Enhancing sustainable livestock-crop production

in smallholder farming systems

Proceedings of the Fourth Meeting of Forage Regional Working Group on Grazing and Feed Resources of Southeast Asia

Nha Trang, Vietnam

20 – 24 March 1995

Sponsored by the

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CONTENTS

Country Project Report

Forage Seed Production and Ley Farming

General Discussion of Workshop Sessions

ENHANCING SUSTAINABLE LIVESTOCK-CROP PRODUCTION IN SMALLHOLDER FARMING SYSTEMS

CONTENTS

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Organized by
The National Institute of Animal Husbandry
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Edited by
C.C. Wong and L.V. Ly

FOREWORD

The Regional Working Group (RWG) on Grazing and Feed Resources of Southeast Asia has entered its 7th year of existence with the fourth Regional Meeting held successfully in Vietnam.

The group comprised initially three countries, Malaysia, Philippines and Thailand and has now grown to six members with the recent participation of Vietnam, Laos, and Indonesia. Senior of ficers of the CIAT/CSIRO/AIDAB forage project participated, for the first time, in the Workshop to allow a growing integration of knowledge on forage use and improvement in the region. The group meeting provides an opportunity for researchers and scientists to establish working collaboration and exchange of expertise and also to find some financial support.

The theme "enhancing sustainable livestock-crop production in smallholder farming systems" signifies a holistic approach to forage in the livestock production and farming systems of the region. The papers provide useful information for the understanding of the management and use of forages by smallholders. I hope this information will be used for long term research activities.

The success and expansion of the RWG has largely been due to the dedication, and enthusiasm of local scientists and extension officers, and the close collaboration among the National Coordinators.

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PREFACE

With the regional working group grown in strength over the years, the fourth meeting held in Vietnam achieved another success with the participation of representatives from the Forages for the Smallholders Project (FSP) under CIAT/CSIRO/AIDAB Collaborative Forage Programme. With this linkage of FSP, the FAO Forage Regional Networking Group has reached a new era in cooperation and complement of research in feed resources development and expansion in this region. This meeting has resulted in a total of 26 papers presented. Obvious in the meeting was the high standard of achievement by the various member countries on their on-farm research. Thailand had gone into the development of low-cost irrigation system by smaU farmers for improved production while in Malaysia, intensive production systems involving efficient management for quality pasture and seed production were given. In Philippines, the use of urea-molasses mineral block in disaster areas as well as the production of sheep in farming system were highlighted. In Indonesia, the intensive integration of the diversity of tropical grasses, legumes and fodder shrubs into forage production system was realised. The vision is to modemise forage resources development as part of the goal to uplift the social and economic wellbeings of the local farmers. In the rapid phase of development in these countries, the livestock, sector particularly the ruminant sector has to remain sustainable and competitive. Effective and relevant technologies are thus needed to expedite the development of high quality feed resources industry to ensure the economic viability of ruminant production. Laos and Vietnam, being the new members of the group can now be able to exploit the rich experiences and expertise of the earlier countries and thereby avoid the many unnecessary errors made through ignorance.

On behalf of the Regional Forage Working Group of Southeast Asia, the editors would like to take the opportunity to extend their sincere appreciation to the organizing committee of the host country, Vietnam for the success and smooth running of the meeting as well as those who have contributed in one way or another to ensure an infommative and successful meeting. Of course, nothing is complete without our appreciation and acknowledgment to Dr. Fernando Riveros, the Chief of Crops and Grassland Services, Plant Production and Protection Division, FAO Rome as an initiator and continued facilitator of the networking programme over the years. His zealous dedication and encouragement have been the engine of the expanded growth and sustainable development of the forage networking group in this region.

C.C. Wong &
L.V. Ly
Editors
Forage RWG of Southeast Asia
CONTENTS

GROWTH AND REPRODUCTIVE PERFORMANCES OF BALI HEIFER IN THE THREE STRATA FORAGE SYSTEM

I.M. Nitis, K. Lana, W. Sukanten, S. Putra and T.G.O. Pemayun[1]

SUMMARY

On-farm demonstration plots were carried out for 11 months in a dryland farming area, South of Bali to study the effects of Three Strata Forage System (TSFS) and the Traditional System (NTFS) on growth and reproductive performances of Bali heifers. TSFS is a technique of planting and harvesting grasses and ground legumes (as first stratum), shrub legumes (as second stratum) and fodder trees (as third stratum) so that forage is available all year around. NTFS is tethered grazing of cattle during the day and stall-fed at night with whatever forage available in the farm. The experiment was a randomized design consisted of 2 farming systems (TSFS and NTFS) in five replications with one Bali heifer per replication.

The TSFS heifers gained more liveweight, and were more efficient in utilizing the feed than the NTFS heifer during both the wet and the dry seasons. The reproductive capability (measured in terms of true and silent oestrus cycle) of TSFS heifers was better than that of the NTFS heifers and the physiological puberty (measured in terms of number of oestrus cycle) was earlier than that of the NTFS heifers. There is an indication that growth and reproductive performance of Bali heifers can be improved through the TSFS.

INTRODUCTION

In smallholder dryland farming areas, food crops are the main production, while livestock keeping is a side-line activity (Anon, 1986). No land is specially allocated for livestock feed production. The livestock are fed with crop residues and natural grasses, from shrub and tree fodders grown on the bunds and slopes of rice field and on wasteland. It is not uncommon therefore, that livestock feed is in a shortage of supply particularly during the dry season. After the food crops are harvested, the land which is usually too dry for another cultivation, is used for tethered grazing. Often, uncontrolled tethered grazing and lopping of the fodder shrubs and trees can result in soil erosion. This in turn will reduce the productivity of the dryland farming areas.

An experiment on Three Strata Forage System (TSFS) has been carried out on a farm for 9 years (1984 - 1993) to study the role of grasses and ground legumes, fodder shrubs and trees to supply all year around green forage feed (Nitis *et al.* 1989, TSFS Team 1993). It has been shown that Bali steers raised in the TSFS gained more liveweight, were more efficient in utilizing forage, reached market body weight faster and were less infested with endoparasites than those raised traditionally (NTFS) through tethered grazing during the day and stall-feeding at night

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This paper describes the effects of TSFS on the growth and reproductive performances of Bali heifers over a 14-month period from 15 September 1993 to 15 November 1994.

MATERIALS AND METHODS

Location

The location of the demonstration plot was at the Pecatu village in Bukit Peninsula, South of Bali in a dryland farming area with a'semi-arid climate and an undulating topography of 30% flat and 70% slopping and at 10 - 150 m elevation. The average annual rainfall is 1681 mm with 96 rainy days distributed in the wet season (December - March) and the dry season lasts from April to November. The limestone-based soil is red-brown Mediteran with a pH ranging from 6.7-8.7 and organic matter from 2.2 - 2.9% at 10 - 25 cm soil depth.

Description of TSFS

Each plot of TSFS was 0.25 ha and was divided into 0.16 ha core area, 0.09 ha peripheral area and 200 m circumference area (Fig. 1). The core area which was located in the centre of the plot, was planted with common food crops (e.g. com, soybean and cassava). The peripheral area, which was located between the core and circumference areas was divided into 20 lots of 45 m2 (9 m X 5 m) each. Each lot was planted with *Cenchrus ciliaris* cv. Gayndah, *Panicum maximum* var Trichoglume, *Urochloa mosambicensis*, Centrosema *pubescene, Stylosanthes scabra* cv. Seca and *Stylosanthes hamata* cv. Verano. This 0.09 ha of grass and ground legume pastures is designated as the 1" stratum. The circumference area, which surrounded the peripheral area was planted with *Ficus poacellii, Lannea corromandilica* and *Hibiscus tilliaceus* at 5 m spacing. Between the 2 fodder trees, *Gliricidia sepium, Leucaena leucocephala* or *Acacia villosa* was planted at 10 cm spacing. In this 200 m circumference area there are 1000 *Gliricidia* and 1000 *Leucaena* plants designated as the 2nd stratum while the 14 *Ficus*, 14 *Lannea* and 14 *Hibiscus* plants were designated as the 3,d stratum. The grasses and legumes were introduced species but the shrubs and trees were locally available at the site.

It should be noted that after 8 years of continuous cutting, all the introduced legumes had disappeared; the *Cenchrus* and *Urochloa* existence depended on the farmer preference; while the *Panicum* dominated the plots. *Leucaena* survived sparingly from the severe psyllid attack, while the *Gliricidia* grew prolifically. The *Ficus, Lannea* and *Hibiscus* grew well.

In the traditional system, each plot of 0.5 ha was divided into 0.25 ha tilted land for food crop and 0.25 ha fallow land for tethered grazing. There was no stratification of grass, shrub and trees in the NTFS.

Of the 32 TSFS and 32 NTFS plots, 22 were located in flat land and 24 on the slope and 18 in the flat-slopping topographical conditions. However, only 5 TSFS and 5 NTFS plots were selected and used as demonstration plots (demoplots).

Balicattle

Bali heifers were brought from Beringkit cattle market, 60 km from the demoplots. After ovariam examination through rectal exploration, 10 Bali heifers with an average liveweight of 157 kg were bought. Each heifer was identified with an earmark. Selection was based on phenotypic characteristics which were acceptable to the farmers.

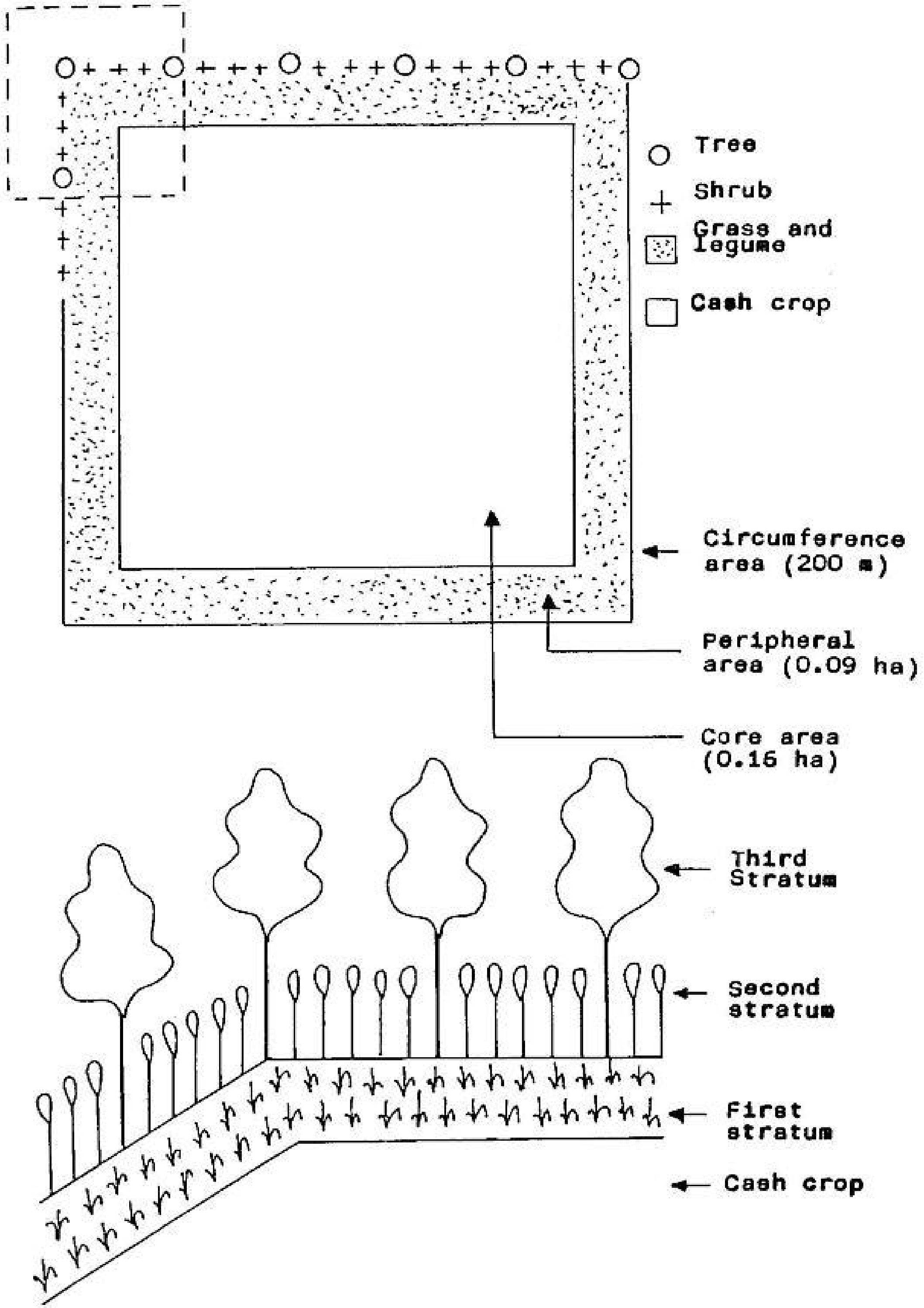

Fig. 1. Stratification of TSFS (Nitis *et al.* 1989)

Design

The design was a completely randomized block consisting of 2 farming systems (TSFS and NTFS) as treatments and 5 replications per treatment. Each replication consisted of one Bali heifer.

Shed

Each heifer was housed in a shed (3m X 2m) made from trunk poles and located in the vicinity of either the TSFS or NTFS plot. The shed had a bamboo feed trough (2 m x 2 m), a limestone floor, a galvanized-iron roof adequate to house one heifer and a calf and a feed storage space (1.5 m x 1.0 m).

Feeds and feeding

The TSFS heifer was always kept in the stall and fed with cut forage. The feed composition of TSFS consisted of 65% from the 1 st stratum, 25% from the 2nd stratum and 10% from the 3rd stratum during the wet season. In the mid dry season, the feed composition was 35, 55, and 10% from the 1st, 2nd and 3rd strata, respectively while in the late dry season the feed composition was 10, 35 and 55% from the 1st, 2nd and 3rd strata Feeding was ad libitum. Feeds were given twice a day. The forage was cut in the afternoon and fed the next day.

The NTFS heifer was tethered grazed during the day and stall-fed at night with whatever forage was available in the NTFS. A 5-m plastic cord was used to tether each heifer. Tethering began in the morning (6.00 h), moved to new site in the afternoon (14.00 h) and returned to the stall in the evening (18.00 h). Due to the stony surface, the effective tethered grazing area was 85% of the total area covered by the 5-m cord radius.

Artificial insemination

All heifers in the demoplots were artificially inseminated. The semen and the inseminator were provided by the Livestock Service of Badung Regency. The Bali bull semen was obtained from the Singosari semen centre, east Java.

Observation

All the heifers were weighed individually every 28 days. Reproductive performances (coming into heat, insemination, pregnancy) were recorded. Botanical composition, weight of the forage on-offer and residues were recorded for 2 days prior to weighing the cattle. At the beginning and end of both wet and dry seasons, botanical composition and yield of pasture before and after tethered grazing were recorded using 0.5 m by 0.5 m quadrat. Any signs of abnormality in animals were recorded and treatment provided accordingly.

Medication

All animals were treated with anthelmintic drugs and vaccinated against S.E. upon arrival at the site. All the heifers were sprayed with an external parasite disinfectant whenever needed. Other medical treatments and prevention were applied whenever required.

Statistical analysis

All data, whenever possible, were analysed with Student 't' test according to the method described by Steel and Torrie (1960).

Farmer participation

The 10 farmers (5 males and 5 females) were selected on their willingness to give up their land for demoplots and to participate in the project. Each participating farmer carried out the daily work (cutting the forage, feeding, care and maintenance, etc) as assigned according to the types of demoplot. Every 28 days, the animals were weighted and the farmers attended meetings and discussed the various matters related to the growth and reproductive performances of the Bali heifers.

From the knowledge gained on heat detection, each farmer would reported to the forewoman when his/her heifer come into heat. The heifer was then brought to the insemination stall and the inseminator contacted for AI services within 12 hours after oestrus appearance.

As an incentive, each farmer received one calf alternatively until the cow became infertile. The cow was then sold and the proceed divided equally. A small incentive was given to the farmers for the time spent in taking the cattle to the weighing scale and in attending the monthly discussion.

The weaned calves received by TSFS team and the heifers bought from the proceeds of the sale of culled cow and weaned male calf, would be given to the farmers interested in practising the TSFS when the Project was terminated. All these transactions were managed by the farmer groups.

RESULTS AND DISCUSSION

Growth performance

During the 3-month wet season, TSFS heifers gained more liveweight than the NTFS heifer despite initial higher feed consumption of the NTFS heifers. (Table 1, Figs. 2 and 3). Such a higher liveweight gain was not due higher feed consumption but to higher efficiency in feed utilization (Figs. 4 and 5). The better quality of the forage offered to the TSFS heifer in the stall-fed condition, had resulted in higher liveweight gain and efficiency of feed utilization. During the 8-month dry season, the same trend persisted (Table 2). Even though enough forage was offered during tethered grazing (Fig. 6), the forage consumed was still low because the forage was fouled with urine and dung (Fig. 7). As a whole, liveweight gain, efficiency of feed utilization and body dimension of the TSFS heifer were higher than those of the NTFS heifers (Tables 3 and 4).

Reproductive performance

The present experiment showed that TSFS cattle exhibited more frequent apparent and true oestrus cycles, but less frequent silent heat than the NTFS cattle (Table 7). This was presumably due to the better quality of nutrients supplied from the TSFS. The higher liveweight gain and better efficiency of feed utilization of the TSFS cattle suggested that exposure to sunshine had little effect on the improvement of the oestrus cycle. The higher detection of oestrus sign in the morning than in the afternoon added support to this observation.

Even though the average appearance of the first oestrus cycle after the treatment was similar (Table 5), individual variations between and within the treatments were not similar (Table 6). In the TSFS heifer, it varied from 39 - 79 days; while in the NTFS heifer it varied

Table 1. Growth performance of heifers during the 3 months wet season January - March 1994)

No.	Respond	Treatment		Level of significant
		TSFS	NTFS	
1	Average initial liveweight (kg)	157.2	157.2	P>0.1
2	Average liveweight to date (kg)	196.4	186.0	P>0.1
3	Average liveweight gain (kg)			
	a) 3 months	39.2		P<0.01
	b) per day	0.47	0.34	P<0.01
4	Average feed consumption (kg)			
	a) Stallfed	5.29	2.89	P<0.01
	b) Tethered grazing	-	4.09	
	c) Total (a + b)	5.29	6.98	P<0.01
5	Botanical composition of the feed offered (%):			
	a) Tree	5.36	3.25	
	b) Shrub	27.38	29.98	
	c) Grass	64.90	66.53	
	d) Crop residues	2.36	0.25	
6	Botanical composition of the forage consumed (%):			
	a) Tree	5.0	4.82	
	b) Shrub	16.6	36.17	
	c) Grass	75.33	58.65	
	d) Crop residues	3.0	0.36	
7	F C R	12.25	20.53	P<0.05

1) Average of 5 heifers. NS = not significant (P>0.05). *Significant (P<0.05)

from 25 - 101 days. Such a variation was not due to the liveweight of the heifer (physiological age), but probably due to age of the heifer (chronological age), which could not be determined accurately at the time of purchase.

The interval of apparent oestrus cycle in the present experiment varied from 31.8 to 46.3 days; which was probably due to the presence of silent heat which varied from 63 - 82 days (Table 7). When taking this silent heat into consideration, the true oestrus cycle was 20 - 21 days, which was within the ranges of 18 - 24 days reported in the literature for cattle (Payne 1975). The higher incidence of silent heat in the NTFS cattle was probably due to difficulty in detecting heats, since the NTFS cattle was tethered grazed during the day.

Frequency of apparent and true oestrus cycle of TSFS cattle was more often, while frequency of silent heat was less than those of NTFS cattle. This had resulted in more insemination being carried out on the TSFS cattle than the NTFS cattle. Failure to conceive was not due to the heifers being not yet ready to accept motherhood as insemination had been carried on to the third oestrus cycle. Nevertheless, it was possible that the heifers were not ovulating because of their poor body weight. Also, technical and physical limitations could have resulted in heifers being inseminated in late (4th and 5th) oestrus cycles instead of being earlier.

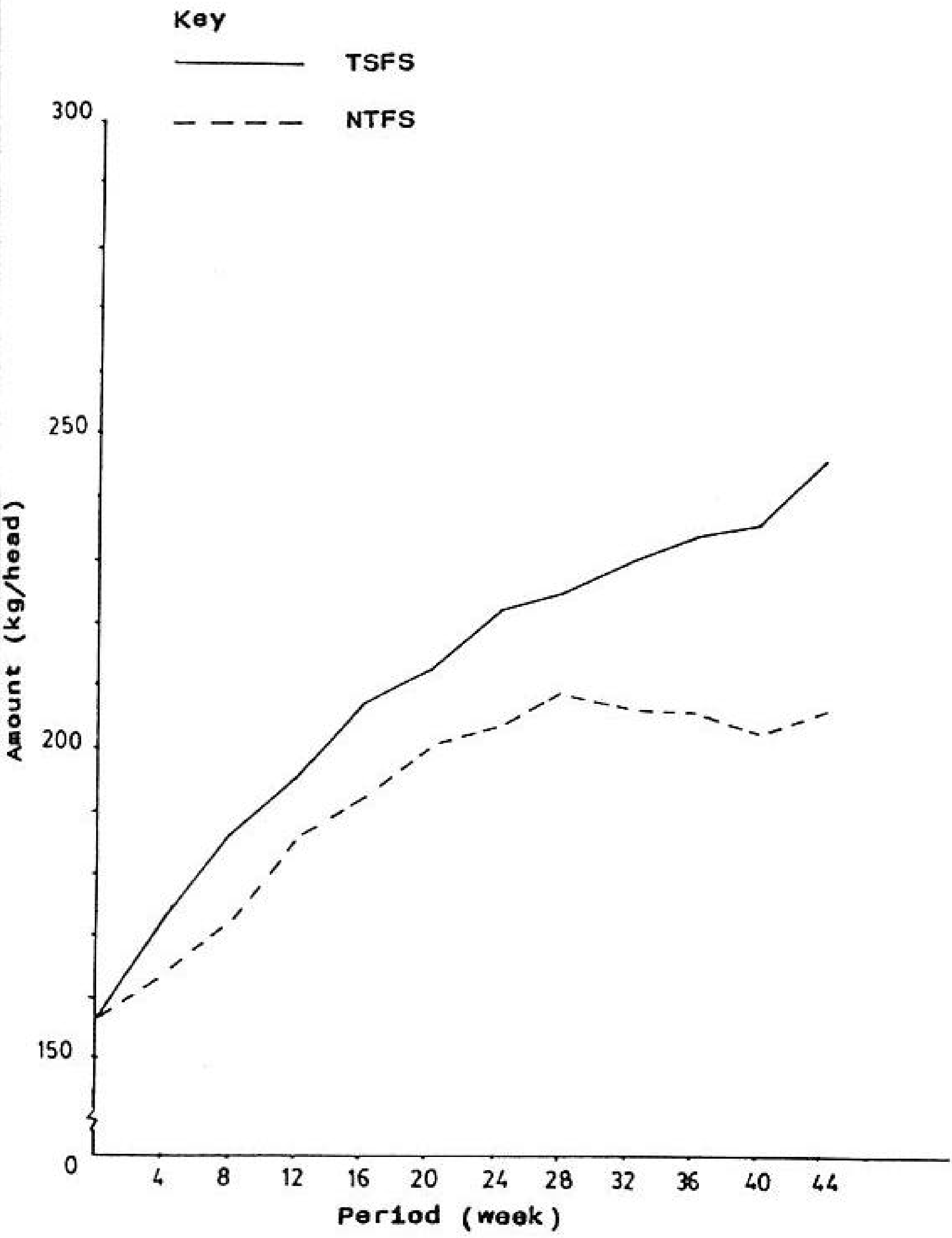

Fig. 2. Liveweight of heifers

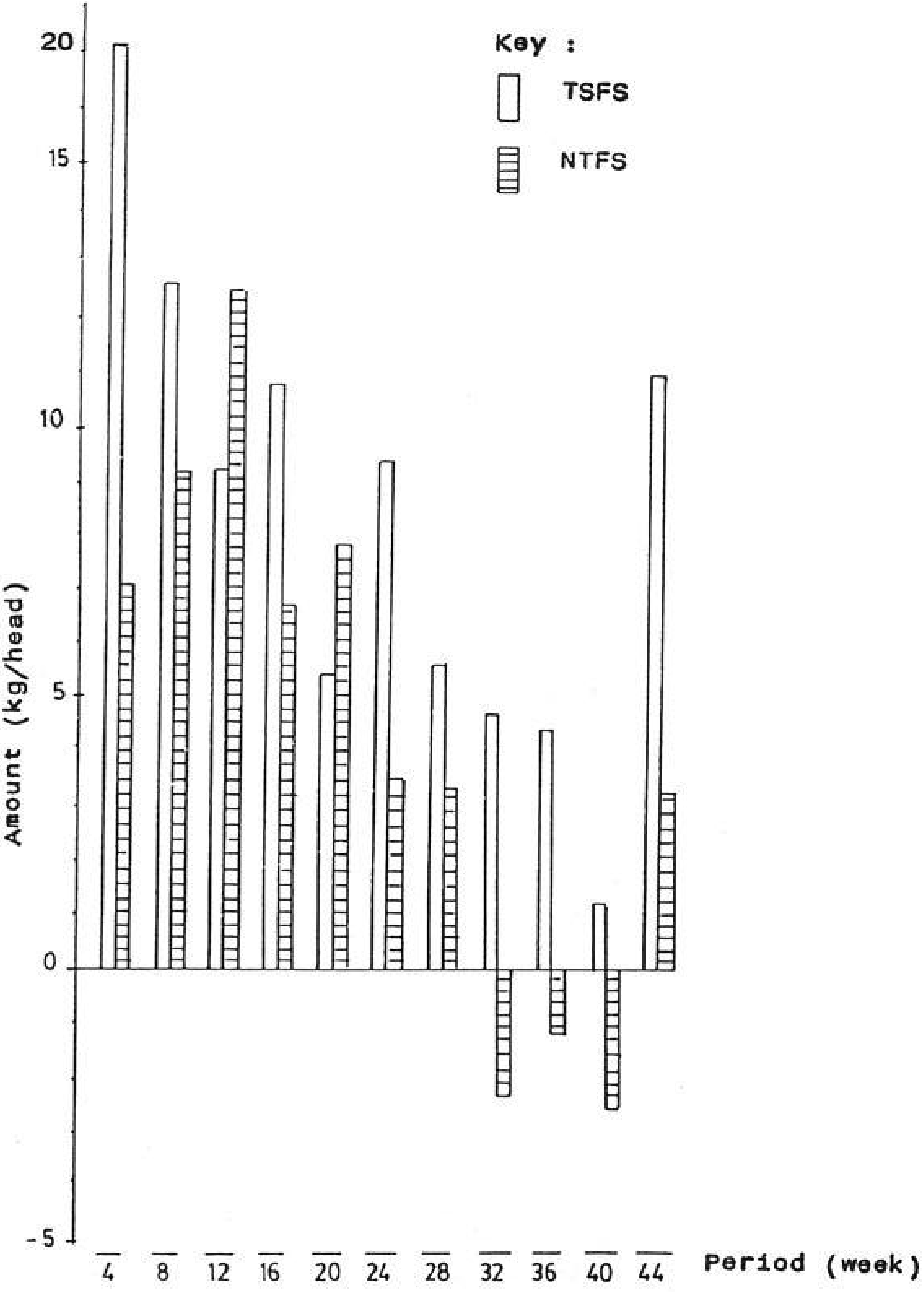

Fig. 3. Liveweight gain of heifers

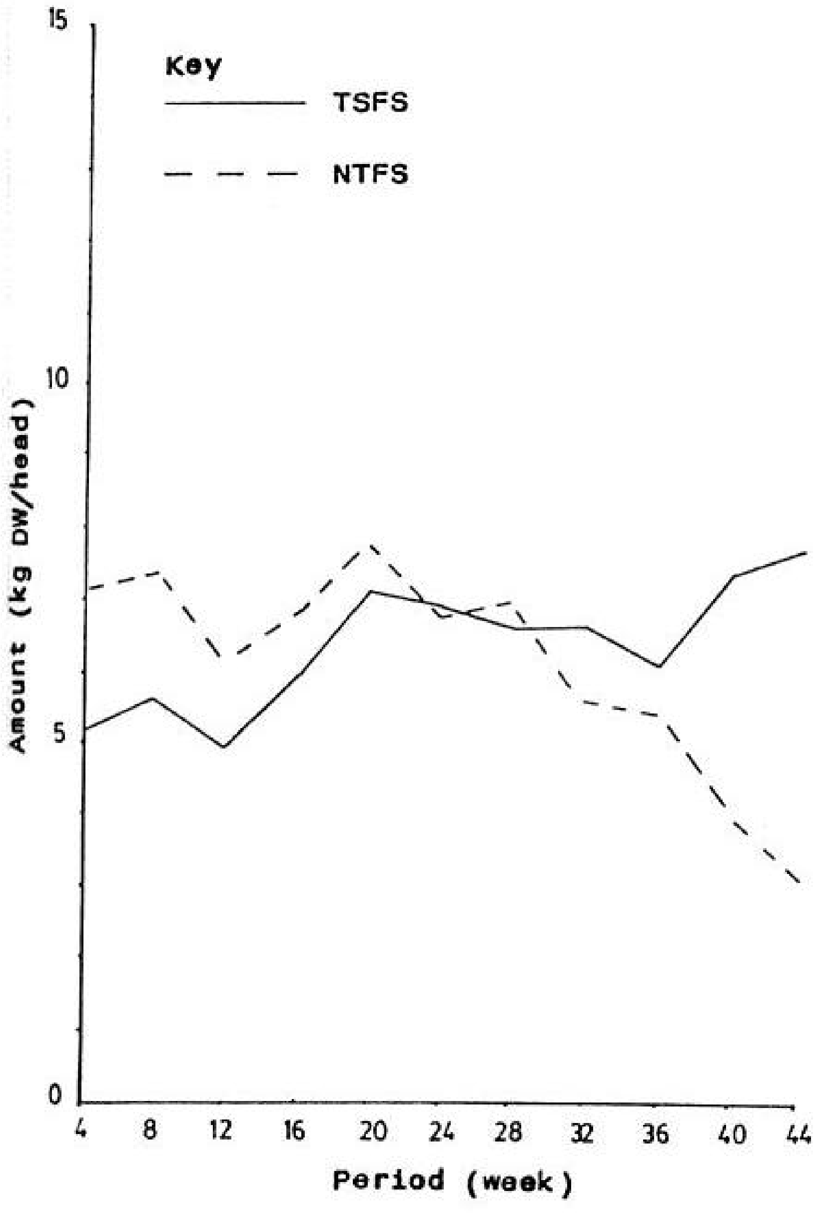

Fig. 4. Feed consumption of heifers

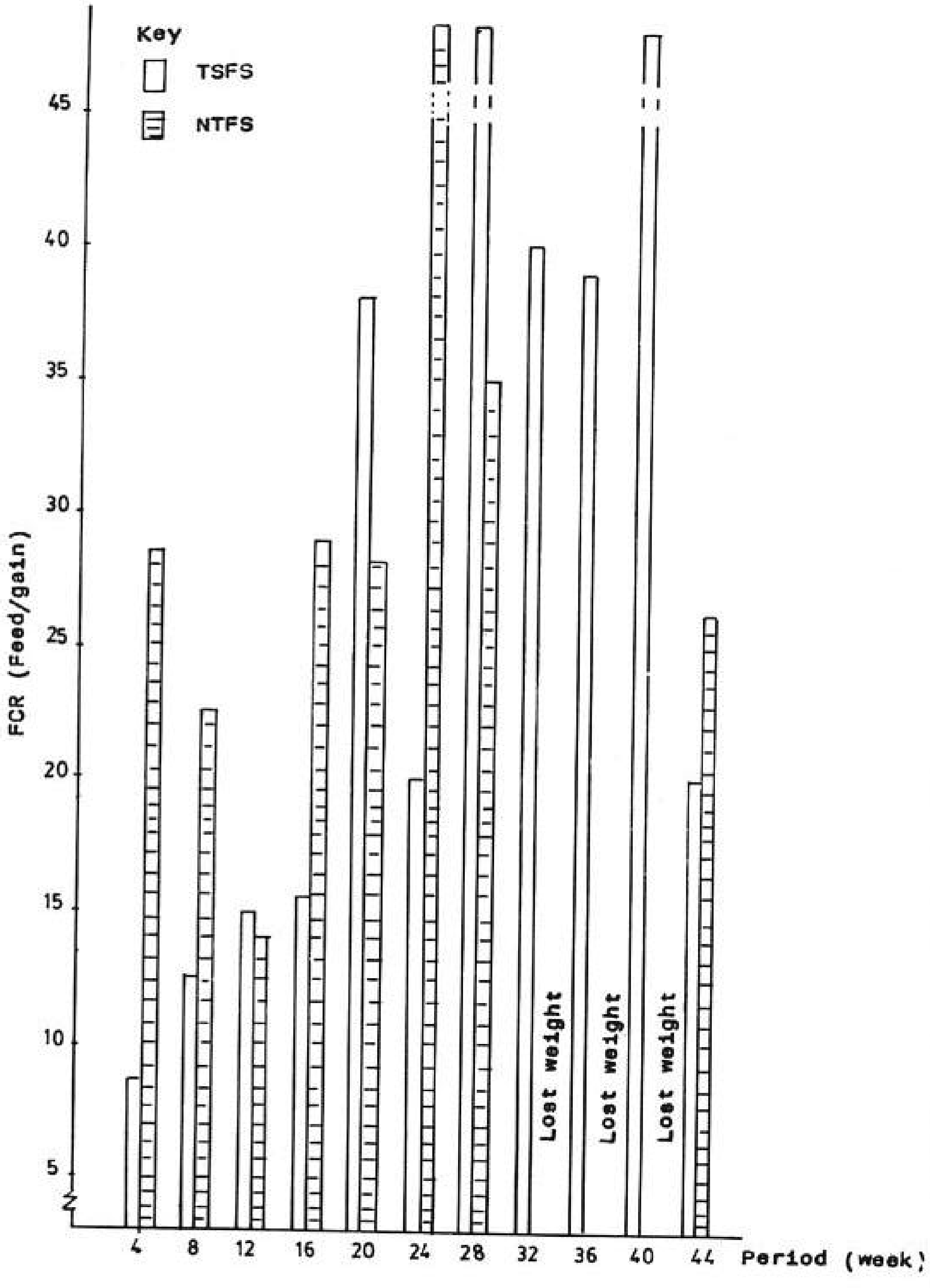

Fig. 5. FCR (feed conversion ratio) of the heifers

Table 2. Growth performance of the heifers during the 8-month dry season (April - November 1994)

No.	Respond [1]	Treatment		Level of significant
		TSFS	NTFS	
1	Average initial liveweight (kg)	196.4	186.0	P>0.1
2	Average liveweight to date (kg)	246.4	206.6	P<0.01
3	Average liveweight gain (kg)			
	a) 3 months	50.0	20.6	P<0.05
	b) per day	0.22	0.09	P<0.05
4	Average feed consumption (kg)			
	a) Stallfed	6.84	3.06	P<0.01
	b) Tethered grazing	-	2.37	
	c) Total (a + b)	6.84	5.43	P<0.05
5	Botanical composition of the feed offered (%):			
	a) Tree	27.45	25.62	
	b) Shrub	48.54	31.31	
	c) Grass	25.58	42.94	
	d) Crop residues	1.43	0.13	
6	Botanical composition of the forage consumed (%):			
	a) Tree	29.39	28.24	
	b) Shrub	45.59	32.21	
	c) Grass	23.53	39.35	
	d) Crop residues	1.49	0.20	
7	F C R	31.09	60.33	P<0.01

[1] Average of 5 heifers

The present data showed that the true oestrus cycle of Bali heifer varied from 19 - 30 days, while the silent heat varied from 30 - 80 days. When there is no heat detected after 80 - 90 days, the cattle is considered pregnant. Based on this assumption two of the TSFS cattle and four of the NTFS cattle showed no sign of heat for 81 - 95 and 99 - 112 days, respectively. However, rectal exploration showing no sign of pregnancy. This indicated that silent heat that was taking place after the first insemination was due to carelessness of the farmers to check the sign of oestrus, since they believed that their cattle were already conceived. The more frequent insemination after the rectal exploration on the 3rd month added support to this suggestion.

The causal factors for the failure of heifers to conceive using AI were not known. The field and on-farm conditions did not rule out the possibility of lower quality of semen due to exposure to heat during transportation, lack of right temperature during storage or other conditions that induced poor services.

CONCLUSION AND SUGGESTION

The present data indicated that:

1. TSFS heifers gained more liveweight and were more efficient in utilizing the feed than the NTFS heifers in both wet and dry seasons.

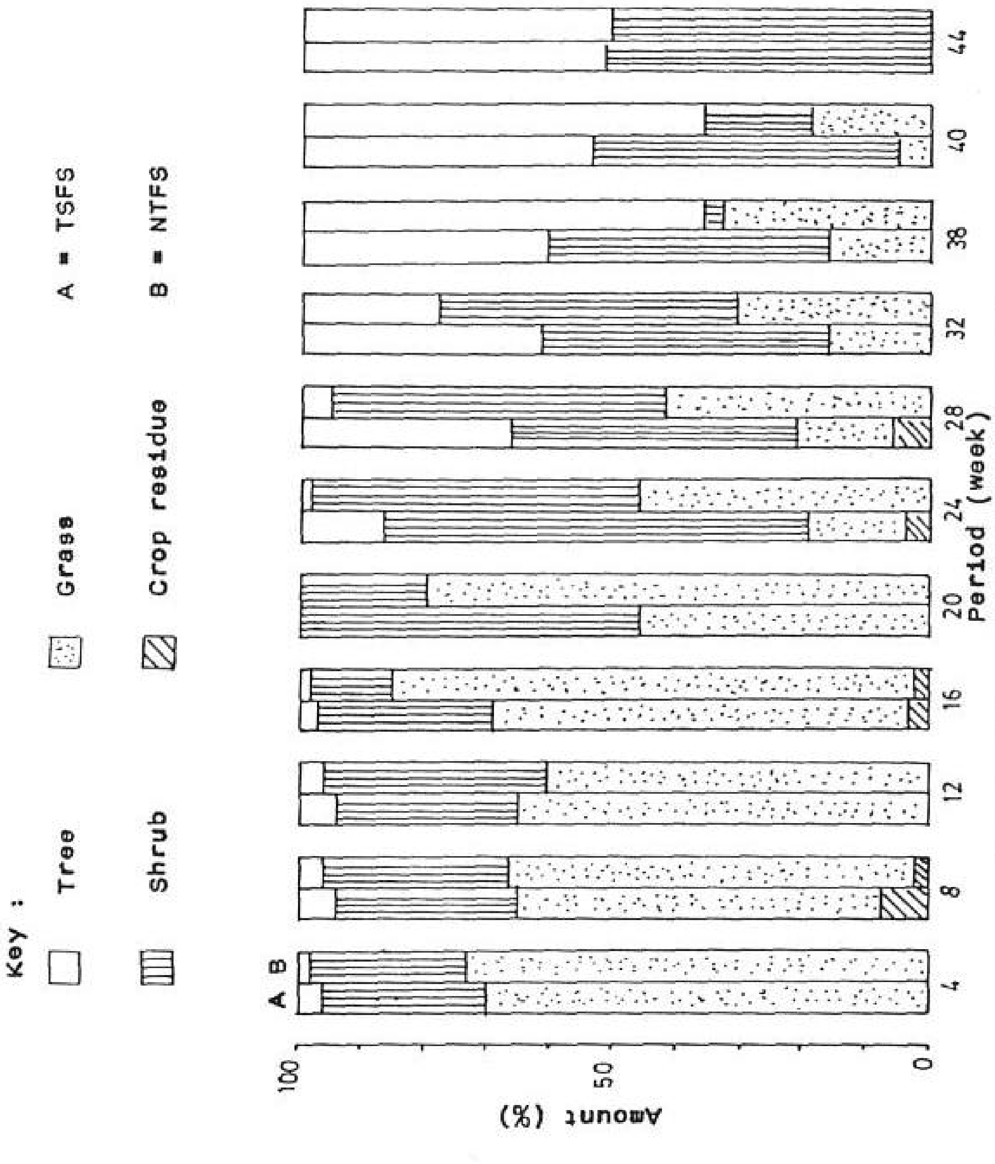

Fig. 6. Botanical composition of the forage offered to heifers

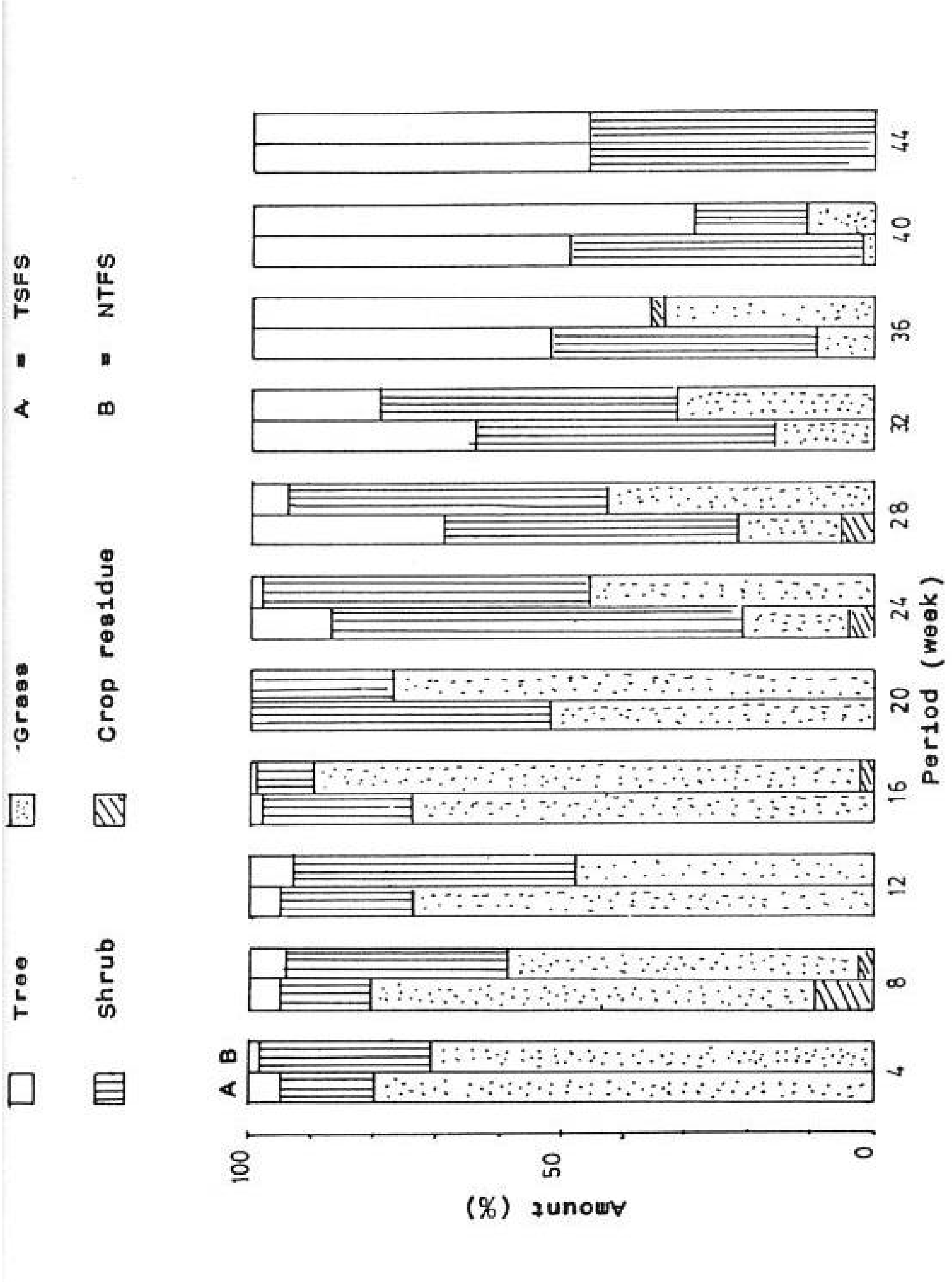

Fig. 7. Botanical composition of forage consumed by heifers

Table 3. Growth performance of heifers during the 11-month wet and dry seasons (January - November 1994)

No.	Respond [1]	Treatment		Level of significant
		TSFS	NTFS	
1	Average initial liveweight (kg)	157.2	157.2	P>0.1
2	Average liveweight to date (kg)	246.4	206.6	P<0.01
3	Average liveweight gain (kg)			
	a) 3 months	89.2	49.4	P<0.05
	b) per day	0.29	0.16	P<0.05
4	Average feed consumption (kg)			
	a) Stallfed	6.42	3.02	P<0.01
	b) Tethered grazing	-	2.84	
	c) Total (a + b)	6.42	5.86	P>0.1
5	Botanical composition of the feed offered (%):			
	a) Tree	21.42	19.52	
	b) Shrub	42.77	30.94	
	c) Grass	34.12	49.38	
	d) Crop residues	1.69	0.16	
6	Botanical composition of the forage consumed (%):			
	a) Tree	22.73	21.85	
	b) Shrub	37.70	33.29	
	c) Grass	37.66	44.61	
	d) Crop residues	1.94	0.25	
7	F C R	22.14	36.63	P<0.05

[1] Average of 5 heifers

Table 4. Increased (cm) in body dimension of heifers in 11-month period

Respond [1]		Treatment	
		TSFS	NTFS
1	Body length	14.2	6.6
2	Chest width	10.2	7.2
3	Chest depth	9.6	5.8
4	Chest girth	20.0	11.8
5	Body height	6.6	5.4
6	Thigh width	6.4	5.4
7	Thurl width	6.6	4.8

[1] Average of 5 heifers

Table 5. Reproductive performance of heifers during the 9-month period

No.	Respond [1]	Treatment		Level of significant
		TSFS	NTFS	
1	Appearance of 1st oestrus (days)	55.6	56.3	ns
2	Interval of each oestrus cycle (days)	31.8	46.3	*
3	Duration of each oestrus (days)	1.75	1.68	ns
4	Diurnal appearance of each oestrus (%):			
	1) Morning (6.00-12.00)	69	62	ns
	2) Afternoon (12.00-18.00)	31	38	ns
5	Number of AI applied (times)	3.2	2.0	*

'Average of 5 heifers. NS = not significant (P>0.05). * = Significant (P<0.05)

Table 6. Interval variation of oestrus cycle (days) during the 9-month period

Sequence of oestrus	Treatment	
	TSFS	NTFS
1st	39-79	25-101
2nd	19-25	16-107
3rd	16-24	16-28
4th.	25-95	19-112
5th	18-42	46-74
6th	13-25	
7th	21-45	
8th	23-53	

[1] Appearance of 1st oestrus cycle after treatment

2. Reproductive capability (measured in terms of true and silence oestrus cycle) of the TSFS heifers was better than that of the NTFS heifer.
3. Physiological puberty (measured in terms of frequency of oestrus cycle) of the TSFS heifers was faster than that of the NTFS heifer.

