3 | Work Plan Sessions *(Section V.9; VI.2.2-3.3.2)* | | | | | | | | | | | | |
| A 1.4 | Identification of Demands *(Section VI.4)* | | | | | | | | | | | | |
| A 1.5 | Identification of Shortages *(Section VI.5)* | | | | | | | | | | | | |
| A 1.6 | Description of Needed Varieties *(Section VI.6)* | | | | | | | | | | | | |
| A 1.7 | Finding Partners in Seed – Seed Sources *(Section VI.7)* | | | | | | | | | | | | |
| A 1.8 | Decision On Seed To Be Tested and Seed Source *(Section VI.8-8.2)* | | | | | | | | | | | | |
| A 1.9 | Formation of PEA Group *(Section VI.9)* | | | | | | | | | | | | |
| A 1.10 | Trial Sites Identification *(Section VI.10)* | | | | | | | | | | | | |
| A 1.11 | Trial Sites Preparation *(Section VI.10-11)* | | | | | | | | | | | | |
| A 1.12 | M & E Establishment of Trials *(Section VI.12)* | | | | | | | | | | | | |

## Year Two, Implementation Phase

### Result R 1:

*Implementation Phase: Small Scale Seed Production Process Initiation*

| Activity No | Extension Worker/Intermediary; Extension Worker/Intermediary and Farmer; Farmer; Trainers | Year One, Implementation Phase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| A 1.13 | M & E of Trials in Programme Area *(Section VI.13)* | | | | | | | | | | | | |
| A 1.14 | Budgeting of Seed Production Activities *(Section VI.14)* | | | | | | | | | | | | |
| A 1.15 | Technical Report to Extension Organisation / NGO *(Section VI.15)* | | | | | | | | | | | | |
| A 1.16 | Planting *(Section III.6; VI.11.2; VI.16)* | | | | | | | | | | | | |
| A 1.17 | Seed Crop Husbandry *(Section III.2; VI.17)* | | | | | | | | | | | | |
| A 1.18 | Variety Characterisation *(Section III.1.10-1.10.5)* | | | | | | | | | | | | |
| A 1.19 | Monitoring of Variety Booting *(Section III.1.10)* | | | | | | | | | | | | |
| A 1.20 | Field School Training *(Section VI.18-19.2)* | | | | | | | | | | | | |
| A 1.21 | Field Days *(Section VI.3.3; VI.24)* | | | | | | | | | | | | |
| A 1.22 | Organisation of Exposure Visits *(Section VI.13)* | | | | | | | | | | | | |
| A 1.23 | Training on Physiological Maturity, Cleaning and Moisture *(Section VI.13)* | | | | | | | | | | | | |
| A 1.24 | Harvesting and Conditioning *(Section VI.22)* | | | | | | | | | | | | |

## Year One, Implementation Phase

**Result R 1:**

*Implementation Phase: Small Scale Seed Production Process Initiation*

| Activity No | Extension Worker/Intermediary; Extension Worker/Intermediary and Farmer; Farmer; Trainers | Year One, Implementation Phase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| A 1.25 | Harvest Data Collection, Processing and Analysis *(Section VI.25-25.1)* | | | | | | | | | | | | |
| A 1.26 | Elaboration of Seed Garden *(Section III.6; VI.29)* | | | | | | | | | | | | |
| A 1.27 | Seed Garden Site Identification *(Section III.6; VI.27)* | | | | | | | | | | | | |
| A 1.28 | Seed Garden Site Preparation *(Section VI.28)* | | | | | | | | | | | | |
| A 1.29 | Planting of Seed Garden *(Section VI.29)* | | | | | | | | | | | | |
| A 1.30 | Seed Garden Seed Crop Husbandry *(Section VI.30)* | | | | | | | | | | | | |
| A 1.31 | Seed Garden Site Irrigation *(Section VI.31)* | | | | | | | | | | | | |
| A 1.32 | Organisation of Information Exchange *(Section VI.32)* | | | | | | | | | | | | |
| A 1.33 | Organisation of Seed Fair *(Section VI.33)* | | | | | | | | | | | | |
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# Year Two, Implementation Phase

**Result R 2:**

*Implementation Phase: Process Continuation and Farmer's Exposure*

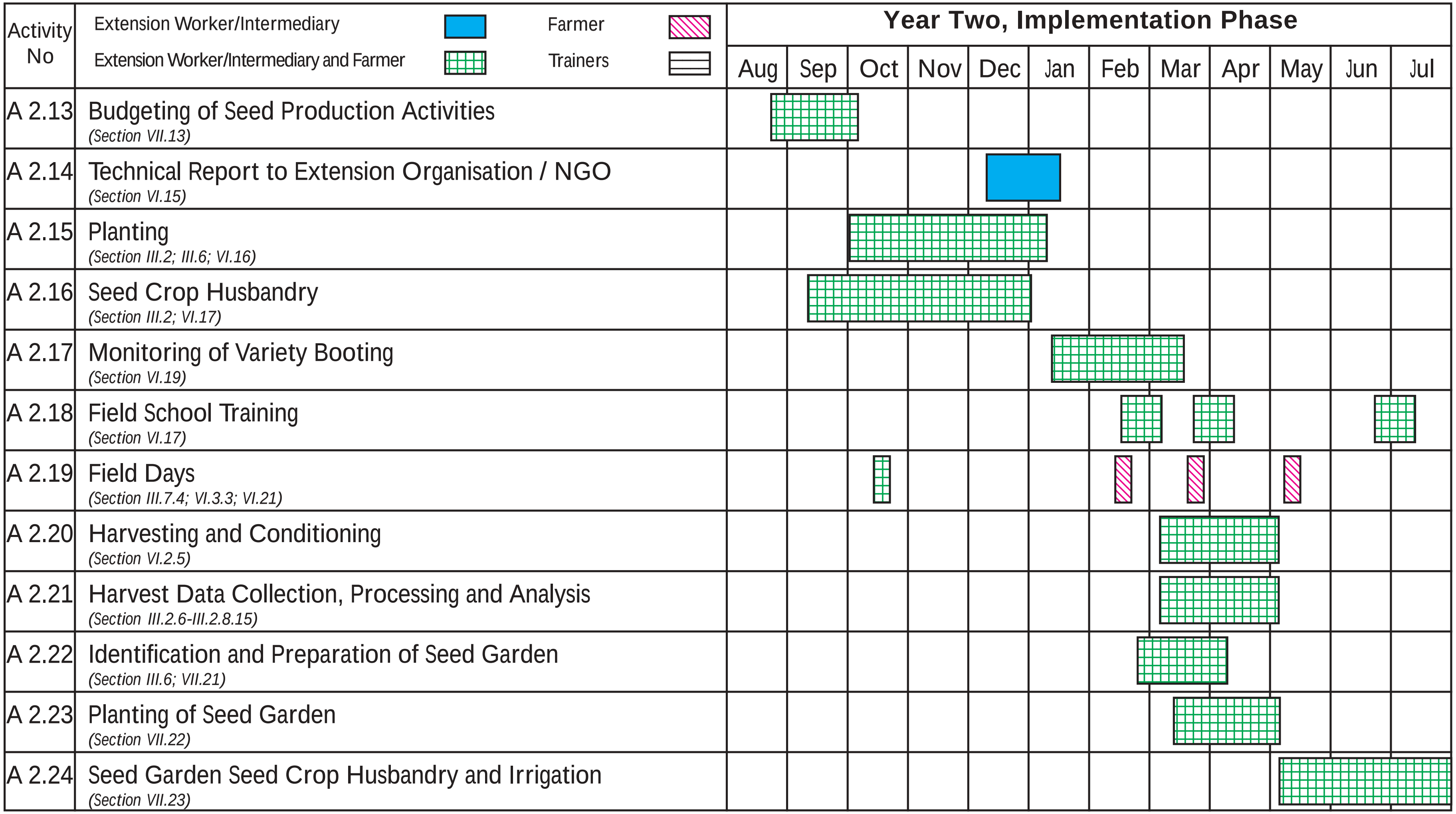
Legend: Extension Worker/Intermediary (blue); Extension Worker/Intermediary and Farmer (■); Farmer (▨); Trainers (horizontal lines)

| Activity No | Activity | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year Two, Implementation Phase | | | | | | | | | | | |
| A 2.1 | Community Mobilisation<br>*(Section VII.1)* | ■ | ■ | | | | | | | | | | |
| A 2.2 | Work Plan Sessions<br>*(Section VII.2)* | ■ | ■ | | | | | | | | | | |
| A 2.3 | Identification of Demands<br>*(Section VII.21-VIII.3)* | ■ | ■ | | | | | | | | | | |
| A 2.4 | Identification of Demands<br>*(Section VII.4)* | ■ | ■ | | | | | | | | | | |
| A 2.5 | Description of Needed Varieties<br>*(Section VII.5)* | ■ | ■ | | | | | | | | | | |
| A 2.6 | Seed Sources<br>*(Section VII.6-VII.7)* | ■ | ■ | ■ | | | | | | | | | |
| A 2.7 | Decision Seed To Be Tested and Seed Source<br>*(Section VII.7)* | | ■ | ■ | | | | | | | | | |
| A 2.8 | Trial Site Identification and Preparation<br>*(Section VII.8-8.1)* | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | |
| A 2.9 | Multiplication Site Identification and Preparation<br>*(Section III.2.2; VI.10-11; VI.27-28)* | ■ | ■ | ■ | ■ | ■ | | | | | | | |
| A 2.10 | Organisation of Exposure Visits<br>*(Section VII.10)* | | | ■ | | ■ | | ▨ | | ▨ | | | |
| A 2.11 | M & E Establishment<br>*(Section VII.12)* | | | | ■ | ■ | ■ | ■ | | | | | |
| A 2.12 | M & E in Programme Area<br>*(Section VII.13)* | | | | ■ | ■ | ■ | ■ | | | | | |

## Year Two, Implementation Phase

**Result R 2:**

*Implementation Phase: Process Continuation and Farmer's Exposure*



## Year Two, Implementation Phase

**Result R 2:**

*Implementation Phase: Process Continuation and Farmer's Exposure*

| Activity No | Extension Worker/Intermediary; Extension Worker/Intermediary and Farmer; Farmer; Trainers | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Year Two, Implementation Phase** | | | | | | | | | | | |
| A 2.25 | Marketing of Seed Products *(Section VI.I.24)* | | | | | | | | | | | | |
| A 2.26 | Official Registration and Listing of Needed Varieties in National List of Varieties for use *(Section VII.25)* | | | | | | **To Next Season** | | | | | | |
| A 2.27 | Limited Clearance from Plant and Genetic Resources Control Authority *(Section VII.26)* | | | | | | | | **To Next Season** | | | | |
| A 2.28 | Application for Official Registration of FSV *(Section VII.26)* | | | | | | | | | | | | |
| A 2.29 | FSV Listing on Recognised National and Regional Varieties for use *(Section VII.26)* | | | | | | | | **To Next Season** | | | | |
| A 2.30 | Organisation of Information Exchange *(Section VII.25)* | | | | | | | | | | | | |
| A 2.31 | SWOT Analysis of Implementation of Second Year Seed Supply Programme and Work Plan for Next Phase *(Section VII.25.1)* | | | | | | | | | | | | |
| A 2.32 | Organisation of Seed Fair *(Section VII.26)* | | | | | | | | | | | | |
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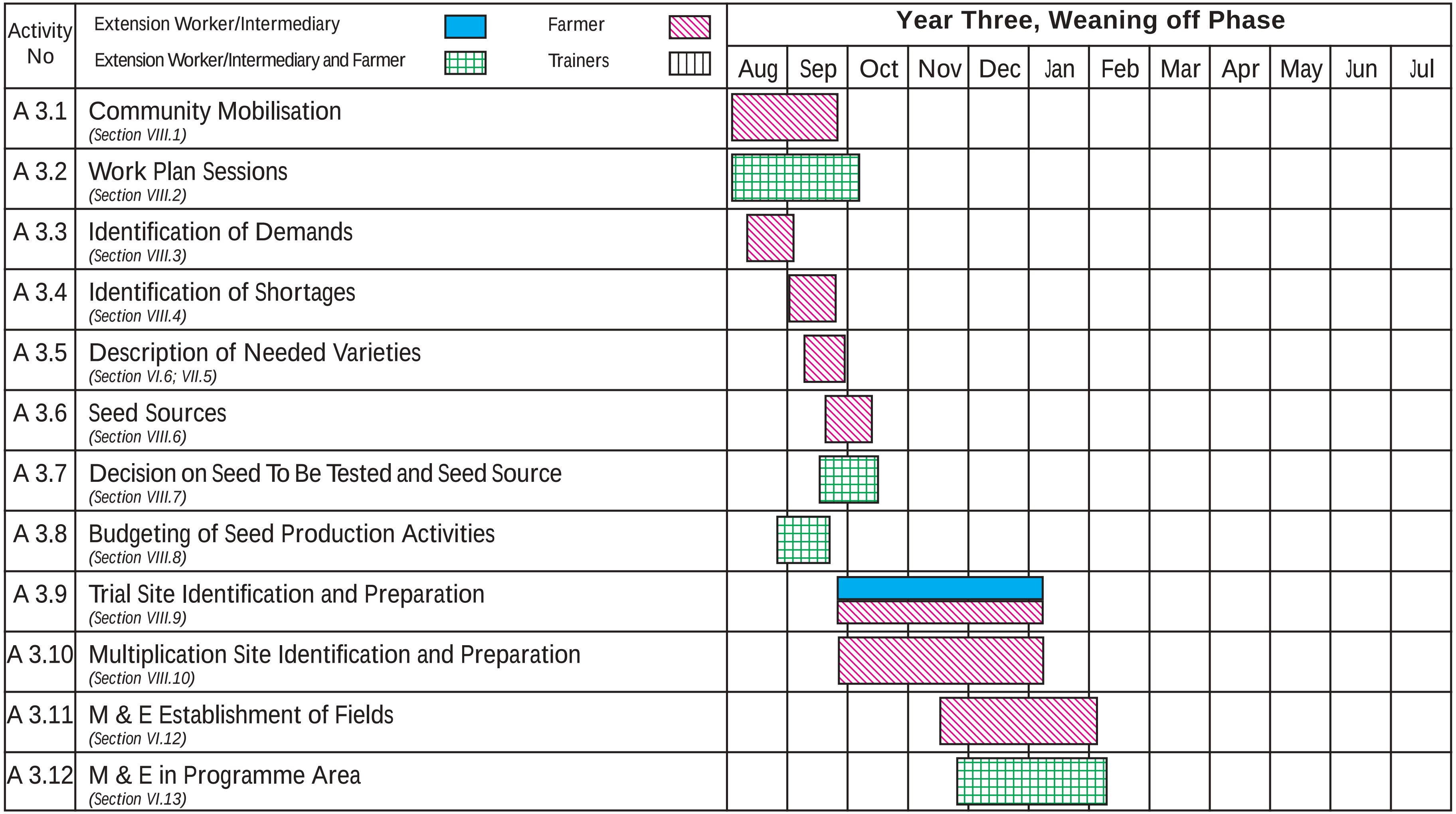
## Year Three, Weaning of Phase

**Result R 3:**

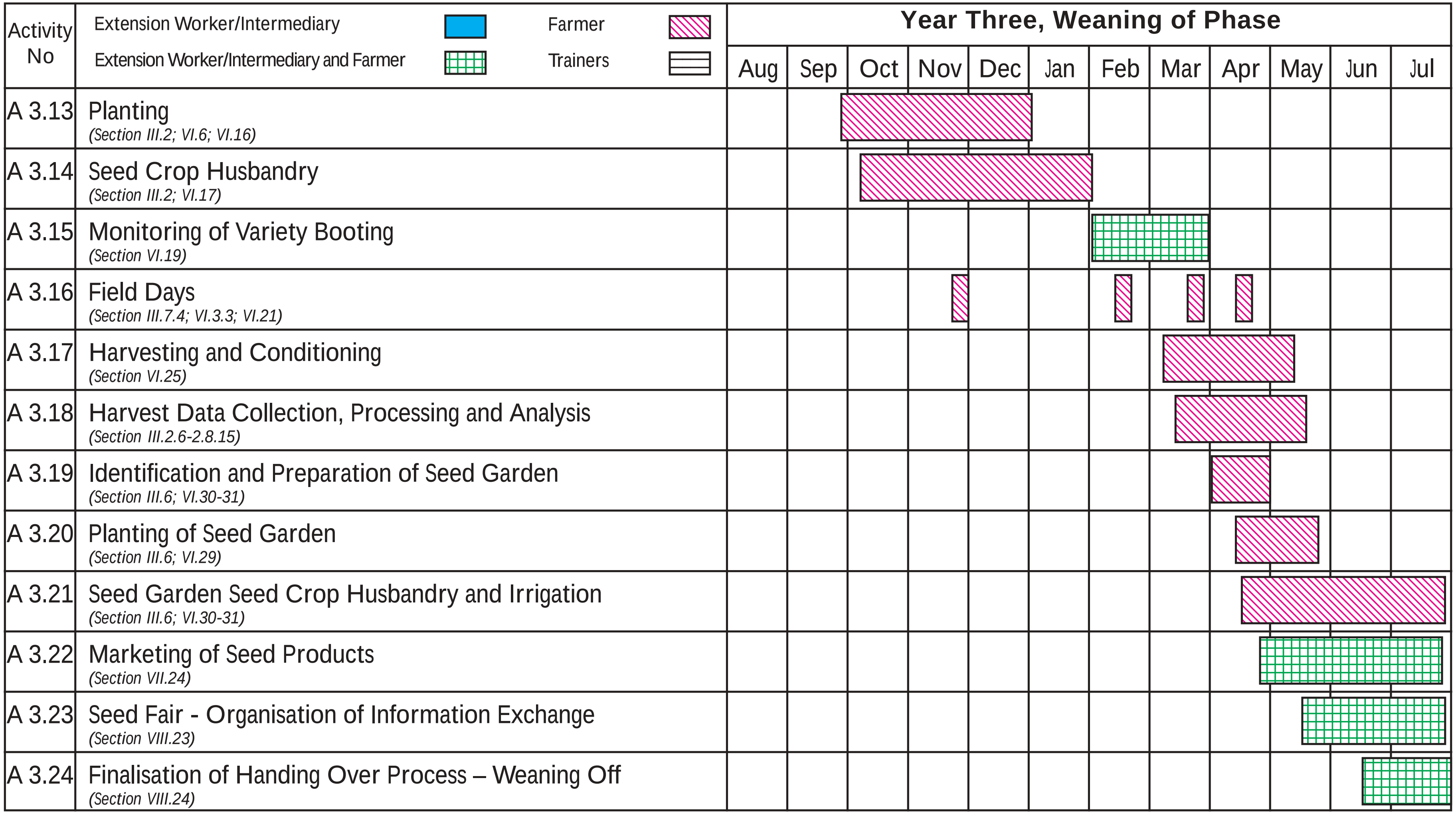
*Weaning off Process:*



## Year Three, Weaning of Phase

**Result R 3:**

*Weaning off Process:*



## Year Three, Weaning of Phase

**Result R 3:**

*Weaning off Process:*

| Activity No | Extension Worker/Intermediary; Farmer; Extension Worker/Intermediary and Farmer; Trainers | Year Three, Weaning off Phase | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| A 3.25 | Official Registration and Listing of Needed Varieties in National List of Varieties for use *(Section VII.24)* | | | **From Previous Year** | | | | | | | | | |
| A 3.26 | Limited Clearance from Plant and Genetic Resources Control Authority *(Section VII.24.2)* | | **From Previous Year** | | | | | | | | | | |
| A 3.27 | Application for Official Registration of FSV *(Section VII.24.3)* | | | | | | | | | | | | |
| A 3.28 | FSV Listing on Recognised National and Regional Varieties for use *(Section VII.24.4)* | | | | **From Previous Year** | | | | | | | | |
| A 3.29 | SWOT Analysis of Implementation of Third Year Seed Supply Programme and Work Plan for Next Phase *(Section VII.25.1)* | | | | | | | | | | | | |
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## Year Four, Breeding and Multiplication

**Result R 4:**

*Preeding and Multiplication:*

| Activity No | Extension Worker/Intermediary; Farmer; Extension Worker/Intermediary and Farmer; Trainers | Year Four, Breeding and Multiplication | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| A 4.1 | Work Plan Sessions *(Section XI)* | | | | | | | | | | | | |
| A 4.2 | Identification of Demands *(Section VIII.3)* | | | | | | | | | | | | |
| A 4.3 | Identification of Shortages *(Section VIII.4)* | | | | | | | | | | | | |
| A 4.4 | Description of Needed Varieties *(Section VI.6; VII.5)* | | | | | | | | | | | | |
| A 4.5 | Seed Sources *(Section VIII.6)* | | | | | | | | | | | | |
| A 4.6 | Decision on Seed To Be Tested and Seed Source *(Section VIII.7)* | | | | | | | | | | | | |
| A 4.7 | Budgeting of Seed Production Activities *(Section VIII.8)* | | | | | | | | | | | | |
| A 4.8 | Trial Site Identification and Preparation *(Section VIII.9)* | | | | | | | | | | | | |
| A 4.9 | Multiplication Site Identification and Preparation *(Section VIII.10)* | | | | | | | | | | | | |
| A 4.10 | M & E Establishment of Sites *(Section VI.12)* | | | | | | | | | | | | |
| A 4.11 | M & E in Area *(Section VI.3)* | | | | | | | | | | | | |
| A 4.12 | Planting *(Section III.2; III.6; VI.16)* | | | | | | | | | | | | |