Natural mating should be carried out to validated the AI technique and longer field experiment is needed to get complete data on the importance of TSFS affecting reproduction of Bali cow.

ACKNOWLEDGEMENTS
The authors wish to thank FAO for the financial support, Udayana University for the facility and the Livestock Service of Badung Regency for the AI facility. The participation of the farmers are acknowledged with pleasure.

Table 7. Frequency and interval of oestrus cycle during the 9-month period

Respond [1]	Treatment		Level of significant
	TSFS	NTFS	
Interval of oestrus cycle (days):			
1) Apparent[2]	31.8	46.3	*
2) Silent[3].	63.1	82.5	*
3) True	20.9	20.1	ns
Frequency of oestrus cycle (times):			
1) Apparent	5.4	3.2	*
2) Silent	3.2	4.1	*
3) True	8.9	6.9	*
Silent oestrus cycle (%)	25.9	37.5	*

[1]Average of 5 heifers, [2] See Table 5, item 1. ns = not significant (P>0.05),* = significant (P<0.05)

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FORAGE DEVELOPMENT IN LAO PDR

G. Sihanath[1]

SUMMARY
Farming systems in Lao PDR are mainly rice based at subsistence level where livestock production plays a supplementary and complementary role. Farmers' priority is on rice cultivation. Buffaloes and cattle are mainly kept in free range systems and are the most important economic animals because of their use for draft power, as a source of animal protein for human cunsumption and for foreign exchange earnings. Constraints in their production are caused by poor animal husbandary, feeding systems and diseases. Recently, several forage improvement programmes were initiated at the Nam suoang Cattle Development Station. In 1994, Livestock Adaptive Research and Extension, DLVS has cooperated in implementing the Regional Tropical Pasture/Forage Development for smallholders in S.E. Asia Project. The main activities of the project are the development of demonstration sites, formulation and implementation of forage training course and supply of planting materials and laboratory equipment. The six demonstration sites were Namsuoang Livestock Adaptive Research Center, Vientiane province, Xienkhuang province, Liang Namtha province and Champasak province. There are few species suitable for the different agroecological zones of the country. More studies are needed to identify promising forages to benefit the farmers.

INTRODUCTION
The Lao PDR is a landlocked country with a total land area of 236,800 km^2 and a population of 4.2 million. About 85% of them are involved in various forms of agriculture. Lao PDR is bordered by Myanmar and China in the North, Cambodia in the South, Vietnam in the East and Thailand in the West. The Lao people are made up of 3 main ethnic groups:

Lao lum
Lao lum (lowland) group comprises roughly two-thirds of the country's population. They traditionally engaged in lowland rainfed rice production and livestock rearing.

Lao theung
Lao theung (midland) group makes up one-quarter of the population. They are engaged in "Swidden" cultivation, primarily upland rice and other food crops mixed with animal husbandry.

Lao sung
Lao sung (highland or mountainous) group has about one-tenth of the total country's population. They practise traditional, pioneering "swidden" cultivation of maize, upland rice and other root crops. They also raise cattle, horses, pigs and poultry.

Livestock production is a component of the country's agricultural economy and is traditionally practised on a subsistence level, complementary and supplementary to crop

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production. Buffaloes and cattle are the most important economic animals, because of their use for craft power and as a source of animal protein, but recently they are being increasingly exported for foreign exchange earnings. In 1993, the livestock population comprises of 1,166,000 buffaloes, 1,009,000 cattle and 140,000 sheep and goat, 1,559,000 pigs, about 9 million poultry birds. Average annual livestock population growth rates for the period 1983-1993 are 2.4% for buffalo, 7.4% for cattle, 2.0% for pigs, 8.5% for sheep and goat, 3.2% for poultry. According to preliminary estimation, the potential natural grassland suitable for grazing in LOAS PDR covers approximately 8.1 million hectares.

Animal husbandry is predominantly based on smallholder production system. Management of the herd is poor and very traditional. There is practically very little or no input in animal health care, better nutrition and breed improvement. Therefore animal productivity is rather low.

FARMING SYSTEMS

Farming systems in the Lao PDR are mainly rice-based at subsistence level where livestock production is a supplementary and complementary component of the systems. Results of surveys show that the lowland areas are predominantly occupied by Lao lum who cultivate paddy rice crop as their main occupation. The farm size averaged about 1.9 ha per household with 2.24 tons of rice yield or an average of 344 kg of paddy per person.

In the farming systems of Xienkhouang plateau, farmers cultivate about 1.8 ha of paddy field per household. They produce enough rice for their own consumption. Cattle, buffalo, pig and poultry are reared for monetary security for emergency use. In Boloven plateau (Champasak province), where there is no suitable land and climate for rice production, farmers (mainly Lao theung) produce cash crops like coffee, potato and cabbage in order to purchase rice from the lowland areas. Labor is concentrated on agricultural production. Aside from crop production, farmers also rear livestock such as cattle, buffaloes, pigs and poultry.

The upland areas are predominantly populated by the Mong people who practise slash and burn shifting cultivation. Each household cultivates about 0.9 ha of upland rice using the slash and burn shifting cultivation technique. The rice yield of about 1 ton/ ha indicates that farmers are not self-sufficient in rice. Planting of com and other crops and rearing of cattle, pigs and poultry are being undertaken to boost agricultural productivity.

CONSTRAINTS IN LIVESTOCK PRODUCTION

Free Range Systems

Livestock production is greatly constrained by poor animal husbandry, feeding and diseases. Buffaloes and cattle are mainly kept in the free range systems. After rice harvesting in the dry season, farmers let loose their buffaloes and cattle for natural grazing for approximately 6 months from November to April. At this time of the year, cattle graze day and night, and gather near drinking water resources or grazing areas. Before the rice planting season, the fammers will look for their animals and take them home. Cattle usually graze about 10 hours a day starting from 7 am. to 5 pm. Buffaloes are used to plough rice field. In Xiengkhuang plateau, almost every night cattle and buffaloes are kept in the pen in order to collect manure for rice field where the soil is infertile. Without manure, rice yield is generally very low.

The major sources of the feed for ruminant are natural grasses, agricultural by-products such as rice straw and tree leaves from the forest. However animal feeding systems vary in different agro-ecological zones such as lowland, plateau and mountainous areas. These have potential natural grazing areas of approximately 8.1 million hectares as follows:

* 2.4 million ha in the lowland
* 0.4 million ha in the plateau
* 5.3 million ha in the mountainous area.

a) Distribution of Cattle

According to the national livestock statistics, cattle are distributed in different densities all over the country. At present cattle are concentrated in the central (Vientiane municipality, Vientiane province) and the southern part of the country (Savannakhet, Saravan and Champasak) at a stocking rate of less then 2-3 ha of native pasture to a beast. During a survey, particularly in the dry season, we noticed overstocking in these areas due to low the carrying capacity of the existing native pasture and the high stocking rates in the lowland areas. This situation suggests that there is a need to improve animal nutrition through forage development, better utilisation of agricultural by-products such as rice straw, sugar cane tops, maize stem and other locally available feed resources.

b) Technical Constraints

There are many technical constraints in livestock production in Lao PDR. Some of the major ones are:

(a) Relatively long dry season, affecting the productivity of the grazing areas. Cattle gain weight in wet seasons and lose weight in dry seasons and are susceptible to diseases.

(b) Limited utilisation of crop residues and by-products due to difficulty in collecting and transporting straw, lack of finance to treat straw, lack of labor to apply the technology, lack of skill to manage the technology effectively.

(c) Lack of good tropical forage technology. Limited choice of suitable grasses, legumes and fodder tree species for use in different agro-ecological systems, i.e. open ranches, smallholdings.

(d) Main parts of the natural grassland are infertile acidic soil, particularly in Xiengkhuang plateau and Savanna land.

c) Socio-econornic Constraints

These are related to:

(a) Farmers' priority is on rice production involving high production input compared to livestock production which generates relatively high output with low production input.

(b) Limited government services to support livestock development and production, research and extension, and lack and/or limited trained staff.

(c) Problems in communications and transportation linkages between regions of potential pasture development. Middlemen usually transport live animals over long distance (sometime it takes a week) from producers to the market.

(d) Insufficient credits for smallholders

PASTURE/FORAGE DEVELOPMENT

Grass/legume pasture demonstration and development in Lao PDR has commenced through collaboration with Australian grants. Namsouang Cattle Development Station was established during 1982 - 1991 to implement several forage improvement programs. Since 1994 Livestock Adaptive Research and Extension, DLVS has cooperated in implementing the regional Tropical Pasture/Forage Development for smallholders in S.E.Asia Project under FAO programmes (TCP/RAS/2361).

Main activity

In order to achieve the objectives listed in the project memorandum to solve the shortage of forage resources for livestock production in Lao PDR, programmes on improving fodder production, and year-round stock feeding systems were instituted. The package technology in tropical pasture for livestock production has been development and introduced. Technologies are transferred to farmers through the training course and demonstration on cultivation of tropical pasture/forage. The progress of the implementation of the project up to date is described below:

- Experimental site for demonstration
- Formulation and implementation of training course
- Supply of planting materials and laboratory equipments for smallholders
- Presentation of results of demonstration trials

<u>Experimental sites for demonstration</u>

Six sites (*Fig. 1*) have been selected for extension and demonstration purposes. They are:

(i) *Narn souang Livestock Adaptive Research Center*

This research station was established by Lao-Australian Livestock Development project. The demonstration of tropical forage development in this station are:

(a) Pasture/forage management trials (a grazing trial with four stocking rates (1 to 4 beast/ha)

(b) Estabilishment of 1.5 hectares of fodder trees to demonstrate the benefits of fodder trees to improve livestock feed especially protein supplement feeding during the dry season. The species include *Leucaena, Gliricidia, Acacia* spp.

(c) Production potential of 5 hectares of improved tropical grasses and legumes. These include ruzi grass, signal grass, koronivia grass, gamba grass, guinea grass and centro.

(d) A nursery has been established at this station to propagate the fodder tree seedlings for distribution to farmers around Vientiane province. Seedlings of *Leucaena, Sesbania* and *Calliandra* are being propagated.

(ii) *Vientiane province*

Vientiane province is located in the lowland area. The farming system is cultivation of lowland, rainfed rice. Livestock is integrated into this farming system as draught power and as well as saving bank. This means farmer will sell their animals when the need for cash is urgent such as shortage of rice consumption due to natural disaster i.e drought and flooded. The main livestock feeds are rice straw and natural grassland which are of low quality. The shortage of feeds occurs in both dry and wet seasons.

During the wet season, grazing areas are limited because it is rice planting time and livestock cannot graze freely. Livestock are fed mainly with rice straw from May to mid-October. In the dry season, livestock are allowed graze freely on the paddy field after harvesting. However the quality of natural grasses is poor due to the maturity and lack of water in the dry season.

Two model farmers have been selected for demonstration of high productivity of pasture/forage production. These are key farmers to demonstrate pasture and forage production around this area.

(A) Nongtaleo Agriculture Farm. The pastures are mainly *Brachiaria decumbens* (signal grass) and *B. ruziensis* (ruzi grass).

(B) Namham Farm. The pasture demonstration includes 4 hectares of improved pastures. The species planted are *Brachiaria decumbens* (signal grass), *B. ruziensis* (ruzi grass), *Andropogon gayanus* (gamba grass), *Panicum mazimum* (guinea grass) and *Paspalum plicatulum*. These are 2 hectares of improved native pastwe oversown with legumes such as *Stylosanthes* spp..

(iii) *Xienihuang province*

Xienkhuang province is located in northeast of Laos. It is a plateau, rich in natural grassland resource for livestock production and has high potential for development of the ruminant industry. Rainfed paddy rice is cultivated on flat or valley land while slash and bwn is practiced for upland rice and upland crop. Livestock are kept for draught power, and as saving bank. Animal manure is used to fertilise paddy rice field. To meet demand of animal manure for paddy field of 1.5-2 hectares per family, approximately 5-10 head of cattle or buffaloes per family are kept.

Livestock mainly grazed on natwal grassland and rice fields after harvesting. The shortage of feed occurs in dry season from October to mid May. Although in the wet season the natural grassland is enough for livestock, but the forage quality is very low due to the poor soil fertility. Most of the soils in this plateau lack phosphorus.

One cattle farm on this plateau has been selected for demonstration of tropical pasture/forage development. The farm has a 2-hectare area established with the following:

i) Grasses: signal grass, ruzi grass, pwple guinea, gamba grass.

ii) Legumes: Hedge Lucerne, Calliandra, Chinese pigeon pea and

iii) Sub-tropical species have been suggested by C.P. Chen project consultant such as *Setaria sphacelata* cv. Nandi, *Pennisetum clandestinum* (Kikuyu), *Desmodium intortum* (Greenleaf desmodium) *D. uncinatum* (Silverleaf desmodium), but the seeds are not available.

(iv) *Luang namtha province*

Luang namtha located in the north of Laos is a mountainous province. All villagers practise shifting cultivation in this mountainous areas except for a small minority in the valley where rice is grown. Livestock are kept for draught power and also as "saving bank". Livestock are sold when cash is needed. Livestock are grazed on upland crop areas after harvesting and also in forest. The shortage of feed occurs in the dry season from the end of October to mid May.

Two farmers have been selected for demonstration of tropical forage cultivation. Generally, farmers are not bothered with the forage development for ruminant production because of their ignorance on improved pastures. This demonstration trial has resulted in successful adoption by farmers around the place of work

The demonstration trial (0.5 hectares).

i) Grasses: signal grass, ruzi grass, *Paspalurn plicatulum*, gamba.
ii) Legumes: centro, *Stylosanthes hamata* cv Verano, *Leucaena*.

(v) *Savannakhet province*

Savannakhet province is situated in central Laos. The farming system is mainly rainfed rice cultivation. Livestock are kept for draught power and as "saving bank". Livestock graze mainly in grassland and paddy fields after rice harvesting. The shortage of feed occurs in both wet and dry seasons. In the wet season cattle are grazed on the waste land which has not being planted with rice. There are limited grazing land during the season. However, in the dry season cattle are grazed freely in the paddy field, but the quality of feed is very low. Cattle and buffaloes are usually calve during at this time. High mortality of small calves occurs in the dry season due to the lack of nutrition.

In this province one progressive farmer has been selected for demonstration of tropical pasture/forage. About 3.5 hectares of improved pasture have been established. The species indude:

(i) Grasses: *Brachiaria decumbens* (signal grass), *B. ruziziensis* (ruzi grass), purple Guinea and Koronivia grass.
(ii) Legumes: *Stylosanthes* spp. and *Leucaena*.

(vi) *Champasak province*

Champasak province is in the southern part of Lao. It is located in both the lowland and the plateau. For demonstration of pasture/forage, Bolovens plateau has been selected to be the project site because of the slash and burn farming system for crop production. These include tea, coffee and some root crops and tubers and also upland rice but the rice production low. Farmers sell their livestock and some cash crops to buy rice for their family consumption.

CONCLUSION

Forage development for livestock production in Lao PDR is secondary to rice production at subsistence level. Farmers mostly raise cattle and buffaloes under the low input and low output free range systems. From past experiences there are a few forages species suitable for the different agroecological zones. However more studies in forages species, and development of extension package technology will benefit the smallholders.

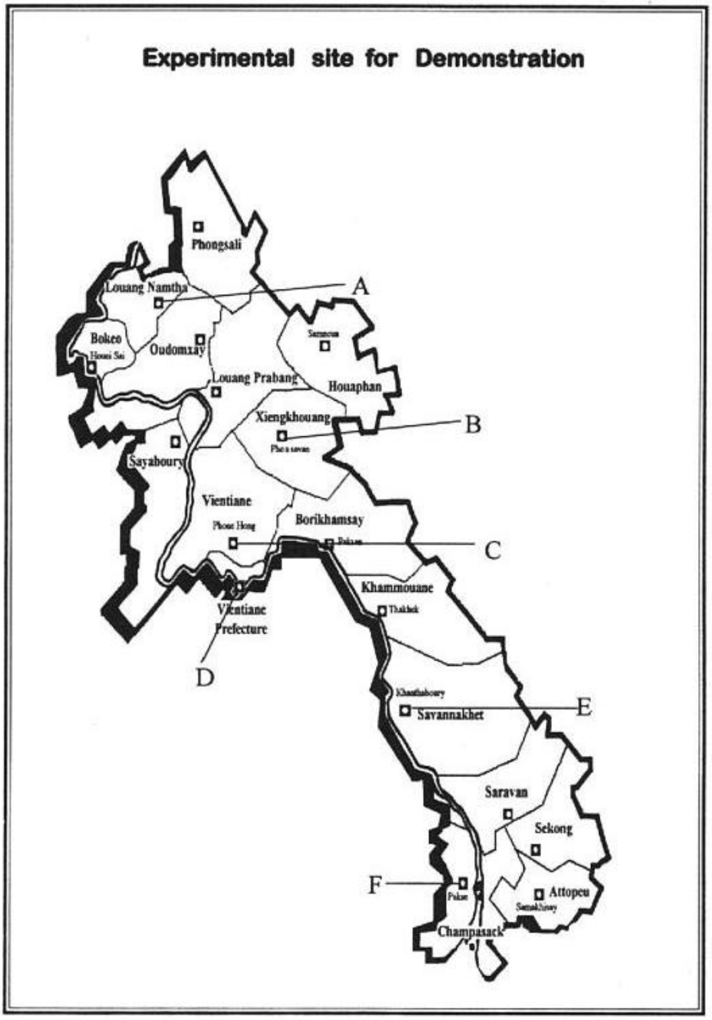

Fig. 1. Experimental site for demonstration of tropical forage production

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THE SELECTION OF HYBRID LINE LEUCAENA FOR FORAGE PRODUCTION IN THE TROPICS

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SUMMARY
The hybrid lines of *Leucaena leucocephala x L. diversifolia* crosses for forage production were screened at 4 different agro-ecological sites. Preliminary results of the F5 generation indicated that the potential in the selection of acid-soil/psyllid tolerant plants for tropical environments was tremendous. The lines, 40-1-18, 62-6-8 and 62-6-3 were consistently outstanding in their performances at the 4 sites. Selection of the few promising hybrids was based on growth vigour, medium to large leaflet, large leaf and good branching with short internodes to maximize edible dry matter (EDM).

INTRODUCTION
The persistence to intensive defoliation of *Leucaena leucocephala* (Wong and Mohd. Sharudin, 1988) has gained its recognition as a high-valued leguminous crop to livestock in Malaysia. With the onset of devastation from psyllid insect (*Heteropsylla cubana*) on *Leucaena* in the mid-1986, there has been a slack of interest by the end users. During this time, it was observed that the severity of damage was not severe enough to destroy the whole plants. The psyllid population has been observed to fluctuate between seasons. Possibly, this might be linked with the build-up of predatory and parasitic insects.
In view of its centre of origin being in South and Central America, the edaphic conditions in Malaysia are definitely problematic to cultivation of Leucaena. The selection of acid-soil tolerant Leucaena species and its interspecific hybrids between *L. Ieucocephala* and *L. diversifolia* (Hutton 1990), gave promising results of *Leucaena* production in the oxisol and ultisol soils.

Screening of the above hybrid lines in diversified agro-ecological environments would allow greater observation in the variability of the plant materials. Of all the 4 sites, the two in the south were taken to select promising plant materials for acid soil tolerance (2.7-3.2 at Kuala Linggi; and 4.0-4.5 at Serdang) and high aluminium (60-80%) saturation. Whilst the other 2 stations in the north are indicative of better environments for seed production and plant growth. Initial results indicated that the major minerals, N, P, K contents in hybrid plants were higher (Lim and Chen 1993) but no significant differences between lines. Calcium levels in young leaves were usually low but the acid tolerant hybrid lines were having higher values reaching to those levels of old leaves. There were great variations in agronomic measurements (flowering, plant vigour, height and stem girth), in digestibility and in tannin contents between and within hybrid lines, showing good opportunities for selection of plants with contrasting characteristics.

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Present report highlights the evaluation and selection of some promising hybrid lines in a range of acid soils located at the 4 different sites in Malaysia.

MATERIALS AND METHODS

There were 7 selected *Leucaena* lines of hybrid crosses between *Leucaena leucocephala* and *L. diversifolia* in the F5 generation assessment (Table 1).

Table 1. Hybrid *Leucaena* lines (F5) selected from different agro-climatic environments for further assessment

Kuala Linggi & Serdang (Bulked)	Jeram Pasu Bulk (Bulked)	Bukit Tangga & Gajah Mati (Bulked)
40-1-18	40-1-18	40-1-18
62-6-8	62-6-8	62-6-8
53-1-4	53-1-4	53-1-20
62-6-3	62-6-3	62-6-3
53-3-15	ML1*	
39-2-18	Cunningham*	
51-1-14		

*Control

The involvement with *L. pallida* crosses was dropped because of poor performance earlier. Screening of hybrids were conducted at the four agro-ecological sites viz. (a) Kuala Linggi (KL), Malacca of acid sulphate soil, (b) Serdang (S), Selangor of sedentary inland soil, (c) Jeram Pasu (1P), Kelantan of granite-wash soil, and (d) Gajah Mati (GM), Kedah of alluvial soil. Details of these agro-ecological sites were reported earlier (Chen and Hutton 1993). There were not much changes on experimental sites since the overall allocation of land for pasture research was predetermined. The great variations of soil were at Jeram Pasu and at Kuala Linggi where flood caused tremendous disturbance to the results obtained.

It was apparent that selection emphasis was biased strongly on materials coming from Serdang and Kuala Linggi sites which had low pH and poor soil fertility. Seeds of best F4 plants from these stations are planted individually in rows of 2m x lm x lm. Seed materials of F4 plants from Gajah Mati and Jeram Pasu stations which had higher pH and better soil conditions were bulked within each lines for agronomic evaluation. The duplication of similar lines in experiments was undertakev to check on performance differences of two sources of same plants materials, and to select some plants for local production in specific environments. There were 23,500 F5 seedlings planted in 1994 season comprising 46% at Serdang, 21% at Kuala Linggi, 16% at Jeram Pasu and 17% at Gajah Mati. We were fortunate to obtain almost 100% (with small percentage from Serdang) selection of these F5 trees from Kuala Linggi site which saved at least 12 months of time in the process. The dug-out stumps of the F4 selection from Serdang which were transferred to Jeram Pasu for production of F5 seeds, failed badly in establishment, whereas those from Kuala Linggi achieved 90% survival. The plants have yet to produce seed from these F4 stumps at Jeram Pasu.

The agronomic data of Tables 2 and 3 were taken from the top 50-60 plants of each field parameters measured at Serdang, Kuala Linggi and Gajah Mati Stations. The actual overall means of these readings, in fact, were expected to be lower than those shown in the tables especially those of controls which were smaller in population sizes.

Table 2. The agronomic performance of hybrids Leucaena at Serdang in comparison with the controls

Hybrid line	Plant Height (cm)	Girth of stem at 50 cm (cm)	Psyllid Aug. 94		Psyllid Nov. 94	
			Number*	Damage**	Number*	Damage**
40-1-18	209.7	1.66	0.19	0.63	2.53	3.24
62-6-8	216.7	1.69	0.40	0.91	2.37	3.48
53-14	214.7	1.83	2.47	3.14	2.73	3.63
62-6-3	202.7	1.55	2.60	2.57	2.50	3.80
53-3-15	119.0	0.78	1.25	0.65	2.50	3.43
39-2-18	118.0	0.77	1.59	1.27	2.10	3.30
51-1-14	123.0	0.79	1.49	0.66	1.90	2.60
ML1	204.0	1.42	1.92	1.95	3.20	3.30
Cunningham	138.0	1.02	2.30	2.00	3.00	4.10

Scale of psyllid scoring: * number: 0 = no psyllid, 3 = a lot
** damage to shoot: 1 = no damage 5 = seriously defoliated.

Agronomic measurements including plant heights, stem girth at 50 cm, flowering and psyllid attack were monitored. While foliar and soil samplings were carried out according to localities of experiments, the results on flowering and soils, and foliar were not ready for this report.

RESULTS AND DISCUSSION

SERDANG STATION

The large population planting (March-April, 1994) at Serdang contained all the selectea lines, mainly 62-6-3, 39-2-18, 53-1-20 and 53-3-15. Almost all these seeds were collected from the vigourous selections at Kuala Linggi and small amounts of seed from Serdang because the Serdang site gave poor seed set. A similar strategy was adopted for the subsequent selection unless determined otherwise by results from Jeram Pasu and Gajah Mati. Other plantings of these originated from seeds of Gajah Mati (GM), Kuala Linggi (KL)/Gajah Mati (GM) and Jeram Pasu (JP) selection which may or may not have been derived from earlier KL selections.

(a) Psyllid attack

A bad psyllid attack on the hybrid lines occurred (August-November 1994) in Serdang out af the 4 sites. Despite the bad attack, 12 good selections were made in line 53-1-4, and 8 in line 62-6-3. With the prolonged dry weather and unusual hazy sky, psyllid seemed to be spreading fast. It started first (late July) with plant material of line 53-1-4 right at the centre of experimental site. Strange thing was observed on same material which was separated by a 3.0-meter walking path where no psyllid damage was recorded. After entire defoliation of line 53-14 material, the insect started moving out from both sides of the centre to infect lines 62-6-3 and 62-6-8 and subsequently 53-3-15, the controls, the 51-1-4, the bulk materials from JP, GM and BT/GM. Line 40-1-18 which was hardly 25 m away was the last to be invaded by psyllid. Bad psyllid damage was recorded eventually to all those planted materials, but in different sequences. It took about 2 months to complete the whole process. A small amount of rain came in at the last 2 weeks of October 1994. Almost all plants recovered especially the 53-1-4 line. However, a second psyllid attack occurred in November 1994 when the dry and hazy conditions persisted. The results recorded are shown in Table 2. Overall mean values of damage by the insects indicated that line 40-1-18 was the most tolerant materials among all. Other agronomic performance showed that lines 40-1-18, 62-6-8, 53-1-4 and 62-6-3 were better than the controls.

(b) Leaflet size

The aim to select trees with medium to large leaflets and long or large leaves was to give high yield of edible dry matter (EDM) in very acid soil (4.2-4.5 pH). A short internodes and good branching were included for high leaf yield. Comparison of vigour was obtained through measurements of heights and girth size.

With the advance to the F5 generation, stability of leaflet size had been obtained, so selections with medium-large leaflet could be easily selected. Smaller leaflet types, if vigorous, would be retained. The smaller leaflets are often from L. diversifolia parents.

(c) Nutritional aspects

It is very apparently important that without the addition of dolomite, there are distinct differences in subsoil Ca and Mg. Thus, it is vital to do appropriate soil profile samplings (0-20 cm, 20-50 cm, 50-80 cm) in contrasting areas as well as leaf sampling for N, P, K, Ca and Mg. There were great variations in soil nutrients in both between and within sites because of the non-selective allocation of land to the research programme.

The basic data of soil and plant nutrition are essential to quantify exactly the acid-soil tolerance of those lines compared with that of controls. In selecting the new varieties, the plants have to thrive on exchangeable soil Ca levels at to about 0.2 m eq/ 100 gram soil in order to put real nutrition pressure on these lines. At this stage, the use of Ca (and probably Mg) as a nutrient at about 100 kg dolomite/ha would be practical for small farmer who would probably add this in animal manure applications.

KUALA LINGGI (KL)

The Kuala Linggi planting (17-30 April 1994) was destroyed by flood, but a few survived. Half of the area planted with less promising lines showed good results. Interesting to note the 500 kg/ha dolomite application was essential for Leucaena survival under this very acid conditions at Kuala Linggi. The Ca in dolomite was rapidly converted to CaSO4 by the sulphuric-sulphurous acids in these acidic soils. This gave high exchangeable Ca (0.6 mg eq) in the sub-soil which was easily absorbed by the root tips and quickly translocated to the meristems of the stem tips.

From the remaining plants that survived, it seemed that 40-1-18 was maintaining huge productivity (Table 3). Selection of medium-large leaflet size was thus needed. The original plantings (F3 and F4) of this at Kuala Linggi are still persisting quite well and this gives confidence in its potential as a variety.

Table 3. The agronomic performance of hybrid Leucaena at (a) Kuala Linggi and (b) Gajah Mad Station

Hybrid Line	Kuala Linggi		Gajah Mati		
	Height (cm)	Girth (cm)	Height (cm)	Girth (cm)	Psyllid damage
40-1-18(a)	207.5	1.66	244	1.86	1.08
40-1-18(b)	261.9	2.09	na.	n.a.	n.a.
62-6-8	209.0	1.62	243	1.95	1.29
53-1-4	203.6	1.59	163	2.05	2.71
62-6-3	216.9	1.71	220	1.60	1.37
53-3-15	222.0	1.79	182	1.09	1.36
39-2-18	189.0	1.52	172	1.08	1.58
51-1-14	217.0	1.68	173	1.08	1.71
ML1	261.9	2.09	214	1.45	1.16
Cunningham	-	-	179	1.37	1.65

1ERAM PASU STATION (JP)

All the F5 Leucaena trees planted in 30 April-15 May 1994 were derived from KL F4 seed except those from bulked F4 seeds from superior selection at Jeram Pasu and Gajah Mati. At this stage of growth, the Jeram Pasu plots were disappointing due to significant soil variations from relatively good soil in the first half to poor soil in second half of sloping down to wet area. This should even up the new F5 planting and make selection and assessment more positive.

Unfortunately, the hybrid line 40-1-18 was planted on the sub-soil area which affected plant growth. Despite the poor soil area, growth of hybrid, 40-1-18 was fairly well compared to the other hybrids and the controls. When selections were made at floweringpodding stage, emphasis was given to select only those trees with medium-large leaflets, vigour and leaf size. As expected, there was a tendency towards smal1 leaflets in the selected lines of hybrid. For the bulk of Jeram Pasu planting, it was apparent that seeds from only vigorous, medium leaflet F4 trees had been collected.

Hybrid lines, 62-6-8 and 62-8-3 F4 had a higher proportion of medium-large leaflets although some had too many small leaflets. These hybrids performed well at where the soil conditions were also better and were superior to the controls. They were not enough controls across the area for a good comparison.

Hybrid lines, 53-14 and 53-1-15 were good in the better soil areas and had a higher proportion of trees with medium leaflets.

However, in the next season's replicated F6 plots the controls ML1 and Cunningham will be given equal status as the hybrids and on more uniform soil areas to enable positive comparisons. One line 39-1-9, an l lx25 hybrid from Serdang which had been promising previously would need to be given some consideration. It was unfortunate that many of the dug-up stumps from Serdang for seed production at Jeram Pasu station died, but there were a few vigorous trees surviving. The majority of those Kuala Linggi stumps have grown well and need an application of basic P and K fertilizer and dolomite promote good seed production.

Inspite of the soil problems faced, the overall results on screening at Jeram Pasu indicated that 40-1-18, 62-6-8 and 62-6-3 were superior to the controls. This appeared to apply also to hybrids, 53-14 and 53-3-15 as well.

GAJAHMATI

Here the F5 plots planted from 10-28 May 1994 with seeds from F4 selections at Kuala Linggi, Serdang/Kuala Linggi, Serdang, Bukit Tangga/Gajah Mati and Gajah Mati included all the lines as at the other stations, but smaller in population. In general the area was relatively uniform. The main hybrids, 40-1-18, 62-6-8, 62-6-3 and 53-14, were superior to the controls at the stage of data collection (end of August 1994). The first three lines had a good proportion of trees with medium large leaflets but 53-14 tended to have too many trees with smaller leaflets. The F4 plots planted in 15 December 1992 have grown vigorously (Sm high) in spite of no application of dolomite indicating adequate Ca in the subsoil. The variations in plots resulted in wood rather than leaf production which is confined to the tree tops. At Bukit Tangga where F3 plots planted in May 1991, trees grew to 15-20 m high. The outstanding hybrid was 40-1-18 with an average trunk diameter at 50 cm cutting level of about 10-15 cm, which was significantly greater than that of all other hybrids. This gave confdence in the future selection of 40-1-18.

GENERAL SUMMARY OF FUTURE PROCEDURES NEEDED

A high priority is needed for soil profile and plant foliar analyses during next round selection. The profile samples 0-20, 20-50 and 50-80 cm can be reduced to the number by bulking samples from areas apparently differing in fertility. Analyses includes the pH, P and exchangeable A1, Ca, Mg, K. The foliar analyses needed in stem tips with unfolded leaflets and psyllids free, need to be for Ca while those for green mid-stem leaves need to be for N,P,Ca,Mg and K.

Emphasis in selection should be based on trees with vigour, medium to large leaflets, large leaves and good branching with short internodes. This will maximize edible dry matter (EDM). From current results, it is possible to obtain two new selections one from 40-1-18 (11 x 31 cross) and one from 62-6-8 or 62-6-3 (11 x 25 cross). The first should be good for leaf and animal production, and it could be valuable for wood production if needed. The second would be good for leaf and animal production; and probably it could be easier to manage than 40-1-18.

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DAIRY PRODUCTION THROUGH STRATEGIC UTILIZATION OF PASTURE, FORAGE CONSERVATION AND AGRO-INDUSTRIAL BY-PRODUCTS: A WORKSHOP FOR DAIRY SMALLHOLDERS IN MALAYSIA

C.P. Chen[1]

INTRODUCTION

Although Malaysia is in evergreen tropical environment, the country, like any other developing nation, faces feed shortage problems in livestock production during certain period of time in the year. This is particularly true to these dairy farmers whose situations are further complicated by the lack of forage land. Of course, there are periods of surplus forages and roughages but conservation or utilization has not been practised due to many other reasons. Local researchers have been working on agri-byproducts as animal feeds for some years. A substantial information on methodology of processing, storage and utilization of these by-products have been cummulated over the years. Yet many dairy farmers are still practising the traditional and conservative way of production. The imbalance of protein, energy and mineral in the diet of either overfed or underfed the animals, results in poor milk yield. This is because of the conservative nature and ignorance of farmers who are not able to perceive the impact of tropical grasses and legumes in milk production. It is a known fact that there is a big gap in technologies between researchers, extension workers and livestock producers. An effective extension approach to disseminate the technologies to farmers is through a farmers' workshop and on-farm demonstration to farmers. This approach was boldly adopted to narrow down the technological gap between farmers, extension workers and researchers.

OBJECTIVES

a) To demonstrate and disseminate available technologies in forage conservation and utilization of byproducts to farmers.
b) To assemble information on methods of forage production, conservation and byproduct utilization into a practical handbook as a guide for farmers.
c) To provide a forum for the interaction of farmers with researchers regarding practical problems in feeding during periods of feed shortage.
d) To provide a catalyst for the implementation of existing technologies in forage conservation at the farm level.

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SELECTION OF PARTICIPANTS

Selection of farmers for the workshop was based on their performance and capacity for growth. The capacity for growth of business of farmers relies on the land, the labour and the number of animals available in the farm. Potential farmers of the MCC (Milk Collection Centre) provided by the Department of Veterinary Services (DVS) were selected in principle one from each state based on the above criteria. They were 20 dairy farmers selected for the workshop. While the resource persons or subject matter specialists from Department of Veterinary Services (DVS), University Pertanian Malaysia (UPM) and MARDI will be invited for participation as trainers. In addition, the key extension workers in major milk production areas were also recruited to the workshop.

List of participants

1. Azman bin Johar Ariffin
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   35000 Tapah, Perak.
2. Hj. Yusof bin Hj. Mohd. Isa
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   06000 Jitra, Kedah.
3. Mohd. Salim bin Ibrahim
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   06000 Jitra, Kedah.
4. Gan Thye Kuan
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   45800 Jeram, Selangor.
5. Hussein bin Ismail
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   43900 Sepang, Selangor.
6. Abd. Majid bin Mat Isa
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   86000 Kluang, Johor.
7. Nasimon bin Kasan
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   80730 Johor Bharu, Johor.
8. Gulam Rasul bin Abdul Rahim
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   16450 Ketereh, Kelantan.
9. Bachalal Babutiram
   Pusat Pengumpulan Susu
   Jabatan Perkhidmatan Haiwan
   77000 Jasin, Melaka.
10. Chok Tong Juan
    Pusat Pengumpulan Susu
    Jabatan Perkhidmatan Haiwan
    77000 Jasin, Melaka.
11. Mohd. Shah bin Lembek
    Pusat Pengumpulan Susu
    Jabatan Perkhidmatan Haiwan
    72000 Kuala Pilah
    N. Sembilan.
12. Hj. Ahmad bin Bakar
    Pusat Pengumpulan Susu
    Jabatan Perkhidmatan Haiwan
    14200 Sg. Bakap
    P. Pinang.
13. Atan bin Mohamad
    Pusat Pengumpulan Susu
    Jabatan Perkhidmatan Haiwan
    21400 Bukit Payong
    Terengganu.
14. S. Shanmugam
    Pusat Pengumpulan Susu
    Jabatan Perkhidmatan Haiwan
    28700 Bentong Pahang.
15. Shabbir bin Ahmad
    Jabatan Perkhidmatan Haiwan
    06000 Jitra, Kedah
16. K. Pathamanathan
    Jabatan Perkhidmatan Haiwan
    35000 Tapah, Perak

17. Tn. Hj. Kamarulzaman b. Mohd. Ramli Jabatan Perkhidmatan Haiwan
28700 Bentong Pahang

18. Bahrum b. Jamil
Jabatan Perkhidmatan Haiwan
77000 Jasin
Melaka

19. Loh Teik Sin
Jabatan Perkhidmatan Haiwan
43900 Sepang Selangor

20. Harchand Singh
Chop Lam Thye Trading Sdn. Bhd.
31, Jalan Besar
4100 Klang Selangor

CONTENTS OF TRAINING/WORKSHOP

1. Feed Resources for Dairying in Malaysia.
   Ahmad Tajuddin Zainuddin
2. Forage Species for Strategic Utilization
   Wong Choi Chee and Chin Fook Yuen
3. Establishment of Improved Forages
   Idris A. Bakar, Ghazali Hussin and Aminah Abdullah
4. Roles of Legume in Pasture and Animal Production
   Ridzwan A. Halim
5. Forage Management for Efficient Production and Utilization
   Chen Chin Peng and Choo Teck Wah
6. Conservation of Feeds for Dry Season Feeding
   Mohd. Najib Mohd. Amin, Aminah Abdullah and Idris A. Bakar
7. Exploitation of Fodder, Browse Shrubs and Other Herbaceous Species for Forage Use
   Chin Fook Yuen and Tay Kim Soon
8. Utilization of Crop Residues and Agricultural By-Products
   Razak Alimon, Yusoff Sudin and Abu Hassan Osman
9. Use of Urea-molasses Mineral Blocks (UMMB) to Improve Feeding of Dairy Cattle
   Wan Zahari Mohamed and Yusoff Sudin
10. Roles of Women in Dairy Industry
    Zaharah Salleh
11. Dairy Feed Formulation Using Locally Available Feed Resources
    Abu Bakar Chik, Mohd. Yunus Ismail, Mohd. Ariff Omar and Azizan Abd. Rashid
12. Video/Slide show, pracdcal work and field visit
    (a) Integration of cattle with oil palm plantation (RISDA ESPEK, Trengganu)
    (b) Utilization of oil palm frond as animal feed resources for (i) dairy and (ii) beef cattle production (smallholder farms).
    (c) Ammonia treatment for straw (video)
    (d) Fibrous materials (rice straw and corn stover) for animal production (video)
    (e) Forage museum and forage conservation (MARDI).

EXPENDITURE AND IMPLEMENTATION

With the full support and cooperation from leading national institutions such as DVS, MARDI and UPM in the form of providing transports, training facilities, communication backup and allowance for travelling of of ficers, the budget allocation by FAO of this project was solely used for operation. Total expenditure incurred was RM$5366 (US$2146) for a 4-day workshop (15-18 August 1994) at MARDI, Serdang including 20 small dairy farmers and 14 resource officers involved with lecturing and demonstration. The medium of instruction was in Malay but lecture notes were prepared in both the Malay and English languages.

FINDINGS AND CONCLUSION

1. There is a big gap between farm production and research in technologies on nutrition, animal husbandry and feeding system which need to be redress through processes of extension, on-farm demonstration and discussion with farmers.
2. Many farmers do not understand the concept of utilization of forages and by-products in feeding system as balanced diet (protein, energy etc.) to milking animals. Farmers tend to either overfed or underfed their animals especially when dealing with different physiological classes animals. Hence, it results to poor milk yield and lower profit.
3. In view of the present favourable milk prices in the market, improvement of forage based feeding regimes at farm level, will lead to greater success of dairy production. Farmers are relatively ignorant over the utilization and cultivation of tropical forage legumes and shrubs in dairy production.
4. Farmers requested if a frequent meeting/dialogue/discussion of this kind could be held for dissemination of research information and packages of new technology.
5. This workshop achieved all its objectives except that the publication of handbook for farmers from the workshop lectures was not made possible due to insufficient fund.

ACKNOWLEDGEMENTS

The reporter would like to acknowledge the approval for this country project by FAO Forage Regional Working Group of Southeast Asia. The full support given by MARDI, DVS and UPM and by the organising committee and all the invited speakers is greatly appreciated.

IMPROVED PASTURES UNDER COCONUTS IN BICOL

F.A. Moog, A.G. Deocareza and H.E. Diesta[1]

SUMMARY
Grazing trials on improved pastures particularly signal grass (*Brachiaria decumbens*) under coconuts conducted in Albay province showed that a higher income was obtained from coconut plus cattle operation compared to that of coconut alone. The trials which are being continued had served and will continue to serve as demonstration trials on pasture development in Bicol region. With the trial farmers taken to planting materials of improved pasture species, they have undertaken to establish, propagate and further distribute to other farmers.

INTRODUCTION

It is estimated that 3.2 million ha of the total land area (30 million ha) of the Philippines are planted to coconuts (PCA 1989). Coconut plantations in Mindanao account for more than 50% of this area, and the remaining areas are located mainly in Southern Luzon (including Bicol Region) and Visayas.

Average nut production is estimated at a low of 49 nuts/tree/year or about 4649 nuts/ha/year. There are marked regional differences in production ranging from 64 nuts/tree/year in Southern Mindanao to 38 nubs/tree/year in Central Luzon. Approximately 25% of the 401 million trees planted are non-bearing or unproductive. Coconut farmers with an average land holding of only 3.3 ha have an estimated net income of only $164 per year.

With the current low productivity of coconut plantations, one of the alternative approaches is to integrate livestock particularly cattle under coconuts.

Grazing Trials

Guinea grass and pare grass am the most common species grown under coconuts in the Philippines. But signal grass (*Brachiaria decumbens*) and humidicola (*Brachiaria humidicola*) are becoming popularparticularly in Albay and Sorsogon provinces where they were observed to be more productive than pare or guinea grass.

Several ongoing studies supported by the Food and Agriculture Organization (FAO) through the Regional Working Group on Grazing and Feed Resource in Southeast Asia on improved pastures under coconuts were reported (Moog 1993). One of the studies compared the performance of cattle on signal grass pastures at 3 different stocking rates (Moog 1993a). The study showed that the best stocking rate for signal grass pastures under coconuts in Albay was 2 beast per hectare (Table 1). Using the results from the study, Table 2 shows the cost and economics returns analysis from coconut alone and coconut plus cattle on signal grass pastures grazed for 533 days at different stocking rates. With coconut alone, only PhP12,750 return per hectare was obtained but with cattle on signal grass it was PhP16,900-20,800.

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Table 1. Mean Liveweight gains of cattle grazing on grass pasture at different stocking rates (December, 1991 - May 18, 1993).

PARAMETER	TREATMENT		
	A	B	C
Number of animals	6	6	6
Observation period (days)	533	533	533
Initial weight (kg)	164.15	161.61	64.65
Final weight (kg)	343.7	323.7	294.7
Average daily gain (kg)	0.34	0.30	0.24
Total liveweight gain/head (kg)	179.55	158.15	130.05
Total liveweight gain/ha (kg)	179.55a	315.34b	391.54b
Total LWG/ha/year (kg)	124	219	262.8

Legend: TA - Signal grass at 1.0 a.u./ha
TB - Signal grass at 2.0 a.u./ha
TC - Signal grass at 3.0 a.u~ha

Note: Figures with similar superscript are not significantly different P<0.05).

Table 2. Cost and economic returns analysis from coconut alone and coconut + cattle on signal grass pastures. (PhP/ha/year)

ITEMS	COCONUT FARM (CONTROL)	COCONUT + CATTLE		
		A Signal 1.0 a.u./ha	B Signal 2.0 a.u./ha	C Signal 3.0 a.u./ha
Cash Expenditures:				
1. Establishment cost per ha (PhP) [a]	-	1,849	1,849	1,849
2. Biologics	-	200	400	600
3. Maintenance cost	-	1,000	1,000	1,000
Total expenditures	-	3,049	3,249	3,449
Income from cattle [b]	-	6,200	10,950	13,140
Income from coconut [c]	12,750	13,776	12,915	11,193
Total income	2,750	19,976	23,865	24,333
Total net income	12,750	16,927	20,616	20,884

[a] Cost of land preparation, labor for planting, planting materials, fertilizer, labor for forcing, barbed wire and fence posts spread in 8 years.
[b] at PhP50/kg LW
[c] at PhPl.00/nut

The Bicol region, which includes Albay is frequented by typhoon and if a strong one comes in a year, no nuts can be harvested for the next two years. This observation clearly indicates that integrating cattle under coconuts in typhoon prone areas will ensure income to farmers from his land rather than not having anything at all when a catastrophe comes.

Results of another study compared the performance of cattle at 1 and 2 a.u./ha in the first 2 sets or batch of animals. Higher liveweight gains were observed in the first set at lower stocking rate (1 a.u/ha) than at 2.a.u./ha. However, the second set of animals had higher liveweight gains at 2 a.u./ha compared to 1 a.u./ha. indicating that higher quality herbage was available to grazing animals at 2 a.u.tha and mature herbage was accumulating at the lower rate (1.0 a.u./ha).

Table 3. Mean liveweight gains of cattle grazing on signal pasture at different stocking rates (a../ulha)

Parameters	Grazing Period and Stocking Rate (a.u./ha)	
	February 1991 to June 1992	
	1	2
ADG (g)	465	431
LWG/hd (kg)	109	134
LWG/ha (kg)	109	268
	August 1992 to March 1994	
	1	2
ADG (g)	240	371
LWG/hd (kg)	142	219
LWG/ha (kg)	142	438
	May 1994 to December 1994[1]	
	2.5	3.0
ADG (g)	350	490
LWG/hd (kg)	72	100
LWG/ha (kg)	72	200

[1] UMMB supplements given

In the third set of animals, stocking rates were raised to 2.5 and 3 au/ha (because based on herbage data there were more than enough biomass for 1 and 2 au/ha) and UreaMolasses-Mineral-Block (UMMB) supplementation in both stocking rates. UMMB improved the liveweight gain performance of animals compared to the second set even with high stocking rates. Higher liveweight gains were attained at 3.0 au/ha compared that of 2.5 a.u/ ha. This could be attributed to the presence of *Centrosema* in the pasture at 3.0 au/ha but none at 2.5 au/ha. The presence of *Centrosema* could be attributed to higher stocking which reduce the competing ability of signal grass against the legume.

The model farm and its role in pasture development

Grazing trials undertaken by Ligao Farm Systems Development Inc. serve as models on demonstrating the importance and value of improved pastures in livestock production. The farm serves as a model during field visits of livestock technicians and farmers. With the trials farmers readily became aware of the value of having improved pastures which leads them to be motivated on pasture development.

Ligao Farm Systems Development Inc. is initially the center for pasture development which started in 1988 for signal grass. Pasture development for signal grass was expanded and had reached a total of 60 hectares. In February 1992, *Brachiaria humidicola* (BAI) was introduced and initially established in 0.5 ha-area. Its main objective is to have a nursery for expansion and to be used for a grazing trials in the farm. *Brachiaria humidicola* was later expanded to about 100 hectares due to ease of establishment, high herbage production, persistent, palatable and adaptable under local conditions. The farm serves as a source of planting materials for farmers and cooperatives not only in the province of Albay but in the neighboring provinces such as: Camarines Sur, Masbate and Sorsogon.

Pasture development in smallholderfarms

Individual farmers and cooperatives who visited the demonstration trials with grazing animals in Ligao have developed interest on planting improved pastures in their own farms. More often, before they leave the farm they usually bring along planting materials of either signal or humidicola or both. In fact, those who wish to plant larger areas usually come back to the farm to gather the required plandng materials.

Farmers who got planting materials were monitored. Coordination with the Provincial Veterinary Services and the local municipal staff specifically the Municipal Agricultural Of ficer (MAO) in every municipality in the different towns of Albay is being done.

In general, farmers prefer signal and humidicola over the other species. With cut-and-carry system, napier finds its place, but in smaller scale of plandng.

Degree of success in establishing and monitoring pasture varies among farmers. Cost of pasture are to stray animals of neighbors, absence of fencing, negligence and lack of control on number of stock to graze the pasture. Solving some if not all of these problems will help a lot in convincing farmers to pursue pasture development.

SUMMARY AND CONCLUSIONS

The existing pasture demonstration trials in Ligao, Albay had served and will continue to serve as tools for effective extension work on pasture development under coconuts in Bicol. Observations show that initial planting of farmers who got planting materials of signal grass and humidicola from Ligao has been multiplied and redistribution of planting materials to other farmers has been going on.

Considering the distribution of farmers who planted the various pasture species, monitoring would be difficult. There should be attempts to concentrate efforts of research and extension people focus on specific site(s) where success in pasture development would have high degree of success and experiences gained to be modified and adopted in other sites.

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DEMONSTRATION TRIALS ON UTILISATION OF FODDER TREES AND SHRUBS, CROP RESIDUES AND BY-PRODUCTS FOR SMALL DAIRY FARMS

S.Udchachon and W. Boonpuckdee[1],

SUMMARY

Ten demonstration farms were set up in each of the two provinces, Khon Kaen and Udomthani. The main objective was to demonstrate to farmers how to solve the problem of feed shortage in the dry season through the use of crop residues and fodder trees. There were five major activities such as demonstration on utilisation of crop residues, utilisation of fodder trees, introduction of new forage species, irrigation of pasture species in dry season and field days. Locally available crop residues such as corn stove, cassava leaves, soybean pod husks, sugar cane tops and molasses were tested for adoption by farmers. Five species of fodder trees such as *Leucaena leucocephala, Erythrina subumbrans, Cajanus cajan, Desmanthus virgatus* and *Gliricidia sepium* were investigated for establishment, yield and utilisation. Development of a small irrigation system was undertaken to overcome water stress in the dry season. Impacts on other farmers and the policy of Livestock Development Department on dairy extension were discussed.

INTRODUCTION

Dairy farming has become an important career for Thai farmers in the northern part of the Northeast Thailand since 1991 when a pilot project on dairying was established. More than 3,000 pregnant heifers were imported and provided to farmers under a loan scheme. The project is going well and, at present, expanding. A large milk processing plant will be constructed at Khon Kaen to handle the rapidly increasing raw milk production in the near future.

Dairy areas may be classified into two zones, upland rainfed area and lowland irrigated area. The major constraint in both zones is feed shortage in the dry season from November to May. The problem is more critical to farmers in upland rainfed areas than farmers in irrigated areas. Dairy cattle are fed on rice straw and heavily supplemented with concentrate. This has resulted in a high cost of milk production. In the long term some very poor farmers may not survive in such a system. Although there are some crop residues available, a number of farmers are unaware that they can be used as animal feeds and do not know how to use it effectively. Available crop residues from upland areas are rice straw, cassava leaves, sugar cane tops and molasses. In the lowland area, rice straw, corn stover and soybean pod husks are available. This project was to demonstrate to the farmers on the use of available resources in their areas for animal production. The project also continued the incompleted trials carried

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out during 1991-1992 under the project "Demonstration trial on suitable backyard pasture utilisadon for small dairy farm in Khon Kaen." supported by FAO under the Plant Production and Protection Division.

Main objective: To demonstrate to the farmers on how to solve the problem of feed shortage in dry season.

Location: Khon Kaen and Udornthani province.

Duration: September 1992 - August 1994.

Target farm: 10 farms in each province.

Methodology 1. Training.
2. Regular individual farm visits.

RESULTS

More than 100 farms were surveyed but only 20 farms were selected as demonstration farms. There were five major activities which include: (a) Demonstration on utilisation of crop residues.

(b) Demonstration on utilisation of fodder trees.
(c) Introduction of new pasture species.
(d) Irrigation of pasture in dry season.
(e) Field days.

(a) ***Demonstration on utilisation of crop residues***

Available crop residues are corn stove, cassava leaves, soybean pod husks, molasses and sugar cane tops.

From 1993 to 1994, more than 400 farmers received training on feeds and feeding for dairy cattle under the cooperation of the provincial livestock office and provincial cooperative office in both Khon Kaen and Udornthani provinces. The utilisation of crop residues was one of the topics. After the training courses, follow up farm visits was carried out by regularly. After a few months of visiting and advice, it was found that com stove, soybean pod husks, cassava leaves and molasses were well adopted whereas sugar cane tops had not been adopted yet. The main reason for low adoption was the lack of labour to collect and chop the sugar tops. Also collection of sugar cane tops was hard work compared to collection of crop residues.

(b) ***Demonstration on Utilisation of Fodder Trees***

Five species tested were *Erythrina subumbrans*, *Leucaena leucocephala*, *Cajanus cajan*, *Gliricidia septum* and *Desmanthus virgatus*

There were two stages of work:

Stage I. - Establishment of fodder trees.

Stage II. - Utilisation of fodder trees.

Stage: I. Establishment of fodder trees
Since the project period was short, most of the work was in stage I.

Erythrina subumbrans

On farm activity
In 1993, 1,403 stem cuttings were provided to 7 farms in Khon Kaen and 6 farms in Udornthani (Append II.). Survival rate after one year was 54.81 %. The high mortality of the cuttings was attributed to drought and grazing by animals as annual rainfall was only 946 mm compared to the average of 1,182 mm. Survival of cuttings in field planting was higher if they were planted in well prepared beds and early in the rainy season. Good establishment was achieved by incorporation of cow manure into the seed beds at a rate of 2-3 kg/plant (fresh weight) and watering every 10-15 days during the critical dry periods. For the well established plants, leaves of Erythrina were sampled from 30 plants. Average leaf yield for the first harvest was 1.74 kg/ plant as fresh weight or 0.65 kg/plant as dry weight. Farmers fed fresh Erythrina leaves to animal by picking the leaves from the trees manually or let the animal graze freely. Leaf of *Erythrina* is very palatable to the animal. In 1994, 1,340 stem cuttings were provided to 21 farmers.

On station activity
Due to the poor establishment, an experiment was conducted to study the establishment constraints in *Erythrina*. Effect of hormone NAA on *Erythrina subumbrans* cutting growth. The experiment was carried out in cooperation with the Chaing Yuen Animal Nutrition Station. There were 4 treatments with 4 replications.

T1 = Control
T2 = Dipping *Erythrina*'s branches into NAA sol u don (L-naphthylacetic acid) at a concentration of 1,000 mg/L. for 30 seconds before planting in plastic bags filled with soil.
T3 = Dipping *Erythrina's* branches into NAA solution (L-naphthylacetic acid) at a concentration of 5,000 mg/L. for 30 seconds before planting in plastic bags filled with soil.
T4 = Dipping *Erythrina's* branches into NAA solution (L-naphthylacetic acid) at a concentration of 10,000 mg/L. for 30 seconds before planting in plastic bags filled with soil.

Branches of *Erythrina subumbrans* were cut into 30 cm. Iengths and dipped into NAA solution of various concentrations, depending on the treatments.
The following data was collected.
- Date of leaf appearance.
- Leaf and branch number.
- Plant height.
- Root weight.

In every treatment new shoots started to appeared 17-18 days after planting in plastic bags. There were about 34 shoots appearing almost simultaneously but development was slow. Number of branches were similar in every treatment. There were 4-5 branches per plant until the end of the experiment. Young leaves appeared in the fifth week after planting. Pattern of leave growth is shown in Figure 1. After four months, average plant height was 94 cm and average root dry weight was 1.93 g per plans (Figure 2). No significant difference was found in terms of those parameters mentioned above.

Selection of *Ervthrina subumbrans* variety

It was observed in a surrvey that plants from different locations were different in growth performance. The most obvious was the amount of thoms on branches and stem. *Erythrina* plants collected from Udomthani, Khon Kaen and Mahasarakham provinces had the lowest, medium and the highest amount of thoms, respectively. The number of thorns on a young branch 30 cm. in length, less than two months of age, were 18.61, 23.44 and 50.98 for the varieties collected from Udomthani, Khon Kaen and Mahasarakham provinces, respectively. A comparison on plant growth was carried out at Khon Kaen Animal Nutrition Research Center on soil of high fertility. Locations were used as treatments with 4 replications. Plants were grown from branches of size 6 cm. in diameter and 1 m in length. Leaf and branch number were recorded weekly. At 108 days after planting leaves were harvested by hand picking. Leaf number and leaf yield are shown in Table 1. Leaves were harvested every two months after the first harvest. The varieties collected from Khon Kaen and Udomthani province grew faster than the variety collected from Mahasarakham province.

Parental stock plot

The varieties which are medium and/or low in thoms (Khon Kaen and Udornthani) were used as parental stocks at Khon Kaen Animal Nutrition Research Center. Branches were cut at 1 meter in length and planted into soil with a well prepared seed bed. A total of 192 branches were planted at the beginning of the rainy season in 1993. Weeding was done when necessary. About 84 % of the total were successfully established. Three harvests were carried out. Average dry matter yields per plant for the first, second and third harvests were 314,565 and 879 am. respectively (Table 2). Dry matter yield increased with plant age.

Leucaena leucocephala

From field experiences in 1991 and 1992, establishment of Leucaena was unsuccessful in upland rainfed areas. In 1993, only one farmer was provided with Leucaena seedlings. The seed bed was very well prepared. Soil was ploughed to a 30 cm depth. Cow manure was applied before seedling transplanting. During very dry periods, watering was required. After one year, it was found that most of the 2,000 plants were successfully established.

Cajanus cajan. (Pigeon pea).

From field work experience in 1992 under the project "Demonstration trail on suitable backyard pasture utilisation for small dairy farm in Khon Kaen" supported by FAO, it was found that pigeon pea could be established easily from seed by direct seeding. Pigeon pea was the easiest species to establish compared to the other fodder species.

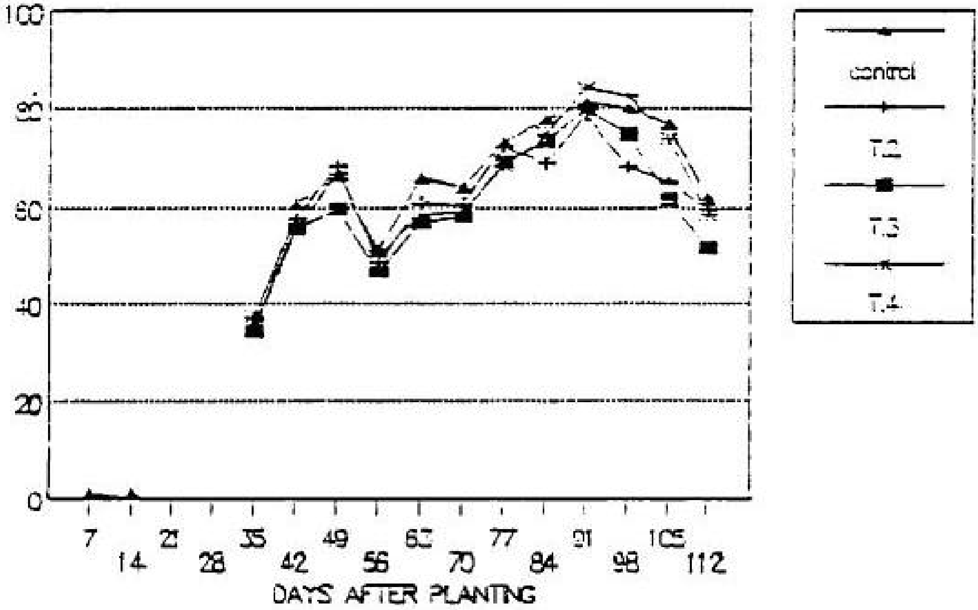


Fig. 1 Leaf number of *Erythrina* seedling

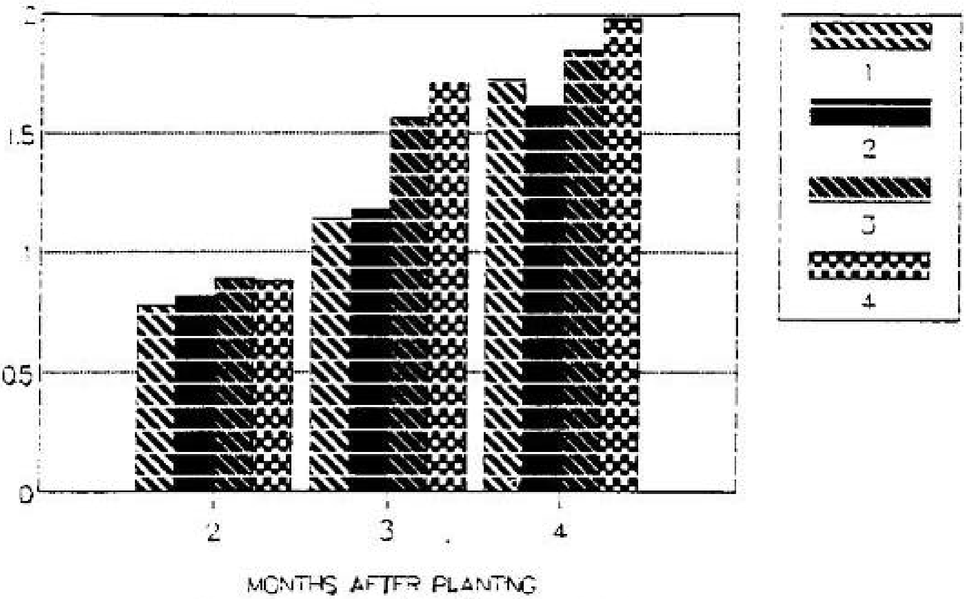


Fig. 2 Dry matter yield of *Erythrina* roots

Table 1. Number of leaves and leaf dry matter yield.

Location	Number of thorns	At 108 days after planting		Total 1eaf dry matter yield (gm/p, or5 harvest.)
		Leaf number	DM(gm/p)	
1. Udornthani	18.61	240.41	0.295	1.96
2. Khon Kaen	23.44	246.71	0.355	2.12
3. Mahasarakham	50.98	165.27	0.196	1.47
CV (%)	10.06	16.08	23.31	22.04
$LSD_{.01}$	**	ns.	ns.	ns.

Table 2. Dry matter yield of *Erythrina*

	Days after planting.	Dry matter yield. (gm/plant.)
First harvest	236	314
Second harvest	365	565
Total for the first year	-	879
Third harvest	455	827

In 1993, farmers were recommended to grow pigeon pea in rows of spacing 2-3 meters, in a mixed ruzi grass and Graham stylo pasture. In the rainy season, cut ruzi grass and Graham stylo were fed to animals whereas pigeon pea was fed to animals in the dry season. Farmers were satisfied with the system. In 1994, they increased the area of pigeon pea / ruzi grass / Graham stylo mixed pasture.

For an existing mixed pasture, 4 methods of introducing pigeon pea into the pastute were tested.

1. Broadcasting of pigeon pea seeds into the mixed pasture with no tillage.
2. Sowing pigeon pea seeds in rows with 25 cm. spacing, into the mixed pasture with no tillage.
3. Direct seed of pigeon pea seeds into small holes of 2-3 cm. depth and 25 cm. spacing.
4. Sowing pigeon pea seed in rows with spacing of 25 cm. on tillage pasture.

It was found that pigeon pea failed to establish using the first two methods. With the third method, pigeon pea established successfully but seedling growth rate was too poor. Plant height after five and a half months was only 1 ft. Dry matter yield was too low to harvest. For the last method of establishment, pigeon pea grew very well and competed successfully with the companion grass and legume. Dry matter yield after five and a half months, by cutting at ground level, was 0.43 kg per one meter row.

S.Udchachon and W. Boonpuckdee

Desmanthus virgatus (Hedge lucerne.)

Seeds of *Desmanthus virgatus* were provided to 11 farmers in 1993. The seed germinated well and seedlings established successfully in three farms where the seed beds had been well prepared; a lot of cow manure was applied and weeding was regular. Seedling growth rate was very slow. However seedlings grew well under sprinkle irrigation even when companion crop with maize. Herbage yield at 3 months after planting was 2,000 kg/rat as fresh weight or 600 kg/rai as dry weight. Crude protein content was 12.73 - 15.20 %. In dry season with no irrigation, herbage yield was very low, but the plants still survived through the drought.

Hedge lucerne was very palatable to animals. However, a disadvantage of this species was the difficulty in establishment. In 1994,44 kg of hedge lucerne seed were provided to 31 farmers.

Gliricidia sepium

In 1993, both seeds and seedlings of *Gliricidia sepium* were provided to farmers. It was grew along fence line. The seed germinated well but later most plants perished during the dry season. In contrast, plants grown from seedlings had a better chance of survival. After one year, survival rate of the 1,982 plants grown from seedlings in 15 farms was 56.17 % but they were still too small to harvest. The slow seedling growth rate and low palatability were the weak characteristics of this species in comparison to other fodder trees species.

In 1994, 770 seedlings were provided to 12 farmers and 559 seedlings were grown for seed production in Khon Kaen Animal Nutrition Research Center.

Stage II. Utilisation of fodder trees

The five fodder tree species were fed to animal as supplementary feed. Fresh leaves were mixed with fresh grass or rice straw and fed to animals. The most palatable fodder trees,in order of preference, were *Erythrina subumbrans, Desmanthus virgatus, Leucaena leucocephala*, *Cajanus cajan* and *Gliricidia sepium*. Some farmers who supplemented their dairy cows with *Erythrina subumbrans* and *Desmanthus virgatus* observed that milk yield per day was increased.

Chemical analysis was carried out in the laboratory while degradability was tested by Nylon bag technique at Khon Kaen Animal Nutrition Research Center (Pimpapom Polsen, personal contact). Nutritive value of the fodder tree species are shown in Table 3. There is no doubt that they can be a good alternative feed resource to replace the utilisation of concentrates. The exception was pigeon pea which had relatively low degradability percentage.

(c) Introduction of new pasture species

Information obtained from the project "Demonstration trial on suitable backyard pasture utilisation for small dairy farm in Khon Kaen" shown that *Panicum maximum* TD58 was the most promising species. Therefore, in 1993 seed was provided to almost 200 farmers in both Khon Kaen and Udornthani provinces. Farmers preferred this species to ruzi grass (*Brachiaria ruziziensis*) and a number of farmers requested for more seeds. Farmers said that regrowth of *Panicum maximum* TD58 was faster and it was easier to cut than ruzi grass. The positive response of farmers to *Panicum maximum* TD58 was one of the reasons DLD produced more seed replacing ruzi grass seed production. The 1994 target for seed production of *P. maximum is 183,000 kg.*

Table 3. Crude protein content and potential degradability percentage (% DMD) of young leaves.

Fodder tree species.	Crude Protein Content (%).	Degradability (%).
1. *Erythrina subumbrans*	22.66	74.79
2. *Leucaena leucocephala*	27.05	78.74
3. *Desmanthus virgatus*	26.46	74.59
4. *Cajanus cajan*	19.63	36.79
5. *Gliricidia septum*	19.24	71.76

(d) Irrigation of pasture in dry season

The project had set up 6 farms in Khon Kaen and 6 farms in Udornthani province as demonstration farms for pasture irrigation in the dry season. The farms used water from different sources such as underground water, water from pond and water from irrigation canals. A small irrigation system was set up to cover 2-5 rai of pasture. Cost for materials of the system was approximately 6,420 baht, comprising of pipe system (3,700 baht) and electric water pump (2,720 baht). A diagram of the pipe system is shown in Appendix III and IV. Forage crop species suited for irrigation and herbage production costs were examined. The tested species were *P. maximum* TD 58, Hybrid sorghum (Jumbo), sweet sorghum (Utong 203) and maize (Suwan 2). Testing will be completed in April 1995.

Irrigation of pasture in dry season has shown that it can solve the problem of feed shortage to some degree. It is realised that an available water supply is an important factor in dairy farming. It has become a policy for DLD that farmers who are going to raise dairy cow must be able to have access a water source. The government is going to support or provide loans to farmers to build up a water source in order to supply suMcient water for use on their farms.

(e) Field days

The project had supported and arranged field days for those members to visit each other. They discussed among themselves and exchanged ideas. After visiting some farmers had improved their farm conditions and animal performance.

Field days had been held many times with the cooperation of many provincial livestock officers. Almost 1,000 farmers and field officers visited these demonstration farms. In addition, 6 short stories on dairying and forage crop had been produced through VDO tapes by using these demonstration farms as information base. The documents have been broadcast on television and are being used as training material.

CONCLUSION AND RECOMMENDATIONS

1. This kind of demonstration farm is a good method for transferring technology to small farmers.
2. Utilisation of crop residues which do not require too much labour, such as corn stove, cassava leaves, soybean pod husks and molasses can be easily adopted by farmers.
3. Utilisation of fodder trees still has the problem of establishment. Establishment technique needs further investigation, with the exception of pigeon pea which can be established easily by direct seeding. Although digestibility of pigeon pea is low it is still better than having nothing to feed animal during dry periods.
4. Introduction of new forage species such as *P. maximum* TD58 was successful. A further investigation for new species, especially legume species needs to be conducted. Pasture species for waterlogging conditions also should be examined.
5. For the farmers who can access to a water source, small irrigation systems can solve the problem of feed shortage in dry season to some degree. In the case of dry spells during rainy season, the irrigation system can also help the young seedlings to survive. However, poor small farmers need loans to set up the irrigation systems.
6. Present demonstration farms should be carry on continued with financial support from DLD or FAO.

ACKNOWLEDGEMENTS

The authors wish to thank the Animal Production and Health Division of FAO for funding this project and also thank to Dr. P.L. Pugliese for his guidance and support.

Appendix I

List of demonstration farms

Khon Kaen province

1. Mr. Somboon Oracha
2. Mr. Uthom Tongphu
3. Mr. Boulai Seankulung
4. Mr. Kongdet Pearchun
5. Mr. Sao Simachun
6. Mr. John Simachun
7. Mr. Phun Nuanbutdee
8. Mr. Sorn Hongwanna
9. Ms. Tongbai Kongchom
10. Mr. Tee Nammongkul

Udomthani province

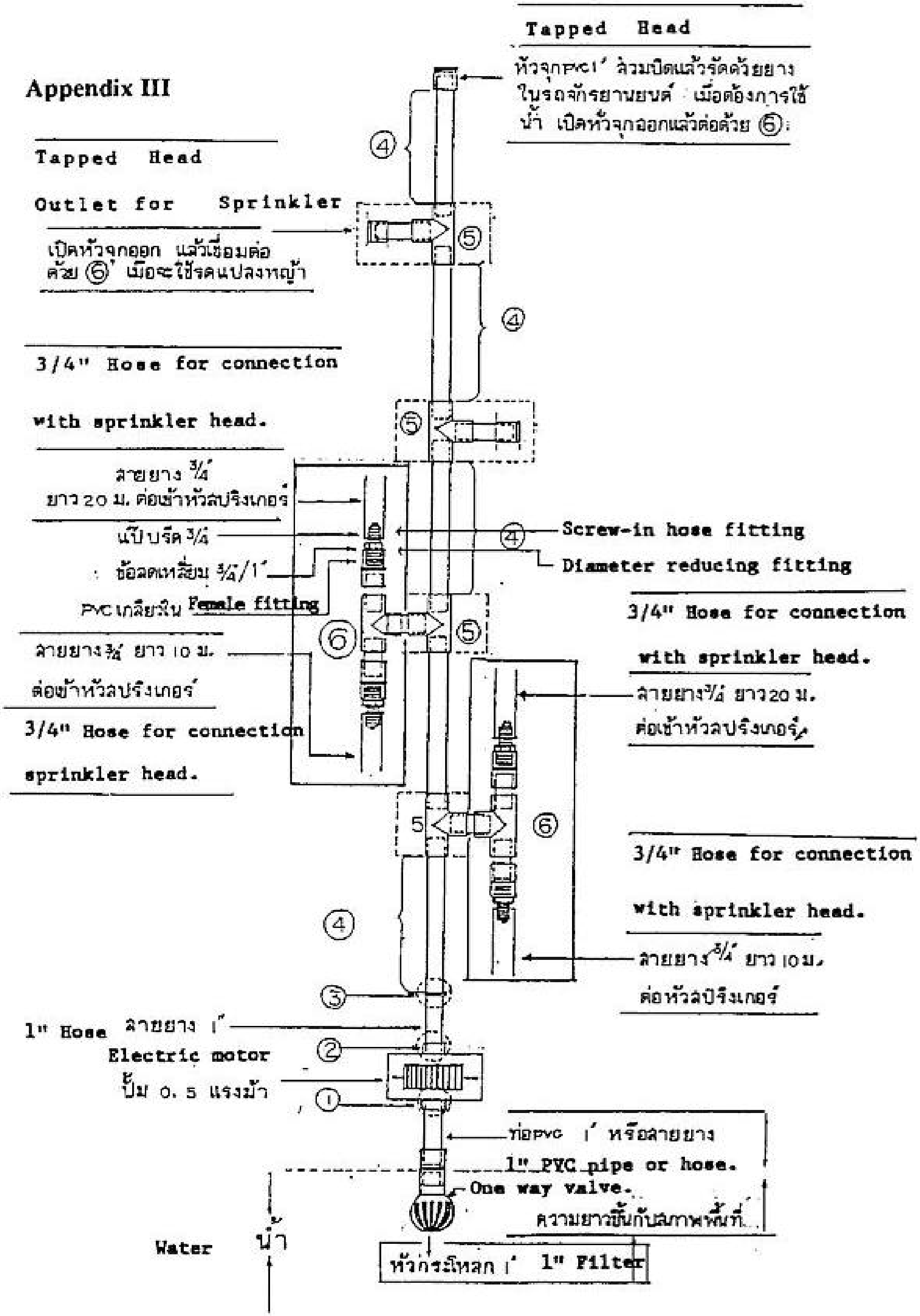
1. Mr. Wattana Sriboonruang
2. Mr. Chunsri Chaimanee
3. Mr. Jeim Boonkhong
4. Mr. Pradist Eamsriri
5. Mr. Urai Phalino
6. Mr. Tong Kanawapee
7. Mr. Vichai Kaewgeot
8. Mr. Sombat Deelord
9. Mr. Tawee Buasai
10. Mr. Sompong Phasook

Appendix II

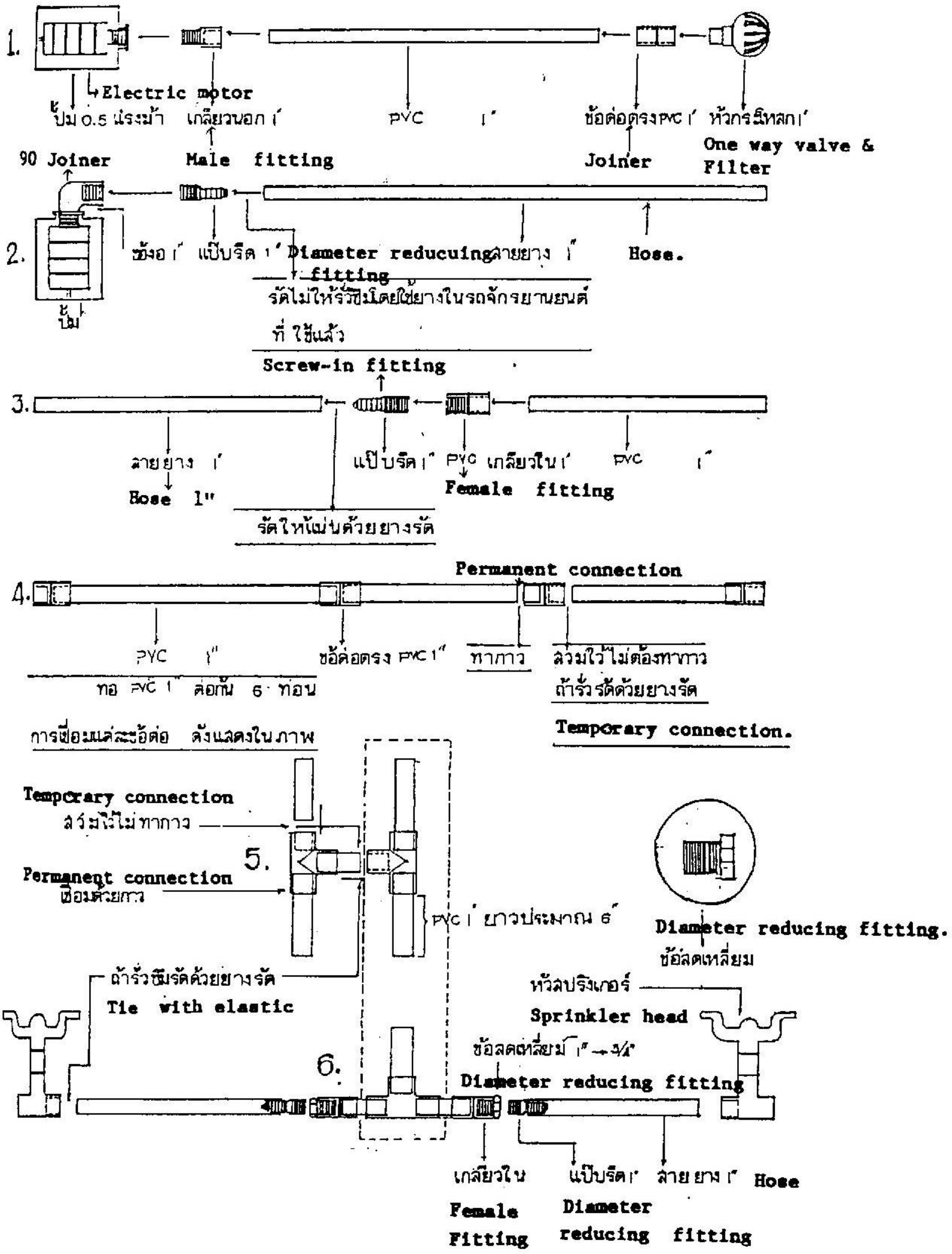
List of members who received *Erythrina subumbrans* seedlings in 1993.

Province	Number of plants received	Number of plants survived after one year
Khon Kaenrovince.		
1. Mr. Somboon Oracha.	217	190
2. Mr. SaoSimachun	63	27
3. Mr. John Simachun	69	10
4. Mr. Phun Nuanbutdee	50	12
5. Mr. Som Hongwanna	50	45
6. Ms. Tongbai Kongchun	50	20
7. Mr. Tee Nammongkul	200	20
Sub total	699	324
Udomthani province.		
1. Mr. Wattana Sriboonruang	208	195
2. Mr. Pradist Eamsriri	105	10
3. Mr. Urai Phalino	185	180
4. Mr. Tong Kanawapee	100	30
5. Mr. Vichai Kaewgeot	56	10
6. Mr. Buahong Titum	50	20
Sub total	704	445
Total	**1,403**	**769**
	100	**54.81**

Appendix III



Appendix IV


1.
Electric motor
ปั๊ม 0.5 แรงม้า
เกลียวนอก 1"
PVC 1"
ข้อต่อตรง PVC 1"
หัวกรองทางเดียว 1"
90 Joiner
Male fitting
Joiner
One way valve & Filter
2.
ข้องอ 1"
แป๊บรีด 1"
Diameter reducuing fitting
สายยาง 1"
Hose.
รัดไม่ให้รั่วซึมโดยใช้ยางในรถจักรยานยนต์ที่ใช้แล้ว
ปั๊ม
Screw-in fitting
3.
สายยาง 1"
Hose 1"
แป๊บรีด 1"
PVC เกลียวใน 1"
Female fitting
PVC 1"
รัดให้แน่นด้วยยางรัด
Permanent connection
4.
PVC 1"
ข้อต่อตรง PVC 1"
ทากาว
สวมไว้ไม่ต้องทากาว
ถ้ารั่วรัดด้วยยางรัด
ท่อ PVC 1" ต่อกัน 6 ท่อน
การเชื่อมแต่ละข้อต่อ ดังแสดงในภาพ
Temporary connection.
Temporary connection
สวมไว้ไม่ทากาว
5.
Permanent connection
เชื่อมด้วยกาว
PVC 1" ยาวประมาณ 6"
Diameter reducing fitting.
ข้อลดเหลี่ยม
ถ้ารั่วซึมรัดด้วยยางรัด
Tie with elastic
หัวสปริงเกอร์
Sprinkler head
ข้อลดเหลี่ยม 1" → 3/4"
6.
Diameter reducing fitting
เกลียวใน
Female Fitting
แป๊บรีด 1"
Diameter reducing fitting
สายยาง 1"
Hose

RUMINANT PRODUCTION IN VIETNAM AND DEVELOPMENT OF FORAGE IN SMALLHOLDER FARM

L.V. Ly[1]

SUMMARY

Cattle and buffaloes are the two most important ruminant species in Vietnam. With the current food situation becoming less critical, there is a tendency among farmers to rear castle for meat and milk, particularly in suburbs close to the big cities. Feed resources are from natural pastures and agricultural by-products from maize, soya bean, potato and vegetables. Natural pastures are generally poor in yield and forage quality. Many varieties of improved grasses had been studied and the promising ones were elephant grass, guinea, pangola grass and pare grass. The two legumes recommended as fodder plants are Cunningham leucaena and Cook stylo. Sugar cane tops and bagasse from the growing sugar cane industry are becoming important feeds in the near future. The constraints of pasture forage improvement programmes in Vietnam are similar to that of other countries in Southeast Asia such as small farm size, low producdvity of local animals, high cost of improved pasture development and the lack of skilled personnel in livestock and forage management as well as the problems in marketing and transportation. Prospects of green fodder development and production are largely determined by the development of the dairy and beef industries although grain feeds and agricultural byproducts will form the foundation for ruminant production.

INTRODUCTION

Vietnam is an elongated country in the shape of the letter, S and stretches from the 8th to 23rd north latitude and has a coastline of over 3000 km. The total land area is 332,000 km^2; of which 3/4s are mountainous and hilly and only 1/4 is of arable land. Being a small and mountainous country with a population of 73 million, Vietnam has a high population density.

Based on ecological characters, Vietnam is divided into 7 ecological-economic zones:

1. Northern Mountain and Midland
2. Red River Delta
3. North Central Coast
4. South Central Coast
5. Central Highlands
6. North-East Southlands
7. Mekong River Delta

These ecological-economic regions are marked by different farming systems which are characteristic to the regions both in terms of plant and livestock classes. For example in the Northern Mountainous Region and Red River Delta, buffaloes are the main ruminant while

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in the central part of the country, cattle is the main animal species. Table 1 illustrates th e number of livestock in Vietnam.

Table 1. Population of different classes of livestock in Vietnam in 1992

Livestock Class	Population 1992 (X1000)
1. Pig	13,881
2. Cattle:	3,192
Draught cattle	1,432
Dairy cattle	13
3. Buffalo:	2,883
Draught buffalo	2,000
4. Poultry	124,500
Fowl	97,500
Duck	27,000
5. Goat	312
6. Sheep	3
7. Horse	133
8. Deer	11

The distribution of land area for different crops is illustrated in Table 2. There is very little land for cultivation of green fodder and pasture in the country. In the past, Vietnam has experienced grain deficit but from 1989 onwards, the country has become self-sufficient in food crops with million tons of rice surplus for export.