## Year Four, Breeding and Multiplication

**Result R 4:**

*Preeding and Multiplication:*

| Activity No | Extension Worker/Intermediary; Extension Worker/Intermediary and Farmer; Farmer; Trainers | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year Four, Breeding and Multiplication | | | | | | | | | | | |
| A 4.13 | Seed Crop Husbandry *(Section III.2; VI.17)* | | | | | | | | | | | | |
| A 4.14 | Monitoring of Variety Booting *(Section VI.19)* | | | | | | | | | | | | |
| A 4.15 | Field Days – Exposure *(Section III.7.4; VI.3.3; VI.21)* | | | | | | | | | | | | |
| A 4.16 | Harvesting and Conditioning; Harvest Data Collection, Processing and Analysis *(Section III.2.6-2.8.16)* | | | | | | | | | | | | |
| A 4.17 | Identification and Preparation of Seed Garden *(Section III.6; VII.21)* | | | | | | | | | | | | |
| A 4.18 | Planting of Seed Garden *(Section III.6; VII.29)* | | | | | | | | | | | | |
| A 4.19 | Seed Garden Seed Crop Husbandry and Irrigation *(Section III.6; V.31; VII.21)* | | | | | | | | | | | | |
| A 4.20 | Marketing and Information Exchange – Seed Fair *(Section VII.23; VII.24)* | | | | | | | | | | | | |
| A 4.21 | Initiation of Participatory Variety Breading in Seed Gardens *(Chapter X)* | | | | | | | | | | | | |
| A 4.22 | Official Registration and Listing of Needed Varieties in National List for Varieties Approved for use *(Chapter X)* | | | | | | | | | | | | |
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# Annex II - Contents



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# Contents - Annex 1I

Training Manual on Small-Scale Quality Seed Production

# Annex II

## Annex II    Local Seed Supply Syllabus

### BLOCK 1
**Introductory Activities**

Introduction to Rural Quality Seed Guidelines
Course Overview
What is Seed?
Food Security as a function of Seed Security
Description of Farming Systems
Seed Provision Systems as a Function of Farming Systems
Seed Fairs-Participatory Rapid Farmer Seed Demand Assessment
Country Experiences

### BLOCK II
**Social Technology**

Farmer Seed Production Group Formation
Agricultural Extension Facilitation of Social Mobilisation
Research-Extension-Farmer Group Linkages

### BLOCK III
**FIFM Demo-Plot Trials**

Rationale & Design of trials
Basis of Variety Characterisation
Role & use of demo-plot
Protocol in farming system
Critical data capture
Crop Pollination Types
Crop structure & Pollination Dynamics
VCU farmers' criteria
VEVO trial-plot data analysis
FSV
Seed physiological quality testing
A    in house (Lab)
B    Field (Seed Gardens)

### BLOCK IV
**FIFM Quality Seed Production Processes**

Seed bed selection
Cross-pollinated crops
Semi-self pollinating crops
Self-pollinating & vegetative produced crops
Soil fertility & water management
Rogueing, weed & pest management
Seed Crop Husbandry; Harvesting, Conditioning, Processing & storage
Seed Gardens bulking of FSV off-season for next season

### BLOCK V
**Variety Purity Maintenance**

Isolation in Space & time approach
Off season seed prod in seed gardens
Concept of Seed Villages
Variety viability testing and validation after long term storage

### BLOCK VI
**Seed Regulatory Framework**

Statutory requirements for seed production and marketing
FSV registration and challenges
PVP and Farmers' Rights
Quality Declared and Certified Seed
Truthfully Labelled Seed

### BLOCK VII
**Seed Networks and Exposure Visits**

Linkages between community, national and regional local seed systems for exchange of variety performance data and variety geographic mapping for market opportunities & disaster preparedness
Access & Exchange of Knowledge & Technology
Harmonisation of Seed Regulatory Framework

# Annex III - Contents

# Annex III

## Annex III Variety Evaluation, Verification and Observation (VEVO) Protocol

### To The Participating Farmer

Thank you for agreeing to participate in this Maize variety evaluation, verification, and observation trial. Yours is one (1) out of six (6) other similar trials in your village. It will be greatly appreciated if you and your family were to allow other members of the community to:-

- participate in all (FIELD-SCHOOL) activities recommended for evaluation of this trial
- use this trial as an instruction and observation tool at all convenient times
- sample, after harvest the meals prepared from each variety

This agricultural development programme was designed to empower you and members of your community to be self-reliant in matters pertaining to seed security of this and other crops, in your area.

### The Protocol

There will be six replicates of this trial in your area. It is imperative that you assist by following this protocol very closely so that the results or outputs are comparable to those of your neighbours as much as possible. We would also be grateful if you recorded all the data requested in the tables supplied. You will retain one set of recorded data for your future reference and return the other to us latest by 25 May for analysis and future planning which will require your invaluable input.

### Maize

#### Activities

1. You have been provided with six (6) envelopes labeled A to F. Five (5), that is, A to E have been filled with 150g quality seed of each variety. Please fill envelope marked F with the same quantity of seed of your farmer-saved variety (the variety you are going to plant for your consumption). Please do not worry with scales. Estimate with your eyes and feel for mass with your hand to check whether or not you have the right quantity of seed.
2. Mark out your block, using the dimensions shown in Figure 1, within your crop field. If possible, please do not plant this trial in isolation. It will take only 0,03 ha of your field crop area.

3. If you have a tape measure, mark the distances on a piece of stick or reed. Use this reed thereafter to mark-out your rows. Alternatively, one (1) long stride is nearly 90cm in length.

4. Plant-out the trials, when you are satisfied that the environmental conditions are right for crop establishment. But use rows, do not broadcast the seed. Plant all six rows with one and only one variety. Plant by digging holes 30-50 cm apart, and then plant two (2) seeds per hole. Cover the seed and peg the plot with a label. Close the envelope and put it aside. Each envelope has enough seed to re-plant if need be. Please keep the seed safe, and in its envelop-please do not mix seed, as the trial may fail. The seed may be useful for a repeat planting.

5. Plant each plot, with six rows of the same variety as shown in Figure 2. Please plant each plot individually and keep the envelopes separate after planting using the same procedure of your choice as you did in activity 2 above.

6. Please ensure that the whole trial is planted the same day, under the same weather and soil conditions.

7. Record the date and other inputs in the Data Sheet 1. Please ensure that both tables are completed. Please do not forget to note any treatment you may have independently included e.g. fertilizer application, herbicide treatment, etc.

8. Record the number of days for 50% emergence of the seedlings. Use the two centre rows for this data, for each variety. It is strongly recommended that you consult with other members of your group about this observation, as this is one of the critical factors, which determine the time frame for other important crop characteristics.

9. At the six-leaf stage or when the seedlings are about 20-30cm tall, it is strongly recommended that if the weather is favourable you thin your rows to one(1) plant per station with inter-plant spacing at 30-50cm. Please weed as necessary. Record this date and record any other observations.

10. After 30 days and for the next 10 days thereafter, record (i) male (tassel) and (ii) female (ear/cob) flowering dates (when 50% of the plants have began pollen shed and extruded silk, respectively), and (iii) plant stand count. Use the inner two (2) rows for this data capture. Consult with your group members, neighbours, and facilitator to confirm this data. Record this information for each variety in the trial. [It is advisable that when you have three varieties at grain filling stage you call your facilitator so as to arrange for a tour of all the five trials for ALL the group members. This is also an opportune time for Field-Day planning where a Breeder could be called to your Field School to discuss each variety's traits with your group]

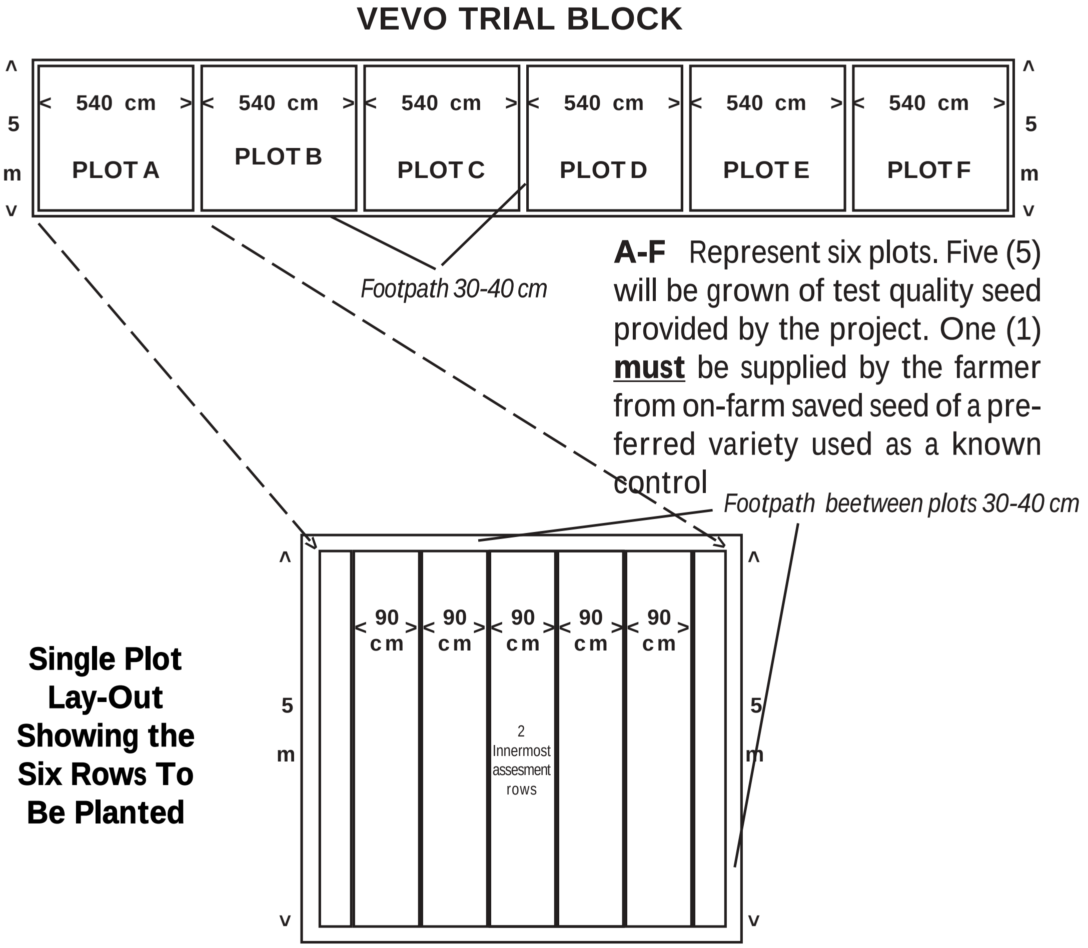
11. The next stage is to check closely when each variety reaches 50% physiological maturity (that is when the grain has passed the dough stage, or when you break it with your thumbnail starch grains freely fall-out or when there is a black layer at the hilum). For this exercise it is recommended that you use the two outer-most rows. Further, you will need the assistance of your facilitator (agricultural extension officer) for this activity. Record this date or number of days from crop emergence to this date. Do this for every variety as they reach this stage.[A Group Field-Day is recommended just before all varieties reach this stage]

12. Ten (10) to fifteen (15) days after each variety has reached physiological maturity, harvest the ripe cobs, and condition them in a rack or crib. Record this day. Keep each variety separate, especially all the cobs from the centre two rows. Please harvest the variety as soon as you are satisfied that all the plants have attained 50% physiological maturity and have attained grain moisture content of about 30-35%.

13. Rank each variety according to your criteria of preference. Record this first (1st) ranking.
14. After the crop has dried, select the cobs (one or two) you think are representative of what you prefer about each variety. Note this in your observation sheet. Keep these cobs for the Seed-Fair. Then thresh the grain from the outer four-(4) rows. Take a sample of this, about five (25) spoons and keep it as seed for the Seed-Fair. Label it correctly. Keep the grain of each variety separately and labeled.
15. Process the grain of each variety separately and prepare meals with it. Record the varieties you prefer according to taste based on a variety of food or beverage preparations. You could pool your harvest with others for these palatability trials Your group's preferences are more valuable than yours alone. Rank your varieties again based on this criterion.
16. Store the grain of each variety in you traditionally store. Rank the varieties again. Now you need to discuss the merits of each variety with your group, neighbours and community. Make a final ranking to arrive at the ranking of each variety based on the opinions of as many community, family, or group members as possible. Record your final and third ranking consolidating all your observations.
17. Please record rainfall figures or incidences as they occur. The days of rainfall are important as much as the quantity. Please record the rain on your crops rather than in your homestead if possible. Mark this is Table 3
18. Please hand-in your data sheets to the facilitator. Remember to keep your own data from this trial. Last day of data collection is 15 June.

Thank you for your co-operation and assistance. Remember this is your trial and your results. The analysis of the data will be completed with you sometime in July. You will be advised as when to continue this exercise with you again. You data will assist in determining the Farmer Selected Varieties, which meet the variety diversity of your preference.

THANK YOU.




**A-F** Represent six plots. Five (5) will be grown of test quality seed provided by the project. One (1) **must** be supplied by the farmer from on-farm saved seed of a preferred variety used as a known control

*FIFM variety evaluation and observation trial plot with a a farmer's crop*

The thick black lines are planted rows of the test variety

ü Only the **two-(2) innermost** rows are used for evaluating for all characteristics of the variety and seed-saving (but not recommended for open pollinated varieties). The other four (4) rows are discards to be used for testing other traits like taste, milling and shelling ration, processing, seed quality testing, training and storage

*Figure 1 Variety Evaluation and Demonstration Trial Block - Single Plot Lay-Out Showing The Six Rows To Be Planted*

| Soil Type | Clay | Clay -Loam | Loam | Silty -Loam | Sandy | Sandy -Loam | Other Specify |
|---|---|---|---|---|---|---|---|
| Potential Root Growth Penetration (cm) | 30 | 50 | 75 | 90 | 100 | | |
| Soil Moisture at Planting | dry | moist | wet | | | | |

*Table 1 Soil Characteristics (please tick where appropriate)*

| Month | S | O | N | D | J | F | M | A | M | J | J | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No of days It rained * | | | | | | | | | | | | |
| Total (mm) | | | | | | | | | | | | |

*Notes*

- Please indicate Number of days it rained and intensity (h) heavy; (m) medium (l) light

*Table 2 Rainfall Data and Frequency Profile*

**The information data capture and procedures for laying out FIFM variety evaluation and observation plots relating to opv maize FIFM trial block.**

## DATA SHEET-1

**Please Return to Facilitator before 25 May**

Farmer's Name__________ District__________ Village__________ Chief__________

Extension Agent's Name__________ Supporting NGO's Officer name__________

| Variety | No of Days to 50% Crop Emergence | No of Days to 50% Tasseling | No of Days to Pollen Shed Initiation | No of Days 50% Silk Production | Period of pollen shed in days | No. of Days to 50% Physiological Maturity | No. of Days to Harvest | Plant Height in cm | Yield in kg of grain at 12% moisture content from 10 cobs chosen at random | Colour Of Grain At Maturity | Type of Grain |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |

**Note:**

- All periods are determined from the day the plot is observed with 50% plant emergence, except for pollen shed which is calculated from the day pollen is first shed to the day it stops
- Data from the shaded areas need to be accurately recorded as it occurs. Avoid filling in using memory. If not filled in, as it occurs you better leave it blank

# Annex IV - Contents

# Annex IV Pilot Seed Crop Production Scheme

## To The Participating Farmer

Thank you for agreeing to participate in this Farmer Selected Variety (FSV) quality seed multiplication programme. Yours is one (1) out of four (4) other similar programmes, but each farmer may produce different crops and/or varieties, in your District. It will be greatly appreciated if you and your family were to allow other members of your farmer's group were to:-

- participate in all (FIELD-SCHOOL) activities recommended for training in quality production of this crop,
- use this crop as a demonstration of the concept of local quality seed crop production for household seed and food security
- obtain enough seed of this variety after harvest, enough to plant 0,5 ha, should they fully participate in all activities for the production of the crop.

This programme is designed to assist your community in:-

- empowering them to have access to technology, information and knowledge related to rehabilitation and or restoring quality seed to improve your crop productivity through crops and varieties of your own choice,
- enhancing the availability of biodiversity in both crops and varieties at family level as a drought and poverty mitigation strategy through products of your preference
- enhancing the ability of each farmer group member to be seed-secure through having access to both quality seed and preferred crops biodiversity easily, and timely at affordable price, through local seed exchange mechanisms.

## The Protocol

This programme will follow a strict participatory research and extension approach (PRE) in its implementation, if it has to achieve the desired objectives stated above. For this to work, you have to accept the risks and responsibilities entailed in being a pivotal point of an agricultural development effort. There are three groups of stakeholders who will be involved in this PRE approach to seed crops variety production and development programme, namely:-

1. Your family and other farmers selected to multiply seeds
2. The host families for the variety evaluation and demonstration trials in your area
3. The community of which you are part of

**THE PROGRAMME OWNERS**

4. The Facilitators (Public Extension Services, Rural Dev. Agencies NGOs & Donors) — **PROGRAMME FACILITATORS**

5. The National Agricultural Research Systems (Breeders, Agronomists)

6. The Commercial Trade Centre — **SERVICE PROVIDERS**

We would be grateful if you were to fully cooperate with all the facilitators of this programme. An integrated participatory approach to_local quality seed systems would follow the steps listed below:

A. Land Preparation and Crop Establishment

B. Seed Crop Management

C. Seed Crop Harvesting and Seed Conditioning

D. Seed Processing and Storage

E. Seed Exchange and Variety Diffusion

## A. Land Preparation and Seed Crop Planting and Establishment

This is divided into choice of the field, tillage, choice of seed, timing of planting and plant density. This section concentrates on the activities that supplement good local crop production practices in order to favour the production of quality seed.

### 1. Choice of the seed field

The plot for seed selection has to be chosen carefully. The land should be able to produce a good crop, because weak crops will produce poor quality seeds. Fertile well-drained soils with optimum water supply should be looked for. We recommend that a 'Seed Garden' near the homestead be established (Figure 11), this should be well fenced. This will enhance your management of the crops.

**Rotation:**

This is critical in quality seed production for the following reasons:

- avoidance of disease build-up of seed-transmitted diseases in the soil and previous crop residues.
- avoidance of varietal mix from volunteer plants which may emerge

**Isolation:**

This is very important when growing modern varieties where accidental contamination from the pollen of another crop may affect the quality of the final product and reduce its value.

- For all cross-pollinated crops like pearl millet and maize, another variety or rogue plants must not be less than 400m, or more, from the seed crop
- For all semi-cross pollinated crops like sorghum, or bambaranuts or pigeonpea, a distance from another variety or rogue plants must not be less than 100m, or more, from the seed crop

- For mainly self-pollinating crops like cowpea, or groundnut or field beans, soybeans, and vegetatively propagated plants like sweet potato or cassava a distance from another variety or rogue plants must not be less than **5m,** or more**,** from the seed crop. However, if a diseased old variety is involved, the isolation distance should be no less than 800m from the seed crop to avoid insect transmission

Staggered planting can achieve the same results where pollen contamination is the main risk. However, risk of disease contamination can only be alleviated through distance isolation.

*Lines of Responsibility.*

| | |
|---|---|
| Field selection and inspections:- | The farmer (s) and Facilitator (Agricultural Extension Officer) |
| Isolation and Rotation inspection:- | The Facilitators |

## 2. Tillage

Proper land preparation is important. Early ploughing is recommended as this may stimulate weed growth. When this is followed by harrowing just before planting, a lot of weeds and volunteer plants which may compete with the crop for nutrients, are likely to be destroyed if they had germinated. Final land preparation of the seedbed is necessary to give the crop an even germination, this is critical for identifying off-types and disease can easily be spotted.