Table 2. Food crop distribution as hectareage and percentage of total cultivated land area (8,755,200 ha) in Vietnam

Rice	6,475,400 ha	73.96%
Maize	478,000 ha	5.46%
Sweet potato	404,900 ha	4.62%
Cassava	283,800 ha	3.24%
Annual Industrial Crop	584,400 ha	6.67%
Vegetable and beans	445,400 ha	5.09%
Potatoes	25,700 ha	0.96%
Pasture	320,000 ha	-

Recently, animal producdon has been develop in both quandty and quality. This can be seen in the increasing of the number of livestock and poultry and the amount of meant produce d every year.

RUMINANT PRODUCTION

Cattle and buffaloes are the two most important ruminant species in Vietnam. Goat has developed but it is of low priority with 300,000 to 400,000 heads. Buffaloes and cattle are reared for draught power, meat and farm manure.

In recent years when the food situation is less critical rearing cattle for meat and milk is being encouraged to develop. The dairy herds in Hanoi and Ho Chi Minh City were made up of 4,000 and 8,000 heads, respectively. The increasing requirement of milk and the good price for milk in these two cities have resulted in the development of a stable dairy. Green fodder is becoming scarce. In the suburbs, families who are rearing dairy cow have to share a certain amount of land for growing grassess as natural pasture and by-products of agricultural crops are inadequate. This constraint has been a factor for stimulating development of cultivated fodder and grasses for dairy production.

The beef cattle production has not received much attention up to now as the price of beef was not as high as that of the breeding stock (breeding stock used for reproduction). Feed resources are from the natural pastures and agricultural by-products, mainly rice straw. The distinction between draught cattle and beef cattle is not clear as they are always considered as dual "purpose".

A big programme on cattle herd improvement was implemented by the government recently. Its objective was to mass produce crossbreds from the crossing of the Yellow Local cow with the Brahman bull (semen) to increase the body weight and also its productivity. Some of the favoured breeds are Red Sindhi, Sahiwal, Red Brahmasn which were well accepted by the farmers.

NATURAL PASTURE

Although it is reported that there are million hectares of the so-call natural pasture existed in Vietnam, actual natural pasture is indeed few. With the rise in population and establishment of new economical zone, existing natural pasture land is being converted into crop farming and building construction. The mountainous and hilly regions are too steep to be grazed and the soil too poor and dry. Consequently such areas are classified as bare "hills".

As they are no proper pasture management, over-grazing has become a serious problem resulting in the soil erosion. The quality of natural pasture is also poor in nutritive value. The regrowth of these grasses is slow and hence pasture land is usually dominated by wild weeds. One big danger for natural pasture is the invasion of *Eupatorium odoratum* which is not eaten by buffalo and cattle because of its strong smell. Improvement of natural pasture is slow and expensive (due to the lack of water and fertilizer). The practice of burning pasture is not accepted as it encourages wild grasses to grow more quickly than the growing of useful grasses.

CULTIVATED GRASSES

Grass cultivation has been studied and developed formany years in research institutions and state farms in Vietnam. Many varieties of grasses have been studied and screened. Some of them have been cultivated in large areas. There are three varieties of grass that have been cultivated widely such as elephant grass (*Pennisetum purpureum*); guinea grass (*Panicum maximum*) and pangola grass (*Digitaria decumbens*). These grasses have high productivity: elephant grass could give 200 tons/ha/year equivalent to 22 tons DM; .guinea grass has yielded

100 tons/ha/year (19 tons of DM), and their productivity depends on amount of fertilizer and it is tolerance to drought. These two grasses are preferred by farmers because of the higher productivity under better management. The persistence of these grasses can last for three years when they have to been resourced.

Para grass (*Brachiaria mutica*) can survive well in low land areas along flooded river bank in the central part of Vietnam. The grass also grows well in the other area in the North like Thuy Phuong and Ba Vi with productivity of about 80 tons/ha.

Legumes are less used in green fodder ration. The two varieties which can be developed as fodder are *Leucaena leucocephala* and stylo. Cunningham leucaena can produce 40-50 tons/ha with crude protein level 25% in the soil of pH>5. Stylo cook is also a promising legume which can yield up to 40 tons/ha.

AGRICULTURAL BY-PRODUCTS

Normally, Vietnam has two rice crops per year. In the North where there is adequate water supply, three crops per year are produced and in areas where water supply is sufficient, two rice crops and one cash crop (in Winter) per year are cultivated. Cash crops like maize, soya bean, potato and vegetables are grown during the cold season and harvested within 3 months. In southem provinces where it is hot all year round, three rice crops per year are cultivated. The cultivation of these crops produces important sources of agricultural byproducts which are important components in the rations of ruminant especially in the dry season.

Rice straw is the major and an very important feed component for ruminants. In Vietnam, over 20 million tons of rice straw are produced. This amount is used for feeding ruminants, fuel, litter, and a part of them is bumt right away in the field after harvesting. If only 30% of them can be used as feed for animal we can have 6 million tons rice straw (18 million MJ). This is a significant number. Rice straw is normally piled up and then is stored for many months. Buffaloes and cattle are fed only rice straw at night or on rainy and cold days when grazing is difficult. The treatment of rice straw with urea is not much practised widely and used only in experimental herd when the trial is undertaken.

Rice bran is also an important feed source. It can be used mostly for pigs and dairy cattle and only used as supplement for buffalo and cattle in hard labour period.
Maize stover is also available in huge quantities but it is rarely used as animal feed except for fuel.

Sweet potato leaf is plenty but used mostly for pig rather than for buffalo and cattle.
Peanut and soya bean residues after harvest are available in abundance but due to their short harvesting time and difficulty in storing, very limited amount is used as animal feed and most of them are turned into green manure.

A special industrial crop in our country is sugar cane which produces important byproducts. Molasses is a high energy feed source (especially for beef cattle and buffalo). Sugar cane is harvested in the dry season. Sugar cane top and bagasse provide important forage for ruminants in areas having long dry period. Sugar cane production in Vietnam seems to be developing quickly and its by-products will be more important in ruminant feeding in the coming years.

Although the quality of agricultural by-products is low, their availability in huge quantity can be exploited for the ruminant development in the near future.

L.V. Ly

Some comments on pasture utilization in cropping systems and ruminant production.

(1) In the Northern Mountain and Midland, cattle and buffalo depend more on natural pasture in the open and the forest and agricultural by-products. Natural pasture is more suitable for buffalo grazing.

(2) In the Red River Delta, rice straw and crop residues are the main feed sources. Recently, the cattle herd has increased while the buffalo herd remains stable.

(3) In the Central Coast of North and South Land, due to the proloned dry season, rice straw is more commonly used. The cattle population commands special advantages from farmers.

(4) In the Central highland, ruminant are grazed on natural pasture in the open and in the forest. Crop residues are also a big feed resource.

(5) In Northeast of Southland, which is closed to the big cities and where there is a demand of beef and milk agro-industrial by-products are used for milk and beef production.

(6) In the Mekong Delta, the ruminant feeds depends mainly on rice straw and crop residues. Buffalo herd decreased due to the expanding of small mechanization.

CONSTRAINTS IN PASTURE DEVELOPMENT IN VIETNAM

1. Almost all the ruminants in Vietnam are local breeds, low in productivity but have good tolerance to poor nutrition level that suits to the production system based on natural pasture and agricultural by-products. This low animal productivity has resulted in the lack of interest in forage cultivation among farmers.
2. The average land size per capital is very low. It is difficult to share land in the delta area for grazing pasture and cultivation of grasses. Natural pastures which are low in forage quality are found in the mountainous and hilly region. The pasture supply is not serious because of the small herd size in the region.
3. The investment for improvement of natural pasture and cultivated pasture is costly. The shortage of seeds, fertilizer and many other things, especially the irrigation system in the country make the improvement efficiency very limited.
4. The pasture production technologies are still new to farmers. Technology transfer on grass production as well as the demonstration pilots has just being initiated. The shortage of knowledge and experienced technicians in pasture management is another constraint.
5. Market outlet for animal products is a key factor constraining production because it is not easy to create stable prices that are beneficial to farmers except in some big cities where there is a huge demand for animal products (milk, lean, meat). Unless such a condition exists, farmers are unwilling to invest more for high quality products if they could not get high returns from their investment. Consequently, there are farmers who prefer to practise the traditional low input feeding with good economic returns.

PROSPECTS OF GREEN FODDER PRODUCTION IN VIETNAM

1. The prospects of green fodder production and pasture in Vietnam are based on the development of dairy and beef cattle production. With increasing milk requirement and the development of dairy industry recently in the suburbs of some big cities, green fodder is becoming a good investment that were a force farmers to pay more intensively on their grasses cultivation in their land gardens.
2. Million of hectares of bare hill and mountain are waiting to be made green. Government has approved a national programme with big investment.
3. Some grasses and legumes have been identified suitable for every ecological regions. Technician staffs have been trained for the technology transfer on grasses production to farmers.
4. Vietnam is a country of highly intensive farming system with sufficient grain feed (energy) and agricultural by-products to form the foundation for animal production development especially ruminant development (dairy and beef cattle).

ACKNOWLEDGEMENTS

I glad to have many friends from different countries coming here to participate in this Meeting/Workshop. We have had little success in improved forage cultivation so far. The experiences exchanged here are sure to be useful in our effort to overcome the many environmental and social obstacles and limitations of improved forage production and utilization by ruminant livestock.

With strong support from FAO, CIAT, CSIRO and other International Organization as well as close cooperation among scientists and researchers in the Asian region, we are hopeful that this workshop will be a step forward for the beneficial development of farmers and a contribution of forages towards environmental sustainability.

We have high considerations for the strong support from FAO and other International Organizations to assist developing countries in pasture research and development. We believe such effort in networking will not only benefit the farmers in forage development but also a sustainable environment for healthy living on this globe.

THE FORAGES FOR SMALLHOLDERS PROJECT

W.W. Stur[1], P. M. Horne[2], J. B. Hacker[3] and P. C. Kerridge[4]

SUMMARY

The Forage for Smallholder Project (FSP) is a regional project, funded by the Australian Agency for International Development (AusAID), to assist partner governments in Southeast Asia to increase the availability of adapted forages and to improve the capacity to deliver them to smallholder farming systems, in particular, upland systems. AusAID has allocated funds for five years starting in January 1995 and has asked the International Center for Tropical Agriculture (CIAT) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia to jointly manage this project.

BACKGROUND

The Forages, Smallholders Project directly follows the Southeast Asian Forage Seed Project (Jan. 1992 to Dec. 1994); a smaller project which operated in Indonesia, Malaysia, Thailand and the Philippines. The Forage Seeds Project has the aim of identifying adapted forages, particularly for acid soils. Six broadly adapted forage accessions were identified (Stur et al. 1995):

Andropogon gayanus cv. Kent and CIAT 621,
Brachiaria brizantha CIAT 6780,
Brachiaria decurnbens cv. Basilisk (= CIAT 606),
Brachiaria humidicola cv. Tully, CIAT 6369, CIAT 16886 and CIAT 6133 (often referred to as *B. dictyoneura*),
Centrosema pubescens CIAT 15160, and
Stylosanthes guianensis CIAT 184.

Some of these species such as *B. decurnbens* cv. Basilisk and *B. humidicola* cv. Tully had previously been identified as promising by workers in Southeast Asia and their broad adaptation was confirmed in regional on-farm testing. In other cases, new accessions of species, which were superior to those already in use, were identified (eg. *Centrosema pubescens* CIAT 15160).

Other species such as *Arachis pinto*) cv. Amarillo, CIAT 18750 and 18748, *Aeschynomene histrix*, *Centrosema acutifoliurn* CIAT 5277, *Desmodium heterophyllum* cv.

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Johnstone (CIAT 349), *Stylosanthes guinensis* (various breeding lines), *Brachiaria* spp. and *Paspalum atratum* were identified as promising at some sites or for specific purposes, and these need to be tested on smallholder farms to confirm their adaptation and suitability.

Thus, the project highlighted the need for evaluation of promising species on-farm to (i) confirm their suitability to specific farming systems, (ii) enhance adoption of these species in target areas, and (iii) to ensure feed-back of farmers' needs to R&D workers. Once particular forage species are adopted and used by farmers in target areas, the next step is to develop delivery systems (ie. locally developed forage technology including seed production and vegetative propagation systems) to make these forages available to farmers in other areas in the region.

Forages for Smallholders Project

The purpose of the Forage for Smallholders Project (FSP) is to support partner countries to identify adapted forages and to integrate these forages (new species as well as those already identified by partner countries) into smallholder farming systems, with emphasis on upland systems.

Where will the project work? Partner countries are Lao PDR, Indonesia, Malaysia, Philippines, Southern China, Thailand and Vietnam. Target agro-ecosystems differ between countries but emphasis will be placed on agroforestry and other upland systems (Table 1).

Table 1. Target Agro-Ecosystems

	Indonesia	Lao PDR	Malaysia	Phillippines	South China	Thailand	Vietnam
Agroforestry	**	***		**	**	*	**
Upland systems	***	***	*	***	**	***	**
Plantations	***		***	***			*
Grasslands	*	**		*	**		**
Lowland systems	*	**		**			**

Planted forages are only one part of feeding systems involving naturally available forages, crop residues and agricultural by-products. For animal production the challenge is to find forages which fit into farming systems, fulfil a particular nutritional need and contribute significantly to livestock production. In addition to these benefits, the contribution of forages to environmental sustainability through control of soil erosion, weed suppression and soil amelioration can be significant in upland agriculture.

Project management. The project will be jointly managed by CIAT and CSIRO. The Leader of the Tropical Forages Program, CIAT (Dr. Peter Kerridge) and the Leader of the Australian Tropical Forages Genetic Resources Centre (Dr Bryan Hacker) have been appointed Project Leaders with CIAT responsible for overall administration. Two scientists (Dr Wemer Stur, CIAT and Dr Peter Home, CSIRO) have been employed by CIAT/CSIRO who will be responsible for the implementation of the project. Regional project offices will be based in the Philippines (Dr Wemer Stur), and in Lao PDR (Dr Peter Home).

How will the FSP work? It is planned that the FSP will operate:

1. As a resource for Natural Programs
   The FSP is designed to be a resource for partner countries. The project will call on germplasm from the genebanks of CIAT and CSIRO, provide information such as the use and performance of forages in other parts of the world, and support forage R&D in partner countries. It is designed to be flexible and responsive to country partner needs.

2. Through farmer participation
   The participation of farmers is seen as essential in the process of evaluation and adoption of forages. While initial screening of forage germplasm for adaptation to soil, climate and disease resistance is possible on research stations, further selection of forages for particular farming systems can most readily be achieved by involving farmers in the selection process. Smallholder farmers often have special criteria, such as labour availability at different times, which apply to their farming system and these cannot be "researched" on station. This is particularly important in cases where there are complex farming systems with different crops and with forage being only one of many feed resources. Feed-back of farmers' opinions and requirements will result in the need for more research to help solve these problems and to identify future research needs.

   Farmer participation is also seen as an important tool in the adoption of forages. Farmers who make their own choice of species are more likely to have a sense of ownership of the species they select for their farm. These farmers can then be become teachers and promoters of the selected species, since other farmers are much more likely to be convinced by one of their fellow farmers than by researchers or extension personnel.

   Farmers also play an important role in the development of delivery systems of forages. Once particular species have been identified in a farming system, these species need to be multiplied to make them available to other farmers. This may occur through farmer field days, involvement of farmers in the technology transfer process and village-based multiplication centres. Development of such delivery systems is essenbial to make adapted forages widely available to smallholder farmers.

3. Through national and international linkages
   Exchange of information on successful species, feeding systems, methodology for research and extension, etc. between R&D workers within and between countries is important to maximise the available resources by stimulating discussion and coordinating activities to avoid duplication.

   The FSP will hold annual regional meetings to foster linkages between partner countries, review results, and plan and coordinate future activities. Another vehicle for information exchange is the formation of R&D networks. Such a network was initiated at the Third Regional Meeting of the Southeast Asian Forage Seeds Project in Samarinda in October 1994; it was called the Southeast Asian Forage Research and Development (SEAFRAD) network.

The FSP will support this network by assisting with the publication and posting of a SEAFRAD newsletter. It was decided that editorship of the SEAFRAD newsletter will be the responsibility of member countries and will rotate among countries. Two issues will be published per year with the Philippines taking responsibility for 1995. The two FSP scientists will assist with editing. The FSP encourages partner countries to publish in-country newsletters in local languages and it would be possible to send these together with the SEAFRAD newsletter.

Another form of linkage which is particularly important for the FSP is with national and international development projects such as cattle distribution programs. Often animal health, credit and extension personnel are employed by such programs and feed resources quickly become the most limiting factor facing farmers. Finding adapted forage species for such situations is likely to result in quick uptake and spread of these species.

4. Through the building of national R&D capacity

Short-term, practical training of partner country R&D staff and farmers is seen as an important and integral part of the FSP.

Training of staff will be through the "training of trainers" who will then hold a series of in-country training for a larger number of staff. This will allow the trainers to hold in-country courses in the local language and adjust training to the needs of particular groups. There will be two training courses for trainers. These will be on the subject of (i) farmer participatory research methods and rapid rural appraisal, and (ii) forage agronomy, seed production and delivery systems.

Training of farmers in the use and management of forages will also be supported by the FSP. This will include field days, the production of news sheets or technical guides on particular forage species, management of forages and nutritional facts.

LEVEL OF ACTIVITY IN PARTNER COUNTRIES

The level of activity will vary between countries. While all countries will be involved in regional networking, greater project emphasis will be placed on supporting R&D activities in Indonesia, Lao PDR, Philippines and Vietnam. This is because resources for forage research and development are less in these than the other countries in the region. The need for the introduction of new forages into Lao PDR and Vietnam is greater than into Indonesia and the Philippines. The latter two countries have previously identified several promising species which now need to be evaluated by farmers and integrated into smallholder farming systems. Success of these forage development activities will depend on input and mutual support from all forage workers in the region and not only those directly involved in the FSP.

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FORAGE SEED PRODUCTION IN HUMID TROPICAL ENVIRONMENT

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SUMMARY
Large scale seed production of various forage species is being carried out at Sintok DVS Farm, Kedah. The results indicated that forage seeds can be produced locally, particularly in agroclimatic zone 1 which has an average annual rainfall of 1,830 rnm and experiences 34 months of dry spell. The selected species were ruzi (*Brachiaria ruziziensis*), stylo CIAT 184 (*Stylosanthes guianensis* CIAT 184) and guinea (*Panicum maxirnurn* cv. common and vencedor). Seed yields of common guinea, ruzi and stylo CIAT were 120,172 and 165 kg. per hectare, respectively. The yield achieved was low compared to yield of other seed producing countries, but the purity and germination results were comparable. Some of the problems encountered include indeterminate flowering habit, uneven ripening of seed, seed shattering and pod dehiscent. Detail studies on seed production and management are therefore required to overcome these problems and to increase seed productivity.

INTRODUCTION

Establishment of pasture is best done by sowing seed because of its convenience, ease and speed of planting. In Malaysia pasture seeds are mainly imported from Australia In 1994, contracts for purchase of pasture seeds by Department Veterinary Services (DVS) were worth about RM300,000.00. Seed viability was reduced under poor transportation and storage conditions. This had caused problems in establishment because of the poor seed germination and slow growth during the early stages. Recently, the escalating cost of imported seeds has resulted in an interest in local forage seed production.

The success of seed production in Thailand, Philippines and Indonesia as well as the promising results of MARDI's seed production research, suggests that it is timely for the country to produce viable seed production on a commercial scale. The area in Northem Peninsular Malaysia located approximately latitude 6!N and longitude 101!E with a mean annual rainfall of 1830 mm is considered a suitable site for forage seed production because of a definite dry season of 34 months from December to April for ripening and harvesting of seed.

A joint project between DVS and MARDI on pasture seed production was thus initiated in early 1992. Among the species selected for this project were guinea grass (*Panicum maximum* cv. Common and Vencedor), ruzi grass (*Brachiaria ruziziensis*) and CIAT 184 stylo (*Stylosanthes guianensis* CIAT 184). The areas were 0.525, 0.867, 0.826 and 0.530 ha, respectively. This paper discusses seed production of these promising forages at the Sintok DVS Farm.

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MATERIALS AND METHODS

Screening and evaluation of forage seed crops were carried out at Bukit Tangga Fruit Research Centre, MARDI. The seeds successfully produced were then planted in the Sintok DVS Farm for production purposes. These seeds were then multiplied within the farm or distributed to progressive livestock farmers in Kedah and government agencies.

Establishment of pasture grasses and legume for seed production

Land Preparation

Land preparation was done before the rainy season between February and April. Ploughing was done to improve the filth of the soil. The first ploughing was to ensure that weeds, stumps and roots from the shrubby trees were destroyed. A basal fertilizer was applied during rotovation to ensure an even distribution.

Planting

Direct seeding was carried using the fertilizer spreader. The recommended seeding rate for grasses was 10-12 kg/ha for ruzi and guinea and 4-6 kg/ha for stylo. The higher recommended seeding rate was to get faster coverage of the area and for effective weed control. Scarification of the stylo seed was done by soaking in hot water at 80 !C for 4-5 minutes to reduce hardseededness of seeds. Seedling preparation was needed for the transplanting method. This require a more time and labour. Preparation of seedling was done 3 months prior to planting either in nurseries or in polybag. After 3 months, seedling plants were transplanted at a planting distance of 0.5 m x 1 m in the field.

Basal Fertilizer

Basal fertilizer was rotovated into soil for good germination and growth. The recommended fertilizer rate for grasses was 60 kg nitrogen, 30 kg phosphorus and 30 kg potassiumlha. Nitrogen was not applied in leguminous crops. Fertilizer used were urea, muriate of potash and triple superphosphate.

Management of pasture grasses and legume for seed production

Type of Weeds and Control

Type of weeds that can be found at this stage were *Pennisetum polystachyon*, *Eleusine indica*, *Digitaria* sp. and the broadleaved weeds such as *Borreria latifolia*, *Eupatorium odoratum* and *Mimosa pudica*. Broadleaved weeds in grasses were controlled by using chemical weedicides, Basagran, (active ingredient bentazon 39.6%). Broadleaved weeds in stylo was controlled manually. Monocotyledon weeds in legume can be sprayed with Fusilade, (active ingredient Fluazifol - butyl, 26%).

Cleaning Cut and Top Dressing

Cleaning cut was done by using service cutter at the height of 20-30 cm from the ground. This process could also be done by controlled grazing. Cleaning cut helped to initiate growth of new tillers, flower production and uniform maturity for seed harvesting. Cleaning cut for grasses was done 3-4 months after planting. Since guinea grass did not respond to long daylight hours, cleaning cut was scheduled during the rainy season and harvesting was done during hot weather even though during the rainy season. The grass was fertilized at the rate of 100 kg nitrogen/ha for high seed production.

For legume like stylo, only 30% from the top was cut to avoid damage to young tillers. This was done during the wet season between the months of August to September annually. [his helped to increase the number of branches and tillers with uniform flowering and seed production.

Flower Production

Many tropical pasture flowered continuously in Malaysia. Therefore, a knowledge on the optimum flowering time was important for the pasture seed production. Since guinea grass flowered 2 weeks after cleaning cut and continued until the ninth week, harvesting usually commenced 42 days after cleaning cut. *Brachiaria* species such as ruzi responded to long day light hours for flowering. Ruzi grass flowered between end of July until September and harvesting was done between the months of October and November with at least 30-40 days after maximum stage of flower production.

Determination of Maturity

Trial results showed that harvesting of grass seeds was best done 6 weeks after cutting (Aminah and Kharmuddin) and ruzi grass 3040 days after maximum flower production. Legume such as stylo needed a longer period of 4-5 months after cleaning cut for seed production. Even though cutting schedules helped to determine the optimum harvesting time, closer observation was needed before harvesting. Stylo seeds normally protruded from the pod when mature. As a result more seeds were available on the ground as compared to that on the plant itself. At this stage the seeds were ready for harvesting.

Harvesting

A knife or sickle was used to harvest grass seeds such as guinea or ruzi for small area in order to achieve high quality production. Harvesting was also be done by shaking the seed head into a container.

Stylo seeds was harvested with a hedge simmer. Cutting was done very close to the ground and cut material allowed to dry under the sun. For large areas harvesting was done by a machine harvestor to reduce labour and time.

Post Harvesting Process

Sweating

Sweating was done by piling up of panicles to a height of not more than 1 meter with little compaction. This was to increase maturity of the seeds. The pile was turned over twice a day to avoid mouldy seeds or a build-up of temperature. Suitable temperature for sweating was between 25-39°C. The temperature was not allowed to exceed 50°C to avoid dead seeds. Sweating period for common guinea and ruzi grass at 2-3 days but the stylo needed about 4-5 days.

Threshing

Threshing was done on the third day after sweating for ruzi and common guinea grass. The seeds were easily separated from the panicle by stamping or threshing. As for stylos after the fifth day of sweating, the branches and the flowers was dried again before threshing was done.

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Drying

The processed seeds contained a high percentage (50%) of water. Slow drying under shade for 3-4 days was undertaken. Later it was dried again at the temperature of not more than 35°C for 5 days until the moisture content drops below 12%. Stylo legume seeds was harvested during dry season at low moisture content so as to facilitate and hasten the drying process.

Cleaning

The pasture seed was cleaned up after drying by winnowing to remove twigs, leaves, branches, sand particles and other foreign materials.

Storage

The tropical forage seed was dried to the lowest moisture content and kept at the lowest temperature. According to Harrington (1960) for every 1 % increase in moisture content, the storage life of seeds is halved with moisture content between 5-14% while for every 5°C increase in temperature between 0-20°C the storage life is halved. Moisture content during storage is very important in determining the storage life of the seed. Low moisture helps to prevent the growth of fungus and damage by insects. It is ideal to dry seeds up to 6-8% moisture and be kept at 20°C for long storage periods with relative humidity reduced at 20-25%.

RESULTS AND DISCUSSION

There were 3.0 ha of Stylo CIAT 184 Stylo, 0.7 ha of Vencedor guinea, 1.0 ha of common guinea and 4.8 ha of ruzi planted for seed production at the Sintok Farm. The amount of seeds produced and estimated cost of production in the farm are listed in Table 1. A total of 1,373 kg of seeds were harvested from 9.5 hectares. The yield of guinea grass was low due to heavy rain and spoilage by fungal ergot.

Table 1. Forage Seed Production at Sintok Farrn

Species	Area Planted at Sintok Farm (hectare)	Total Amount of Seed Produced (kg)	Cost/kg of Seed (RM)
Brachiaria ruziziensis	4.8	741.0	5.15
Panicum maximum cv. common	1.0	103.0	1300
Panicum maximum cv. vencedor	0.7	33.5	-
Stylosanthes guianensis CIAT 184	3.0	495	10.00

Flowering of ruzi grass began at the end of July to September while seed harvest commenced between October and November annually. The amount of seeds produced was 172 kg/ha.

In the case of stylo CIAT 184, results showed that 5th to 6th week after peak flowering was the best time for harvesting the seeds (Table 2). Delayed harvesting caused a drop in standing seed yield while too early harvest produced small seeds of low quality.

Harvesting of stylo CIAT 184 was done in January where seed peak flowering occurred in December after a lenient cutback in August yearly.

Table 2. Seed yields of CIAT 184 Stylo and their contributions to the total harvested yield at different times after peak flowering

Harvesting time (weeks after peak flowering)	Standing* seed yield (kg/ha)	% yield contribution	Fallen+ seed yield (kg/ha)	% yield contribution	Total seed yield (kg/ha)
3	324.8	98	7.8	2	332.6
4	2.87	83	58.4	17	346.2
5	314.0	82	70.6	18	384.6
6	316.6	82	72.2	18	388.8
7	272.2	72	106.0	28	378.2

Source: Aminah A. and Khairuddin G. (1994)
* Seeds in inflorescence
\+ Seeds on the ground

Purity of guinea, ruzi and CIAT 184 stylo was 60.7%, 74-90% and 98%, respectively (Table 3). The germination of common guinea and ruzi grass in water was 34 and 25% respectively; when treated with KNO3, the germination for respective grass species was 25 and 70-91%. Germinadon of CIAT 184 stylo in water was 18% with 65% hard seed.

Table 3. Seed quality of various forage seed crops

	Vencedor guinea	Common guinea	Ruzi grass	CIAT 184 Stylo
Purity %	60.7	52.4	74 - 90	98
Germination				
KN03	22	25	70 - 91	-
Water	6	34	25	18
Dormancy	present	No	present	-
Hard seed	-	-	-	65

Source: Aminah A. and Khairudin, G. (1994)

The seeds harvested from 1992 to 1994 were distributed to livestock farmers in Kedah, Kelantan and Perlis, government agencies and private sectors (Table 4). From the above results, the DVS and MARDI have agreed to increase production acreage for *Brachiaria ruziziensis* and *Stylosanthes guinensis* CIAT 184.

CONCLUSION

Selection of ideal site selection for tropical forage seed production was an important factor to consider especially to produce high quality seeds. High quality seeds could be produced under good management practices, good knowledge of growth and flowering patterns and efficient harvesting and post harvest practices. The results and observations from the trials show that seed production can be undertaken on a larger area to meet the demands of forage seeds among the farmers and livestock entrepreneurs in Malaysia

Table 4. Amount of seed harvested and disposed from 1992 - 1994

Species	Amount harvested (kg)	Livestock farmer (kg)	Government agencies (kg)	Private (kg)	Total disposed (kg)	Balance (kg)
Stylo	135	43	67.5	3	113.5	21.5
Ruzi	586	22	300.7	-	242.7	263.3
Venc	33.5	1.5	9.0	1	11.5	22.0
Guinea	103.0	3.0	97.0	-	100.0	0.3
Total	857.5	69.5	474.2	4	467.3	307.1

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PASTURE SEED PRODUCTION IN THAILAND

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SUMMARY
The policy of the government of Thailand is to increase the income of farmers through livestock farming. Such a policy has resulted in a projected increase in demand of pasture seed for forage development. A short history of pasture seed production in Thailand was given. The present aim of pasture seed research in Department of Livestock Development is to increase seed quantity and quality through improved crop management, harvesting and processing of seed and storage. The grasses selected for experimental studies were *Brachiaria ruziziensi*, *Panicum maximum* cv. Common, *guinea hamil*, guinea TD58, *Paspalum plicatulum, Setaria sphacelata* and *Sorghum* spp. The legume were *Stylosanthes hamata* cv. Verano, *Stylosanthes guianensis* cv. Graham, *Centrosema pubescens, Desmanthus virgatus* and *Leucaena leucocephala*.

INTRODUCTION

Thailand is confronted with the problem of price depression of the main crops such as rice and cassava due to over production and competition of cheaper imports of these products from some neighbouring countries. On the other hand, meat and dairy production have not increased enough to meet local demand. Thus import of these two commodities continues to increase and were valued in 1992 to US$ 222.8 and 4.02 million for dairy and meat products, respectively (Agric. Stat. l992/1993)

For these reasons, the government of Thailand has adopted a policy to increase the income of the village farmers by replacing some rice and cassava area with livestock fanning.

As a result, a 3-year (1994-1996) program was launched to establish 72,000 ha of pasture to replace rice and cassava in anticipation of an increase of 150,000 head of cattle. Under this scheme, the smallholder farmers will receive free pasture seed and planting materials. It is estimated (DLD, 1995) that it will need 7,917,440 ha of pastures by the year 1995. Thus, it will require large amount of pasture seeds.

PASTURE SEED DEVELOPMENT

Pasture seed production in Thailand was initiated as early as in 1975 by the Northeast Livestock Department Project, Department of Livestock Development (DLD) to support improvement of communal grazing land by oversowing with Verano stylo by hand or aerial application. Over 25,000 ha of communal grazing land were oversown with Verano stylo in 1988 and another 35,000 ha in 1989. This included 600 km. of roadsides using low cost techniques. Land was not ploughed and fertilizer not applied (Manidool, 1992). Nowadays, Verano stylo will appear on the roadsides. In the initial stage, the Northeast Livestock

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Development Project encouraged smallholder farmers to produce Townsvill stylo and Verano stylo and brought seed back at USS 1.2/kg. Farmers received a very good retums (Askwith, 1979). Expansion of this project by the DLD has led to participation of 1,131 farmers producing 189 tons of seeds (Hares, 1985).

During this decade (1988-1993) the cattle population increased markedly by 2.88 million (Table 1). Thus, large amounts of pasture seed were required to increase fodder land. The seeds were used for pasture establishment in communal grazing land, back yard pasture, pasture under plantation crops, problem soil areas, to replace low income cash crops and to grow high quality pastures in irrigation areas.

Table l. Number of cattles in Thailand in 1984-1993 (Head)

Year	Central Part	North-Eastern Part	Northern Part	Southern Part	Total
1984	1,105,171	1,705,956	964,539	632,360	4,408,026
1985	1,128,222	1,621,356	950,074	614,835	4,314,487
1986	1,262,792	1,507,441	984,425	596,803	4,351,461
1987	1,248,734	1,495,130	1,057,398	597,837	4,399,099
1988	1,306,093	1,568,405	1,128,636	592,533	4,595,667
1989	1,466,655	1,778,850	1,249,874	624,338	5,119,717
1990	1,597,579	1,984,419	1,428,038	658,494	5,668,530
1991	1,855,842	2,312,023	1,741,763	717,343	6,626,971
1992	2,014,757	2,456,732	1,878,499	771,491	7,121,479
1993	1,878,611	2,759,514	2,067,026	767,422	7,472,573

Source: Provincial Livestock Office 1993

Pasture seed research in Thailand aims to increase seed production and quality through the use of higher fertilizer input, improved crop management, harvesting methods, drying, threshing and seed storage.

FORAGE CROP SPECIES

Many of the pastures in Thailand were introduced from Australia (CSIRO, QDPI, Queenslana University), Colombia (CIAT) and other countries. These pastures were subjected to subsequent evaluation at different locations. The main criteria for pasture selection were adaptation to poor soil fertility, acid soil, saline soil, waterlogging and drought conditions. Suitable species are then propagated and distributed to farmers. Pasture development and improvement are made easier by using seed rather than relying on vegetative cuttings. Therefore, DLD has focused on pasture species which can produce good quality seed. The species studied were

GRASS SPECIES

Brachiaria ruziziensis
Panicum maximum cv. Common guinea, Hamil, TD S8
Paspalum plicatulum

Setaria sphacelata
Sorghum spp.

LEGUMES SPECIES

Stylosanthes hamata cv. Verano
Stylosanthes guianensis cv. Graham
Centrosema pubescens
Desmanthus virgatus
Leucaena leucocephala

Research findings of some important pastures with good seed production potentials are described as follows:

Brachiaria ruziziensis

It is well adapted to a wide range of soils. Dry matter yield on poor sandy soils was 21.1 t/ ha when nitrogen was applied at 200 kg/ha and 16.8 t/ha with no fertilizer applied (Sa~jipanon et al. 1985). It is able to produce high seed yields of good quality. Moreover it is easy to harvest. Seed yield of ruzi grass on poor sandy soil was 531 kg/ha, seed quality was 84% purity and 80% germination (Satjipanon et al. 1989).

Panicum maximum

Panicum maximum TD 58 grows best on fertile soils with sufficient moisture (> 1,500 mm.). Farmers are encouraged to plant backyard pastures, irrigated pastures and pastures under plantation crops using TD 58. It responds well to fertilizer application. Dry matter yield was 36.5 t/ha with a protein content 9% when nitrogen fertilizer was applied at 400 kg/ha at a 28 day cutting interval and irrigated in dry period. (Satjipanon et al. 1994, unpublished data). Dry matter yield under coconut trees was 10.1 t/ha (Intraramanee and Sukkasem, 1994). Purple Guinea may be established together with Verano stylo. This combination gave dry matter yields for Purple Guinea and Verano stylo of 11 and 6.3 tlha respectively (Thinnakorn and Withayayemyong,1994). Harvesting the seed by the shaking seedhead method gave the highest seed yield of 375 kg/ha when planted on fertile soil with sufficient water (amount of rain is more than 1,600 mm/year) (Jltrabanthao and Apikulchaisut, 1995, personal contact). In sandy soils with low fertility and an insufficient amount of water only 118 kg/ha was obtained (Chinosang et al. 1994).

Paspalum plicatulum

lt is drought resistant and tolerant to waterlogging. It is well adopted to poor soils and responds to fertilizer application. When compound fertilizer 12-24- 12 (N-P-K) at 187.5 kg/ ha was applied to poor sandy clay loams soils, it gave a dry matter yield of 7,812 kg/ha (Satjipanon *et al*, 1988). Paspalum plicatulum is able to produce high seed yields of good quality.

AMOUNT OF FORAGE SEED PRODUCTION

In 1986, DLD produced only 217.5 kg of pasture seed. In 1994 seed production had greatly increase to 1,052 tons (Table 2, 3). The total seed production from 1990-1994 was 4,588 tons. The main species grown are ruzi, Purple guinea and Verano stylo. Pasture seed in in Thailand is mainly produced bv Animal Nutrition Research centers/Stations and smallholder farmers.

From 1986-1990, research centers/stations emphasized on producing grass seed rather than legume seeds. Legume seed production was produced mainly by smallholder farmers. Since 1990, smallholder farmers are now the main producers of grass and legume seed (Tables 2, 3). The 1994-1995, target for seed produced by smallholder farmers are 721 tons, worth US$ 1.52 million.

LOCATION OF SEED PRODUCTION

The main area of pasture seed production in Thailand is located in a slightly elevated plateau of 17 million hectares, at about 100 to 300 meters above sea level in the Northeast region. This area lies between 14-19!N latitude and experiences a tropical savannah climate with a pronounced seasonal distribution of rainfall. The rainy season starts in April and ends in October with over 80 % of the annual total of 1,250 mm fall between June to September. The border areas represented by the provinces of Sakon Nakhon, Mukdahan, Nakhon Panom and Nong Khai have a slightly longer rainy season than the central area of the plateau represented by the provinces of Khon Kaen, Udorn-Thani, Mahasarakam, Roi-Et, Buri Ram and Nakhon-Rachasema. Most of soils in the Northeast are of sandy texture, acid reaction, low organic matter contents, low cation exchange capacity and have low levels of nitrogen, phosphorus and sulphur.

Table 2. Grass seed production in 1990-1994 (tons)

Year	Ruzi		Total	Purple guinea		Total	Other seed (C/S)	Total
	C/S	Farmers		C/S	Farmers			
1986								38
1990	128	120	248	-	-	-	37	285
1991	199	268	467	-	-	-	85	552
1992	231	362	593	3	5	8	56	657
1993	203	872	1,074	10	23	33	42	1,149
1994	138	501	639	93	90	183	55	877

C/S-9 Research centers and 22 stations

Table 3. Legume seed production in 1990-1994 (Tons)

Year	Verano Stylo		Total	Other seed (C/S)	Total
	C/S	Farmers			
1986					180
1990	16	131	146	30	176
1991	14	89	103	41	144
1992	13	180	193	37	230
1993	10	301	311	32	343
1994	17	130	147	29	176

C/S-9 Research centers and 22 stations

The Northeast region is considered the most suitable for seed production due to the dry weather conditions during seed harvest and drying. The main areas for ruzi and Verano stylo seed production in the Northeast region are Khon Kaen, Mahasarakham, Roi-Et, Udonthani and Loei. Purple guinea requires a more humid climate than ruzi and Verano stylo. Therefore, it is produced in Sakhon Nakhon, Nakhon Phanom and Mukdahan (rain >1,500 mm/year).

Smallholder farmers in the Northeast produce 96% of the total contracted seed production in Thailand. Two research centers and sixteen stations in the Northeast produce 64 % of government seed production in Thailand (Tables 4, 5, 6). The largest seed producing area in the Northeast is the Khon Kaen province where there are 2,400 smallholder farmers producing 240 tons of pasture seed from 517.8 ha in Amphur Pra-Yern. DLD purchases normally about 125.4 tons of seed for US$ 194,171 which amounts to 25.2 % of the total budget. The remaining seed stocks are sold to middlemen at a price lower than the US$ 1.2-1.6/kg purchase price by the govemment.

Table 4. Pasture seed yield (tons) produced by animal nutrition research centers/stations in each region in 1994-1995

Region	Grass	Legume	Total
Northeastern	182	31	212
Northern	20	3	22
Central	64	12	75
Southern	21	1	22
Total	287	47	331

Table 5. Pasture seed yield (tons) produced by smallholder farmers in each region in 1994-1995

Region	Ruzi	Purple Guinea	Hamata	Total
Northeastern	464	86	130	680
Northern	20	3	-	23
Central	15	1	-	16
Southern	2	-	-	2
Total	501	90	130	721

Smallholder farmers are eager to produce pasture seed because a higher income is derived from pasture seeds compared to that of cassava and rice production. The income from the sale of pasture seed was US$ 9241ha/year (ruzi US$ 2.2/kg Purple guinea, US$ 3.2/ kg and Verano stylo US$ 1.8/kg), while incomes from cassava and rice production are US$ 370 and 261 ha/year, respectively (Agric. Statistics of Thailand Crop Year 1992/93)

Table 6. Total area (ha) used for pasture seed production by animal nutrition research centers/stations in each region in 1994-1995

Region	Grass	Legume	Total
Northeastern	1,210	203.7	1,413.7
Northern	130	17.1	147.1
Central	424.5	76.5	501
Southern	139	6.7	145.7
Total	1,903.5	304	2,207.5

SEED PRODUCTION PROGRAM

The program of seed production was initiated as early as in 1975 in order to produce enough seed for home consumption or demand. The aim was to increase income of smallholder farmers through the creation of a pasture seed market and to treat pasture seed as cash crop. The DLD has contracted a number of farmers to produced seeds based on the following procedures (Table 7):

1. Selection of cooperating farmers
2. Training of farmers on pasture establishment maintenance harvesting and cleaning of pasture seed.
3. DLD officials supervise farmers in land preparation planting and seed harvesting.
4. Buying back of seed at a guaranteed price based on the quality of seeds

Seed harvesting at research canters/stations, done by cutting seedheads using sickles and stacking them in a shed for 2 days. Threshing seed by turning everyday the sweated heaps of seedheads, threshed and sun dried for 2 days.

The harvested seed is sent for final cleaning at a research canters/stations seed processing plant. Seed samples are taken to test the quality (Table 8) which are not below the minimum quality standard set by the DLD. The DLD distributes the seed to the DLD programs, other government units which have requested pasture seed and/or sells to farmers.

GERMINATION TEST-TREATED WITH H_2SO_4 (CONC.) AND KNO_3

After harvesting at the research canters/stations stalks are cut to a height of 10 cm. aboveground to make hay. Smallholder farmers bum the stalks and sow again the next year as old stalks give low seed yield and quality.