*Lines of Responsibility*

| | |
|---|---|
| Land preparation and inspection :- | The farmer(s) and/or group members |

## 3. Source Seed

The quality seed to plant 0,5ha will be supplied, already packed, and properly labeled, in the first instance by the facilitator. Subsequently, you will be responsible for the provision of source seed for two to three seasons. After three seasons you will be required to purchase new source seed from the Facilitators or NARS

*Lines of Responsibility*

| | |
|---|---|
| Access to quality seed:- First year :- | Facilitator (Donor, NGOs or Public Extension) |
| Subsequent Years :- | You and Your Group |

## 4. Timing of Planting

Early planting, with the onset of rains, is recommended to produce a strong crop and to reduce pest and disease incidence. However, here it is strongly suggested that:

- Local knowledge be used to best advantage in planning the planting to facilitate harvesting during dry periods (refer back to data of variety evaluation trials especially time-frame to physiological maturity of varieties you are growing)
- Should planting be later than the main crops to optimize the dry spells during harvesting, to avoid contamination, planning for planting should rely on average flowering periods of the varieties being grown.

*Lines of Responsibility*

Planting::- Local community knowledge (local seed) specialist and data from previous seasons on time-frame for flowering and maturity (Facilitators or VEVO trial Paticipants)

### 5. Plant Population

In seed production plant population is important; this is a function of the number of plants (i.e. number of seeds planted x plant emergence) and the area (number of plants/unit area). Usually the lower the seed plant population compared to food plant population is recommended. The reason for having a lower plant density is that:

- Wider spacing between plants and row width can decrease disease incidence.
- Wider spacing also permits the sun to reach most plant parts inducing stronger plant growth and allows for quicker drying of seed

However, with plants that tiller, it is advisable to do the reverse of these recommendations to allow the crop to mature evenly (Table 1)

*Lines of Responsibility*

Plant population :- Facilitators (Extension services or agronomist)

## B. Seed Crop Husbandry and Management

Seed crop management is one of the most important factors in quality seed provision systems.

There are three elements, which will require particular attention:

- disease, pest and weed management
- variety purity maintenance
- recording important agronomic and weather data which may have implications for quality seed production in your area

### 1. Disease, Pest And Weed Management

Please scout the crop at regular intervals for disease and pest outbreaks. Should there be any sign of disease or pest outbreak, without fail consult with your facilitator. Some diseases can be seed-borne timely intervention can save the crop.

Maintain your seed crop weed-free. Weeds if left unattended may compete for nutrients with the crop and might be reservoirs for pest and disease which reduce seed quality.

*Lines of Responsibility*

Disease, pest and weed control:- Farmer with guidance from Facilitators

## 2. Variety Purity Maintenance

Variety purity maintenance has serious implication for all processes related to local seed provision systems, namely availability of;

- quality seed for crop production,
- quality seed for seed crop production in subsequent years and quality consistency for commercial trade.

It is imperative that you are fully conversant with the growth characteristics of the crop or variety you are producing for seed. Therefore, you need to:

a) Thoroughly scout for plant off-types (plants which do not conform to the basic structure of the majority of the plant population), rogue them out (remove them entirely) before flowering.

b) Tag (tie a cloth round) any plants which flower a week earlier than the rest, you may need to harvest these separately, if dealing with self-pollinating crops

c) Plants, which remain far too behind in flowering-, rogue them out in cross-pollinated crops. For semi-cross pollinating crops rogue up-to 1/10; for self pollinating varieties tag all these off-types and harvest them separately as they are likely to be different varieties which may be bulked independently.

d) Check very carefully for the time frame from crop emergence to 50% seed crop flowering. If the variety is stable the flowering should range from 50 to 100% flowering within 7-days if crop emergence was even. Any plant flowering after this period is a rogue.

e) For those crops with proper flowers like cowpea, groundnut, and bambaranut, flower colour is a prime characteristic for variety identification. It is however important to observe flower colour early in the morning or late in the evening as some flower colours change due to light or heat intensity. Tag all those plants with different colours for self-pollinating crops. However, for bambaranuts there are two alternatives, namely:

   - if you are interested in seed availability, do not rogue
   - if you are interested in variety purity, rogue-out all off-types

f) Note the time-frame for 50% physiological maturity of the crop, rogue-out any off-types still in flower

g) It is important for you to host a Field-Day to demonstrate your crops. Please give two months notice for the trade and other visitors to prepare for this activity

*Lines of Responsibility*

| | | |
|---|---|---|
| Genetic Purity:- | I. Seed availability:- | Farmer and Group members, Facilitator |
| | II Variety Purity:- | Facilitator (breeder and Extension) and Farmers |

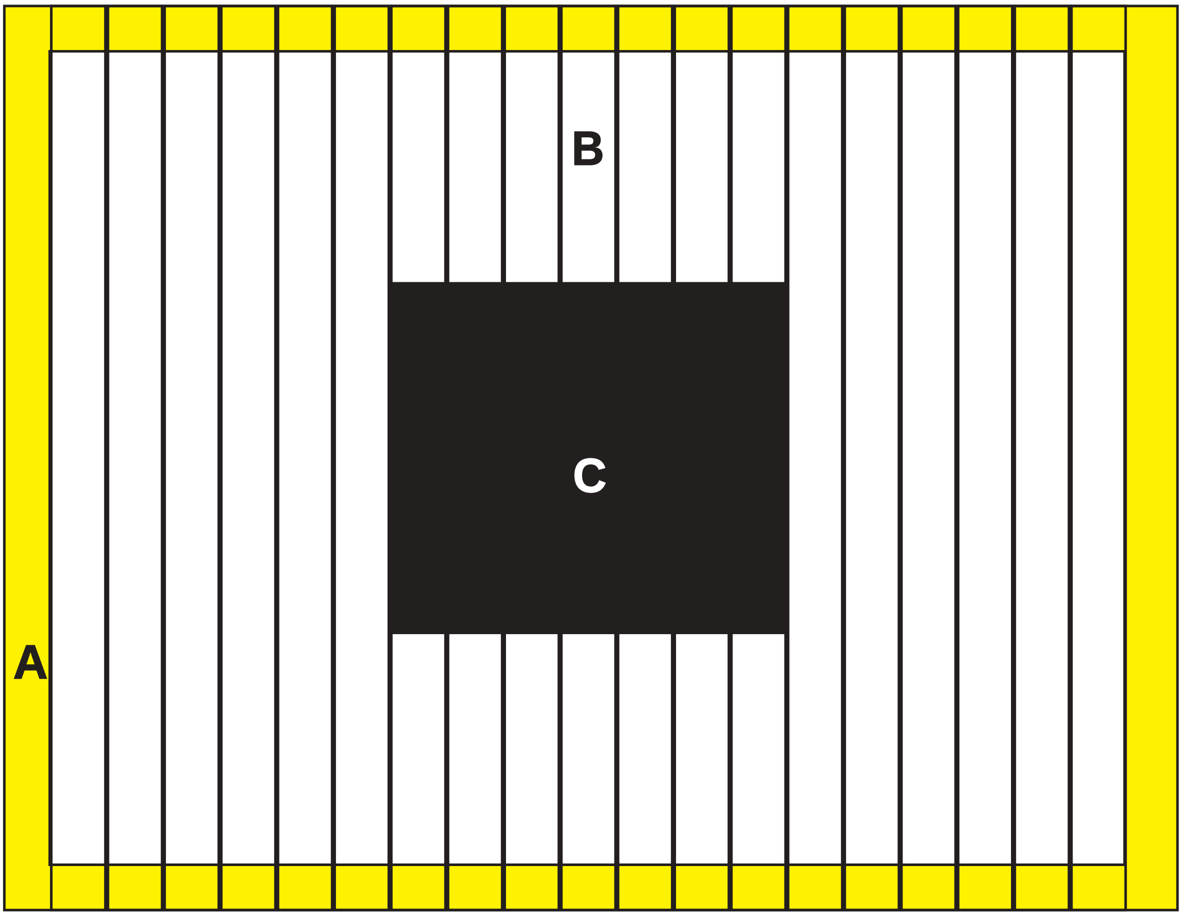
### 3. Recording important agronomic and weather data which may have implications for quality seed production in your area

It is important to keep records for all important agronomic data and weather patterns. Record these in the tables provided.

*Lines of Responsibility*

Data Capture:- Farmer and On-Site Facilitators (Extension, NGOs)

**Figure I** Recommended Seed-Crop Harvesting Format




Notes:

**A** 1-5 meters of seed crop area to be discarded for food consumption. Do not use as seed

**B** All this crop area to be harvested for seed after the obvious rogues have been completely removed

**C** Variety maintenance block. This must be harvested first, and piled separately from the rest of the harvest. After roguing in the field, only diseased ears should be selected out.

## C. Seed Crop Harvesting and Seed Conditioning

Harvesting and Post-Harvest activities have strong effect on seed quality. Harvesting of all crops should be done no more than 20 days after the crop has reached physiological maturity to reduce weevil infestation in the field. There is a temptation to leave the crop to dry in the field, still on its stalks. But this is not recommended for quality seed supply. Figure II indicates areas for harvesting all classes of seed.

Each class of harvest should be kept separately, in particular class C in the centre of the field should be nearly genetically pure.

a) In cross-pollinated crops like maize or pearl millet, all cobs, panicles etc. within this area should be considered as the plant population which constitute the variety. Please do not take only large ears as this may result in genetic drift through selecting out some varietal traits.

b) In self-pollinating crops, both genetic and sanitary quality will be well maintained if the centre population of the crop is harvested separately

### Conditioning

After harvesting, air-dry the harvest in a rack or crib or on hard ground on a large polythene sheet or thoroughly cleaned and sown-together fertilizer bags (make sure the grains do not get in contact with the fertilizer). Make sure if the seed is on the ground that it is turned with a fork every couple of hours. These seed drying structures should be positioned in such a way that they can be covered quickly to prevent rain soaking.

The advantage of polythene sheets is that, should it start raining the polythene sheet can be rolled-over to completely cover the seed. Further, even with a crib or rack the seed can be quickly covered with a large polythene sheet.

For all seed, continue drying until the seed attains 12% or less moisture content before processing.

For variety maintenance seed, the traditional hanging of seed in their cobs or panicles in inside traditional kitchen eves may offer the best conditioning of the seed before threshing for storage. Please do not mix the variety maintenance seed with any other class of seed.

*Lines of Responsibility*

| | |
|---|---|
| Harvesting:- | Farmer and On-Site Facilitators (Extension, NGOs) |
| Conditioning:- | Farmer |

## D. Seed Processing and Storage

These processes are critical for both seed viability (remaining alive), physical purity (only seed of the crop in question minus other seed or inert matter) and vigour (capacity to produce a strong, healthy and normal seedling). Therefore, processing of seed and storage are critical for both the physical (integrity) and physiological (functional) properties of the seed.

**Processing.**

Seed for trade of cereals is better sold threshed. Use the traditional methods for threshing and winnowing the seed. This process is suitable for beans, cowpea, and pigeon pea as well.

Seed grain is best treated immediately after threshing. Use you local pesticide preparations. Seed of groundnuts and bambaranut is best kept in the pod. Even seed for cereals and other crops if its for household use is best left unthreshed but be kept in the traditional kitchen eves. However, check this seed for pest infestation at regular intervals.

**Storage.**

- **For household use**:- Keep enough seed to plant twice the intended crop production area in a traditional seed store. This should include seed for trade.
- **Stock-Seed**:- Keep the variety maintenance seed in an air-tight container. Keep enough to plant twice the area you require for seed-crop production. Cover the top layer with a pesticide before sealing the container. Store seed in a cool place.
- **Strategic Reserve**:- For both variety maintenance and common seed, long-term seed storage is required. Put treated seed enough to plant 0,2 ha and 0,5ha of variety maintenance seed-crop and common consumption crops respectively in a bottle or airtight container. This seed must be stored separately and in a cool area from other seed stores. A seed-bank maybe a good area if it exists. This seed is only used in emergencies and should be replaced every season with new seed. If the variety is not produced at field level, this seed must be tested every two years in a special seed-plot where seed crops are produced to regenerate the crop or variety.

*Lines of Responsibility*

| | |
|---|---|
| Processing:- | Farmer |
| Storage:- | Farmer |
| Pesticide:- | Farmer-Facilitator (Seed technologist) |

## E. Seed Exchange and Variety Diffusion

This programme was designed for diffusing technology (new varieties and seed production), Knowledge (quality seed processes) and Information (enhancing access to germplasm) using a participatory approach. All stakeholders are cognizant of the potential transaction costs involved in this programme. Therefore, the bulk of the seed and all the stock-seed will remain part of your property as a reward for your family, you can trade in it as you wish. However, for every crop and variety supplied by a seed project, it is conditional that to meet the objectives of the project, you as the host must:-

1. Declare your yield after harvest of the entire crop, your trade seed and your variety maintenance seed. This will assist the facilitators to tailor similar programmes to meet requirements of other communities
2. Give all active group member participants enough quality seed from this production to cover 0,5ha of a normal crop. This is dependent on the harvest of course. But to diffuse the variety and achieve household seed security this is imperative. Further, it is important for commercialization of the variety as the trade needs large quantities of a uniform product

3. Receive seed enough to plant 0,5ha of a crop from other participants in your area who may have produced different crops and/or varieties to increase your own crop and variety biodiversity.
4. participate in farmer to farmer extension for information and technology transfer at local level
5. We would appreciate your services if you were to participate in the Local Seed Fair and Display your crops and varieties fully labeled. This will be your seed advertisement avenue and we would be grateful if you described your activities during such fairs so that the commercial and local traders may get an impression of what is available for the next season

*Lines of Responsibility*

| | |
|---|---|
| Seed Distribution: - | Farmer and Facilitator |
| Exchange: - | Facilitator/Seed Fairs |
| Seed Fair | Community/Groups |

**Table 1** Recommended Planting Distances for Seed Multiplication

| **Crop** | Recommended Spacing For A Seed Crop (cm) | |
|---|---|---|
| | Inter-Row | Inter-Plant |
| **Bambaranut** | 50 | 30 |
| **Cowpea** | 50 | 20 |
| **Groundnut** | 50 | 30 |
| **Maize** | 90 | 40 |
| **Pearl Millet** | 90 | 30 |
| **Sorghum** | 90 | 40 |

**Table 2** Rainfall Data and Frequency Profile

| Month | S. | O. | N. | D. | J. | F. | M. | A. | M. | J. | J. | A. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No of days<br>It rained * | | | | | | | | | | | | |
| **Total (mm)** | | | | | | | | | | | | |

Notes

- Please indicate Number of days it rained and intensity (h) heavy; (m) medium (l) light

## Major Activity Diary

(Please Return this Form)

| DATE | CROP | COMMENTS |
|---|---|---|
| Planting | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| DATE | CROP | COMMENTS |
|---|---|---|
| Emergence | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| DATE | CROP | COMMENTS |
|---|---|---|
| Field-Day | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| DATE | CROP | COMMENTS |
|---|---|---|
| Seed-Fair | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| DATE | CROP | COMMENTS |
|---|---|---|
| Seed Distribution | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# DATA SHEET-SEED MULTIPLICATION

**Please Return to Facilitator before 25 May**

Farmer's Name__________________________ District_______________ Village_____________Chief________________

Extension Agent's Name_________________________ Supporting NGO's Officer name_____________________

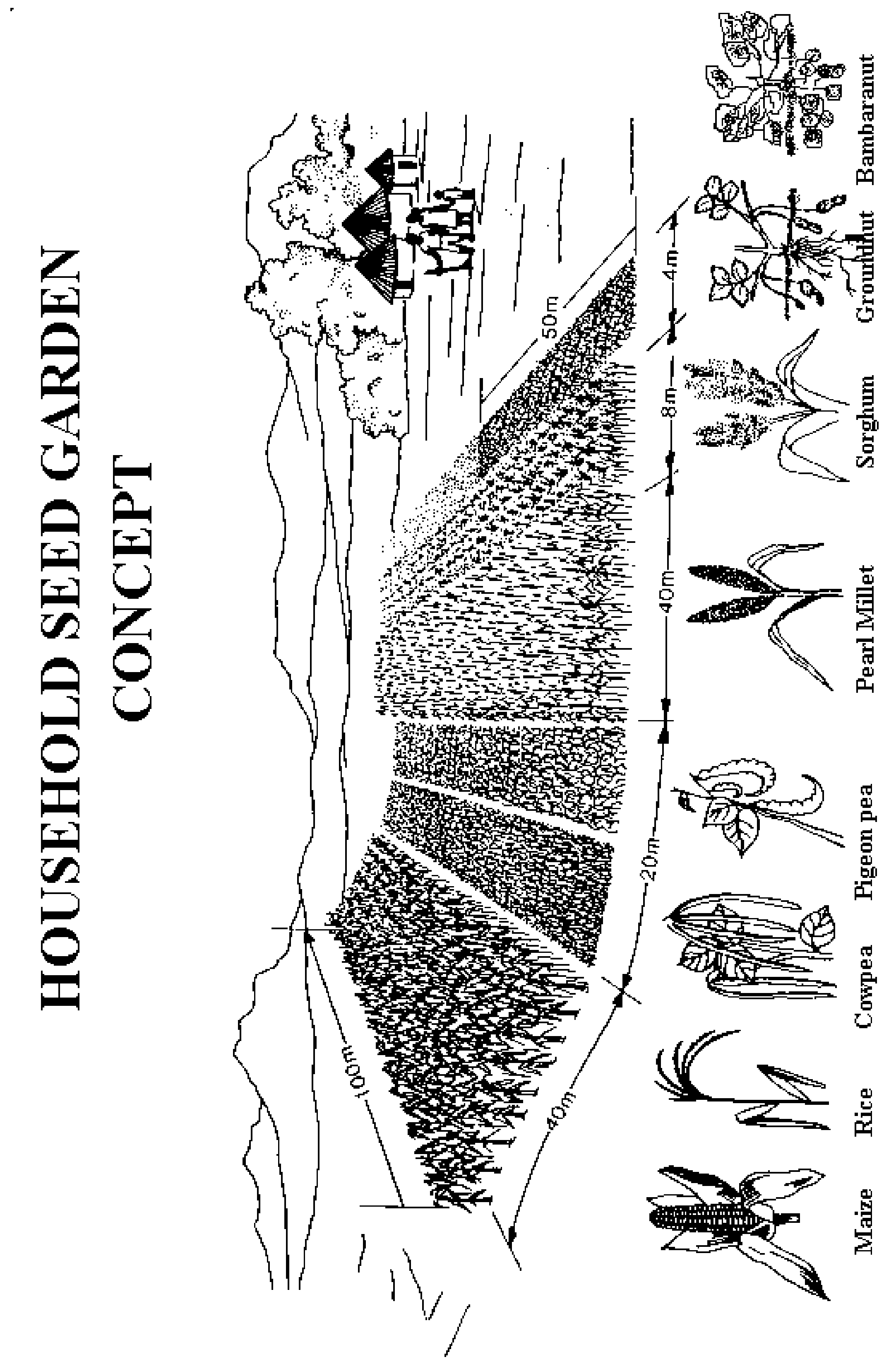
Group's Name______________________ Have You A Communal Seed Bank? **Yes/No** Are You Proposing To Sell Seed? **Yes/No**

| Crop/ Variety | Area Planted Ha | No of Days to 50% Crop Emergence | No of Days to Pollen Shed Initiation | No of Days 50% Silk Extrusion (Maize only) | No. of Days to 50% Physiological Maturity | Date Harvested | Seed Yield Kg | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | W | S | VMS |
| Maize | | | | | | | | | |
| Sorgrum | | | | | | | | | |
| Pearl Millet | | | | | | | | | |
| Cowpea | | | | | | | | | |
| Groundnut | | | | | | | | | |

**Note::**

- You may produce all crops provided it is in a seed garden as shown in Figure 1. That is enough seed for household seed security
- Yield Please clearly indicate (W) whole crop (S) all the seed quality (VMS) seed for variety maintenance

**Figure 1** Household Seed Garden Concept



# Glossary

## Glossary

| | |
|---|---|
| adaptability | the capability of a variety to perform well under given agro-ecological conditions (see wide adaptation, yield stability) |
| advanced material | plants in a breeding programme that show a real deviation from the ancestral materials, but that are not a new variety |
| apomixis | a type of vegetative reproduction through seed-like structures(e.g. in certain grass species) |
| biodiversity | the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part: this includes diversity within species and of ecosystems (Agenda 21, CBD, Rio de Janeiro, 1992) |
| blending | the intentional mixing of seed-lots |
| booting | the development of floral structures in most cereal crops |
| buffer crop | crop planted around a seed field to protect the latter from foreign pollen |
| certification | the assurance of varietal identity and purity in a seed production through generation control, inspection and labelling |
| certified seed | a seed class in a certification scheme, produced from Foundation or Registered (AOSCA-system) or Basic (OECD-system) seed, which is sold to farmers for crop production (see quality declared seed) |
| CGIAR | Consultative Group on International Agricultural Research, being the umbrella organisation for a number of International Agricultural Research Centres (IARCs) throughout the world |
| clone | genetically homogeneous population of a vegetatively propagated crop |
| co-evolution | The evolution of plants, diseases, pests and weeds in interaction with each other and with human activities |
| composite variety | a population of cross-fertilising crop resulting from a mixture of selected components (lines or populations) |
| conditioning | all treatment of seed from harvesting to planting e.g. drying, storage, chemical dressing, packaging |