The price of pasture seed

Species	Price (US$/kg)
Ruzi	2.4
Guinea	3.2
Plicatulum	2.4
Sorghum	0.3
Verano stylo	2
Centrosema	1.2
Leucaena	0.8

Table 7. Method of forage seed production by smallholder farmers

Activities	Ruzi	Purple Guinea	Verano Stylo
Production area (ha)	0.32	0.32	0.32
Land preparation	one ploughing and one harrowing	one ploughing and one harrowing	one ploughing and one harrowing
Seed rate (kg/ha)	6.25	1	6.25
Planting method	50cm between row	30 days seedling are transplanted and spaced 80x80cm apart	Seed treated with hot water at 80°C for 10 minutes before sowing with a spacing of 50cm between row
Fertilizer application (kg/ha)	(15-15-15) 156 kg/ha 1/2 at 30 days after germination 1/2 at flowering stage	Applying urea at 190 kg/ha at seedling stage and 15-15-15 at 156 kg/ha at flowering stage	15-15-15 at 156kg/ ha and Gypsum 62.5 kg/ ha at seeding
Weeding (times)	1	1	1
	at 30 days after germination	at 30 days after germination	at 30 days and 60 days after germination
Seed harvesting	- tie groups of adjacent seedhead into living sheaves - shaking ripe seedhead into broad shallow receptacle - 3-5 days interval for 2 weeks	- tie groups of adjacent seedhead into living sheaves - shaking ripe seedhead into broad shallow receptacle - 3-5 days interval for 4 weeks	- Harvesting of Verano stylo in dry season (January-February) - Shaking ripe seed into theground - Cutting the dry stems at ground level and raked up - Sweeping of fallen seed from ground - Cleaning seed using various sieve sizes (diameter 2 and 3 mm) and traditional minnowing techniques or fan
Drying in shed (days)	2	2	-
Drying in sun (days)	2-3	2-3	-
Seed yield (kg/ha)	440-625	440-625	440-800
Seed cost (US$)	1	1	1
Family income/year	220-400	350-450	180-300

Table 8. Seed yield and quality of pasture seed in 1993-1994

Seed	Seed yield kg/ha	Moisture content (%)	Purity (%)	1000 seed weigh (g)	Viability (%)	Germination (%)
B. ruziziensis						
Minimum quality Standard (MQS)	-	9	90	-	-	50
Government station (GS)	150-180	10-13	90-98	6.5-7.3	93-99	83-90
Farmer (F)	440-625	9-13	90-99.9	6.8-7.1	96-100	55-98
P. maximum TD58						
MQS	-	9	50	-	-	40
GS	150-180	8-12	76-93	1.3	62-95	43-63
F	440-625	8-13	65-99	1.3	68-99	45-96
S. hamata						
MQS	-	9	70	-	-	40
GS	125-200	6.4-8	70-93	2.65	2	18
F	440-800	6.5-8.4	75-91	2.60	-	18-30

CONCLUSION

Pasture seed production research in Thailand is aimed at getting maximum yield of high quality seeds for the adaptive forage species. The results have shown that the environmental conditions of the Northeast region of Thailand are perfect for pasture seed production, seed crop development in the wet season and harvesting in the dry season when moisture and air humidity do not affect seed drying. The species which produce good seed are ruzi, Purple guinea and Verano stylo. This has led to a large scale seed production through contract farming to the smallholder farmers. The problem now is whether the private sector will take up the venture if the government does not continue the contract.

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FORAGE SEED PRODUCTION IN LAO PDR

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SUMMARY

Forage development programmes have become important to improve forage supply to meet increased cattle population in Lao PDR. Some promising species are being identified. Two experiments were carried out under the FAO Regional tropical forage development for smallholders in Southeast Asia. The first experiment was to determine the seed yield of signall grass, ruzi grass and koronivia grass at various harvesting time after first flowering date. The second experiment was to study the effect of nitrogen fertilizer rate on seed yield of signal grass. Signal grass generally flowered earlier than koronivia and ruzi grasses. The earliness in flowering in late August for signal grass and in September for koronivia grass resulted in difficulty of seed harvesting during peak rainfall. Consequently, seed yield was low. Ruzi grass flowered in late October and seed harvest carried out in the dry season resulted in good seed harvest at 50 days after flowering. A maximum yield of seed from signal grass was obtained at a fertilizer rate of 150 kg N/ha.

INTRODUCTION

Livestock production in particular the cattle industry in Lao PDR is smallholder-based, practising traditional village management systems of animal husbandry. The main feed resources are native pastures and agricultural byproducts, such as rice straw. According to the government agricultural policy, livestock sub-sector plays an important role in the national economy development. It contributes 12 % of the total GDP annually and frequently generating more than 50% of household cash income. Nevertheless, the livestock industry in Lao PDR experiences numerous constraints such as high mortality due to diseases, inadequate feed and poor management practices.

The strategies of livestock sub-sector are orientated to increase cattle population to meet local demand and surplus for export market. To achieve these aims, forage development programmes have become very important to improve both quantity and quality of forage feed to meet the increasing feed requirement of the animals. The selection and introduction of highly productive pasture and forage species have been promoted to farmers through support provided by the Department of Livestock and Veterinary Services. Fundings from the government and international organizations have contributed to research and demonstration trials on pasture and forage production recently. A few adapted pasture species have been distributed to farmers for production.

TCP/RAS/2361 project- "Regional tropical pasture and forage development for small holders in S.E. Asia" in cooperation among countries like Lao PDR, Malaysia and Thailand, is funded by FAO. The project was started in 1994 and was for one year. The main objective was to support the Department of Livestock and Veterinary Services of Lao PDR in pasture development through and adoption of appropriate technologies gained in Thailand and

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Malaysia Pasture seed production was one of its activities. This has been carried out in both state and private farms. However, this report describes the seed production of the statc fann known as Namsouang Livestock Adaptive Research and Extension Centre (NLAREC).

DESCRIPTION

Soil

The soils at Namsouang Livestock Centre are described as red-yellow podsolic. They have a sandy loam surface with clay content increasing with depth. The soils have been heavily leached and are acidic with pH ranging from 4.4 to 5.3. The results of a soil test and chemical analysis of soil samples from the centre are summarised in Table 1.

Table 1. Chemical analysis of soils from Namsouang Livestock Adaptive Research and Extension Centre

Test for	Range of result	Comment
pH	4.4 - 5.3	very acid
Phosphorus	3 - 20 ppm	verylow to low
Organic carbon	0.3 - 1.8%	verylow to low
Nitrate-Nitrogen	1 - 3 ppm	verylow to low
Total soluble salts	30 - 145 ppm	verylow to low
Aluminium	20 - 48 ppm	high
CEC	0.9 - 2.5	Iow
Exchangeable Na	6.7 - 17.1%	potential problem

Source: The result of soil sample testing undertaken by National Soil Laboratory, Vientiane, 1981.

CLIMATIC AND RAINFALL DATA

The climatic and rainfall data at Namsouang Livestock Adaptive Research and Extension Centre are summarised in Table 2. The wet season begins in June and ends in October.

Table 2. Climatic data at the Namsouang Livestock Adaptive Research and Extension Centre

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Remark
1.Rainfall	3.5	20.7	29	65.5	304.	294	291	342.	334	88.2	7.5	0	1781	Ave 1987-93
Rainfall	0	18	125.	58.5	272	514	245	510	268.	104	-	-	2113.3	1994
Number of rainy	0	2	5	5	17	11	9	19	13	6	-	-	87	1994
2.Ave.min. Temp (ºC)	15.5	16.6	19.2	21.7	22.6	22.9	22.5	22.7	21.9	20.7	17.3	12.6	1994	
3.Ave.max Temp.(ºC)	32.5	34.5	35.3	38.5	36.8	36.7	35.2	34.0	34.8	35.6	33.5	30.6	1994	

SEED PRODUCTION

Forage seed production began in 1985 at the Namsouang Cattle Station. The seed production potential is illustrated in Table 3.

Namsouang Livestock Adaptive Research and Extension Centre has a great potential to produce pasture seed of almost all of the tropical pasture species like *Braciaria humidicola* and Brachiaria decumbens due to its environmental suitability. It has the materials, machinery, a seed storage room and especially trained personnel with some skills on tropical pasture seed production.

Table 3. Forage seed production at Namsouang Cattle Station

Year	Forage species (kg/ha)					
	Ruzi	Signal	Gamba	Paspalum	Guinea	Verano
1985			500		4500	5000
1986						
1987						
1988	600		100	500	300	1500
1989	400		50	400	150	1000
1990	300			200	100	600
1991	200	20	30	100	50	400
1992	400	20	30	150	100	700
1993	400	10	60	120	110	700
1994	3200	20	180	50	50	3500

Pature seed production supported by T C P/RAS/2361(c) project produced in this centre were.

1. Ruzi grass
   There were 20 hectares of ruzi grass pasture for seed production. Seed was harvested by shaking seed heads and yielded 3500 kg. If it could harvest intensively by binding the seed head, it could have yielded more than 6 tonnes (Udchachon, 1995).
2. Gamba grass .
   There were 2 hectares of Gamba grass (*Andropogon gayanus*). The seed was harvested by shaking and lightly pulling the seed from the seed heads. It produced about 180 kg.

As described above, some pasture species like signal and koronivia grasses produced poor seed. A few experiments on pasture seed production from some promising grasses were carried out at this centre. There were two experiments undertaken to (i) to determine the seed yield of ruzi grass, signal grass and koronivia grass at various harvesting time after flowering date and (ii) to study the effect of nitrogen fertilizer rate on seed yield of signal grass.

The first experiment was on seed production potential of ruzi, signal and koronivia grasses. Existing pastures of these species were cut on 24 June 1994 and fertilised with NPK (16-20-00) at a rate of 300kgN/ha on 29 July 1994. Flowering and harvesting date were observed and recorded. The seed was harvested by shaking seed heads. The results are presented in Table 4.

Table 4. Pasture seed yield of tropical grasses at different harvesting time after flowering date

Pasture Species	Fllowering date			Harvesting date	Day after Flowering (kg/ha)	Seed Yield (kg/ha)
	commence-ment of flowering	50% of flowering	100% of flowering			
1. Ruzi	5/10/94	17/10/94	25/10/94	15/11/94	40	161.12
	25/11/94	50	193.5			
2. Signal	25/8/94	10/9/94	24/9/94	5/10/94	40	58
	15/10/94	50	48			
	25/10/94	60	19			
3. Koronivia	7/9/94	18/10/94	30/10/94	17/10/94	40	12
	7/11/94	50	30			
	27/11/94	60	12			

Signal grass flowered earlier than the other species (koronivia and ruzi grass) and this was in late August where harvesting could proceed in mid September. However, this coincided with the peak rainfall normally received at this time of the year, thus making harvesting time of signal grass seed difficult. However, koronivia grass started to flower during the raining season while the ruzi grass started in the late raining season (in early October). Thus harvesting of ruzi grass in mid October coincided with the beginning of dry season. The low yield of both signal and koronivia grasses could be attributed to the high rainfall received between August and September resulting in mature seed fallen down before the harvesting could proceed. Seed yield of ruzi grass was reasonably high; the highest yield was obtained 50 days after flowering.

The second experiment was to study the effect nitrogen fertilizer rate on seed yield of signal grass. There were 8 rates of fertilizer (16-20-00) at 50 kg N/ha to 400 kg N/ha. It was found that the maximum seed yield of 78 kg /ha was obtained at a fertilizer rate of 150kg N/ ha. The results are presented in Table 5.

CONCLUSION

There is great potential to produce pasture seed in Lao PDR by both smallholders and in state farms. However, some pasture species such as signal and koronivia grass are costly to establish. Research on these pastures for seed production including legumes for specific sites needs to be carried out. Pasture seed can be produced by smallholders on contract farming and this could start at any time if the demand for pasture seed is increased. The technical staff are still young and have limited experiences with pasture seed production. Training on pasture seed technology for both technical officers and farmers is required to achieve the knowledge and expertise in producing high quality pasture seed.

Table 5. The effect of nitrogen fertilizer rates on signal grass seed production

Rate of N-fertilizer (kg/ha)	Seed yield (kg/ha) day after flowering			Total Seed yield (kg/ha)
	40	50	60	
1. 50	16.0	22.0	6.66	44.66
2. 100	29.3	24.6	13.33	67.32
3. 150	31.33	31.33	15.33	77.99
4. 200	28.0	26.66	10.0	64.66
5. 250	20.0	15.33	6.66	41.99
6. 300	18.6	10.0	0	28.66
7. 350	13.33	0	0	13.33
8. 400	6.66	0	0	6.66

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EVALUATION OF INTRODUCED TROPICAL LEGUMES AND GRASSES IN NORTHERN AND CENTRAL VIETNAM

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SUMMARY

An evaluation of 17 introduced forages (9 grass and 8 legume accessions) was conducted in the north (Thuy Phuong area- Hanoi, Ba Vi area - Ha Tay) and central (Long My area Binhdinh, Son Thanh area - Phuyen) regions of Vietnam between 1990 and 1991. Of the grasses, *Penniseturn* spp. grew well on a range of soils, but King grass gave the highest yield of 19.0 - 23.5 ton DM/ha/year. Hamil grass was well adapted to all sites, producing between 9 7 and 17.2 ton DM/ha/year.

Liconi guinea was adapted in the north with 17.5-18.9 tons/ha/year. Among the legumes, Leucaena leucocephala cv. Cunningham gave the highest yield on soils with pH > 5, producing 9.9 - 13.4 tons DM/ha/year. The stylo accessions were well adapted to the poor, acid hilly soils, yielding 6.1 - 10.4 tons DM/ha/year. Siratro grew well in the dry, hot and infertile area with acidic and well drained sandy soils and produced 9.3 tons/ha/year.

INTRODUCTION

Animal production in Vietnam particularly ruminants has improved in recent years, but forage research is still in its infancy. Total pasture land area has been reduced from 1.3 million to 0.3 million ha between 1978 and 1989 due to the expansion of arable and industrial crops cultivation.

Forage plants have always formed the basis of ruminant production although native species are not always the most productive or of the highest quality for animal production. As land utilization intensifies, there is an ever increasing demand for higher level of livestock production performance. This requires improvement in many factors, such as animal breed, animal nutrition and husbandry.

Forage plant evaluation is one of the ways aimed at introducing new species to improve animal nutrition and to increase dry matter productivity per unit land area while maintaining soil stability and long term production. The new species can complement, replace existing pasture vegetation or establish in new areas.

In the past, there has been a considerable amount of work carried out in Vietnam on the suitability of exotic species for sowing or planting in pasture field. During 1970-1985, 142 forage accessions were introduced and evaluated in both the north and south of Vietnam. *Pennisetum purpureum* cv. Selection 1 and King grass gave the highest yields of 25-30 ton DM/ha/year. They are well suited for the cut and carry production system. Pangola grass (cv. Comum, cv PA - 32) couch grass (cv. Bermuda No. 1, cv. Jamaica), Caribbean stylo, Cook stylo, and *Panicum maximum* (cv. K280, cv. Liconi) show promise for grazing. Since the 1990's, forage research has focused on identifying forage species suitable for grazing and cut and carry production systems.

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The present paper highlights the evaluation of 17 forage accessions during 19901991 in the northern and central country.

MATERIALS AND METHODS

LOCATION

a. (Thuy Phuong-Ba Vi) Region in the North. This region experiences the wet season from May to October (6 months). In the dry season there is the northern cool wind from China.
   (i) Thuy Phuong: This site belongs to the National Institute of Animal Husbandry, about 15 km from center of Hanoi, near the Red River.
   (ii) Ba Vi: This area is about 50 km from Hanoi. It is in the middle land of the north.
b. The central country: (Long My - Son Thanh) has a rainy season from October to January (4 months). There is a dry, hot wind from Laos during the dry season.
   (i) Long My: About 15 km from Quy Nhon City. is in the coastal area.
   (ii) Son Thanh: About 40 km from PhuYen town, in middle land of the center.

Table 1. Rainfall and soil types at each the locations for forage evaluation

Parameters	North		Center	
	Thuy Phong	Ba Vi	Long My	Son Thanh
Rainfall (mm/yar)	1700	1900	1700	2600
in wet season (%)	90	90	75	77
Attitude (m)	7	20	7	80
Soil type	alluvial	old alluvial	sandy	basaltic
pH	6.3	5.3	4.1	5.5

ACCESSIONS

a. Grasses:
   Panicum maximum cv Hamil
   Panicum maximum cv Liconi
   Panicum maximum cv Trichoglume
   Panicum maximum cv Makueni
   Pennisetum purpureum x *Pennisetum typhoides*
   Pennisetum purpureum cv Selection 1
   Brachiaria mutica
   Brachiaria decumbens
   Setaria splendida

b. Legumes:
   Macroptilium artropurpureum cv. Siratru
   Stylosanthes hamata cv. Verano
   Stylosanthes scabra cv. Seca

Neonotonia wightii cv. Cooper
Pueraria phaseoloides
Stylosanthes guianensis cv. Cook
Leucaena leucophala cv. Cunningham
Leucaena leucophala cv. Peru

METHODS

1. All the above species were introduced to each region at about the same time, the north in May and the central in October 1990.
2. Each accession was sown in a plot of 20 m2 with 3 replication.
3. Interrow spacing was 50 cm.
4. Rates of fertilizer or manure application:
   Manure : 10 tons/ha/year
   N : 160 kg/ha/year (omitted in legume plots)
   P : 80 kg/ha/year
   K : 80 kg/ha/year
5. Cutting methods:
   * Cutting interval : l-3 months (according as each species)
   * Cutting height:
     For legumes: 20 cm (tree legume: 80 cm)
     For grasses: 3-10 cm
     Tufted, erect grass: 5 cm
     Creeping grass: 8-10 cm

DATA COLLECTION: (for each site)

The following data were collected throughout the course of experiments:

a) Rainfall and temperature
b) Soil texture, fertility and drainage
c) Extremes of climate conditions, such as frosts, floods and droughts
d) Pests and diseases
c) Numbers of cutting
f) Green yield and dry matter yield
g) Chemical composition and nutritive values

RESULTS AND DISCUSSION

1. IN THE NORTHERN REGION

a. Grasses:

Nine grass accessions were evaluated atThuy Phuong and Ba Vi. The herbage productivity are shown in Table 2.

In general, *Pennisetum* grass grew well in the both Thuy Phuong and Ba Vi and gave the highest yield. King grass produced 3.6 tons DM/ha/year. *Pennisetum purpureum* cv. Selection 1 yielded 20.4-21.8 tons DM/ha/year. The results in the Table 2 also indicates that *Panicum maximum* cv. Harnil and *Panicum rnaximum* cv. Liconi are suitable at the two sites, yielding 16.5-17.4 tons DM/ha/year, respectively.

Besides *Brachiaria mutica*, *Panicum maximum* cv. Makueni adapted well at Thuy Phuong on alluvial soil, producing 15.9 and 19.4 ton DM/ha/year.

Table 2. Green and dry matter yields of grasses in the Northern Region

No.	Species	Thuy Phuong			Ba Vi		
		N	GF	DM	N	GF	DM
1	*P.M. Hamil*	9	90.5	17.3	8	86.3	16.5
2	*P.M. Liconi*	11	97.5	17.5	9	100.0	18.9
3	*P.M. Trichoglume*	9	68.2	15.7	7	44.0	10.1
4	*P.M. Makueni*	10	107.9	19.4	7	60.8	12.4
5	*Kingrass*	6	206.7	23.6	5	170.1	22.2
6	*P.P. Selection 1*	6	198.3	21.8	5	169.5	20.4
7	*Setaria splendid*	7	80.4	12.6	7	75.1	14.1
8	*B. mutica*	7	86.2	15.9	5	42.6	10.2
9	*B. decumbens*	6	73.8	11.8	6	56.7	11.2

N: Numbers of cutting; CF: Green fodder tons/ha/year, DM: Dry matter ton/ha/year

b. Legumes:

Eight legume accessions were evaluated in the north. The yield of the accessions are shown in Table 3.

Both *Leucaena leucoephala* cv. Cunningham and cv. Peru grew well in the north particulary at Thuy Phuong on the alluvial soil, producing 8.8-13.5 tons DM/ha/year. The highest yield at Thuy Phuong was from *L. Ieucocephala* cv. Cunningham, yielding 43.5 tons DM/ha/year. At BaVi, *Stylosanthes* spp. were suitable on old alluvial soil. Cook stylo gave the highest yield of 12.5 tons DM/ha/year.

Table 3. Green and dry matter yield of the legumes in the Northern Region

No.	Species	Thuy Phuong			Ba Vi		
		N	GF	DM	N	GF	DM
1	*Verano stylo*	2	23.2	6.1	2	26.5	7.2
2	*S.S Seca stylo*	3	33.8	9.1	3	35.2	10.5
3	*S.C. Cook stylo*	2	25.2	6.4	5	48.8	12.5
4	*Siratro*	3	23.3	4.3	3	23.0	4.3
5	*N.W. Cooper*	4	32.0	6.4	3	21.5	5.0
6	*P. phaseoloides*	3	23.1	5.0	3	20.1	4.8
7	*Leucaena Cunningham*	5	53.8	13.5	4	33.6	10.0
8	*Leucaena Peru*	4	42.1	10.3	3	30.7	8.8

N: Numbers of cutting; CF: Green fodder ton/ha/year, DM: Dry matter ton/ha/year

2. IN THE CENTRAL REGION

a. Grass

Similarly, the above grass accessions were also investigated at Long My and Son Thanh areas. The herbage productivity is shown in Table 4.

The records in the Table 4 indicates that many of the introduced grass accessions grew well on the basaltic soil at Son Thanh. *Penniseturn purpureum* cv. Selection-1 produced 22.9 tons DM/ha/year and was a promising grass for green fodder productivity. At Long My area, the highest yield was from *Pennisetum* spp. with 16.9-19.0 tons DM/ha/year. *Panicum maximum* cv. Makueni, *Panicum maximum* cv. Hamil produced 11.9 and 9.7 ton DM/ha/year, respectively.

Table 4. Green and dry matter yields (tons/ha/yr.) of grasses in the Central Region

No.	Species	Long My			Son Thanh		
		N	GF	DM	N	GF	DM
1	*P.M Harnil*	6	56.9	9.7	7	92.9	17.6
2	*P.M. Liconi*	5	40.6	8.1	-	-	-
3	*PM. Trichoglume*	5	40.9	8.2 7	7	62.4	12.6
4	*P.M. Makueni*	6	60.0	11.9 7	7	77.1	15.0
5	*Kingrass*	5	119.0	19.0	-	-	-
6	*P.P. Selection 1*	5	99.7	16.9	5	176.2	22.9
7	*Setaria splendida*	4	28.1	5.6	-	-	-
8	*B. mutica*	4	28.4	7.6	5	68.9	12.6
9	*B. decumbens*	4	44.2	8.8	5	72.6	13.7

N: Numbers of cutting; GF: Green fodder tons/ha/year, DM: Dry matter ton/ha/year

b. Legumes

The legume accessions evaluated at the region (Long My - Son Thanh) are presented in Table 5.

Table 5. Green and dry matter yields (tons/ha/yr.) of the legumes in the Central Region

No.	Species	Long My			Son Thanh		
		N	GF	DM	N	GF	DM
1	*S.H. Verano*	4	24.7	7.0	3	35.6	8.4
2	*S.S Seca stylo*	4	25.1	6.9	3	40.2	10.6
3	*S.C. Cook stylo*	5	40.9	9.2	4	43.9	9.8
4	*Siratro*	5	43.4	9.3	3	29.7	5.8
5	*N.W. Cooper*	2	14.1	3.0	3	32.8	4.9
6	*P. phaseoloides*	4	21.3	5.0	4	35.7	6.5
7	*Leucaena Cunningham*	2	17.5	3.8	4	46.0	9.9
8	*Leucaena Peru*	-	-	-	4	41.0	9.4

N: Numbers of cutting; CF: Green fodder ton/ha/year, DM: Dry matter ton/ha/year

It was shown that Siratro and Cook stylo adapted well to sandy, gravel well-drained soil, producing about 9.3 tons/ha/year, each at LongMy. Most of the legumes introduced grew well in Son Thanh area on basaltic soil. Some accessions such as *L. Ieucocephala* cv. Cunningham, *L. leucocephala* cv. Peru, *S. scabra* cv Seca, *S. guianensis* cv. Cook gave high yield of 9.4-10.6 tons DM/ha/year. In LongMy area, legumes such as Siratro, Seca and Cunningham withstood the dry hot climate and maintained green leaf during the dry periods.

3. CHEMICAL COMPOSITION OF SOME OF THE ACCESSIONS

The chemical composition (dry matter, crude protein, crude fiber) of the promising accessions are presented in Table 6.

In general, percent crude protein of the grasses varied between 9 and 11%. In the legumes, crude protein contents were 15-22%. Crude fibre contents of all accession ranged between 25 and 34% of total DM.

Table 6. Chemical composition of some of the accessions

No.	Species	Dry matter (%)	Crude protein (%)	Crude fibre (%)
	Grasses:			
1	King grass	11.4	10.5	28.3
2	P.M. Hamil	19.1	9.7	28.5
3	P.M. Liconi	19.4	11.2	30.5
4	P.M. Trichoglume	18.0	10.3	33.6
5	P.M. Makueni	18.0	9.3	32.7
6	Setaria splendida	15.7	11.0	25.5
7	B. mutica	18.4	8.7	32.2
8	B. decumbens	16.0	9.0	31.4
	Legumes:			
9	LL. Cunningham	25.0	25.0	24.8
10	S.G. Cook	25.6	15.0	32.2
11	SH Verano	26.5	15.0	34.8
12	S.S Seca	26.8	14.6	33.7
13	MA. Siratro	18.8	17.0	29.0

CONCLUSION

Penniseturn spp particularly King grass grew well on a wide range of soil, producing the highest yield. These should be used well in cut and carry system for smallholders in both the north and the center of Vietnam.

Panicum maximum cv. Hamil grew well in the northem and central country. It should be used in cut and carry or grazing system if possible in appropriate region.

Leucaena leucocephala especially cv. Cunningham grew well in the drained, fertile soils with pH>5. *Stylosanthes* spp. particularly *S. guianensis* cv. Cook were suitable up to the middle land and *Macroptilium atropurpueum* cv. Siratro adapted to acid, dry drained soils. The promising legume accessions should be expanded in each suitable region for animal production.

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FORAGE PRODUCTIVITY OF GUINEA GRASS IN DIFFERENT FARMING SYSTEMS

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SUMMARY
Three small experiments were conducted to determine the productivity of guinea grass under different cutting and grazing management systems. Guinea under cutting produced the highest yield in dry matter and crude protein but leaf production rate and crude protein content were higher under grazing. In mixed swards, guinea mixed with leucaena produced the highest yields of dry matter and crude protein. Three shade reduced DM production but guinea could produced as much as 53 tons of fresh yield/ha/year.

INTRODUCTION
Guinea grass is widely distributed in the tropical and sub-tropical areas of the world (Whyte, Moir and Cooper 1959). It can produce over 20 tons DM/ha (Gerardo and Oliva 1977) but suffers from drought when dry matter production can be reduced to as low as 40% of its yield potential. Guinea grass responds well to cutting and grazing, and is fairly pest resistant (Gerardo and Oliva 1977). It adapts well in different kinds of lands and under the shade and is resistant to weed invasion once well established (Humphrey 1974). Although it is apomictic in reproduction, guinea can produce over 400 kg/ha of seed (Bilbao and Matias 1977).
Due to its wide adaptability in a variety of ecological environment, this grass has received much attention and detailed investigation of its potential in Vietnam in the last few years. Some of the experiments were conducted with the main objective to determine its productivity under different cultivation systems.

MATERIALS AND METHODS

Guinea grass was planted in soils with a pH of 4.4 - 5.1; N (%) of 0.13-0.31; P_2O_5(%) of 0.017-0.105 and K_2O (%) of 0.15-0.19. The soils are genaally classified es poor end aciditic. The grass is grown mainly for grazing or cutting in mono-award or mixed with legumes such as *Desmodium*, stylo and leucaena growing under tree shade

Guinea in pure sward at a planting density of 50 x 50 cm received fertilizer rates of N:P:K (160:40:50) at 50 kg/ha for grazing, N:P:K (160:80:80) at 80 kg/ha for cutting. No N fertilizer was applied in mixed swards with legumes. The mixing ratio of 2: 1 (legume:grass) was adopted at the following seeding rate of 5 kg seed/ha for *Desmodium*, 3 or 5 kg seed~a for stylo, guinea by tree trunk and leucaena at seedling density of 15 x 15 cm in rows. The forest comprised 30% *Acacia mangium* and 70% *Eucalyptus* and had a 40% cover in tbe third year.

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RESULTS

Productivity of guinea grass in pure sward

The dry matter yield of guinea grass in pure sward as affected by cutting and grazing is shown in Table 1.

Table 1. Productivity of guinea grass in sole planting

	Yield (Tons/ha/year)			Leaf rate (%)	Selective intake (%)	Chemical composition (%)		
	Forage	DM	CP			DM	CP	CF
Cutting	78.33	17.43	1.870	42.9	91.3	22.26	10.77	34.18
Grazing	33.36	7.91	0.973	66.8	70.6	23.51	12.31	32.12

DM = Dry matter CP = Crude protein CF = Crude fibre

Results showed that although the yield of dry matter and protein of guinea grass under cutting was higher than that under grazing respectively, leaf rate and crude protein content of guinea grass was higher under grazing than for cutting. Guinea grass under cutting and grazing (in feeding cattle) was satisfactory in teens of forage quality and quantity of dry matter.

Productivity of mixed pastures

The dry matter production of the three guinea-legume mixtures is shown in Table 2.

Table 2. Productivity of mixed pastures between guinea and legumes

	Yield (tons/ha/year)			Chemical composition (%)		
	Forage	DM	CP	DM	CP	CF
Guinea x Desmodium	49.78	10.50	1.271	21.06	12.01	30.14
Guinea x Stylosanthes	51.40	10.25	1.276	20.45	12.13	32.18
Guinea x Leucaena	87.94	19.54	4.187	22.28	21.37	22.50

DM = Dry matter CP = Crude protein CF = Crude fibre

It is interesting to note that yields of crude protein and dry matter of guinea mixed with legumes were high The highest yield of forage was from guinea mixed with leucaena.

Productivity of guinea in agro-forestry

Results showed that yield and quality of guinea grass under shade declined slightly as compared with those in the open (Table 3).

Table 3. Productivity of guinea grass in agro-forestry

	Yield (Tons/ha/year)			Chemical composition (%)		
	Forage	DM	CP	DM	CP	CF
Guinea in the open	61.64	12.85	1.407	20.83	10.95	34.46
Guinea under the shade	53.04	11.37	1.169	21.41	10.28	36.07

DM = Dry matter CP = Crude protein CF = Crude fibre

CONCLUSION

In general, guinea grass yielded well in the three cultivation practices of planting (pure, mixing with legumes and under the shade). Production of guinea in pure sward was higher undercutting than grazing. In mixing with legumes, guinea combined well with Desmodium, stylo and leucaena but the best guinea-legume mixture was from guinea mixed with Lsucaena where the fresh yield, dry matter, and crude protein were highest. The average crude protein content was 21.37% on DM basis. The guinea fresh yield under the forest shade could reached as high as 53 tonslha/year to improve feed source for animal. Guinea grass is thus recommended for planting by small householder for feeding cattle in areas of different micro-topography.

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LEUCAENA AS PROTEIN SUPPLEMENTAL FEED FOR MILKING COWS AND GROWING GOATS

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SUMMARY
Twelve milking cows of Laisind breed (Cynthia x Local) were used to investigate the effect of two kinds of diet on milk production. Diet A was poor in nutritive quality, while diet B had 18% of leucaena leaf meal in dry matter. After 60 days, milk production of dairy cows of group B increased by 22% and feed conversion for one kg standard milk (4% of milk fat) improved by 18%.

In another experiment, 12 local growing goats were divided into two groups which were fed with the same feed ration except that group II had 17% leucaena leaf meal on a dry matter basis. The weight gain of group II goats was 25% higher than that of group I goats.

INTRODUCTION
Leucaena [*Leucaena leucocephala* (Lam.) de Wit] is now grown widely in many tropical and sub-tropical regions of the world. Leucaena is considered as a supplemental protein source for ruminant livestock (Norton *et al.* 1994). The outstanding quality of leucaena feed is its excellent palatability, digestibility and intake of herbage, balanced chemical composition of protein, minerals (except Na, I) and amino acids (Jones, 1979) low fibre content and moderate tannin content to promote by-pass protein value (Wheeler, 1994).

In Vietnam, Hawaiian type of leucaena grows freely in many places, especially in Nha Trang-Khanh Hoa province. There are about 3 million hectares of land suitable for leucaena In the last ten years or so, some accessions of giant type leucaena have been introduced into Vietnam and have been evaluated by the National Institute of Animal Husbandry (NIAH) for yield and nutritional value. Leucaena has been studied as a green feed for calves, and leucaena leaf meal (LLM) for laying hens. Peruvian type leucaena is also used as shade and green manure trees in coffee plantations.

Presently, leucaena leaves are not used for ruminant livestock in Vietnam. This paper presents some studies on leucaena as a protein supplemented feed for milking cows and growing goats through the use of locally available feed sources to enhance productivity of both cow-milk and weight gain of goats.

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MATERIALS AND METHODS

Experiment I: **Effect of leucaena leaf meal (LLM) on milk yield and quality of dairy cow-milk**

This experiment was carried out with livestock smallholders in the village around Hanoi city. Twelve milking cows were selected with similar milk production and lactation period. They are milking cows of Laisind breed (Sindhy x Local) and were investigated on two kinds of diet. Diet A was based on poor nutritive feed, comprising 5% urea treated rice straw, while diet B had 18% LLM as dry matter. Every milking cow was fed on both kinds of the diet (A and B) using the switch back method of Reillan, O. (1988) with a duration of 60 days in three phases as following:

		A		B		A
Cow No 1	———	———	———	———	———	———
	t'	t	t'	t	t'	t
		B		A		B
Cow No 2	———	———	———	———	———	———
	t'	t	t'	t	t'	t
		B		A		B
Cow No 12	———	———	———	———	———	———
	t'	t	t'	t	t'	t

A, B: Diet A, B — t' - Prepared period
t' = t = 10 days — t = main period

Leucaena leaf meal was mixed with concentrate and fed twice a day before milking. Milking was done by hand at 5.00 a.m. and 4.00 p.m. Milk samples were analysed every 5 days throughout the experimental duration. All milking cows were fed with the fixed diets accordingly (Table 1).

Table 1. Diets for lactating cows (kg/hd/d)

Feed	A (Control)	B (18% LLM)
Natural grazing grass	6	6
Elephant grass	8	8
5% Urea treated rice straw	2.5	2.5
Concentrate	2.5	1.0
Leucaena leaf meal	0	1.5
CP/kg DM (g)	118.6	137.3
Total DM intake	6.54	6.57

Experiment II: **Effect of leucaena leaf meal on growing goats**

Twelve local growing goats of eight months of age with a mean weight of 8.1 kg were chosen for the experiment. They were divided into two groups which were fed with two different djets. Group I was the control treatment while group II was fed with the feed that had been supplemented with 17% dry matter of LLM. LLM was mixed brewery waste and fed to goats twice each day, early in the morning and late in the afternoon. The experimental period lasted 90 days continuously,. The goats were weighted two times, before and after the experiment early in the morning for two successive days before the goats were fed.

RESULTS AND DISCUSSION

In experiment I, the diets and quality of feeds for milking cows are shown in Table I and 2. Both groups, A and B had similar daily dry matter intake (6.54 and 6.57 kg3 but there were some differences in crude protein per 1 kg of dry matter (DM). In diet A, crude protein (CP) was 118.6 glkg DM which had enough N for microbial activities in rumen (Norton ct al. 1994). When supplemented with 18% of leucaena leaf meal as DM in diet B, CP was increased to 137.3 g/kg DM, with some feed protein escaping as by-pass protein from rumen and thus provided additional protein for absorption in the small intestines (Norton et al. 1994). Gupta et al. (1992) found that when dried leucaena leaves were fed to cattle 60% of the protein by-passed rumen fermentation. So, the increased milk production from the I cows fed with diet B might be attributed to the bypass protein (Table 3). Lascano et al. (1994) stated that when Holstein-Friesian milking cows grazed on pasture with 30% of leucaena, milk production increase 22%. Otherwise, feed conversion for 1 kg standard milk (4% of fat) in group B improved by 31% (1.07/1.56). For Holstein Friesian lactating cows, feed conversion was 1.31 kg for one kg of milk (Proma et al. 1984).

Table 2. Composition (DM and CP) of feedstuff for lactating cows (g/kg)

Feed	DM	CP
Natural grazing grass	243	28
Elephant grass	220	21
5% Urea treated rice straw	450	60
Concentrate	880	116
Leucaena leaf meal	900	200

Table 3. Effect of Leucaena leaf meal (LLM) on the yield and quality of milk

Parameter	A (Control)	B (18% of LLM)
No. (head)	12	12
Duration (day)	30	30
Milk production (kg/hd/d)		
X	3.97	4.63
± SD	±0.64	±0.7
Standard milk (4% of fat) (kg/hd/d)	4.178	6.116
Comparison (%)	100	122
Milk fat (%)	4.21	4.42
Milk protein (%)	3.75	4.14
Feed conversion (kg DM/kg Sta. Milk)	1.56	1.07

DM: Dry matter
Sta. Milk: Standard milk (4% of fat)

In experiment II, daily dry matter intake per goat was 577-580 g for both groups I and II, but crude protein in group II was higher than that in group I (Table 5). Daily weight gain of group II was 44.4 glhd/d. an increase of 25% (Table 6). The average daily gain of goats when fed with agricultural by-product and dried leucaena leaves ranged from 50-60 g while goats without leucaena leaf meal gained 13.2g/hd/d. (Soedomo et al. 1984). When dried leucaena leaves were fed to goats or sheep as a feed supplement, more than 34% of protein by-passed rumen fermentation (Bamualin et al. 1984). This could have resulted in better weight gain when leucaena leaves were included in the diet.

Table 4: Chemical composition and nutritive value of feedstuff for experimental goats (g/kg)

Feedstuffs	DM	CP	ME(MJ)
Natural grass	240	20	2.26
Elephant grass	220	21	1.90
Leucaena leaf meal	900	200	10.30
Concentrate	880	116	11.77
Brewery waste	240	22	1.62

DM - Dry Matter CP - Crude Protein ME - Metabolisable Energy

Table 5: Diet of goats (g/ha/d)

Feedstuffs	I	II
Natural grass	280	280
Elephant rass	1250	1130
Leucaena leaf meal	0	100
Concentrate	190	120
Brewery waste	280	280
DMI intake	577	580
ME (MJ)	5.70	5.68
CP	60	69.4

Table 6: Effect of leucaena leaf meal (LLM) on the liveweight gain of goats

Parameter	I (Control)	II (17% LLM)
No. (head)	6	6
Initial Wt. (X ± ES) kg/hd)	8.1±0.4	8.1±0.5
Final Wt. (X ± ES) (kg/hd)	11.3±0.6	12.1±0.8
Body weight (X ± ES) (g/hd/d)	35.6±6.7[a]	44.4±4.7[b]
Comparison (%)	100	125

Mean with superscripts (a,b) are significantly different at P<0.01

CONCLUSION

When Laisind milking cow was fed on a diet supplemented with 18% leucaena leaf meal in dry matter, milk production increased by 22%. Feed conversion decreased by 18%. Similarly when leucaena leaf meal was included into the diet of local growing goats, the daily weight gain of growing goat achieved 44.4 g; an increase of 25% when compared to goats fed on a diet without leucaena leaf meal.

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FORAGE LEGUMES FOR LEY-FARMING IN THE TROPICS

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SUMMARY

The term "ley-farming" is defined and the role of this land-use system in soil conservation is highlighted. The soil-improving effect of tropical legumes has been recognized several decades ago; qualitatively it compares with that of spontaneous fallow vegetation. Three important examples of tropical legume leys are briefly discussed: The fodderbanks in Nigeria, West Africa; zero-tillage leys in Northern Territory, Australia; and smallholder ley-farming with dairy cattle in Northeast Thailand. In all cases, the system is biologically sound and potentially very successful but the rate of adoption by farmers is below expectations, mainly because of economic reasons. One of the means to overcome adoption constraints is the identification of more productive and lesser inputs requiring legumes. A series of selection criteria for ley legumes is presented and several important conceptual aspects of testing species for suitability as leys are discussed. Along with a list of legumes worth to be tested for their ley potential a series of research topics is mentioned.

INTRODUCTION

The term "ley" is derived from the old-English "lea" which means a grassy fallow vegetation on former crop fields (Glatzle, 1988). It refers to a land use system where arable crops alternate with vegetation used for livestock production. Accordingly, a spontaneous fallow vegetation that is grazed by livestock prior to cropping, is a ley an "unregulated" ley system as defined by Ruthenberg (1976). However, the temm "ley" is mainly used for purposefully established forage vegetation which sooner or later is succeeded by an arable crop (Ruthenberg's "regulated" ley system).

An important distinction, however, is to be made between short-term (temporary) leys which, in general, consist of short-lived plants established not forlong-term persistence but purposefully for rotation with crops, and long-term pastures that were established for persistence but become leys if they are succeeded by a crop. This paper is only concemed with the former type ("ley" in a narrow sense).The latter type is, for example, one of the recent research subjects of the International Center for Tropical Agriculture (CIAT) in the South American savannas (Vera et al. 1992).

The rationale of ley-farming is that the ley vegetation is planted with a double objective:

(1) to provide forage for livestock, and

(2) to restore or maintain soil fertility for subsequent crops.

The system was an important soil conservation practice in Europe during the past century. The most significant success example of modem times is the use of self-generating, annual legumes (*Trifolium subterraneum* and *Medicago* spp.) in the semi-arid, Mediterranean climate of the South Australian wheat belt (Puckridge and French, 1983).

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FALLOW EFFECTS OF TROPICAL LEGUMES

In the tropics, ley-farming research is still a rather recent research development. Among the first efforts are those carried out during the 1930's and 1940's in Uganda which, however, were based on grasses only, mainly *Pennisetum purpureum* (Tiley, 1965). Still in Uganda, in the 1960's the importance of including legumes in integrated pasture/crop production systems was demonstrated (Brockington et al. 1965; Stobbs, 1969).

Further work carried out throughout the tropics by a large number of researchers has shown the beneficial effect of legumes on soil fertility (Australia, e.g. Jones, 1967; Southeast Asia, e.g. Shelton and Humphreys, 1975; sub-Saharan Africa, e.g. Nnadi and Haque, 1986; tropical America, e.g. Staver, 1989; see also summary by Whiteman, 1980). In conclusion, it is suggested that the qualitative effects of tropical legumes on soil properties are, in principle, the same as those of a spontaneous fallow vegetation (Table 1).

Table 1. Summary of effects of fallow vegetation in comparison with those of tropical legumes

Expected effects of fallow vegetation	Tropical forage legumes
Increase in soil organic matter	yes
Increase in plant nutrients (incl. biological nitrogen fixation)	yes (!)
Improvement of soil structure	yes
Erosion control	
Control of weeds, break in pest and disease cycles	yes
Through:	
Appropriate root and symbiotic systems	yes (!)
Intensive soil biological activity	yes
Permanent soil cover	yes
Nutrient cycling without export	no
Diversity of vegetation	no

There are, of course, considerable quantitative differences between the effect of legumes and that of fallow vegetation in general. Thus, a major advantage of a leguminous vegetation over a spontaneous mixture of fallow plants consists of biological nitrogen fixation if there is an effective symbiosis with rhizobial bacteria. A potential disadvantage is (1) a reduced diversity of vegetation if the legume ley is monospecific, and (2) the fact that nutrients are exported if the ley is used but under grazing such exports are theoretically minimal (Spain, 1989).

Examples of tropical legume leys

Although a substantial body of biological evidence, that has been accumulated during the past decades, shows that also in the tropics ley-farming is feasible and a potentially most beneficial land use system, there are not too many examples of legume-based ley-farming systems that have found their way from research and development programs into practice. Three examples are briefly outlined:

West Africa. In view of the increasing trend towards mixed farming resulting from increased interaction between pastoralists and farmers in the subhumid zone of West Africa in the late 1970's the International Livestock Centre for Africa (ILCA) has developed the fodderban k technology in Nigeria. It consists of fenced forage legume paddocks that are used for strategic supplementation of livestock grazing natural pasture; after 2-3 years the J area is cropped with a cereal but can subsequently reconvert to legume paddocks (Mohamed Saleem et al. 1986). Essentials of the system are the use of a prolifically seeding, self regenerating legume such as Stylosanthes hamata cv. Verano; low-input establishment including minimum or no-tillage , fertilization with superphosphate and broadcast-sowin g (alternatively undersowing the legume into a crop); and early control of spontaneous-grass competition through strategic grazin g (Mohamed Saleem and Suleiman, 1986).

The system has been very successful, both in terms of soil fertility increase in the form of a nitrogen equivalent contribution to a subsequent maize crop of as high as 90-100 kg/h a (Table 2) and in terms of substantial livestock production increase due to the strategi c dry-season grazing of the fodderbanks (Mani et al. 1994).

Table 2. Maize grain yield after previous alternative land uses (taken from Moharned Saleem et al. 1986)

Previous land use	Maize grain yield at zero N (kg/ha)	N contribution* (kg/ha)
Cropped 3 years	461	
Natural fallow	1275	30
Stylosanthes hamata 2 years	1369	32
Stylosanthes hamata 3 years	2507	90
Stylosanthes guianensis 1 years	1643	44
Stylosanthes guianensis 2 years	2696	100

*Amount of N required on cropped soil to give a yield to that at O N after respective land use

In Nigeria, this ley-farming technology has been supported by b ank credits and was readily adopted by farmers. However, its spread has in recent years slowed down, probably because of one or more of the following reasons (Mohamed Saleem and Fsher, 1993):
Costs of growing the legume (labour, fences); land tenure problems (pastoralists do not own land); fodderbank failures when the technology was taken to unsuitable environments ; insufficient credit for farmers; and deficient extension service. As another possible reason, it is suggested that for livestock producers interested in more drought tolerant forage plants, the virtually only legume available for ley-farming in West Africa, *Stylosanthes hamata* cv. Verano, might not be sufficiently convincing.
North Australia. In the dry-subhumid Katherine-Darwin region of the Northem Territory , experimental work was conducted in the early 1980's with the legumes *Stylosanthes hamata*, *Alysicarpus vaginalis* and *Centroserna pascuorurn*. Here, the system is also characterize d by (1) legumes that are short-lived and prolifically seeding; (2) zero-tillage establishment via herbicide applications to prevent soil erosion; and (3), after 1-2 crop years (sorghum), legume re-establishment via an adequate soil seed bank (Jones et al. 1991).

The leys are strategically grazed by cattle with substantial benefits during the main dry season (Table 3); they are also used to produce high-quality legume hay. The annual nitrogen contribution from the leys to the system is equivalent to 10-90 kg/ha; the potential, however, is higher but considerable early leaching occurs before the crop can use the mineralized nitrogen (McCown et al. 1986).

Table 3. Liveweight changes (g/head/day) during the main dry season on four legume leys in Northen Territory, Australia) taken from McCown et al. 1986)

Legume	Year		
	1982	1983	1984
Stylosanthes hamata (cv. Verano)	+448	+559	+443
Stylosanthes vaginalis	+449	+451	+235
Centrosema pascuorum (CPI 55697)	+459	+541	+467
Natural grass	+168	+143	+238

The system is being actively promoted in the region by research and development agencies, even via videos (NT DPIF-CSIRO, 1993), but the rate of technology adoption by farmers does not seem to be very high. Problems encountered so far are particularly related to the management of the leys: The main issue seems to be the extent to which spontaneous grasses should be allowed to invade the legume. Jones et al. (1991) suggest a series of factors that would favour a certain grass proportion in the ley such as the resulting reduction of nitrate leaching and soil acidification, availability of higher-quality forage during the early rainy season, and higher availability of mulch for the zero-tillage establishment of the crop.

Northeast Thailand. In the 1980's, an on-station and on-farm research project of the Khon Kaen University investigated the potential of legume leys for smallholder dairy production in those areas of dry-subhumid NE Thailand where upland rice is not possible and cassava is the main crop (Gibson, 1987). *Macroptilium atropurpureum* cv. Siratro and *Stylosanthes hamata* cv. Verano were the most successful legumes among the species tested. On the low-fertility upland soils that are characteristic for the project area, the cassava yield increasing effect of legume leys, however, was only substantial when the legume was fertilized. With adequate, yet still modest, applications of phosphorus, potassium and sulphur to the legume, after one year Siratro ley cassava yields were more than doubled (Table 4).

With this technology, smallholder dairy production is theoretically very profitable: Calculating the economics of a legume ley rotation with traditional upland cropping, Gibson (1987) found that the yearly net income from a total of 1.3 ha can be increased from $ 260 to $ 777 (US dollars).

In spite of the demonstrated benefits of the ley-farming technology developed for NE Thailand and the corresponding subsequent extension efforts, adoption of the rotation technology has been ratherlow (Foppes, 1993). The reasons seem to be complex and of ten related to traditional thinking. Among them, Foppes (1993) and Simaraks (1993) mention

Table 4. The effect of a one-year *Macropitilium atropurpureum* cv. Sirato ley on cassava yields in Notheast Thailand (taken from Gibson, 1987)

Land use 1980	Land use 1981	Fertiliser application 1980-82*	Cassava yield 1982 (fresh weight tubers) t/ha
Cassava	Cassava	yes	13.0
		no	11.0
Siratro	Cassava	yes	28.0
		no	17.0

* Fertilizer application rates: 1980: 30 kg triple superphosphate/ha, 20 kg gypsum/ha, 50 kg potassium chloride/ha; 1981-82: 10 kg triple superphosphate/ha, 10 kg gypsum/ha, 15 kg potassium chloride/ha

the novelty character that several components of the technology have for the farmers; the need to fertilize the legume; the reluctance of farmers to reduce the cash crop area of their small holdings; the lack of an immediate and direct cash benefit from the legume fey; and failures due to ley mismanagement such as overstocking.

ECONOMICAL AND RESOURCES MANAGEMENT CONSIDERATIONS

From the aforementioned experiences it can be concluded that short-term legume-ley farming in the tropics is biologically sound and potentially most successful. The rate of adoption of available technologies, however, besides being affected by traditional thinking and farming practices, seems to be mainly determined by economics: Benefits from the system must be substantially higher than the ley establishment and maintenance costs.

In this context, particularly important factors to be considered are: the extent of soil degradation due to continuous cropping (farmers see often no urgent need to restore soil fertility!); prices of altemative fertilizers required for the arable crop; labour and fertilizer requirements to establish the fey; and prices of the agricultural products (crop and livestock products).

In spite of the adoption difficulties, short-temm ley pastures are an option that merits further attention, continuing efforts by researchers and extension agents, and, eventually, governmental interventions in the form of incentives, such as price subsidies, for farmers to adopt new technologies. It is generally accepted that the continuing increase of population pressure on arable land leads to a declining land productivity. Consequently, low-input based changes in agricultural production systems in the tropics are required in order to restore and maintain a sustainable land productivity. Short-term ley pastures may be one of the answers to this important challenge.

LEGUME SPECIES

Selection of tropical legumes for leys has hitherto been more a spillover from forage legume development programs rather than the result of systematic screening of large germplasm collections for suitability as leys. The example of *Stylosanthes hamata* cv. Verano shows that the selection has been successful. However, it also reflects the narrow genetic base of tropical legumes available for the presently advocated ley technologies. Thus, it is suggested that an area of ley-farming research warranting urgent attention is the evaluation and identification of legumes for subsequent development of cultivars that are more efficient and require less establishment and management inputs than the legumes that are presently available for short-term leys.

Legume characteristics that are particularly relevant for ley systems are as follows:

1. ease of establishment (high seed production potential),
2. ease of re-establishment (high soil seed reserve potential, hardseededness),
3. ease of control during the crop phase,,
4. high nitrogen fixation (a function of plant productivity and soil adaptation),
5. drought tolerance Tolerance to diseases and insect pests,
6. high animal production (a function of plant productivity and nutritive value)

The objective and outcome of a cultivar development program, however, should not necessarily be just one or only a few broadly adapted species and varieties. Rather, different germplasm options should be considered and eventually developed for different environments in terms of soil, climate, and production systems. In Table 5, 20 species are suggested that are worth to be examined for their potential as ley legumes

Table 5. Some species suggestions for research on short-term legume leys

Aeschynomene americana	*Clitoria ternatee*
Alysicarpus vaginalis	*Crotalaria spp.*
*Cajanus cajan**	*Lablab purpureus**
Calopoginium mucunoides	*Macroptilium atropurpureum*
Canavalia spp.	*Macroptilium lathyroides*
Centrosema brasilianum	*Macroptilium longepedunculatum*
Centrosema pascuorum	*Phaseolus aureus**
Centrosema pubescens	*Stylosanthes hamata*
Centrosema schottii	*Vigna unguiculata**
Chamaecrista rotundifolia	*Zornia spp.*

* Dual-purpose legumes

In addition to a wider species range, evaluation of legumes shoud be based on an intraspecific variability as broad as possible. This means that rather than testing just one or two genotypes within a given species, materials representing the known variability within a larger germplasm collection of that species should be screened for their suitability as leys. In many tropical legumes, the natural intraspecific variability is extremely great.

Another important aspect when deciding on the legume species to work with is that of the longevity of species. Although the concept of a short-term ley almost implies that the respective legume is short-lived, it may well be worthwhile to consider also persistent legume-banks or mixed pastures with a high legume content. In comparison with annuals, longer-lived legumes will have an important advantage during the dry season. In this context, an interesting potential option that should be researched is that of mixtures of complementary legume species.

Rainer Schultze-Kraft

A potentially successful research area is furthermore to explore the use of dual-purpose legumes, such as cowpea, in ley systems (Mohamed Saleem and Fisher, 1993). Like the forage-only legumes, they improve soil fertility and eventually also provide feed for livestock, but in addition they produce grain for human consumption. Their use as leys could be particularly relevant for smallholder subsistence farmers. An especially important selection and breeding objective in dual-purpose legumes in general, is retention of leaves after grain harvest.

FUTURE RESEARCH

Research topics that merit further attention are suggested as follows:

1. Screening of germplasm collections for suitability as ley legumes and subsequent development of selected species and varieties
2. Identification of species and varieties for particularly degraded soils
3. Low nutrient requirements and high nutrient uptake efficiency are particularly important selection criteria.
4. Optimum duration of the ley phase in short-term ley systems (viz. 1, 2, or more years?)
5. Potential of mixtures of complementary species (including short-lived legumes with perennials)
6. Measurement of animal production on legume leys (so far only very few data are available)
7. Break of pest and disease cycles through legume leys
8. Characterization of the potential of soil seed reserves and seedling recruitment Dual-purpose legumes

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Rainer Schultze-Kraft

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INTRODUCTION OF RUZI GRASS INTO GREY PODZOLIC SOILS IN SOUTHEAST PART OF VIETNAM

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SUMMARY

About 5 g of ruzi grass seed were introduced and evaluated at the Ruminant Research and Development Center (RRDC), Song Be, Vietnam in 1988. After the first sowing and initial observation, the grass was found to be potentially promising and more attention was given to the grass than any other grasses. It was then evaluated on red podzolic soil in Southeastern part of Vietnam, especially in Song Be province.

Ruzi grass was tolerant to drought, the ratio of leaf to stem was high (1.23-1.42) and the forage succulent and palatable. In the rainy season, green forage yield could be more than 70 tons/ha and was comparable to that of elephant grass or guinea grass. It is a grass preferred because of its low cost of chaffing, weed control, and animal can take upto 100% of forage given.

The grass appears promising and needs to be promoted widely for ruminants production in Vietnam.

INTRODUCTION

Ruzi grass (*Brachiaria ruziziensis*) is a perennial grass thriving in natural grassland communities and is a pinoneer species in Africa It is also known as Congo signal grass, Kennedy ruzi or ruzi grass.

Ruzi grass is a vigorous, prostrate to semi-probate perennial, reaching a height of 1 m. Leaves are soft, covered with fine hairs, sharply pointed and 10 to 25 cm long. Flowering culms terminate in an erect panicle with 5-7 drooping spike-like seed stalks. Seed number is about 270,000/kg. It is well adapted to tropical, frost-free humid condition with a rainfall in excess of 1500 mm. The grass thrive well on a wide range of soils but does best on well drained soils of high fertility (Yates, 1987).

The grass is now well developed in many tropical countries like Thailand and Australia. In Australia, it was introduced from Madagascar by CSIRO in 1961, although there had been two previous introductions from Belgian Congo and Kenya.

In Vietnam, ruzi grass was introduced for the first time in 1988 to the Ruminant Research and Development Center (RRDC), Song Be. At that time, there were about 5 g of seed and it was sown in 15 m^2 of land. After the first year of observation, it was shown to be very promising grass with high germination percentage (95%), strong resistant to drought, high ratio of leaves to stems (1.23-1.42). Hence greater emphasis was given to this grass at the Center. From 1988 to 1990, ruzi grass was multiplied by stem cuttings and by 1991, there was enough planting material some experiments. Until 1994, RRDC-Song Be is the only place planted with ruzi grass in Vietnam.

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MATERIALS AND METHODS

All experiments on ruzi grass were conducted on grey podzolic soils of southeastern part of Vietnam. The physical and chemical properties of the soil are shown in Table 1.

Table 1. Physical and chemical characterisitics of grey podzolic soils in southeast Vietnam

Physical		%	Chemical		%
Sand	:	72.50	C	:	0.65
Loam	:	11.70	N total	:	0.05
Clay	:	16.05	P_2O_5	:	0.015
pH (H_2O)	:	4.2	K_2O	:	0.014
pH (KC1)	:	3.8			

The buffalo manure was used in the experiments as a basal fertilizer and was put before sowing along with P_2O_5 and a part of K_2O. The manure pH (H2O) was 7.4 and the chemical composition was made up of C (46.5%), P_2O_5, (0.407%), N total (1.01) and K_2O (0.66%). The climate of the region is characterised by a mean maximum temperature of 34.5 ^oC in March and a minimum temperature of 21.0^oC in January. The average temperature is about 27.0^oC. Relative humidity reaches a maximum of 100% in the rainy season and a low of 20% in March with an overall relative humidity of 79.5%. The average rainfall ranges from 1800 to 2200 mm (mainly from May to November). Four experiments were carried out.

Experiment l: Determination of some growth characteristics of ruzi grass

This experiment was conducted from 1991 to 1994 on plot of 70 m^2, with 3 replications and at four nitrogen levels. The levels of nitrogen fertilization were as follows:

T1:20 tons manure/ha/year
T2:T1+150 kg N+100 kg P_2O_5+50 kg K_2O per hectare per year
T3:T1+180 kg N+120 kg P_2O_5+60 kg K_2O "
T4:T1+210 kg N+140 kg P_2O_5+70 kg K_2O "

The cutting interval was 60 days for the first cut and 45 days for the subsequent cuttings. Harvesting was done by hands. During the experiment, plant height, tiller number per clump, number of leaves /tiller and fresh yield of forage harvested were determined.

Experiment2: Effect of nitrogen levels on yield and chemical composition of ruzi grass

This experiment was conducted from 1992 to 1994 with 5 levels of nitrogen at 0, 35,45, 55 and 65 kg N/cut/ha and three basal fertilizations of T1 (20 tons manure), T2 (140 kg P_2O_5+70 kg K_2O), and T3 (N1+N2). Each treatment was replicated three times. The harvest was done for first time after sowing 60 days and 45 days in subsequent harvests. The proximate analysis of the harvested forage samples was done at RRDC-Song Be.

Experiment3: Comparison of the yield of Ruzi grass with that of other tropical grasses

This experiment was conducted in 1994 with each plot size of 15 m^2 (3x5 m) in three replications. The basal fertilization for all plots was 20 tons manure, 140 kg P_2O_5 and 70 kg K_2O/ha/year and two levels of Nitrogen at 55 and 65 kg N/cut/ha. The cutting intervals were same as in other experiments. The grasses selected were elephant grass, guinea grass, Hamil guinea and Pangola grass K280.

Experiment 4: Determination of digestibility coefficients of ruzigrass

The experiment was conducted in 1994 by using 12 growing Murrah buffaloe calves of body weight from 180 to 200 kg. The animals were kept separately and fed with ruzi grass For 3 weeks and the digestibility was done at the 4 week. The intake, the residue of grass and faece were recorded daily for each animal during the 6 days

RESULTS AND DISCUSSION

The growth characteristics of ruzi grass in experiment 1 are summarised in Table 2. The average height of the plant was about 36 cm and there were about 62.48 tiller /plant clump. The fresh forage yield was about 13.2 kg/plot/harvest. Mune Gowda et al. (1983) showed that in Karnataka, ruzi grass under intercropping in coconut plantations could attain a height of 37.4 to 80.6 cm in red sandy loam soils of medium soil fertility, produced 15.2 to 46.1 tillers/clump and 4.5 to 221 leaves/clump.

Table 2. Growth characters of ruzi grass sown in Song Be

Characters	Harvest No.				Average
	I	II	III	IV	
Height of the plants	22.6±8.1	39.4±2.9	40.3±8.4	41.6±6.1	36.0
Numbers of tiller/clump	37.4±2.6	60.1±5.2	69.6±6.0	82.4±8.2	62.4
Numbers of leaves/tiller	3.6±0.4	4.2±0.2	4.4±0.3	4.6±0.4	4.2
Yield of forage/cut	6.5±2.8	13.6±6.2	15.3±7.17	7.7±8.0	13.3

± Standard errors

In experiment 2, the yields of green forage, dry matter and crude protein are illustrated in Tables 3, 4 and 5. These tables showed that the yields increased with increased level of nitrogen, but the efficiency of nitrogen utilization decreased when quantity of nitrogen applied was more than 55 kg N/cuVha. The results also show that buffaloe manure was better than the chemical mixture of P_2O_5 and K2Q in dry sandy soils of southeastern region.

Mune Gowda et al.(l983) reported ruzi grass yielded 72.7 tons/ha at Hebbal, Bangalore under coconut plantations, 125 tons/ha in open field and 31.4 tons/ha in Hasan district of Karnataka, India. In Thailand, Satjiparon et al. (1989) reported 11 tons DM/cut after 70 days of sowing. In other place, Alvim et al. (1990) obtained an annual DM of 12.03 tons/ha with the application of 150 kg N/ha and showed that ruzi grass was least responsive to applied nitrogen in dry season. On the other hand, Aragao et al. (1983) got only 4.76 tons DM/ha/3 cuts.

Table 3. Yield (ton/ha/year) of green forage at different nitrogen treatments (4 cuts in rainy season)

Levels of nitrogen	Basal fertilizers			Average
	N1	N2	N3	
0N	42.3	34.1	45.9	40.7±4.9[a]
35N	57.3	49.3	61.5	56.±5.1[b].
45N	65.0	58.5	70.1	64.7±4.8[c]
55N	71.9	66.5	78.3	72.2±4.8[d]
65N	73.9	67.0	79.0	73.3±4 9[d]
Average	62.2±11.5[e]	55.1±12.3[f]	67.0±12.3[g]	61.4 ±12.0

Values with different letter superscript are different at P<O.OS for basic fertilization and P<0.001 for different levels of nitrogen

Table 4. Yield of dry matter of ruzi grass

Levels of nitrogen	Basal fertilizers			Average
	N1	N2	N3	
0N	9.2	7.5	9.9	8.87±1.0[a]
35N	12.7	11.2	13.7	12.52±1.1[b]
45N	15.4	13.6	16.5	15.15±1.1[c]
55N	16.7	15.9	18.4	17.01±1.1[d]
65N	17.0	16.0	18.7	17.20±1.1[d]
Average	14.18±2.9 [e]	12.83±3.18[f]	15.44±3.28[g]	14.15±3.13

Values with different letter superscript are different at P<0.001 for different levels of nitrogen

Table 5. Yield of crude protein of ruzi grass at different levels of nitrogen

Levels of nitrogen	Basal fertilizers			Average
	N1	N2	N3	
0N	864.7	661.0	963.3	829.7±125.98[a]
35N	1212.6	1060.6	1464.4	1245.9±166.5[b]
45N	1478.0	1344.8	1753.2	1525.3±170.0[c]
55N	1805.4	1648.4	2003.7	1819.2±145.4[d]
65N	1877.7	1693.4	2062.0	1877.7±150.5[d]
Average	1478±376[e]	1222±385[f]	1649±402[g]	1459.6±387.5

Values with different letter superscript are different at P<0.001 for levels of nitrogen

Table 6 shows the chemical composition of ruzi grass as affected by the different levels of nitrogen applied. It is clear that levels of nitrogen applied had no significant effect on composition of ruzi grass.

Table 6. Chemical composition of ruzi grass

Level of nitrogen	Dry matter	Crude protein	Crude fibre	Ether extract	NFE	Ash
0N	21.8	2.0	8.7	1.0	7.5	2.6
35N	22.8	2.2	8.7	1.1	7.5	2.6
45N	23.4	2.4	8.7	1.2	8.3	2.7
55N	23.6	2.5	9.;0	1.2	8.1	2.7
65N	23.6	2.6	9.1	1.1	8.1	2.8
Average	22.9±0.8	2.3±0.2	8.9±0.2	1.1±0.1	7.9±0.5	2.7±0.1

± standard error

Botrel et al. (1990) reported the crude protein content of ruzi grass ranged from 6.913.4% and the content of CP was increased by the higher nitrogen application from 0.75 to 150 kg/ha.

The results of experiment 3 are shown in Table 7. Highest yield was obtained from elephant grass, guinea grass (Hamil) and ruzi grass while the lowest yield was obtained from pangola grass and guinea K280. Although elephant grass produced high yield of green forage, its yields of DM and CP were the lowest due to its high moisture content.

Table 7. Comparative yields of other grasses with ruzi grass

Grasses	Green forage (Tons/cut/ha)	Green forage (Tons/cut/ha)	Dry matter (Tons/cut/ha)	Crude protein (kg/ha/year)
Nitrogen: 55 kg/cut/ha				
Pangola grass	11.5[b]	46.1[b]	12.1[a]	855.8[c]
Elephantgrass	13.3.[a]	53.38[a]	8.7[c]	936.0[c]
*P.maximum*Hamil	13.2[a]	52.78[a]	12.8[a]	1398.38[a]
*P.maximum*K280	l0.96[b]	43.5[c]	11.8[b]	1073.9[b]
Ruzigrass	11.6[b]	46.3[b]	10.8[b]	1159.0[b]

Values in the same column followed by the same letters are not signifcantly different at the 5% level.

This table also shows that yield of ruzi grass was lower than that of elephant grass but was about the same with that of *P. maximum*. Nevertheless, it was better than other grasses in DM production because of the following reasons:

1. The shoot was soft and there is no need of chaffing after cutting
2. Animals consumed readily almost all the cut forage given
3. No need to control weeds after each cut
4. Multiplication can be done by seed or by stems.

Gomide (1989) also showed that *B. ruziziensis* was the most productive grass when conducting experiment on phosphorus.

The results of experiment 4 on the coefficient digestibilities in ruzi grass are shown in Table 8. The average digestibilities of DM, CP and crude fibre were 60.8%, 57.3% and 55.1%, respectively.

Table 8. Digestibility coefficients of ruzi grass

Number of animals	Dry matter (%)	Crude protein (%)	Crude fibre (%)
1	69.3	61.4	59.6
2	56.6	54.3	52.9
3	63.2	59.6	58.7
4	64.6	59.1	62.0
5	66.4	62.3	59.3
6	59.5	57.1	56.4
7	59.7	55.9	51.6
8	55.9	54.3	49.1
9	59.1	56.2	53.1
10	52.3	51.7	48.1
11	62.4	58.2	55.2
12	60.0	57.3	55.0
Average	60.8±4.5	57.3±2.9	55.1±4.2

±Standard errors

CONCLUSION

The conclusions for ruzi grass in view of its adaptability and agronomic potential in Vietnam are:

1. Ruzi grass is a new grass in Vietnam and has showed to be a very promising pasture. It is tolerant to drought and grows fast in rainy season. It can provide good forage for ruminants.
2. Ruzi grass is preferred because of its high palatability; intake being higher with this grass than other grasses; low weeding cost and no need of chaffing after cutting. Multiplication can be by seed or by stems
3. In grey podzolic soils, manure application is very important for vigorous growth of ruzi grass
4. Nitrogen application will be better if it is applied after each cut and at less than 60 kg/ ha.
5. This grass is very promising and need to be promoted quickly to every ruminants farms and smallholders in the country.

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INTENSIVE FARMING ON PURE AND LEGUME-BASED ELEPHANT GRASS FOR CUTTING

L. H. Binh and H. V. Nung[1]

SUMMARY
Three experiments were conducted to study the effect of organic manure and nitrogen fertilizer rate on dry matter (DM) productivity of elephant grass and its compatibility with two tropical legumes under intensive cutting. The production of DM yield of elephant grass was not evenly distributed throughout the year with the winter yield accounted for about 22.3% of the total. Application of inorganic fertilizer at the rate of NPK (50:80:80) kg/ha gave the highest production of DM in elephant grass. There was a 67% increase over the control. The application of nitrogen fertilizer increased DM productivity. Highest production of DM and crude protein was obtained at 300 kg N/ha/year and also at 80 tons of manure/ha/ year. Elephant grass grown with tropical kudzu or leucaena gave the highest yield than pure swards of elephant grass.

INTRODUCTION

Vietnam with a population of over 70 millions has a low average agricultural land per capita (0.01 ha). To promote developmental changes of agricultural production components, dairy cattle production at small households has been given great anention with the aim of increasing milk production for domestic consumption. However, feed resources are presently erratic and natural pasture is often scarce for dairy cattle production, particularly in winter when yield is low (13-28% of the total). Due to the limited feed availability, it has been suggested that efforts be made to grow high yielding grasses under intensive farming system as an effective and suitable alternative. Elephant grass is a tropical grass. It thrives well in different types of land and grows very fast in hot and humid conditions. In many countries, elephant grass gives the highest productivity of dry matter compared with other grasses.

Thus, a study was conducted to evaluate the effect of fertilizer rates on DM productivity of elephant grass and its compatibility with some tropical legumes.

MATERIALS AND METHODS

An experiment on elephant grass (*Pennisetum purpureum*) was studied on a hilly area of Bavi. The soil has a pH of 5.3, 0.12% N, 0.04% P_2O_5, 0.05% K_2O and 1.73% total humus. The soil is generally acidic and poor in nutrients.

The experimental site has a climate condition of 20°C averge temperature, with 123.3 hours/month of sunshine time and a total rainfall of 1746 mm/year; 90% of the rainfall are concentrated in the rainy season. Relative humidity is about 84%.

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Under the intensive trial of eleplant grass, the treatments of fertiliser applied before winter were 10 tons/ha of manure, 50 kg/ha of nitrogen, combined fertilizer of 80 kg/ha P_2O_5 and 80 kg/ha K_2O and and a combined fertilizer NPK (50:80:80) at N levels of O, 150 and 300 kg/ha/year and organic manure of 0, 20, 40 and 80 tons/ha/year were applied. In another experiment on mixed grass-legume trial, elephant grass was grown with kudzu (*Pueraria phaseolodes*) or leucaena (*Leucaena leucocephala*). The mixed plots received no nitrogen fertiliser.

Elephant grass was establishment from cuttings of 34 nodes at a planting distance of 50 cm. ln the mixed swards, the ratio of kudzu and leucaena to elephant grass was 1 :2 and 2:1, respectively. The seeding rate of kudzu was 10 kg/ha and leucaena planting at 15 cm apart. Legumes were planted a month ahead of the grass.

The two experiments adopted a random complete block design with 3 replicates each.

Data collected during the course of experiments were:

(a) Height of the grass at harvest (cm)
(b) Number of cuttings per year
(c) Fresh yield, DM and crude protein (tons/ha/year)
(d) Efficiency of fertilizer apply
(e) Quality of grass in mixing pasture

RESULTS

The fresh yield production of the elephant grass was not evenly distribution throughout the year. The yield in winter accounted for 22.3% of the total (Fig. 1)

Fertilizer application before winter at the level of N:P:K (50:80:80) kg/ha gave the highest yield (18.3 tons/ha) with an increase of 67% over that of the control plot (Fig.2)

Table 1. Effect of different rates of Nitrogen supply on elephant yield

Nitrogen rate (kg/ha/year)	0	150	300
Height (cm)	124	136	143
Dry matter yield (ton/ha)	18.0	23.2	26.1
Crude protein (kg/ha)	1543	2110	2912
Efficiency (kg dry matter/kg N/ha)	-	34.66	27.00

Increased application of nitrogen fertilizer enhanced productivity of dry matter in elephant grass. An application of 300 kg N/ha/yr gave the highest yield. Yields of DM and CP in the plots supplied with 300 kg N/ha/yr were also higher than those at 150 kg N/ha/yr, being significantly different at $P<0.01$ and $P<0.001$, respectively.

Under the intensive farming system of management, 6 cuts per year was obtained with an application of 40-80 tons of manures/ha. However at 80 tons of manure supply/ha, the yields of DM and crude protein were significantly higher at ($P<0.001$) and ($P<0.001$) respectively).

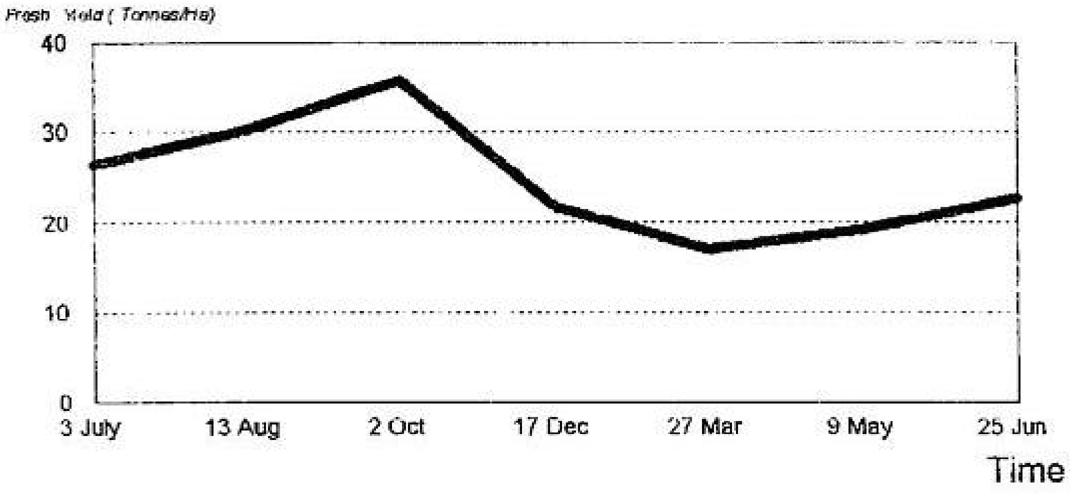

Fig. 1 The variation of elephant grass yield in the year

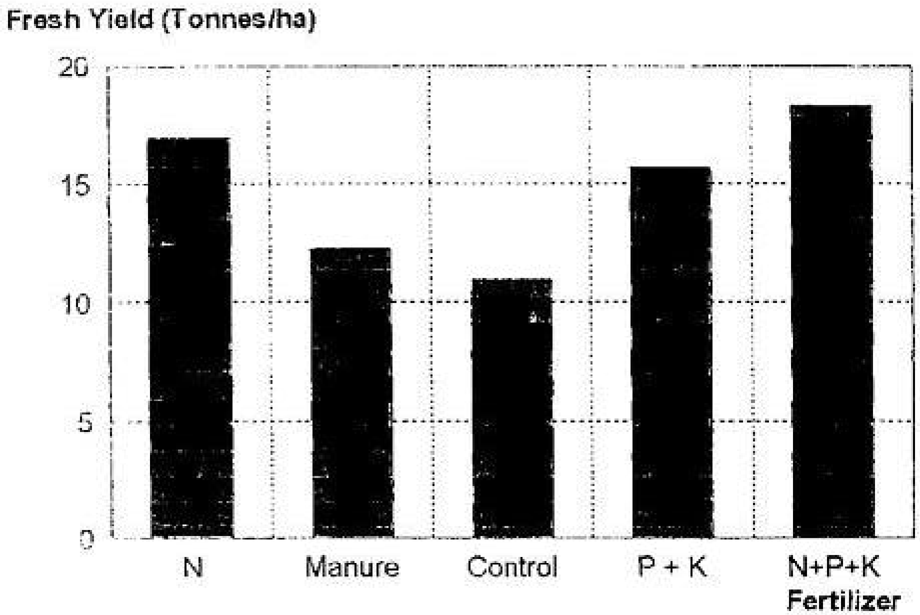

Fig. 2 Effect of fertilizer on elephant grass yield in winter

Table 2. Effect of different levels of manure on elephant grass yield

Levels of manure supply (tons/ha)	0	20	40	80
No of cutting (times)	4	5	6	6
Fresh yield (tons/ha)	110.05	142.75	182.58	246.52
DM yield (tons/ha)	18.73	21.47	24.32	29.64
Crude protein (kg/ha)	1538	2151	2665	3492

Table 3. Productivity of mixed pastures between elephant grass and legumes (tons/ha/year).

Formulas	Fresh yield	Dry matter	Crude protein
Elephant grass	114.69	16.90	1.03
Elephant grass + kudzu	141.92	20.92	1.77
Elephant grass + leucaena	138.63	22.38	2.83

The results show that mixing elephant grass with kudzu or leucaena resulted in higher yield than in pure swards.

Elephant grass mixed with leucaena produced the highest yield of CP (2.8 tons/ha/year).

Table 4. Chemical composition of Elephant grass in mixing pasture (% DM basis)

	Pure sward	Mixed with kudzu	Mixed with leucaena
Dry matter	14.7	14.0	12.1
Crude protein	6.1	6.7	7.8
Crude fibre	33.2	30.6	32.0

Chemical composition of elephant grass in pure sward was different to that of elephant grass in mixture with legumes, especially in the CP content. Crude protein content of elephant grass mixed with tropical legumes was higher than that of pure sward. The highest value was in mixing with leucaena.

CONCLUSION

1. Elephant grass was a high yielding grass but uneven in distribution of production but application of N, P, K fertilizer before winter can increase that fresh yield in winter.
2. Application of nitrogen and manure enhanced the yield. Total CP produced per ha/ year was 2912 kg at 300 kgN/ha/year. The fresh yield and DM were 246 and 29 tons/ ha/year at 80 ton/ha/year of manure applied
3. Elephant grass grown with kudzu or leucaena (under suitable pH level) gave higher yield of dry matter and CP/ha than in pure sward.

RECOMMENDATION

These results support the use of elephant grass in smallholder farms for increasing forage supply for dairy cattle production under intensive system of management.

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SUSTAINABILITY OF PASTURE WITH INTRODUCTION OF SHEEP UNDER DURIAN ORCHARD

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SUMMARY
Forage availability under plantation crops declines when trees grow older. Durian orchard is probably a good alternative for integration in view of its better light transmission and thus better growth of the ground cover. With a stocking rate of about 15 sheep/ha under matured durian, the dry matter availability did not go lower than 1,000kg/ha. Probably, more than 15% leguminous forage were required to achieve a sustainable pasture in this livestock integration system. *Brachiaria humidicola* did not affect the growth of young durian trees and the grass could sustain about 30 cheeps/ha under nomadic rearing system.

INTRODUCTION

Sheep integration with tree-crops managed as a commercial entity was started in the mid-eighties. Since then, many projects were set up in Peninsular Malaysia. However, the overall success rate of these commercial projects was considered low as many could not progress well and some closed down after a few years of operation. Several constraints and problems were encountered during the implementation of the projects especially in the areas of forage resources, management practices and animal productivity. Forage availability under plantations crops such as oil palm and rubber, declines when trees grows older.

Pasture improvement under rubba and oil palm had been previously attempted but was not sustainable due to inadequate light transmission for growth. Re-orientation of the planting system need to be done to create a more suitable environment for sheep integration in plantations (Chong and Tajuddin 1994, Abdullah et al. 1992). However, this practice may not be applicable to all areas under the tree-crops because of different degree of slope and type of elevation since the planting rows need to be along the east-west position in order to get good light transmission.

Fruit orchards, such as durian may be a good alternative in view of this problem. There are about 163,000 ha of fruit orchards in Malaysia of which 34% are grown with durian (Nik Masdek and Zahari 1993). Comparatively, there was more light penetration in matured durian (20-25% of the full sunlight) (Mohd Najib unpublished data) compared to that in mature rubber and oil palm when the canopy closed in (Chen et al., 1988). Even though the level of illumination improves slowly during the stage of maturity of oil palm and rubber, the subsequent under-storey vegetation is mainly fern.

The main aims of this study were to record the availability, productivity and sustainability of native pasture under mature durian and of *Brachiaria humidicola* pasture under young durian with the introduction of sheep. The study was supported by Prisons Department, Malaysia.

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MATERIALS AND METHODS

The area under study covered a total of 7.4 ha of matured durian and 0.4 ha of young duriar trees, at Dusun Datuk Murad, Ayer Keroh, Malacca, a prison for juvenile delinquents Malin-crossed sheep were reared at a stocking rate of about 15 animals/ha under the matured trees. *Brachiaria humidicola* was planted together with durian seedlings, initially, to find out the survival of the two crops through time. The grass was fertilized in four split applications annually, at the rate of 200kg N,40kg P and 100kg K per hectare/yr using Urea, Triple Superphosphate and Muriate of Potash, respectively. Another area of about the same size was treated as control. All the durian trees were planted at 30m x 30m spacing.

Initially, *B. humidicola* was cut as fodder at every six-week interval. After three years of growth, the grass was grazed by Malin-crossed sheep at about 30 animals/ha. Ten percent of the durian trees were chosen randomly for girth measurement at 0.5m above the ground. Data were recorded every 24 weeks to find out the girth increment over time.

At commencement, the age of the animals was between 0.8-1.5 years old. They were allowed to graze for five hours daily and were given sufficient water and mineral lick. Old stocks were sold and replaced by new ones. Grazing was managed using nomadic system and two shepherds looked after the animals each day.

Forage samplings for dry matter (DM) and botanical composition were carried out every 12 weeks. Botanical composition scoring was done using the method advocated by Mannetje and Haydock (1963). One percent of the total land area was taken randomly during each botanical sampling. Samplings for DM availability was carried out using lm x lm quadrats adequately.

Light measurement was conducted using light meter LI-COR model LI-I000 at 24weekly interval. Four fixed sites were chosen under the mature durian trees for this purpose. Data were recorded every hour from 0800hr to 1800hr at every one metre sequence along and across rows of the tree crop.

The study was carried out in a five-year duration with the co-operation of the staff of the Ayer Keroh juvenile prisons.

RESULTS AND DISCUSSION

(a) Forage production and composition

The average forage DM availability sampled at every 12 weekly interval, decreased in the second year but was significantly higher in the third year onwards (Table 1). Even though the feed-on-offer fluctuated over the period of investigation, with the stocking rate of 15 animals/ha, the DM availability did not go lower than 1,000 kg/ ha. Under mature oil palm and rubber, the forage DM availability was only about 500kg/ha (Wan Mohamed 1977). Based on the 12-weekly samplings, forage DM availability was slightly low during the months of February-March and August-September but the forage on offer to the sheep was relatively stable and sufficient.

In the presence of sheep, forage botanical composition progressively changed even though the percentage light transmitted through the durian canopy was more or less the same throughout the period under study. The grass component continuously increased whilst the legumes decreased in the first three years and slowly increased in the subsequent years. The presence of broad-leaved forages was not stable and appeared to be so little at the end of the five-year investigation. The major forage species observed were *Ottochloa nodosa, Ischaemum muticum, Ischaemum timorence, Axonopus compressus, Paspalum conjugatum, Paspalum notatum, Calopogonium mucunoides, Calopogonium caeruleum, Pueraria phaseoloides, Centrosema pubescens, Desmodium ovalifolium, Asystasia intrusa* and *Mikainia cordata*. The grasses were quite widespread whilst most of the legumes and broad-leaved forages occurred in patches, especially towards the end of the study.

The data in Table I indicate that animal liveweight gain (LWG) was positively related to total available crude protein (CP) and percentage legume component of the native forage. The increase in the grass component did not seem to affect the total CP and animal LWG as shown in Year 3 in the table. Probably, more than 15% leguminous forage were required to achieve a sustainable pasture in this livestock-crop integration system. In general, a high percentage of legume may not be desirable for fruit bearing durian crops because too much nitrogen in soil may reduce the fruit production. However, the continuous introduction of the sheep into the orchard had resulted in better fruit production, as told by the of ficer-in-charge of the juvenile prison. Financially, by the end of the study, the department was getting almost higher inncome than before the experiment started, even though the unit price was maintained. Probably, durian requires desirable and controlled cover crops and organic matter to conserve moisture. Lee (1991) found that *Paspalum notatum* cv Pensacola resulted in higher soil organic matter, better soil structure and enable fruit orchards to produce higher yield, when grown as ground cover.

Table 1. Dry matter production, botanical composition of forage and animal liveweight gain under matured durian

Year	DM Availability (kg/ha)	Botanical Composition			Total Ave.CP (kg/ha)	Animal LWG (kg/ha)	Light (%)
		Grass (%)	Legume (%)	Broad-leaf (%)			
1	1257.2b*	67.1c	21.0a	ll.9a	128.2	242	21
2	1198.6c	72.3b	18.1b	9.6bc	106.7	236	20
3	1305.5a	78.5a	12.4d	9.1c	84.9	218	23
4	1283.9a	74.5b	15.2c	10.3b	100.1	225	22
5	1246.4b	80.0a	16.3c	3.7d	101.0	230	21

DM - Dry matter of native forage
CP - Crude protein
LWG - Liveweight gain of sheep
* Means followed by different letters down each column are significantly different (P=0.05).

(b) Growth of *Brachiaria humidicola* in young durian tree plot and animal performance Herbage yield of *B. humidicola* harvested every six weeks and girth increment of the young durian trees are summarized in Table 2.

The results shown in Table 2 are for cut-and-carry and grazed pasture using about 30 sheeps/ha. The dry matter yield of the B. humidicola grass continuously increased under the cut-and-carry system, from 12,015 kg/ha in the first year to 17,165kg/ha in the third year. A previous study had shown that this grass species normally experienced slow growth at the beginning and proceeded to the full scale when harvested at certain intervals as fodder (Wong et al. 1995). The tree girth was not measured in the first two years of growth because the plants were still very young and small to differentiate among them. However, from the third year onwards, girth increments of the durian trees were always higher when grown together with B. hurnidicola than those in the control plot. The results seem to indicate that the grass did not affect the growth of the young durian trees which performed better than those without the grass. Since the tree crop was also fertilised sufficiently, competition for plant nutrients was very unlikely. The presence of the grass probably resulted in cooler soil environment for the growth of the durian. This extra benefit and others have also been studied by Lee (1991) using *P. notatum* cv Pensacola.

Table 2. Herbage yield of Brachiaria humidicola and mean girth increment of durian trees

Year	DM Yield of Grass (kg/ha)	Girth increment of Durian (at 0.5m above Ground)	
		With Grass (cm)	Control (cm)
1	12,015	not measured	not measured
2	14,950	not measured	not measured
3	17,165	10.4	6.4
4	(grazed)	12.2	7.0
5	(grazed)	14.1	10.6

Table 3 summarizes the forage feed availability and animal performance on grazed *B. humidicola* pasture integrated with durian.