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| contract grower | farmer producing seed for a seed organisation or company on contract |
| cross-fertilisation | a crop where under normal conditions seeds are produced by intercrossing of pollen between plants within a population |
| cultivar | see 'variety' |
| D.U.S. | Distinctiveness, Uniformity (homogeneity) and Stability in characteristics of a crop variety. These are the requirement for seed crop certification, variety registration and protection |
| degeneration | the loss of seed quality through subsequent generations. This could be due to build-up of seed transmitted diseases, or genetic changes through mutations, introgression or admixture that results in unwanted characteristics such as small grain, lack of uniform product, etc. |
| domestication | the genetic adaptation of wild plants to the cultivation environment through selection |
| dormancy | The condition that a viable seed does not germinate when supplied with those factors normally considered adequate for germination |
| double cross hybrid | hybrid resulting from a cross between two single cross hybrids |
| emasculation | removal of potential effective male organs (e.g. in hybrid seed production) |
| emergence | the breaking of the soil by a developing plant seedling after germination, normally below the soil at field level (see also germination, viability and vigour) |
| FAO | Food and Agricultural Organisation of the United Nations |
| farmers'-rights | the rights that local farmers and communities can claim over genetic resources in landraces |
| farm-saved seed | Seed sown at the same farm where it was harvested |
| FFS | Farmer Field School: a PEA to knowledge, information and skills transfer based on using the trial site, plants, variety and/or crop as a medium of instruction with farmers having a hands-on experience on aspects presented in the lesson |
| field inspection | inspection of a seed field to check for isolation, seed crop management, presence of pests and diseases, varietal purity etc; |

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| FIFM-trials | Farmer Implemented and Farmer Managed trials: this is a PRE approach for testing a given crop development component based on on-farm research. The service providers (research, extension etc) supply only one component that needs to be evaluated including the trial plot design. The farmers are left to decide for themselves how best to manage the trial, based on individual experiences with regards to optimum crop varieties performance under their own agro-ecological conditions (see also on-farm trials) |
| formal seed supply systems | seed supply through an organised chain of events by specialised breeders, seed producers, marketing and distribution agents including certification |
| FSV | Farmers Selected Varieties are those improved or landraces chosen by farmers as appropriate to meet their demand for rural household food economic and social security |
| genebank | a genetic resource centre where genotypes and population are stored as seeds, pollen or plants |
| generation system | a method in formal seed production where a seed lot can be traced back to a particular lot of pre-basic seed. This forms the basis of a certification system |
| genetic diversity | the genetic variation within and between populations of a species |
| genetic drift | random genetic changes in a population due to small population size |
| genetic erosion | the global loss of genetic diversity, or a loss of genetic diversity in crops in particular in a farming system |
| genetic resources | synonym of germplasm with emphasis on its actual or potential value as a resource |
| genotype | the entire genetic constitution of an organism |
| germination | the resumption of development and growth of a fully developed embryo, starting with the uptake of water and ending when photosynthesis starts. (see also emergence, viability and vigour) |
| germplasm | any living material: can be used for breeding or propagation purposes, emphasis being on the genetic content |
| GIS | geographic information systems data capture and analyses used in agriculture to map-out areas of crops and/or variety adaptations zones at regional or continental level. |
| heterogeneous | mixed, variable. When used in genetics or breeding systems it refers to a population consisting of a mixture of genotypes |

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| heterosis | the superiority in performance of a hybrid combination to the mid-parent value for both parents. It is often used where a hybrid is superior to both parents |
| heterozygous | the combination of two or more different alleles (traits) on the same locus (point of trait expression) in one genotype |
| hybrid | general: the first generation progeny of across between two parents. In seed production, a variety, of which the seed is produced by controlled crossing of two different parents |
| hybridisation | the crossing of two different plants with the aim of creating variety diversity or hybrid seed |
| IARC | International Agricultural Centre e.g. CIMMYT, ICRISAT, IITA etc |
| in situ conservation | preservation of genetic resources in an area where they naturally occur, i.e. in nature or in the farmers' fields |
| inbred line | genetically (nearly) homogeneous and (nearly) homozygous population, used for hybrid seed production |
| inbreeding | self-fertilisation, or mating of individuals that are more closely related genetically than individuals meeting at random. In cross-fertilising crops this may lead to inbreeding depression |
| inbreeding depression | the loss of vigour and fitness as a result of self-fertilisation in species that are normally cross fertilised |
| integrated seed supply systems | combination of different aspects of the formal and informal local seed supply systems, aimed at improving the performance of both systems |
| introgression | the integration of foreign alleles in a population through cross-fertilisation (with other varieties, or plants of the same species including weeds with a similar genotype e.g. sorghum and Sudan grass) |
| ISTA | International Seed Testing Association |
| KITT | Knowledge, Information and Technology Transfer |
| landrace | a variety developed by rural farmers in a particular agro-ecological and socio-economic conditions, usually a complex, heterogeneous population |
| line | progeny of a single (self-fertilised) plant |
| M and E | monitoring and evaluation |
| mating system | the common way of combining male and female gametes in a species: self-fertilisation, (semi)-cross-fertilisation, cross-fertilisation |

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| mini-kit | small quantity of different components of anew technology (e.g. seeds, fertiliser, pesticide, information leaflets, etc.) distributed by service providers to increase adoption rate. |
| multi-line variety | mixture of similar but not genetically identical pure lines of a self fertilising crop, selected for improved performance |
| multiplication factor | general: the number of seeds produced from one parent seed. in seed production: net seed yield per hectare (i.e. after seed cleaning and quality control) divided by the seed rate |
| mutation | a spontaneous or induced variation of genetic material of a cell. |
| NARS | National Agricultural Research Systems: public, private and individual crop development systems |
| OECD | Organisation of Economic Co-operation and Development |
| off-type | a plant differing from the variety in morphological or other trait, e.g. result of segregation, mutation, cross-fertilisation or mechanical mixing. Such plants are either removed (rogued) or nurture (as possible improvement of the variety) |
| on-farm research | strategy of formal agricultural research, whereby farmers are involved in problem definition, setting research priorities, testing and selecting technologies. |
| on-farm trials | the testing component of on-farm research where all components included in the trial are determined by the service providers (see also farmer implemented, farmer managed trials) |
| OPV | Open Pollinated Variety which refers to a variety multiplied through random fertilisation i.e. opposite to hybrid (commonly used for cross fertilised species only e.g. maize, sunflower, pearl millet etc) |
| Parastal | company operating under public administration rules and regulations, of which business operational losses are replenished by government |
| PEA | Participatory Extension Approaches: used as a tool for extending agricultural extension messages through pro-active farmer participation (see also PRE) |
| phytosanitary control | measures to avoid introduction of foreign plant diseases, pests and weeds |
| plant breeders' rights | the legal intellectual rights of the originator of a modern crop variety within the framework of a plant variety protection system |
| plant population | the number of plants per unit area, expressed normally in number of plants per hectare. (See also population) |

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| plant variety protection | legal system of granting exclusive rights over varieties to the originator (breeder or discoverer) |
| population | a group of individuals that share a common gene pool and have the potential to interbreed |
| post control | a final quality check n seed lots, used a an internal quality control of the seed quality control organisation |
| PPM | Project Planning Matrix |
| PRA | Participatory Rural Appraisal |
| PRE approaches | Participatory Research and Extension approaches: this is a tool found effective in creating effective and appropriate linkages for transfer of new technologies from research to farmers through extension. This approach allows farmers to be directly involved in modification of the application of new technologies to be consistent with their socio-economic needs which often results in better adoption rates of introduced technologies (see also PEA) |
| pure line variety | genetically homogeneous and homozygous variety of a self-fertilising crop |
| PVB | Participatory Variety Breeding |
| QDS | quality declared seed is a seed class restricted to open or self pollinate varieties, excluding true hybrid seed, produced by a registered seed producer from basic or any class of certified seed, provided there are no technical reason to exclude some certified seed. QDS may reproduce other QDS with approval of the national seed quality controlling authority that could impose a limitation of a number of generations permissible to maintain all technical aspects that underpin quality seed. (see certified seed) |
| roguing | removal of individual plants from a seed field, because they are off-type or diseased |
| RRA | rapid rural appraisal - an impromptu technique based on assessing available material presented by a target group as representative of what obtains in a given community. However, Seed Fairs contribute reliable data on crop genetic resources available to a given community if organised properly |
| SADC | Southern Africa Development Community |
| seed | generative or vegetative part of a plant that is used as a propagation material |

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| seed chain | the successive operations and processes leading to seed supply, i.e. germplasm selection, breeding, seed production, conditioning, quality control, marketing etc |
| seed class | denomination of a generation within a certification scheme |
| seed cleaning | removal of unwanted inert matter, weed and other seed from the seed stock |
| seed dressing | improvement of seed performance through application of chemical or other treatment of the seed coat. |
| seed policy | statement by government to guide the development of seed supply |
| seed security programme | activity designed to avoid the loss of seed by a large group of farmers |
| segregation | the appearance of different plants in an offspring due to the separation of different alleles in the mother plant. Segregation normally occurs during the first generation after a cross, and less frequently later |
| self-fertilised crop | a crop where under normal conditions seeds are produced as a result of self-fertilisation in at least 95 percent of cases |
| semi-cross-fertilised crop | a crop where the majority of seeds are produced through self-fertilisation but varying percentages of cross-fertilisation may occur up to 50 percent depending on agro-ecological conditions the crop may be subjected to e.g. sorghum |
| single cross hybrid | cross between two inbred lines |
| SWOT | strengths, weaknesses, opportunities and threats and/or challenges identified during implementation of project activities whose analyses might offer areas for improving performance for the project |
| synthetic variety | a variety produced by crossing a number of genotypes selected for their good combining ability |
| three-way cross hybrid | hybrid resulting from across between an inbred line and a single cross hybrid |
| top cross hybrid | hybrid resulting from a cross between an inbred line and a population of a stable open pollinated variety |
| true-to-type | a plant which conforms with the description of the variety it belongs to (opposite to off-type) |
| TSSWP | Timed Seed Supply Work Plan |
| UPOV | International Union for the Protection of New Varieties of Plants |