Table 3. Forage feed availability and animal performance on grazed *Brachiaria humidicola* pasture integrated with durian

Parameter	Range	Mean
Forage dry matter Availability (kg/ha)	1951.1 - 2447.8 (Year 4)	2.362.5
	1789.3 - 2014.7 (Year 5)	1,902.2
Animal body weight (kg/hd)	26.9 - 35.4	32.1
Average daily liveweight gain (g/hd)	34.1 - 98.4	44.8

Mean forage DM availability in the fourth year was 2,326.5kg/ha However, the productivity was noticed to be below 2000kg/ha due to low rainfall during the dry months of February-March and August-September. Similarly, the same pattern occurred in the fifth year of investigation. The average availability was lower than in the fourth year may be due to increase in animal consumption due to increase in body weight. The sheep attained a body weight between 26.9 - 35.4kg/hd when they were allowed to graze the *B. humidicola* pasture. The average daily weight gain was found to be between 34.1 - 98.4g/hd with the mean value of 44.8g/hd. Similar animal performance was observed by Wong et al. (1995) when *B. humidicola* was grazed by sheep on an inland soil at Serdang and by goats on bris soil at Sungai Baging MARDI Station. On the other hand, old neglected swards were not observed during the study, unlike as reported by Wong et al. (1995).

The grass, *B. humidicola* seemed to strive well when grown together with durian. The full coverage by the grass is probably required by the durian trees for better growth during the young stage. Proper pasture management should be determined and imposed under this system of sheep production, especially when the tree-crops grow older.

CONCLUSION

Forage availability under durian was able to sustain crop-sheep production using nomadic rearing system. Growing of *Brachiaria humidicola* did not affect durian tree growth. Fruit yield improved when sheep were introduced into the durian orchard.

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POTENTIAL OF SOME PROMISING GERMPLASMS FOR THE DEVELOPMENT OF SHADE TOLERANT FORAGE PLANTS

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SUMMARY
Poor adaptation of many improved tropical pastures in shade environment limits ruminant production in plantation crops. Shade affects persistence, yield and quality of understorey forages. Results from both artificial and natural shade environments have identified some species of grasses and legumes which have show good regrowth, persistence and well mixed among them, and have satisfied the selection criteria for use as productive forages for cattle grazing under mature coconut.

INTRODUCTION
Indonesia has an extensive area of plantation crops, involving at least 2.6 million ha of coconut; 2,4 million ha of rubber, 0.26 million ha of oil palm and 0.35 million ha of clove (Rika 1985). These plantation lands with their understorey forages represent one of the most extensive and underutilized feed resources in the region. The major constraint in the exploration of these plantation lands for forage is the fasting changing light environment below the plantation canopy over time. It is clear that most improved tropical pastures are sun species (Ludlow 1978) with poor adaptation to dense shade.

Despite the large areas planted to plantation crops, there has been no systematic evaluation of shade tolerant forages for these shade environments in Indonesia. Recently our work and other studies has been undertaken to evaluate some species for shade tolerance. The major selection criteria are provision and ground cover, feed acceptability to animals, compatibility of species mixtures and animal production.

This paper reports some of our findings in relation with other studies.

SHADE ENVIRONMENTS
Relative air humidity under the tree canopy is likely to be increased compared with that in the open. Under artificial shade the maximum increase was about 6% over that in the open (Wilson and Ludlow 1991). Decreased radiation load under the shade of tree canopies should benefit the water relations of the pasture species. Evaporative demand will be greatly reduced in the shaded environment, and soil water availability for the pasture will be maintained at a higher level than in the open (Wilson and Wild 1991) through the combined effects of less evaporation from the soil and lower transpiration rates of the pasture.

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The air temperature above the pasture under mature rubber trees is about 2 - 3°C lower at midday than above pasture in the full sun (Chen 1989). Soil temperatures can differ much more, and as much as 10°C lower under the tree canopy than in the open at the soil surface (Wilson and Wild 1991) or 3 - 10°C at a depth of 2.5m (Ovalle and Avendano 1988).

THE EFFECT OF SHADING ON PASTURE

The definition of shade tolerance is the relative better growth of the plant to that of other species in shade habitats such as plantations. Shading influences the persistence and yield of species under plantation crops. Shade affects the growth and morphological development of plants. Tiller production and leaf, stem, stubble and root production are often reduced at low light with formation of thinner leaves with higher water content and a higher specific leave area (Won" 1991). The elongation of stem is commonly observed as a responses of non shade tolerant species at lower light environment. Many sun species yielded well initially in shade habitat but did not persist under regular cutting or grazing (Watson and Whiteman 1981, Kaligis and Samulong 1981). This is due to poor adaptation of the sun plant under repeated defoliation in shade.

Recent evidence suggests that shading may be beneficial to pasture production and pasture quality. Wilson et al. (1990) found a 35% increase in accumulated dry matter (DM) of a Paspalum notatum pasture under trees compared with that in the open pasture. There was also an increase in the proportion of green leaf, nitrogen and potassium and moisture contents under the trees. These findings support earlier work using artificial shade (Wong and Wilson, 1980) as well as trees shade (Cameron, et al. 1989).

True shade tolerance in forage species is associated with a number of morphological and physiological adaptation of plants. These include higher leaf area ratios and specific leaf areas, and higher chlorophyll densities which in turn influence the efficiency of interception and use of radiation and therefore growth potential at low levels of radiation (Stur, 1991).

ADAPTATION OF SPECIES IN NEW ENVIRONMENT

Forage species for plantation crops not only adapted to lower light levels, but also to the climate and soil properties in the shade environment and to the management imposed.

Screening forage species for shade tolerance has been investigated under artificial light regime. Wong et al. (1985b) reported that shading reduced tiller production and leaf, stem, stubble and root yield but increased specific leaf area and shoot/root and leaf/stem ratios, particularly in shade-tolerant species. These authors indicated some species suitable for light to moderate shade are *Brachiaria decumbens, B. brizantha, P. maximum, C. pubescens, D. intortum cv Greenleaf, L. Ieucocephala* and *D. ovalifolium*. Other species such as A. compressus, S. secundatum and *B. milliformis* persisted well in dense shade of 30% sunlight.

Recently a large number of species grasses and legumes originally from shaded habitats has been evaluated by Stur (1991). He had identified a number of grasses and legume accessions which have shown a high yielding capacity at 50 and 20% light transmission and many of these also had a high relative yield and could be regarded as being shade tolerant. Many of these accessions have not previously been used under plantation crops.

From our species evaluation studies (Kaligis and Sumolang 1991), under natural shade condition, we were able to identify some forages which were adapted, grew well in coconut plantations. Species which showed good regrowth and persistence, but slightly lower total yields over harvests, were Arachis pinto), A. repens, Arachis sp. Johnstone. The grasses were *Paspalum notatum* cv. competidor, *P. wettsteinii, A. compressus* and *S. secundatum*. These low growing species such as A. pinto) have stoloniferou habit and seed burial attributes are that characters which favour persistence under close grazing conditions. Incorporation of livestock into these plantation systems would be expected to enhance the rate of nutrient cycling and reduced the need of weed control, both of which would produce major direct benefits to the plantation crops. Although these species gave lower yields than the other species, they showed generally good seedling vigour and resistance to disease and insects. Further, they gave a very good ground cover and indicated an ability to compete with weeds.

As reported in Bali by Rika et al. (1991) we found tall growing grasses such as *P. maximum* sp. and *Setaria sphacelate* cv. Spenda were suitable for cut and carry systems. Under rubber plantation, species which showed good regrowth and persistence under the declining light environments of maturing rubber over six harvests were *Panicum maximum* (cv. Riversdale and cv. Venceder), *Brachiaria* spp. and *P. notatum, Stylosanthes scabra* cv. Seca and *S. guianensis* CIAT 184 (Ng, 1991).

Even some species appear promising, but there are still questions about their ability to grow in mixtures and to suppress weed growth before they can be recommended to pastures under coconut plantation.

PERFORMANCE OF GRASS-LEGUME MIXTURES

The shaded forage resource under the coconuts currently consisted of naturalised grasses and weed species of low productivity.

A series of "best bet" forage species mixtures was selected from species evaluation experiments (Kaligis and Sumolang 1991) for testing in large plots under very light stocking rate, and to investigate (i) promising grass species grown with a common legume, and (ii) three grasses grown in combinating with four legumes. The results of these trials are summarized in Appendix 1 and Appendix 2.

In all the experiments, *B. humidicola* was consistently high yielding both in combination with legumes and with nitrogen fertilizer. Reynolds (1988) reported *B. humidicola* to be medium shade and drought tolerance but very tolerant of heavy grazing. The contribution of planted legume to DM production of *B. humidicola* treatments decreased with successive harvests. However, the *Arachis* spp. *Desmodium ovalifolium* and *D. heterophyllum* combined moderately well with *B. humidicola*.

The shade tolerant species, *P. notatum* and *S. secundatum* ecotypes were comparatively slow to establish, but were persistent, combined moderately well with legumes, resisted weed invasion, and DM production was increasing compared to other species. The ease of vegetative establishment of *Stenotaphum* spp. and *B. humidicola* had made these species more suitable for smallholders than *P. notatum*.

Arachis spp. were persistent but low in productivity, but *Arachis repens* was very persistent over successive harvests. *Desmodium ovalifolium* combined productively with *B. humidicola*, but less with other species. Results from *D. heterophyllum* yielded well in a range of vigorous grasses an experiment by Monijung (1991) showed that under coconut plantation *A. pintoi* cv. Amarilo as promising species was also to form stable mixtures with naturally occurring grasses and *P. wettsteinii* under cutting frequency of 3, 6 and 9 weeks over an 18 weeks periods, although the proportion of legume was negatively related to the length of cutting interval. More recent work by Pelealu and Kaligis (1994) found that under different length of grazing time of 2, 4, 6 and 8 hours per day, and different ages of mixed pastures of *A. pintoi* and *S. secundatum* 2, 4, and 8 weeks, the mixtures were well maintained DM yield and the grazing time of 6 hours on 4 weeks old pastures gave the best DM yield and botanical compositions.

ANIMAL PRODUCTION ASSESSMENT

Successful integration of plantation crops and ruminants usually requires efficient grazing of livestock in the management of the plantation crops, and that the combined income of the two enterprises is greater than obtained from plantation crop alone.

Liveweight gains (LWG) of cattle grazing pastures under coconut have recently been summarized by Shelton (1991). There are many factors influencing the variation in gains and some of them are plantation palm density and age, species of forages, legume content and management of animal.

Sown pastures have been shown to persist in a number of long-term studies (Smith and Whiteman, 1983) especially under light transmission of less than 50%.

Based on our selection (Kaligis and Sumolong 1991) of some shaded tolerant forages, an investigation to evaluate the performance of promising grass/legume mixtures was undertaken. Three grass-legume mixtures were selected from the best species and evaluated for stability and animal production potential under continuous grazing over the 18 months period. From this trial we found that average individual liveweight gains were comparable to those cited in the literature (Smith and Whitemen 1983 and Reynolds 1988) for all treatments. High stocking rates were sustained throughout the experiment and this contributed to the relatively low LWGs achieved. The signal grass treatments produced the highest cattle LWG gain at 0.42 kg/hd/d and a reasonable legume content was maintained, but weed invasion of up to 25% and tended to increase over time. On *S. secundatum* treatment LWG was low at 0.25 kg/hd/d. This was probably due to low legume content at less than 5%. The importance of legume to pasture quality under coconuts was demonstrated in Vanuatu where low LWG were reported for animal grazing pure *S. secundatum* pastures (MacFarlane and Shelton 1986), and it was increased up to 0.70 kg/hd/d over 100 days measurement periods where containing the naturalized legumes (Shelton 1991). Despitc the low yield of pure *S. secundatum* grass and low animal production, this species completed with weeds effectively.

CONCLUSION

During the evaluation periods, *B. humidicola* as a more productive forage under coconut combined moderately well with twinning legumes, but prostrate legumes persisted poorly. Other improved grass species produced almost weed-free and combined moderately well with legumes, except *B. decumbens* and *S. secundatum* which were easy to established vegetatively and able to keep the pastures weed free. *Arachis* spp. has great potential to reduce weed invasion and improved forage quality. More work is needed to investigate at farm level management of promising grasses, especially *B. humidicola*, *Setaria* spp., *S. secundatum* in mixture with *Arachis* spp.

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Appendix 1. Species combinations, DM yields and percentage legume contribution from 4 harvest periods (HP)

Species mixture	DM yield (t/ha/month)		Legume contribution (%)	
Experiment 1	HP1	HP4	HP1	HP4
Native forages				
Axonopus compressus (local) + legume mixture[1]	0.9d*	l.0b*	21	26
Paspalum notatum Competidor + legume mixture	0.8d	0.8b	39	42
Stenotaphrum secundatum Vanuatu + legume mixture	l.lcd	0.8b	33	15
Stenotaphrum secundatum Vanuatu + *Calliandra calothyrsus*	0.9d	l.0b	32	26
Brachiaria decumbens cv. Basilisk + legume mixture	1.2cd	0.8b	23	14
Brachiaria humidicola CPI 27690 + legume mixture	2.0a	0.8b	1	1
Brachiaria humidicola + nitrogen fertiliser (200 kgN/ha/yr)	1.4bc	1.5a	-	-
Experiment 2				
Paspalum notatum CPI11864 + *A.pintoi* Cv .Amarillo + *C.pubescens*	0.7b*	1.1b*	50	18
Axonopus compressus (local) + Amarillo + centro	l.0b	0.7bc	76	47
Brachiaria humidicola cv. Tully + Amarillo + centro	1.6a	1.4ab	24	11
Bracharia decumbens cv. Basilisk + Amarillo + centro	1.8a	0.9bc	8	5
Setaria sphacelata cv. Splenda + Amarillo + centro	1.8a	1.7a	9	9
Stenotaphrum secundatum Floratus + Amarillo + centro	0.6b	0.6c	55	32
Experiment 3				
Paspalum notatum cv. Competidor + *Desmodium scorpiurus*	0.7n.s	0.9 n.s	8	3
Paspalum notatum cv. Competidor + *Desmodium heterophyllum*	0.7	1.0	29	7
Paspalum notatum cv. Competidor + *Desmodium ovalifolium*	0.9	1.0	51	1
Paspalum notatum cv. Competidor + *Arachis glabrata* CPI 93483	0.7	0.9	8	6
Stenotaphrum secundatum (Vanuatu) + *Desmodium scorpiurus*	1.1	1.0	6	1
Stenotaphrum secundatum (Vanuatu) + *Desmodium heterophyllum*	0.9	1.0	41	12
Stenotaphrum secundatum(Vanuatu)+*Desmodium ovalifolium*	0.9	1.0	36	5
Stenotaphrum secundatum (Vanuatu) + *Arachis glabrata* CPI 93483	0.6	0.9	10	6
Brachiaria decumbens cv. Tully + *Desmodium scorpiurus*	1.5	1.3	6	3
Brachiaria decumbens cv. Tully + *Desmodium heterophyllum*	1.3	1.3	20	18
Brachiaria decumbens cv. Tully + *Desmodium ovalifolium*	1.1	1.2	27	12
Bra*chiaria decumbens* cv.Tully + *Arachis glabrata* CPI 93483	1.0	1.1	5	2

[1] legume mixture: Arachis pinto), A. repens and Centrosema pubescens CPI 58575

* treatment means with common letters are not significantly different (P>0.05)

Appendix 2. Experiment 3 main treatment effects

Grass main treatment groups	Year 1	Year 2	Year 1	Year 2
	grass DM yield (t/ha/yr)		Legume contribution (%)	
Paspalum notatum cv. Competidor	8.5[1]	9.6[1]	18	4
Stenotaphrum secundatum (Vanuatu)	10.5b	10.4b	22	8
Brachiaria humidicola cv. Tully	14.3a	11.6a	12	8
Legume main treatment groups	Legume DM yield (kg/ha/yr)		Average legume contribution (%) to grasses	
Desmodium scorpiurus	830[2]	390[2]	5	4
Desmodium heterophyllum	2820	570	4	5
Desmodium ovalifolium	3080	840	14	8
Arachis glabrata CPI 93483	750	1120	18	10

[1] treatment means with common letter are not significantly different
[2] treatment groups not significantly different

Appendix 3. Liveweight gains of cattle, weed invasion and legume contribution

Treatment	LWG (kg/hd/d)	Weed (%)	Legume (%)
Natural pasture	0.30	80	5-10
P. notatum	0.35	50	15-20
S. secundatum	0.25	5	<5
B. decumbens	0.42	25	10-20

STRATEGIES FOR SUSTAINABLE PRODUCTION OF TROPICAL FORAGES UNDER SHADE

C.C. Wong[1]

SUMMARY
Sustainable forage production and persistence of tropical forages in shade are substantially affected by defoliation management. The tolerance level of utilization in shade beyond which defoliation becomes excessive and threatens forage survival is a function of the frequency and severity of defoliation and its timing in relation to plant development. The threshold level varies between and within forage species in accordance to their morphophysiological responses to defoliation management such as (a) inherent bud regeneration capacity upon defoliation, (b) rate of growth of new and existing tillers, (c) rapidity in restoration of leaf area, (d) partitioning of dry matter to shoot and root components, and (e) utilisation of total non-structural carbohydrate reserves in stubble-cum-stolons. These adaptive strategies exhibited by different pasture species, in shaded situations can be exploited to sustain dry matter production and improve forage persistence through appropriate management practices that can ensure fast recovery of defoliated plants.

INTRODUCTION
In plantation shade, sustainable pasture productivity is limited by the declining radiant energy and defoliation management. Defoliation whether by hand or by animals reduces leaf area and induces a carbon shortage in plants through reduction in light interception. Under such an environmental constraint, forage plants often develop differential growth responses to defoliation to produce adaptive patterns of tiller development, shoot and root growth, and source-sink relations which confer varying ability of the plants to procure the limited environmental resources for optimal growth and yield.

Plant species differ in their growth responses to defoliation; their responses are often confounded by growth habit, environmental stresses and competition from other species (Youngner 1972). Pastures with stoloniferous or rhizomatous growth habits tolerate moderate to heavy grazing or defoliation because of the presence of basal meristems that enable the plants to persist (Humphreys 1981, Clements 1989). On the other hand, climbing or trailing tropical legumes with meristems located along the stems, do not persist under heavy grazing (Jones 1974a,b, Jones and Clements 1987).

In an effort to understand the mechanisms of sustainable dry matter (DM) production and forage persistence in shade, a study was undertaken by Wong (1993) to investigate morpho-physiological responses of two tropical grasses with contrasting growth habits to shade of 20 and 50% light transmission and defoliation at 2 and 4 weekly cutting intervals at 5 and 10 cm cutting heights.

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The study involved two experiments. The first experiment examined regrowth potential of an erect grass (*Paspalum malacophyllum*), and a stoloniferous species (*Paspalum wettsteinii*) to three shade levels (inclusive of control) and at two defoliation frequencies (2 and 4 weeks) at a cutting height of 5 cm over three regrowth cycles of 4-week duration. The drastic treatments undertaken were to expedite expression of morphological and physiological mechanisms involved insustainable production and plant survival. The second experiment investigated the influence of defoliation intensities of 5 and 10 cm cutting heights at the two cutting intervals on regrowth and persistence of the two grasses under shade. Plant adaptive mechanisms that contributed to plant survival in shaded situations were elucidated in terms of DM productivity, tillering capacity, DM partidoning, light interception and total nonstructural carbohydrate content (1NC) status of organs below cutting height. This paper highlights some of the important agronomic responses of shaded forages that can affect sustainable production and persistence of forages to defoliation management.

GROWTH RESPONSES TO SHADE AND DEFOLIATION

The study showed that shade depressed total DM production, shoot, stubble-cum crown and root growth (Figure 1) in both species, the depression as expected being proportional to the quantum of photosynthetic active radiation reduction. The study did not conclusively support the hypothesis that prostrate grasses persist and yield better than erect species in shade. *Paspalum wettsteinii*, a prostrate grass selected for its shade tolerance, persisted poorly under sustained, frequent defoliation in shade (Figure 2). Plant survival was down to 66 and 86% in the 2-weekly and 4-weekly defoliation treatments respectively in 20% light transmission. In contrast, *P. malacophyllum* suffered less than 6% in plant mortality in similar light environments, irrespective of defoliation frequency despite its erect growth habit.

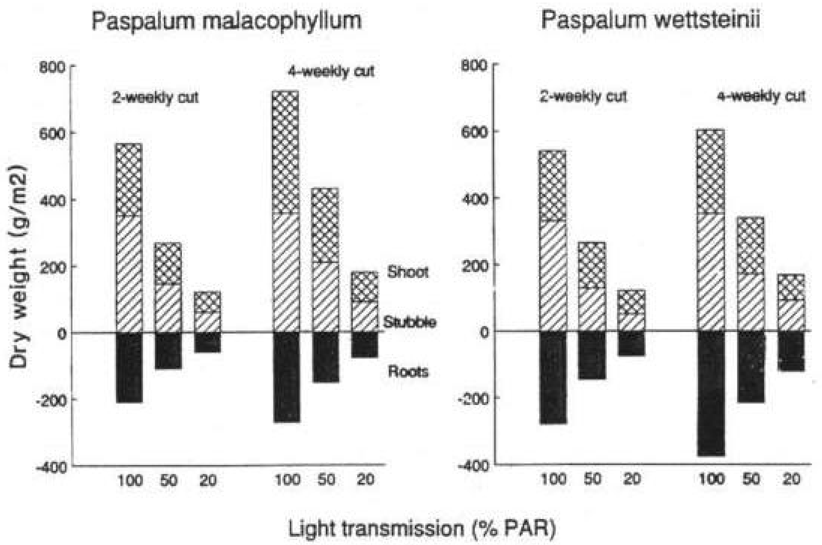

Fig. 1 Effects of shading and defoliation frequency on total dry matter (TDM) production of two shade-tolerant grasses, *P. malacophyllum* (PM) and *P. wettsteinii* (PW) over 3 regrowth cycles of 4-weekly interval

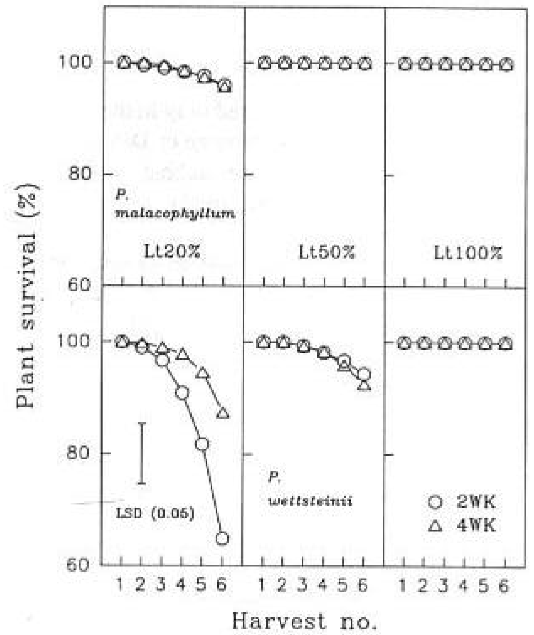

Fig. 2 Plant survival (%) of *P. malacophyllum* (PM) and *P. wettsteinii* (PW) as affected by shading and defoliation frequency over harvests

The poor performance of the grass with the prostrate growth habit was contrary to published results on shaded pastures. Chen and Bong (1983) have shown the resilience of stoloniferous and prostrate indigenous grasses in surviving grazing under shade, even at extremely low light level. They also reported poor plans survival of improved tropical, erect grasses like guinea grasses and setarias in dense shade. On the basis of such contrasting responses from species with different growth habits, it appears that other morphophysiological adaptations to defoliation in shade were more critical.

MORPHOLOGICAL RESPONSES TO DEFOLIATION

Briske (1986) reported that morphological responses to defoliation displayed by forage species could influence grazing resistance. The study undertaken by Wong (1993) showed that productivity and persistence of the two shade tolerant grasses under light limited environment were largely determined by-the photosynthetically active radiation (PAR) levels and the development of Leaf-stem area index (LSAI) to intercept the available low light energy. This was achieved through the following: (a) differential partitioning of dry matter to shoot and root (b) tillering dynamics and basal bud development, (c) restoration rate of leaf area and light interception, (d) role of residual leaves, (e) utilisation of TNC in stubble-cum -crown.

(a) DM partitioning

The two shade tolerant grasses of contrasting growth habit produced similar TDM production under shade levels but there were significant differences in DM partitioning within the plants, particularly in the shoot and root components. In shade-stressed situations, *P. malacophyllum* channelled relatively more DM into leaf and stubble growth initially while stem growth increased only in the 4-weekly cut. In contrast, *P. wettsteinii* devoted a relatively high percentage of DM to root growth at the expense of shoot development, particularly in the stubble component. Strong growth of stubble was achieved only in full sun (Figure 2).

(b) Tiller dynamics and basal buds

The dominating influence of shade on inhibition of tiller production was obvious in both species. Total tiller number declined with shading, being lowest in 20% light transmission. The severity of this dense shade stress was reflected in the gradual decline in total tiller number per surviving plant of *P. wettsteinii* over the three regrowth cycles; if considered in conjunction with plant mortality, tiller number of *P. wettsteinii* was considerably lower than that of *P. malacophyllum* (Figure 3) The imposition of defoliation frequency produced number in the two grasses.

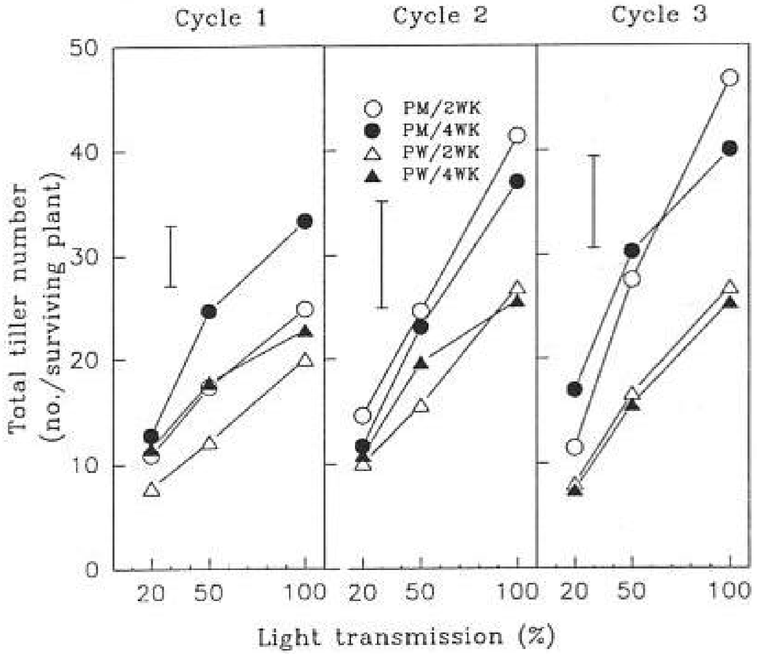

Fig. 3 Shade and defoliation frequency on total tiller number (tiller no./plant) of surviving plants in *P. malacophyllum* (PM) and *P. wettsteinii* (PW) over three regrowth cycles. Vertical bars represent LSD (0.05) for interactions

Tiller number was a significant factor, contributing to higher shoot yield and plant persistence in *P. malacophyllum*. Surviving tillers from the previous harvest made up more than 60% of the total tiller density (data not shown) and therefore, the major contributor of DM yield in the subsequent regrowth process. Although there were no obvious differences in the percentage of tiller classes between the two species in the different light levels to relate to persistence, the higher density of new and secondary tillers in *P. malacophyllum* had positively contributed to the higher higher shoot yield compared with those of *P. wettsteinii* in moderate shade and in full sun.

147

Also, shade reduced basal bud production in both species but the effect of defoliation frequency was less obvious. *Paspalum malacophyllum* produced significantly more basal buds than *P. wettsteinii* in later harvest (Figure. 4). Cutting to 10 cm height increased basal bud number in both species.

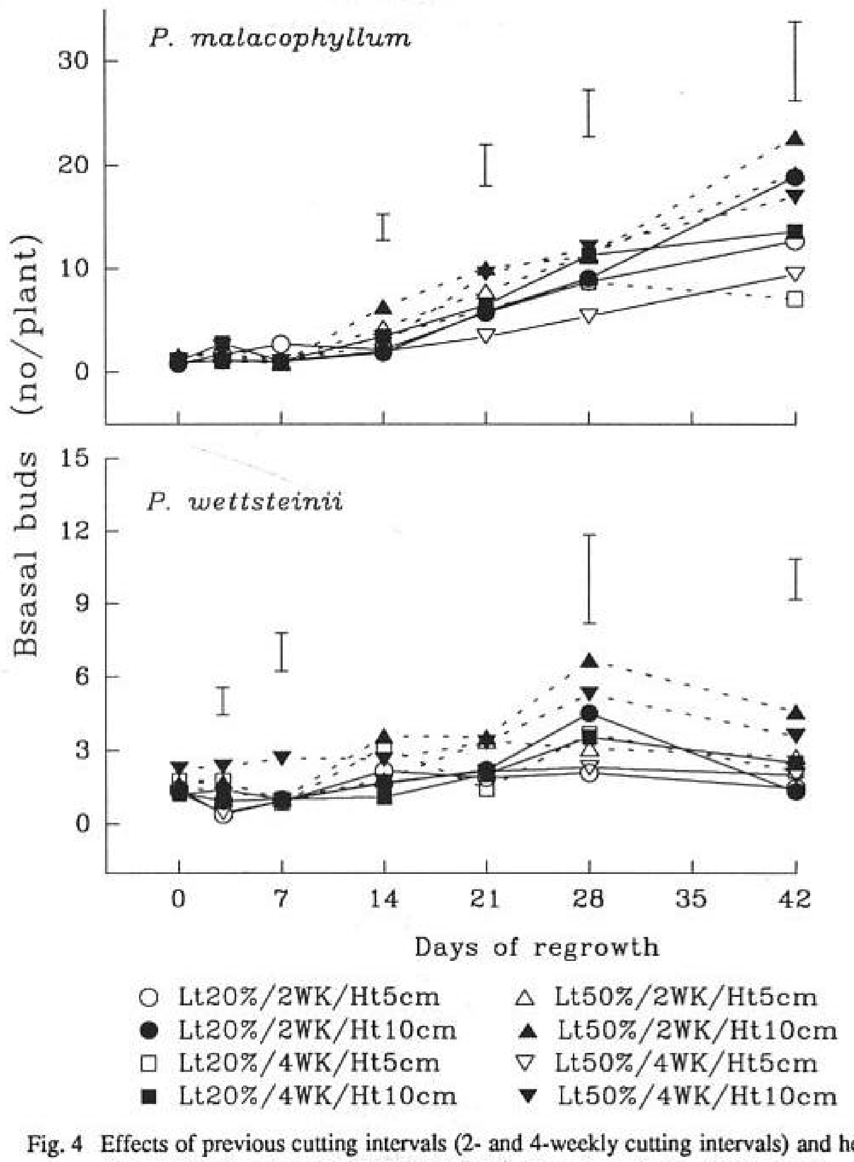

Fig. 4 Effects of previous cutting intervals (2- and 4-weekly cutting intervals) and heights (5 and 10 cm) on basal bud development in *P. malacophyllum* (PM) and *P. wettsteinii* (PW) in 20 and 50% light levels over a 42-day regrowth period. Vertical bars indicates LSD (0.05) for interactions

(c) Leaf-stem area index (LSAI) restoration and light interception

Leaf-stem area index (LSAI) declined with time in the 2-weekly defoliation treatment (Figure 5). Shading and frequent defoliation (2-weekly) depressed ($P<0.01$) LSAI restoration in all three regrowth cycles. Species differences in LSAI restoration in the 2-weekly defoliation treatment were generally small. In the 4-weekly cutting frequency, LSAI of *P. malacophyllum* was higher ($P<0.01$) than that of *P. wettsteinii* in all shade treatments of regrowth cycles I and 3.

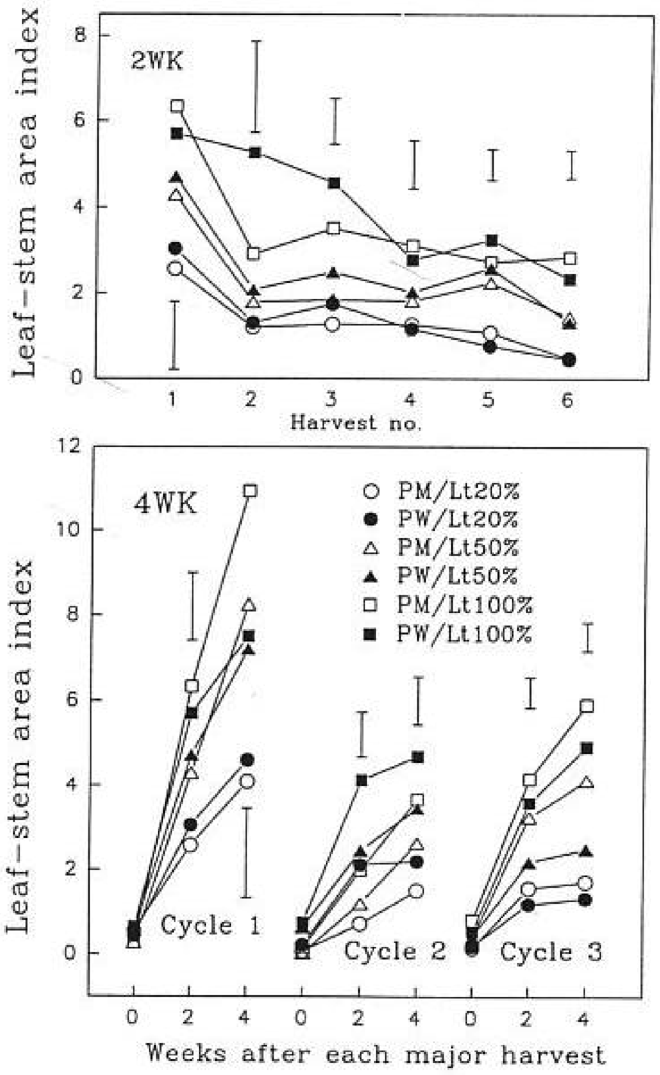

Fig. 5 Effect of shading on leaf-stem area index (LSAI) in *P. malacophyllum* (PM) and *P. wettsteinii* (PW) over harvests in a 2-weekly defoliation treatment and over three regrowth cycles in a 4-weekly defoliation frequency. Vertical bars represent LSD (0.05) for interactions

Since shading and frequent defoliation depressed LSAI restoration, light interception, measured just before harvests was similarly affected in both grasses (Figure 6). Highest light interception was obtained in the full sun treatment and lowest in dense shade for the 2-weekly defoliated swards of *P. malacophyllum* and *P. wettsteinii*. A gradual decline in light interception profiles over 2-weekly harvests (harvests 4-6) was observed in the two grasses at 20% light transmission. Profiles for light interception in the 4-weekly cutting were similar in both species for shade response.

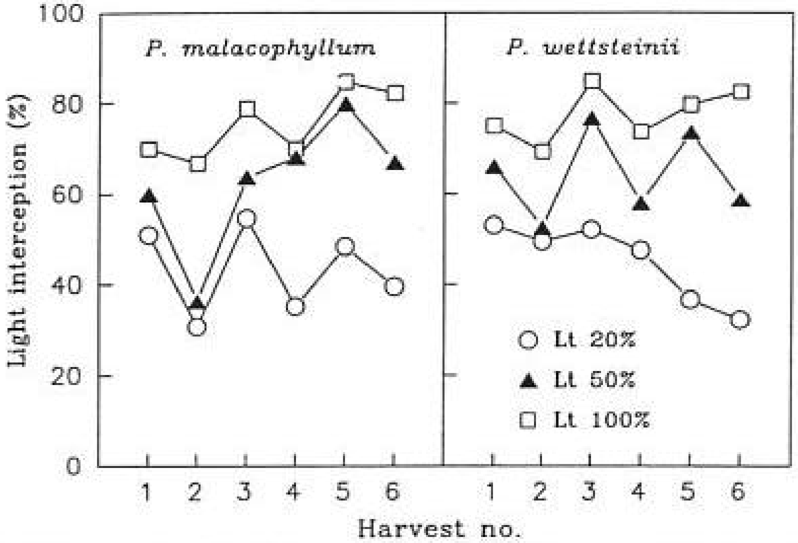

Fig. 6 Light interception (%) of *P. malacophyllum* and *P. wettsteinii* prior to harvest of the 2-weekly cutting treatment in 20, 50 and 100% light levels

Light extinction coefficients (k) derived from the linear regression analysis of natural logarithmic transformation of pooled data of canopy light transmission on LSAI of the two species irrespective shade and defoliation treatments are presented in Figure 7. The k values for *P. malacophyllum* and P. *wettsteinii* were 0.41 and 0.32, respectively. The greater k value indicated a greater light interception by *P. malacophyllum*, possibly caused by the higher shoot growth while a lower k suggested better canopy light transmission in *P. wettsteinii* due to slow shoot growth despite its prostrate growth habit.

(d) Residual leaf area

In the recent study, Wong (1993) reported that shading significantly reduced ($P<0.01$) residual leaves of stubble in both species. Due to the short duration of the experiment, there were no significant effect of defoliation frequency on residual leaves in both grasses. However, removal of residual leaves of *P. malacophyllum* had no significant effect regrowth (Figure 8). In *P. wettsteinii*, regrowth was significantly ($P<0.01$) was depressed by removal of stubble leaves irrespective of cutting height and shade level.

Recovery from defoliation depends on the quantity of residual photosynthetic area and its photosynthetic capacity as well as the rate of development of new foliage and the photosynthetic capacity of these new leaves (Brougham 1956, Ryle and Powell 1975).

150

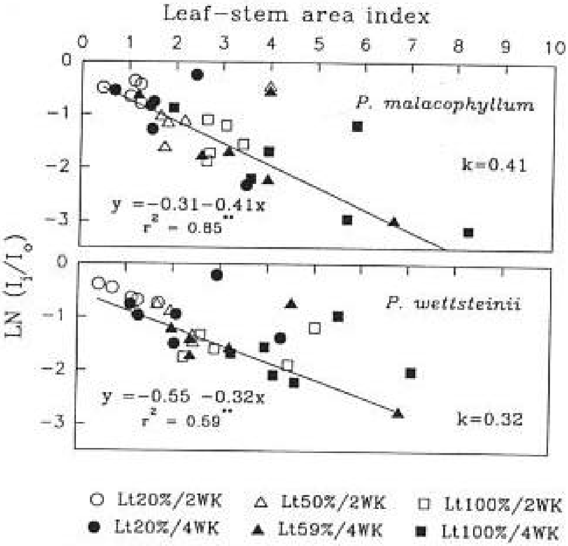

Fig. 7 Leaf-stem area index (LSAI), light extinction coefficient (k) and canopy light transmission as (ln li/lo) of *P. malacophyllum* (PM) and *P. wettsteinii* (PW) at 20, 50 and 100% light levels. Data used are means of three cycles; ln = natural logarithm; li and lo are light levels below and above canopy respectively

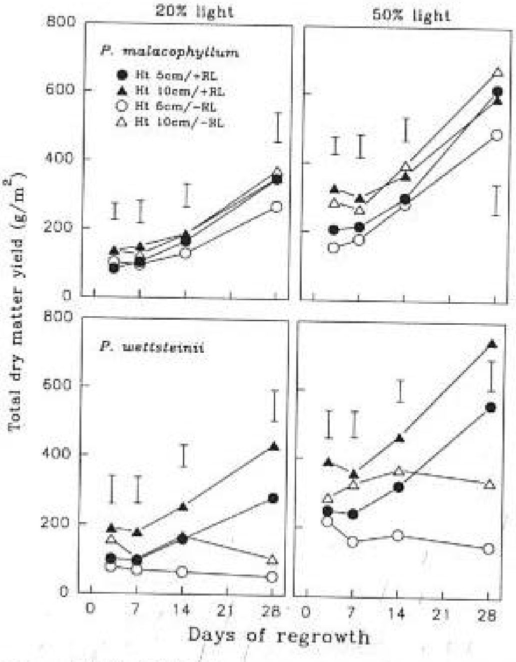

Fig. 8 Total dry matter yield (g/m²) during regrowth of *P. malacophyllum* and *P. wettsteinii* at 20 and 50% light transmission, following defoliation of swards at 5- and 10-cm cutting heights, with and without removal residual levels (±RL) of stubble. Results are means over defoliation frequencies of 2 and 4 weeks. Vertical bars indicate LSD (0.05) for interactions

Cenchrus ciliaris developed a high residual leaf area after defoliation, which subsequently contributed to higher leaf area and shoot weight production (Hodgkinson *et al*. 1989). Frequent and close defoliation of Trifolium subterraneum resulted in the formation of a dense network of photosynthetic stolons that accounted for two-thirds of the intact sward photosynthesis (Davidson and Birch 1972). Thus, these phenotypic and physiological adjustments in pasture plants contribute to the rapid resumption of shoot growth after defoliation.

(e) Carbohydrate reserves

Growth of a pasture sward is a succession of regrowth to each defoliation. The cyclic phenomenon of exhaustion and storage of carbohydrate compounds observed in pastures was associated with sward vigour and persistence (Troughton 1957, Weinmann 1961). Nonetheless, the role of carbohydrate reserves in enabling pasture plants to persist under defoliation has remained controversial (May 1960). The level of TNC (total nonstructural carbohydrates) accumulated in C4 grasses is relatively low (3.712.2%) when compared with (8-25%) in C3 species (Davies 1988).

The TNC% (<6%) in the stubble and crown in both species during the regrowth period was low. *Paspalum malacophyllum* maintained a higher TNC concentration in the crown and stubble fractions than *P. wettsteinii* (data not shown). During regrowth, TNC yield of the crown and stubble in both grasses declined initially in response to defoliation but yield increase from day 7 onwards for both species. Higher light level and cutting height promoted increased TNC yield significantly (Figures 9 and 10) in both grass species. Crown TNC yield of *P. wettsteinii* was generally lower than that of *P. malacophyllum*. Recovery of TNC yield of crown and stubble to their original levels at day 0 was attained by day 14 in *P. malacophyllum* while P. wettsteinii failed to regain its original crown and stubble yield within the 14-day regrowth except for the stubble TNC yield in 20% light transmission and at 10 cm cutting height. The decline in TNC reserves in the first seven days after defoliation supports the contention that TNC reserves had been utilised for initial development of regrowth until the plants become self independent of TNC reserves. This might account for the poor correlation of shoot regrowth with available TNC yield.

MANAGEMENT STRATEGES

From the results of the study based on the two grasses, it appears that tropical forages have different pathways to survive defoliation stress in shade (Table 1). The prostrate *P. wettsteinii* relied on residual leaves for its survival because of its low tiller production, slow shoot growth and a preferential DM allocation to root growth. *Paspalum wettsteinii* produced fewer but larger tillers than *P. malacophyllum*. Over 45% of the photosynthate produced were allocated to root and crown growth.

The poor tillering habit of this species and the Iovv labile carbon reserves in the stubble and particularly of the crown fraction may have contributed to the eventual death of defoliated plants. In addition, the preferential diversion of photosynthate to roots in *P. wettsteinii* was a physiological constraint to rapid shoot recovery in shade. Coupled with the inadequacy of labile carbon buffer, *P. wettsteinii* had to depend on the photosynthetic capacity of its residual leaves to recover from defoliation. The rate of recovery was dependent on the quantity of remaining foliage and the photosynthetic capacity as well as the rate of new leaf development.