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| VCU. | Value for Cultivation and Use; the combined values of a variety to meet food and socio-economic demands of the end user under farming systems and agro-ecological conditions it might be selected for |
| varietal hybrid | hybrid resulting from a cross between two open pollinated varieties' populations (population hybrid) |
| varietal maintenance | the conservation of the important features of a variety through continuos selection |
| variety | a plant grouping within a botanical taxon, which can be precisely defined by expression of characteristics resulting from a given genotype or a combination of genotypes, and sufficiently homogeneous to be distinguished from other such similar groupings of plant populations by the expression of at least one characteristic. Synonym: cultivar |
| variety registration | the official registration of a new crop variety as sufficiently different from other similar crop varieties to be eligible for plant variety protection in its own right. However, this does not necessarily mean that a registered variety would be released for general multiplication. |
| variety release | the official approval of a variety for multiplication and distribution |
| VEVO-trials | Variety Evaluation, Verification and Observation trials: a PRE tool used farmers to select an appropriate crop variety to meet demand for their own food and socio-economic security. VEVO-trials are single variety plot trial conducted though FIFM- trial system. Randomisation is achieved by multi-location FIFM-trials widely dispersed within a village, ward or block and the whole district, commonly six similar trials are implemented in a single village. The vast number of FIFM-VEVO-trials allow both farmers and research to select appropriate technology within a single season as such trials capture all the possible variations in management, agro-environmental conditions and socio-cultural wealth status found within a community and a district within a single season when subjected to scientific and even farmers' own analysis. |
| viability | the ability of a seed to germinate and emerge to produce a normal seedling when conditions are ideal (see also germination and vigour) |
| vigour | the properties which determine the potential for rapid, uniform emergence and development of a normal seedling under a wide range of field conditions (see also germination, viability) |
| VRC | Variety Release Committee |

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| weed | a plant that grows where people do not want it to grow: it can be a wild or cultivated species growing in a desired crop |
| wide adaptation | the ability of a variety to perform well under a variety of agro-ecological conditions |
| yield stability | low variation in crop yield over time in a particular locality, even when seasons differ considerably (see adaptation, wide adaptation) |

# References - Contents

# References

## REFERENCES FOR CHAPTER I

Musa T. M. and Jannier van der Mheen-Sluijer. 1999. Review State of the Art in the Field of Local Seed Supply Systems. SADC/GTZ Project on Small Scale Seed Production by Self-Help Groups. Harare, Zimbabwe.

Rohrbach D. D., Mtenga K., Kiriwaggulu J. A. B., Monyo E. S., Mwaisela F. and Saadan H. M. 2002. Comparative Study of Three Community Seed Strategies in Tanzania. ICRISAT, Bulawayo, Zimbabwe

Seed Compendium of Zambia. 2001. Agricat Training and Consultancy Services. Lusaka, Zambia.

## REFERENCES FOR CHAPTER III

AGRITEX. 1998. Learning Together Through Participatory Extension: A Guide to an Approach Developed in Zimbabwe. Harare: Department of Agricultural, Technical and Extension Services (AGRITEX).

Alard R. W. 1960. Principles of Plant Breeding. John Wiley & Sons. New York.

Almekinders C. J. M. and Louwaars N. P. 1999. Farmers' Seed Production: New Approaches and Practices. Intermediate Technology Publications. London, UK.

Anandajayasekeram P., Matata J. B., Kiriro F.H., Wandera E.O. and Dixon J. 2001. Farming Systems Approach to Technology Development and Transfer: A Source Book. FARMESA-SIDA.

Anandajayasekeram P., Mvula M., Mbunji M. K., Akulumuka V., Opolot O. S. and Sithole D. (eds.). 2001. Farm Level Germplasm Multiplication and Distribution in East and Southern Africa: Experiences of FARMESA Member Countries. FARMESA-SIDA.

Development, Maintenance and Seed Multiplication of Open Pollinated Maize Varieties. 1966. CIMMYT Publication. Harare, Zimbabwe.

Feistritzer Walter P. (ed.) 1975. Cereal Seed Technology: A Manual of Cereal Seed Production, Quality Control and Distribution. FAO, Rome.

Hagmann, J; E. Chuma and K. Murwira. (1996). Improving the Output of Agricultural Extension and Reassert Towards Farmer Participatory Innovation, Development and Extension: Experiences from Zimbabwe. In the Proceedings of International Symposium on " Food Security and Innovation - Successes and Lessons Learnt. March 1996 Federal Republic of Germany. University of Hohenheim

Muliokela Stephen (ed.). 1997. Zambia Seed Technology Handbook. Ministry of Agriculture, Food and Fisheries of Zambia. Lusaka, Zambia.

Nyakanda P.N and G.L. Hildebrand (1999) Recommended Groundnut Practices for Smallholder Farmers in Zimbabwe. Causevay, Harare, Zimbabwe Department of Research and Specialist Services, Ministry of Lands and Agriculture, Harare, Zimbabwe, Seed Co Limited

Srivastava J. P. and Simarski L.T. (eds.). 1984. Seed Production Technology. ICARDA

van der Mheen-Sluijer Jannier. 1996. Socio-Economic Issues in the Production of Small Scale Seed Production. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

## REFERENCES FOR CHAPTER IV

Almekinders C. J. M. and Louwaars N. P. 1999. Farmers' Seed Production: New Approaches and Practices. Intermediate Technology Publications. London, UK.

Anandajayasekeram P., Mvula M., Mbunji M. K., Akulumuka V., Opolot O. S. and Sithole D. (eds.). 2001. Farm Level Germplasm Multiplication and Distribution in East and Southern Africa: Experiences of FARMESA Member Countries. FARMESA-SIDA.

Development, Maintenance and Seed Multiplication of Open Pollinated Maize Varieties. 1966. CIMMYT Publication. Harare, Zimbabwe.

Enda, Mugedza C. and Musa T. 1996. A Review of Agricultural Seed Supply Systems in the Smallholder Sector in Zimbabwe. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

Feistritzer Walter P. (ed.) 1975. Cereal Seed Technology: A Manual of Cereal Seed Production, Quality Control and Distribution. FAO, Rome.

Neuendorf, O. (ed.) 2003. Curriculum on Rural Based Small Scale Seed Production. A comprehensive approach to improve seed availability for small-scale farmers. SADC/GTZ Project on Small Scale Seed Production by Self-Help Groups. Harare, Zimbabwe.

Nyakanda., P. N. and G.L. Hildebrand. 1999. Recommended Groundnut Production Practices for Smallholder Farmers in Zimbabwe. Causeway, Harare. Zimbabwe Department of Research and Specialist Services, Ministry of Lands and Agriculture. Harare. Zimbabwe: Seed Co Limited

Muliokela Stephen (ed.). 1997. Zambia Seed Technology Handbook. Ministry of Agriculture, Food and Fisheries of Zambia. Lusaka, Zambia.

Mutsaers H. J. W., Weber G. K., Walker P. and Fisher N. M.(eds.). 1997. A Field Guide for On-Farm Experimentation. ISNAR

Rohrbach, D. D, K. Mtenga, J. A. B. Kiriwaggulu, E. S. Monyo, F. Mwaisela and H. M. Saadan. 2002. Comparative Study of Three Community Seed Strategies in Tanzania. ICRISAT, Bulawayo, Zimbabwe.

van der Mheen-Sluijer Jannie. 1996. Socio-Economic Issues in the Production of Small Scale Seed Production. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

Ocram V. K., Delimini L. L., Asaboah R. A. and Asiedu E. A.. 1998. Seed Management Manual for Ghana. Ministry of Food and Agriculture. Accra.

Rusike Joseph, Sukuma C. and Takaravasha D. 1999. Opportunities for Small Scale Seed Production by Self Help Groups. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

Srivastava J. P. and Simarski L.T(eds.). 1984. Seed Production Technology. ICARDA.

## REFERENCES FOR CHAPTER V

Bryceson, D. 2000. Rural Africa at the crossroads: Livelihood practices and policies. Natural Resources Perspectives No.52. ODI

Douglas Johnson E. 1980. Successful Seed Programs: A Planning and Management Guide. Westview Press. Boulder, Colorado.

Enda, Mugedza C. and Musa T. 1996. A Review of Agricultural Seed Supply Systems in the Smallholder Sector in Zimbabwe. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

Muliokela Stephen (ed.). 1997. Zambia Seed Technology Handbook. Ministry of Agriculture, Food and Fisheries of Zambia.

Neuendorf, O. (ed.) 2003. Curriculum on Rural Based Small Scale Seed Production. A comprehensive approach to improve seed availability for small-scale farmers. SADC/GTZ Project on Small Scale Seed Production by Self-Help Groups. Harare, Zimbabwe.

Rohrbach D. D., Mtenga K., J. Kiriwaggulu A. B., Monyo E. S., Mwaisela F. and Saadan H. M. 2002. Comparative Study of Three Community Seed Strategies in Tanzania. ICRISAT, Bulawayo, Zimbabwe.

Rusike Joseph, Sukuma C. and Takaravasha D. 1999. Opportunities for Small Scale Seed Production by Self Help Groups. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

Seed Compendium of Zambia. 2001. Agricat Training and Consultancy Services. Lusaka, Zambia.

van der Mheen-Sluijer J. 1999. Seed and Planning Material Sources in Selected SADC Countries. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

van der Mheen-Sluijer J. 1999. Towards Household Seed Security. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

van der Mheen-Sluijer J. 1996. Socio-Economic Issues in the Production of Small Scale Seed Production. SADC/GTZ Project Promotion of Small Scale Seed Production by Self Help Groups. Harare, Zimbabwe.

## REFERENCES FOR CHAPTER VI

Anandajayasekeram P., Mvula M., Mbunji M. K., Akulumuka V., Opolot O. S. and Sithole D. (eds.). 2001. Farm Level Germplasm Multiplication and Distribution in East and Southern Africa: Experiences of FARMESA Member Countries. FARMESA-SIDA.

Bryceson, D. 2000. Rural Africa at the crossroads: Livelihood practices and policies. Natural Resources Perspectives No.52. ODI

Douglas Johnson E. 1980. Successful Seed Programs: A Planning and Management Guide. Westview Press. Boulder, Colorado.

Muliokela Stephen (ed.). 1997. Zambia Seed Technology Handbook. Ministry of Agriculture, Food and Fisheries of Zambia. Lusaka, Zambia.

Neuendorf, O. (ed.) 2003. Curriculum on Rural Based Small Scale Seed Production. A comprehensive approach to improve seed availability for small-scale farmers. SADC/GTZ Project on Small Scale Seed Production by Self-Help Groups. Harare, Zimbabwe.

Rohrbach D. D., Mtenga K., J. Kiriwaggulu A. B., Monyo E. S., Mwaisela F. and Saadan H. M. 2002. Comparative Study of Three Community Seed Strategies in Tanzania. ICRISAT, Bulawayo, Zimbabwe.