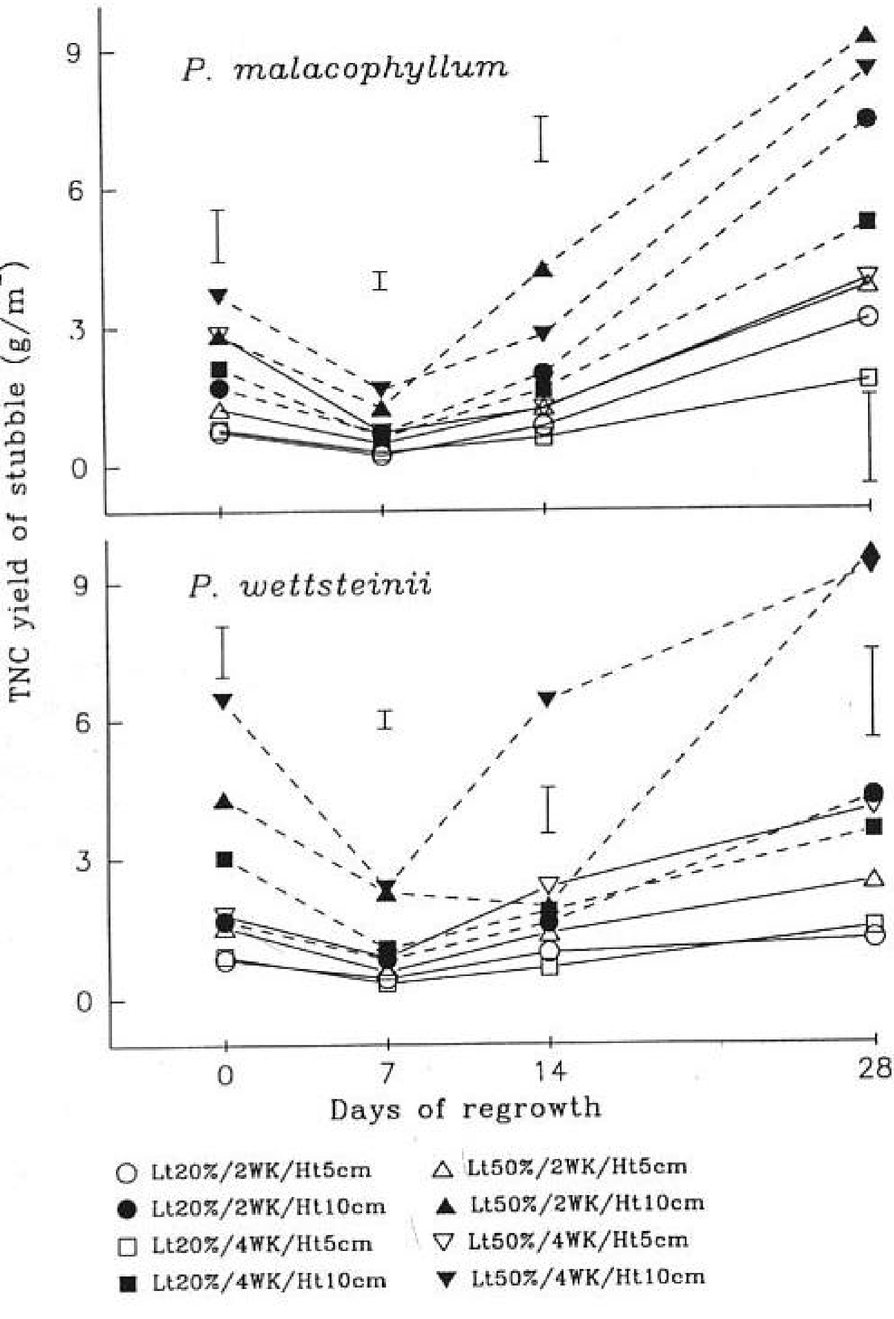

Fig. 9 Effects of previous cutting interval and height on total nonstructural carbohydrate (TNC) accumulation in the stubble of *P. malacophyllum* and *P. wettsteinii* in 20 and 50% light levels over a 28-day regrowth period

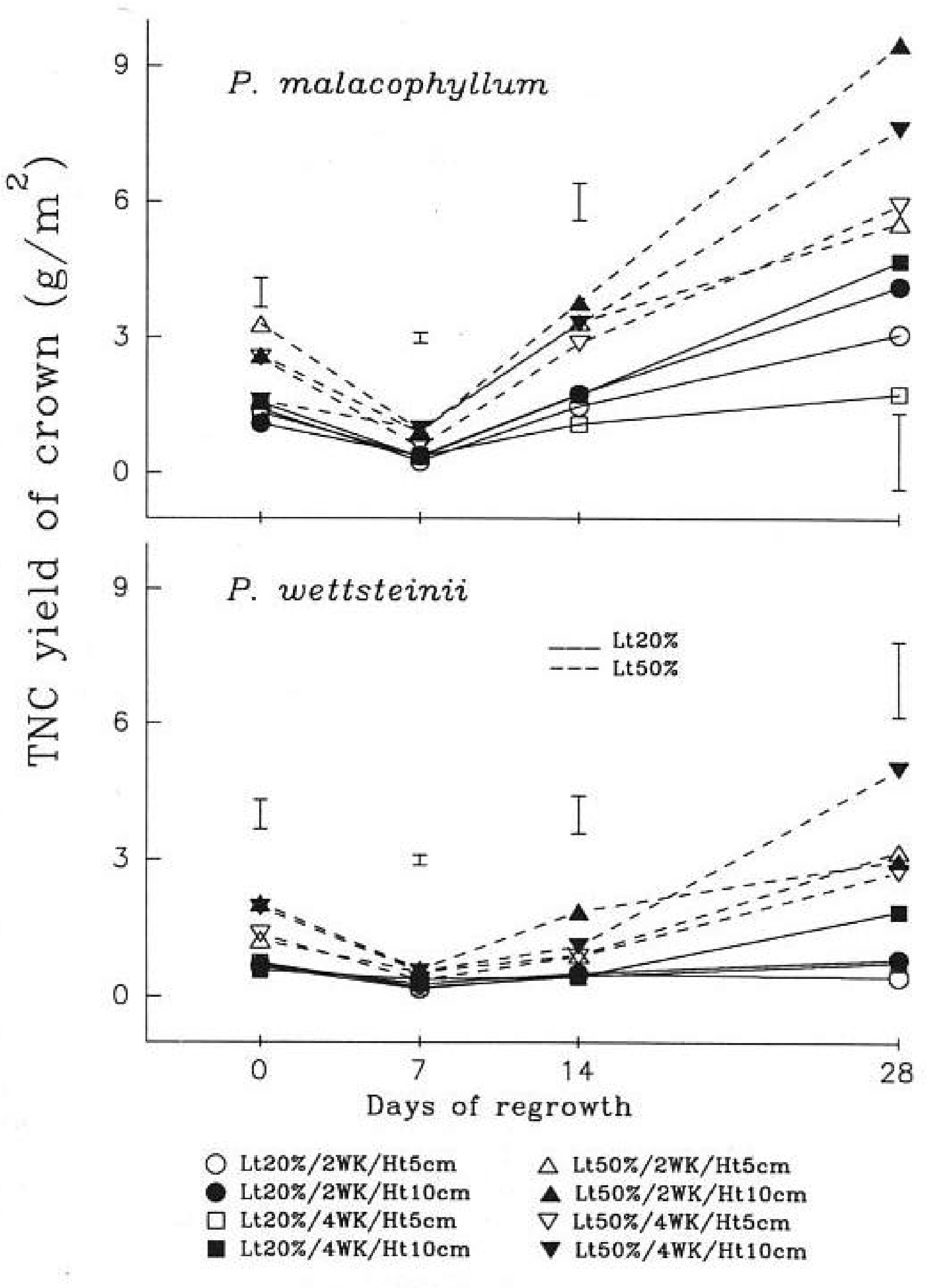

Fig. 10. Accumulation of total nonstructural carbohydrate (TNC) accumulation in the crown of *P. malacophyllum* and *P. wettsteinii* after harvest 4 as affected by previous cutting intervals (2- and 4-weekly) and heights (5 and 10 cm) in 20 and 50% light transmission over a period of 28-day regrowth day

Table 1. Summary of different strategies of *P. malacophyllum* and *P. wettsteinii* for recovery from defoliation

	P. wettsteinii	*P. malacophyllum*
1.	Low basal bud development	High basal bud development
2.	Production of few but large tillers	Production of many but smaller tillers
3.	Residual leaves important for regrowth	Residual leaves less important for regrowth
4.	Low TNC in stubble and crown	High TNC in stubble and crown
5.	More DM partitioning to roots	More DM partitioning to shoot
6.	Slow growth of expanding leaves after defoliation	Rapid growth of expanding leaves after defoliation

The agronomic role of residual leaves in regrowth of *P. wettsteinii* was well demonstrated in Figure 8, where removal of residual leaves resulted in slow biomass production. In contrast, *P. malacophyllum* partitioned only about 30% of its photosynthate to roots. The ability of *P. malacophyllum* to allocate its organic reserves into tiller initiation and development led to a higher rate of shoot regrowth. Such a growth response may have mitigated.

The importance of residual leaves for initial regrowth. *Paspalum malacophyllum* relied primarily on residual TNC in the growth of expanding leaves which were cut during defoliation and the development of initiated tillers. Its capacity to initiate new tillers enabled the plants to restore foliar losses and to become photosynthetically independent as early as possible. This ability to regenerate photosynthetic surface was indeed an important adaptive feature for growth and persistence in shade.

The sensitivity of pasture persistence to defoliation frequency and intensity varied among species. Frequent cutting at 5 cm cutting height in 20% light transmission reduced plant persistence in *P. wettsteinii* more than in *P. malacophyllum*. Increasing cutting interval and cutting height enhanced regrowth and plant persistence in both species, particularly in *P. wettsteinii*. But increased cutting interval also has its limitations. A long cutting interval wil1 result in larger plants. Defoliation of such large shaded plants results in a temporary shortage of concurrent photosynthate, leading to a high turnover of tissue as occurred in *P. wettsteinii* in the 4-weekly cut at 5 cm height. The high plant mortality of *P. wettsteinii* in this experiment showed the vulnerability of bigger plants in prolonged cutting interval treatments to intensive defoliation in shade. A lax cutting or grazing intensity (i.e. high cutting height) is recommended to alleviate the severe defoliation stress of shaded plants, should a longer cutting interval be required.

It is recommended that management of shaded forages should be geared towards the individual growth and developmental pattem of each species concerned. In this study, growth habit did not provide a good agronomic attribute in the selection or identification of plant persistence. The relative importance of availability of active meristems and of priority changes in carbon allocation to shoot growth in the alleviation of shade constraint on plant growth was well illustrated by the defoliation responses of *P. malacophyllum*. Adaptation to short- or long-term stress often incurs additional carbon costs which are derived either from reserve carbon if photosynthesis is inhibited or from currently assimilated carbon.

Plants that exhibit high tillering capacity even in a shaded environment and a moderate preferential allocation of DM to shoot growth can mitigate the adverse effects of shade stress through a rapid development of photosynthetic tissues. The ability of shaded *P. malacophyllum* to allocate its TNC to tiller initiation (basal buds) and growth at the vegetative phase is a successful survival strategy directed towards expeditious foliage growth following defoliation.

The results also showed the low TNC accumulation in both shaded species and its importance in affecting plant persistence. The lower TNC reserve pool in stubble and crown of both species appeared to be due to their preferential partitioning of photosynthate to vegetative growth at the expense of buffer reserve for regeneration. Intensive defoliation of plants at such a stage of growth may be detrimental to plant persistence, particularly in dense shade, due to inadequacy of organic reserves for regrowth (as observed in *P. wettsteinii*). A lax defoliation management which maintains adequate residual leaves on stubble is thus recommended during the active growing seasons. Adapting forage management to enhance or maintain the morphological responses of forage species to shading is a strategic approach to restore rapidly homeostatic growth and persistence of species in the rapidly changing shade environment of plantation crops. Nonetheless, the present study focussed on short-term adaptive responses to defoliation in shade and caution must be exercised in extrapolating long-term performance.

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BREEDING SCHEMES FOR RUMINANTS IN TREE CROP PLANTATIONS

M. Ariff Omar[1]

SUMMARY
Nutritional environment in tree crop plantations varies with age of the trees. The available dry matter production from ground vegetation may not be sufficient to meet the energy requirement of ruminants, hence supplemental energy and protein are suggested to support breeding groups. Input cost under such a feeding condition has to be minimised to effect an efficient production if that being the breeding objective. Rearing ruminants in tree crop plantations can be viewed as an evaluation of genotype x environment interaction. Breeds of ruminants of diverse biological types are available in the Asian and Pacific region and provide the breeders with vast opportunities for selection. Breed multiplication could then proceed via either of the two methods: group breeding scheme or nucleus breeding scheme. Both schemes source their foundation animals from the general population but differ in the concentration of nucleus and cooperating units within a given area. Logistically a nucleus breeding unit would be more practical for implementation in plantation environments with an organised central organisation.

INTRODUCTION

In many parts of Asia and the Pacific region, the pattern of ruminant production of cattle, buffalo, sheep and goats merges well with existing cropping systems. The absence of large scale famms based totally on pasture grazing has led to the flourishing of small scale farms. These small enterprises are sustained by several condusive factors which favour small size operation. Among the factors supporting the small scale agricultural systems are land holdings which are generally small in size, herd size is restricted by labour capability, input level commensurate with credit worthiness of small producers and husbandry capability ensures limited control on the production. Smallness in operational size can be profitable if there is adoption of a better way of producing a product. A scheme of providing technological support and financial assistance to small livestock entrepreneurs should be institutionalised with the leading role undertaken by the industry interest groups and financial institutions. As in the manufacturing industry, the focus of development can be directed towards the development of better managed and more focussed small and medium scale livestock industries for the production of milk, meat and eggs, and even animal feeds. Livestock production must progress by adopting changes to keep pace with the rate of economic development of each country.

Breeding systems for ruminants do not differ very much in terms of concept and mode of implementation when dealing with the different production systems. Differences between one production environment and another are mainly connected with nutrition levels and climatic attributes. With the presence of breeds of ruminants of diverse biological efficiency, breeds

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may react differently when exposed to differing environments. The task for animal breeders is to search for the most suitable breed to suit the local environment for achieving optimum output at minimum cost. Efficiency of production is of primary importance here since cost is a major factor to be considered when the issue of borderless trading of food commodities becomes a realisation in the coming years.

GENOTYPE X ENVIRONMENT INTERACTION

The evaluation of ruminant productivity in a plantation environment can be examined as an interaction between the genotypic factor and the environmental factor. The inherent characteristics of the different breeds of ruminant species are best exposed when these species are reared in the specific climatic and nutritional environment to which they are adapted. Indigenous breeds of ruminant species of the Asian continent have specific adaptational requirements which do not make them to be the common breeds in all regions of the continent. For example, the coarse wool sheep breeds coming from the arid condition of West Asia are unsuited to the humid tropics whereas the hair sheep of West Africa where the climatic condition allows moderate rainfall have been found to adapt well to the humid condition of Malaysia (Khusahry et al. 1994).

In any production environment, nutrition is the major limiting factor which restricts performance of livestock species. In a plantation environment, the levels of dry matter output on offer tend to decline with the age of planting. A contributing factor in restricting feed supply under this condition is the decreasing light intensity reaching ground vegetation as a result of an expansion of the dense canopy cover. Chen (1990) estimated that the biomass of dry matter of ground vegetation under oil palms declined from 2.8 to 4.8 tonnes per ha at immature stages (4 to 5 years of age) to less than 1 ton per ha at the mature stages (8 to 22 years of age). The energy concentration of the ground vegetation under the oil palms was estimated to vary from 7.0 to 10.1 MJ ME per kg dry matter (Chen, 1990).

The maintenance cost of an adult female is proportionately related to her mature size. Cattle and sheep use 50 % of the total feed energy intake solely for body maintenance. In terms of improving efficiency of production, increasing output per unit of maintenance cost would provide a major altemative for action. Besides, energy is required to meet the demand for reproductive function, lactation and tissue deposition. When energy is limited, supplemental protein will be used until the energy needs are satisfied. However when protein is the limiting nutrient, the extra supplemental energy provides no increase in production level or performance. A feeding strategy incorporating the use of ground vegetation and supplemental energy and protein has to be in place to ensure breeds perform to their potentials unrestricted by a nutritional limitation.

BREEDING OBJECTIVES

Breeding objectives are the definate goals of achievement for an individual or composite trait or traits. In many production operations a common breeding objective is to improve the overall efficiency of production. As efficiency is defined as total input cost/total product output, both the biological efficiency factor and the input cost factor are taken into account (Dickerson, 1978). When traits are related to effect genetic changes in size, conformation and production of animals, their expected nett effects on efficiency of livestock production have to be considered. The definition of the breeding objective should include the total environment of the production system (climatic, management, social and economic factors) and be flexible to accommodate future changes in the production systems (Barker, 1994).

In many crossbreeding projects involving ruminants the expanded multiplication of superior crosses following the positive evaluation of early filial generations does not proceed as planned due to the poor definition of breeding objectives. Thus breed multiplication has to cease prematurely in spite of the superiority of first crosses over their parental breeds or their back crosses.

SELECTION CRITERIA

Selection criteria are the specific traits to be selected to achieve the breeding objectives. Traits to be improved (breeding objectives) may not be the same as the traits to be selected (selection criteria). For example, if an objective is to improve the production efficiency, a suitable selection criterion would be any trait that has a significant contribution to efficiency, such as feed conversion efficiency. However a knowledge on the biology of the interrelationship among the adaptive factors and the productive factors becomes very useful when setting these criteria.

In dealing with ruminant production, the interest has always been on the improvement of the total herd or flock productivity rather than of individuals. Total herd productivity is a sum total of the productivity of the three components: mature cows, breeding bulls and calves. The definition of the selection criteria must address specific traits related to each of the herd components in the group structure. There are primary traits related to direct production: mature size, rate of maturing, lactation level, rate of ovulation, reproductive rate and ancillary traits which affect production by indirectly limiting genetic potential: fitness, adaptability, temperament (Cartwright 1982).

SELECTION PROGRAM AMONG INDIGENOUS BREEDS

Genetic gain obtained from a within-breed selection program is cumulative and permanent. By its nature and design, a selection program involving one or several breeds would 1) last several years involving many generations of progenies, 2) incur higher expenses to develop basic infrastructures and maintain breeding groups and pastures, 3) require use of a large pool of resources including land and animals, 4) have to hire trained technicians to institute a comprehensive selection scheme and 5) have to adhere strictly to the original breeding objectives from inception till termination of the selection program lasting for many years.

The vast pool of world breeds of livestock species provides an opportunity to the animal breeders to select among them for production purposes in specific locations. According to World Watch List (Lofrus and Scherf 1993) there are 169 breeds of cattle, 161 of sheep and 51 of buffalo found in the Asia and Pacific region. Many of these breeds lack information on their performance potential and adaptive characteristics, thus making it difficult to choose objectively among them.

The breeding objectives in the selection program involving tropical breeds of cattle and sheep may be directed at improving reproductive rate and efficiency of lean growth. Increasing the reproductive rate of the female population would increase total output of product and would lead to improved efficiency of production provided total cost can be kept at minimum level. Lamb production can be increased greatly by incorporating ewe breeds of higher ovulation rates in the selection program. The Javanese sheep have been reported to demonstrate a higher ovulation rate compared to the Malin sheep of Malaysia and the Long Tail of Myanmar and Thailand (Table 1).

Table 1. Ovulation rates among several tropical breeds of sheep

Breeds	Origin	Ovulation rate	Reference
Malin	Malaysia	1.04	Azmiet al. (1993)
Long Tail	Myanmar/ Thailand	1.10	Azmi et al. (1993)
Javanese Thin Tail	Indonesia	1.80	Bradford et al. (1986)
Javanese Fat Tail	Indonesia	2.03	Bradford et al. (1986)

Efficiency of lean growth is a function of voluntary feed intake and efficiency of conversion of feed nutrients into non-fat tissues. As producers are paid a better price for slaughter animals which produce carcasses of high meat:bone ratio with minimum fat cover, it makes an economic sense to feed market animals to reach maximum lean growth.

GENETIC IMPROVEMENT VIA A CENTRAL BREEDING UNIT

The supply of young males as sires, genetically superior to the females to which they are mated, must be made available regularly to the breeding herds. To achieve this end, three prerequisites need to be addressed: 1) defining the traits of economic importance, 2) recording these traits objectively and 3) applying an effective selection and mating system. The response to selection can be improved by decreasing the proportion of the breeding group retained for breeding. A higher replacement rate and using replacement females and males as young as possible would also reduce generation interval.

The logistics in many developing countries do not favour the use of extensive field performance recordings to evaluate potential sires. Progeny testing of dairy bulls using lactation records of their daughters combined with artificial insemination is a powerful tool to realise increased genetic gain in milk production, but needs good infrastructures linking artificial breeding centre with cooperating farms and consistent services in artificial insemination, data collection and reporting to sustain the program. However methods of genetic improvement utilising superior animals identified at a central station and disseminating these selected genetic materials to as many breeders as possible would offer a better alternative for implementation in many developing economies than methods involving extensive field recordings. Two of these methods of identifying superior animals and expanding their use in producers' farms: group breeding scheme (Highs and Quartermain, 1970) and nucleus breeding scheme (Smith 1988), are discussed below.

GROUP BREEDING SCHEME

In a group breeding scheme, several performance recorded herds are grouped and serviced by a central nucleus herd (Highs and Quartermain 1970). Initially the choice of animals meant for the breeding group could come from other nucleus herds. The number of cows in the nucleus herd could be 10 times lesser than the number of cows in the scheme. All animals generated within the group are screened for high productivity and transferred to a central test station for comparative ranking in a common environment. All sires used in the scheme are bred from elite cows identified in the herds within the scheme. Cooperating herds within the scheme could also contribute superior cows to the nucleus unit and would share ownership of breeding males produced by these cows. In the central herd, cows are ranlced based on the performance of economically important traits and the herd will eventually be closed to ensure an accurate comparative evaluation of maternal ability.

Replacement heifers and bulls selected to generate future generations are performance tested within sex groups. These animals can be retained for use in the nucleus herd or in other herds within the group on a roster basis. The setting up of the group breeding scheme has the aim of replacing a high proportion of all sires used each year. The top young sires are used in the central unit before sold to other cooperating schemes or to the industry. Artificial insemination could be incorporated in the scheme if sufficient control can be imposed on the logistics of artificially breeding the females in the different herds belonging to the scheme.

NUCLEUS BREEDING SCHEME

When performance data on local breeds are available, a choice of the best breed suited for a particular production environment could be made objectively. Further genetic improvement on specific traits of economic importance on the breed could be achieved through the implementation of a Nucleus Breeding Scheme. Akin to the Group Breeding Scheme, a nucleus breeding unit would require the pooling of superior animals with the highest genetic merit from many sources to form the foundation animals. The initial collection of genetically superior animals would provide the boost for faster rates of genetic change (Table 2). A basic difference between a group breeding scheme and a nucleus breeding unit is all herds belonging to a group scheme have to be performance recorded whereas in a nucleus breeding unit the performance of potential sires is evaluated at the central herd based on individual as well as sib information. Incorporating MOET program in the nucleus breeding scheme has the advantage in generating sires' breeding values estimated from sib information.

Table 2. Advantages and disadvantages of nucleus breeding units (after Smith, 1988)

Advantages	Disadvantages
Genetic lift in establishing the unit	Difficult to obtain commercial conditions for selection
Faster rates of genetic change	Use as a show centre
Economic benefits obtained sooner with short generation interval	Long term commitment
More effective selection on economic merit possible	
Lower total cost on a national scale	

A model of a nucleus breeding scheme for beef cattle is being implemented in Malaysia. Arising from the outcome of a crossbreeding project conducted by MARDI, a new beef cattle genotype, Brahman-KK cross, has been identified for widespread uptake by beef breeders in the country. The scheme involved the setting up of a nucleus herd at a central stadon with cooperating breeder famms obtaining their supply of bulls from the central station (Figure 1). Several multiplier herds have been planned to be established with a total populadon of 2000 cows. At present three multiplier herds with a total cow population of 500 head have been set up.

CONCLUSION

Genedc improvement program targeted at the herd level organised in small groups has to be simplified to circumvent the constraints in large scale evaluation of sires requiring extensive field records. When the herds are organised in smaller groups, performance can be recorded at the herd level and sires identified at the nucleus herd based on progeny information from field data can be disseminated to member herds within a group breeding scheme. Altematively the herds could depend on the nucleus breeding unit for their supply of sires which are performance tested at the nucleus herd.

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INTEGRATION OF SHEEP IN PHILIPPINES SMALLHOLDER PLANTATIONS

F.A. Moog[1]

SUMMARY
Smallholder coconut and other tree plantations predominate the scenario of agriculture in the Philippines. With landholding of 2 ha or less, the potential to integrate small ruminants, particularly sheep remains high. Several on-farm trials have indicated the compatibility of sheep under plantations. Native vegetation underneath plantations could support several number of sheep which in terms of liveweight gains or lambs mean additional income. Raising of sheep improves fertility of soil in plantation and does not cause compaction. Stocking rate experiments have indicated the value of determining the carrying capacity of pasture under plantations for sustainable long-term integration.

INTRODUCTION
With small landholdings and the absence of necessity to raise draft cattle and buffaloes the potential of integrating small ruminants in smallholder plantations remain high. In addition, with small ruminants, farmers could raise more in terms of number per unit area of land and individually smaller animals are easier to dispose of compared to larger ones.

Raising of sheep, however is not common and as popular as raising goats in the Philippines. In general, most people are used to eating goat's meat and prefer it over that of sheep's. However, some people who had eaten sheep's meat said it tastes better and is more juicy and tender.

In Sta. Cruz, province of Laguna initial experiences with the IDRC-supported "Small ruminant-coconut systems project" indicate that sheep is more compatible and preferred over goats by some farmers because it is less destructive to intercropped trees and food crops in the plantations. In addition, they are more docile, easier to handle and are more adapted to existing local conditions.

This paper presents some experiences and results of on-farm trials undertaken in Philippine smallholder plantations with more reference to coconut.

LANDHOLDING IN PLANTATIONS
There are about 1.5 million coconut farmers in the Philippines (PCA 1988): In terms of land area, about 33% of the 3.4 million hectares planted to coconut are less than 5 ha and are owned by 92% of the farmers. This means that most farmers had an average farm size of only 1.4 ha but 67% of the total coconut area belong to about 7% of the farmers who own over 5 ha. In fact, 45% of the coconut plantation are owned by 2% of the farmers with an average area of 88 ha.

A survey reported by Sumayao (1991) showed that in 4 villages in Sta. Cruz, Laguna, coffee mixed bananas and other fruit trees are 70% of the farmers own one ha or less, 18% with two hectares or below and only a few owns more than 3 hectares (Moog 1994).

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In the case of rubber, 78% of the 75 thousand hectares belong to 4,000 smallholders with an average landholding of 2 hectares (PCARRD 1982).

FORAGE RESOURCES

Native vegetation in plantations

With grazing animals, feeding involves primarily the use of native vegetation, particularly in large plantations, However, in the case of smallholders who grow annual cereal food crops, supplementation of crop byproducts and cut grasses is practised. In a study of the botanical composition of native vegetation under coconuts in Sorsogon province, Moog et al. (1989) reported that *Imperata cylindrica* constituted 40%, *Paspalum* and *Digitaria* spp. 6%, *Pueraria phaseoloides* 33%, and weeds 21%.

In 1991, Moog reported 40 species present in native pastures under coconuts in Santa Cruz, Laguna. From another experiment 85 species were collected and identified where in terms of biomass grasses constituted 47.3%; legumes, 14.3%; broadleaves, 36.7% and trees, 1.6%. The most predominant species were *Axonopus compressus, Paspalum conjugatum*, and *Cyrtococcum* sp. among the grasses, *Pueraria lobata* and *Mimosa pudica* among the legumes and *Ageratum conyzoidez* and *Blechum pyramidatum* among the broadleaves (Moog et al. 1993).

Table 1 shows the botanical composition of underneath vegetation before sheep was introduced in four farms representing different kinds of plantation in San Jose, Batangas (Moog 1994a). The composition of pasture is determined by the degree of shading inside the plantation. With heavy shading in coffee plantation Paspalum conjugatum (grass) and broadleaf species like *Achyrananthes aspera, Mikania cordata* and *Synedrella nodiflora* were dominant. With lower degree of shading in citrus plantation, the dominant grass and broadleaf species were *Imperata cylindrica* and *Triumfetta semitriloba*, respectively and *Centrosema pubescens* was also present.

Fodder trees

Fodder trees like *Gliricidia, Erythrina* and *Leucaena* are commonly grown particularly by smallholders under coconuts. These species have economic values other than fodder, as hedgerow fence to establish ownership boundaries or as support to black pepper, and being grown for such makes them readily available for feeding livestock (Moog 1992). In general, fodder trees are very valuable during dry season in the villages. In a coconut growing village (Matipunso, San Antonio) in Quezon province, fodder trees composed 36.9% of the cattle feed from December to June (dry period) but only 3.1% from July ta November (rainy season).

In coffee plantations where bananas are common intercrops and in black pepper plantations where gliricidia serves as support or living pole leaves of both plants are harvested. Both banana and gliricidia leaves were observed being fed by farmers raising the introduced sheep in San Jose, Batangas during the height of the dry season (March-April when biomass underneath coffee plantations was scarce (Moog 1994).

Table 1. Botanical composition of pasture in four different plantations

Species	Plantation			
	Coffee	Coffee+ banana	Coffee+ banana+ lansomes	Citrus
Grasses	30.4	50.5	53.1	43.6
Axonopus cornpressus	3.3	-	18.6	-
Imperata cylindrica	-	-	-	34.3
Paspalurn conjugatum	18.6	44	7.8	-
Cyrtococcum accrescens	8.5	6.5	11.4	9.3
Centotheca lapacea	-	-	15.3	-
Legumes	8.2	-	0.5	10.8
Centrosema pubescens	2	-	0.5	10.5
Desrnodium sp.	6	-	-	-
Broadleaves	61.4	49.5	46.4	45.6
Aystacia gigantica	5.2	4.5	2.3	-
Mikania cordata	3.8	6	20.7	3.2
Elephantopus spicatus	0.8	-	1.4	2.7
Ageraturn conyzoides	11	8.5	9.4	4.2
Sida rhombifolia	3	-	-	-
Synedrella nodiflora	8.8	13.5	2.3	4.2
Triurnfetta semitriloba	4.4	-	1.4	22.3
Achyranthes aspera	24.4	17	8.9	3.4
Hyptis capitata	-	-	-	5.6

GRAZING IN PLANTATIONS

Effects on pasture/vegetation

Based on herbage yields from 5 coconut farms in Sta. Cruz, Laguna, Trung et al. (1991) estimated that one hectare of native pasture under coconuts could support 10 mature sheep or goats. However, results of a grazing trial comparing 5 SRE (small ruminant equivalent) and 10 SRE/ha is equal to 20 kg liveweight), Moog in 1991 reported that overgrazing and dominance of unpalatable species in pasture under coconuts occurred at 10 SRE/ha. Higher proportion of grasses was observed at 5 SRE/ha during the wet seasons but a higher proportions of broadleaves was observed throughout the grazing period at 10 SRE/ha (Table 2). This indicates that due to higher palatability of grasses a greater amount of the available grass herbage was consumed at higher. The grasses, *Paspalum conjugatum* and *Cyrtococcum accrescens* were heavily grazed at 10 SRE/ha, thus the broadleaf species, particularly *Ageratum conyzoides*, *Blecum pyrarnidatum* and *Borreria laevis* dominated the pasture.

Table 2. Changes in botanical composition (%) on native pasture under coconuts at 5 SRE and 10 SRE per hectare

Stocking rate	Botanical Composition of Pasture	Year/Season			
		1989-1990		1990-1991	
		Wet	Dry	Wet	Dry
5 SRE	Grasses	72.4	66.8	65.8	41.3
	Legumes	3	3.5	7.1	8
	Broadleaves	24.6	7.4	17.7	50.5
	Shrubs/trees	-	2.3	9.4	0.2
Total		100	100	100	100
10 SRE/ha	Grasses	49.4	65.4	21.6	67.6
	Legumes	0.7	5.1	45.4	9.2
	Broadleaves	49.9	29.5	33	22.8
	Shrubs/trees	-	-	-	0.4
Total		100	100	100	100

SRE - Small ruminant equinalent

Liveweight gains

In Zamboanga (Mindanao, Southem Philippines), average daily gains of sheep in coconut farms were 64 g (Parawan 1987) while those which grazed under rubber including pasture swards along farm boundaries were 43-44 g (PASGC 1989).

Performance of sheep is markedly affected by both stocking rates and seasons of grazing. In 1994, Moog reported the results of grazing experiments involving three sets or batches of growing sheep with initial weights ranging from 10 to 14 kg which were grazed on native pasture under coconuts (Table 3). The first and third sets of grazing coincided within the rainy season (May to December) and the second set within the dry season (January to May). Average daily gain (ADO) and liveweight gains per hectare were lower in the dry season than during the rainy seasons for all stocking rates. However, lowest liveweight gains were obtained from 4 SRE/ha during the first period of grazing due to health problems encountered in one of the sites. Highest ADG and LWG/hd were obtained from the lowest stocking rate of 4 SRE/ha compared to higher stocking rates during the dry season (January to May).

Performance of sheep was lower during the rainy season of 1993 than in 1992. In the same period, ADG and liveweight gains were lowest at 8 SRE, indicating that as grazing continues, sheep performance is adversely affected at high stocking rates even during the rainy season. In all grazing periods, highest liveweight gains per hectare were obtained from 8 SRE except in July to December (rainy season of 1993). Higher ADG, LWG/hd and LWGtha were obtained from 6 and 8 SRE/ha than from 4 SRE/ha during the rainy season. These observations indicate that the high biomass available during the early part of the grazing period can support 8 SRE/ha. Table 4 shows the seasonal biomass on-offer in these grazing trials. Based on herbage samples taken in August 1992 and 1993, higher biomass is available during rainy compared to dry season in all stocking rates. This phenomenon explains why better animal performance was observed during the rainy season.

Table 3. Liveweight gains of sheep grazing on native pastures under coconuts at different stocking rates

Stocking rate (SRE/ha)	Average daily gain (g/hd)	Liveweight gain/hd (kg)	Liveweight gain/ha
May to October 1992			
4	40	6	24
6	67	10	60
8	64	9.6	76.8
January to May 1993			
4	35	5.2	20.8
6	28	4.2	25.2
8	27	4	32
July to December 1993			
4	42	6.2	35.2
6	43	6.4	38.4
8	29	4.4	35.2

Table 4. Seasonal herbage yields (herbage on-offer, tons DM/ha) of native pasture under coconuts at different stocking rates

Stocking rate (SR/ha)	1992			1993			
	May	Aug	Dec	Feb	May	Aug	Nov
4	0.38	1.08	0.83	0.83	0.29	1.34	0.92
6	0.28	1.46	0.94	0.8	0.57	1.95	0.85
8	0.16	1.1	1.1	1.13	0.26	0.67	1.04

In terms of botanical composition, higher proportions of grasses and legumes were observed at lower stocking rates. Higher proportions of shrubs and trees were recorded through the grazing period in all stocking rates. The proportions of broadleaf species were high at 8 SRE/ha where *Ageratum conyzoides* and *Hyptis rhomboidea* dominate in the rainy season. Both species are not palatable to sheep and continuous grazing allows them to dominate at the expense of desirable species, like *Axonopus compressus*, *Paspalum coniugatum*, *Cyrtococcum accrescens* among the grasses and *Mimosa pudica*, *Pueraria* sp. and *Centrosema pubescens* among the legumes.

Benefits Derived

Additional source of income

Liveweight gains/ha from Table 3 were given values in Philippine pesos (PAP) and is summarized below (Table 5). Returns per ha ranged from PhPl,040 - 3,840 per 5-month grazing period (25.78 PhP-1 US$). In general, higher returns were obtained from higher stocking rates, but declined as grazing continued, indicating that optimum stocking rate should be maintained to obtain maximum long-term benefit from integration.

Table 5. Value (PhP) of liveweight gains per hectare from native pastures under coconuts at different stocking rates

Set/Batch	Stocking Rate (SRE/ha)		
	4	6	8
First	1200	3000	3840
Second	1040	1260	1600
Third	1240	1920	1760
Total	3480	6180	7200
Mean	1160	2060	2400

SRE - Small ruminant equivalent

Control of weeds

With three of the four farmers involved in San Jose, Batangas, weeding was totally avoided when sheep was introduced in coffee plantations in 1993. In 1992, each farmer paid PhPI,000-2,900 for hired labor in weeding.

Improvement of soil fertility

Grazing improves the soil fertility of pasture with the cycling of nutrients through the sheep manure. Soil with native pasture under coconuts grazed at 10 SRE/ha appeared to be more fertile than the soil at 5 SRE/ha. Both organic matter and K contents of the soil increased in the two stocking rates but the increase was more marked in pasture grazed at 10 SRE/ha after 16 months of grazing (Moog et al. 1993). This observation could be attributed to higher amount of manure contributed by more sheep at higher stocking rates. Sheep at both stocking rates has not compacted the soil in the pasture.

Problems Encountered

Dogs that preyed on sheep and diarrhoea were the major problems encountered in San Jose, Batangas (Moog 1994a). Dogs are common pets and "guards" of every households in the village where sheep was introduced. Most of the mortalities was caused by dog bites. Dogs preying on sheep were also reported in Sta. Cruz, Laguna.

SUMMARY AND CONCLUSION

The predominance of small landholding in plantations indicates that small ruminants particularly sheep will play a significant role in integrated tree-livestock production systems.

Moreover, sheep had been observed to be not as destructive as goats to other crops grown in association with plantation crops. On-farm grazing trials indicate that sheep could utilize the vegetation underneath plantations giving additional income to farmers, save labor for weeding and improve soil fertility. Determination of optimum stocking rate should be of utmost consideration in integrated sheep plantation system. While higher returns could be obtained during the early part of grazing from higher stocking rates. Overgrazing of pastures occur and weeds dominate grazing continued. Long-term productivity of pasture could be attained only by adopting the optimum stocking rates through the years based on available herbage underneath the plantation.

Dogs prey on sheep. Where stray dogs are common, introduction of sheep should be avoided.

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EFFECT OF STYLO LEGUME SUPPLEMENT TO ELEPHANT GRASS DIET ON THE PERFORMANCE OF BALI STEER

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SUMMARY

Experiments at the laboratory, on-station and on-farm levels were carried out over 15 months to study the effect of dietary mixture of elephant grass (*Pennisetum purpureum*) and stylo legume (*Stylosanthes guianensis* cv. Schofield) on the growth performance of yearling Bali steer. The design of the field experiment was a completely randomized arrangement with 5 dietary regimes (100/0, 75/25, 50/50, 25/75 and 0/100 elephant grass/stylo legume ratio) and 4 replications in each treatment.

The legume not only contained more CP and GE, but its digestible DM, OM, CP, CF, NFE, EE, energy and ash were also higher than those of the grass. However, when the yearling Bali steer fed either legume or grass alone, its liveweight gain was lower than that fed 50:50 grass-legume mixture. The cattle preferred the grass than the legume and preference to the grass-legume mixture was more than either the grass or the legume alone.

There was an indication that weaned Bali steer when fed on a sole diet of either elephant grass or stylo legume did not performed as well as those fed 50:50 grass-legume mixture.

INTRODUCTION

In the wetland farming areas of Bali, Bali cattle has been integrated in the mixed farming system either as draft animals or as side-line undertakings. The cattle are fed on crop residues, natural grasses cut either from the road side, slope of the field or under the cash crops and plantation crops. The ground legume proportion in the roughage diet was low (Nitis et al. 1980).

To increase the quantity of the forage, elephant grass has been grown on the slopes and bunds of the fields (Nitis et al. 1989); while to increase the quality of the forage, *Stylosanthes* has been grown as companion crop to the corn and cassava food crops (Nitis, 1978).

This paper discusses the effect of stylo legume supplement to elephant grass diet on the growth, efficiency of feed utilization, feeding behaviour and forage digestibility in yearling Bali steer.

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MATERIALS AND METHODS

Location

Petang area is a buffer zone between the wetland farming area and dryland farming area and it is one of the potential cattle fattening areas in Bali. The field site was carried out at Petang district, 31 km from Denpasar and at 450 m elevation. The average annual rainfall was 2299 mm with 103 rainy days, distributed mainly during the (November-May) wet season. The temperature ranged from 19-28°C and relative humidity varied from 65-96%. Four experiments were conducted at the site.

Grass and legume plots

Soil preparation on a 5 ha land started in early September and planting of elephant grass (*Pennisetum purpureum*) cuttings at a 1 m x 1 m spacing was carried out in September-October period. Stylo legume (*Stylosanthes guianensis* cv Schofield) was grow at the same period from seed broadcasted at the rate of 4 kg/ha. Before planting, the stylo legume seeds were scarified with hot water. Of the 5 ha lands, 3 ha were planted with stylo legume and the other 2 ha were planted with elephant grass.

The elephant grass plot was fertilized with 400 kg urea/ha which was splitted into 4 applications of 100 kg each every 3 months. The stylo legume was also fertilized with 100 kg TSP (Triple Super-phosphate)/ha with 4 equal applications of 25 kg each every 3 months. A low introgen rate of 5 kg was also applied to the stylo legume plot to induce initial legume growth (Anon 1978).

During establishment, the grasses and legumes were cut every 2-3 months at 10-15 cm height. During the dry season, the slow growth of the elephant grass and stylo legume made the harvesting slightly lower than 10 cm above the ground level.

Bali cattle

Thirty weaned calves were bought from the Kediri sale yard and were transported by truck to the site. They were treated with a broad-spectrum antibiotic (Teramycin) on arrival. Two days later, they were nose-ringed, ear-tagged, castrated, sprayed with boxinox solution to control the tick and drenched with piperazine to control the internal parasites. Two weeks I later, they were vaccinated against SE.

The weaners were accustomed to the stall and the diets for 2 weeks before imposing the feeding regimes. Twenty weaners with average initial liveweight of 87.4 kg were selected for the feeding experiment.

Stall

All cattle were housed in a corrugated iron roof shed with padas stone floor and bamboo feed trough. Each cattle was confined in 2 m x 1 m stall and fed individually.

Statistical analysis

Data were analysed with analysis of variance and when significant ($P<0.05$) they were subjected to the Duncan Multiple Range Test (Steel and Torrie, 1960).

EXPERIMENT 1. NUTRIENT COMPOSITION OF THE FORAGE

Objective

To study the variations in the chemical composition of the grass and legumes fed to the cattle during the wet and dry seasons.

Materials and methods

Elephant grass and stylo legume samples were collected every 28 days. Sixty percent of these sample were cut into 2-4 cm pieces and the other 40% were separated into leaf, sheath and stems. All samples were dried int he forced-draught oven at 70°C to constant weight and then ground to pass I mm screen. The ground samples were kept in sealed plastic bottle for chemical analysis.

Crude protein (CP) was determined using micro Kjeldahl double distillation apparatus as described by Ivan et al. (1971). The other proximate analyses were determined according to AOAC (1970). Gross energy (GE) was determined by Automatic Adiabatic Bomb Calorimeter (Gallenkamp 1976). All samples were analysed in duplicated and expressed on dry matter (DM) basis. Since the monthly values (28 days) showed no definite trend; the monthly values were pooled to represent the seasonal trend.

Results

Stylo legume contained more CP an GE, but less ash than the elephant grass, where as the CF content was about the same (Table 1). The higher CP content was mainly due to the leaf CP, whereas the higher GE content was due to the leaf and stem portions. Stylo leaf contained less CF, whereas the stem contained more CF than those parts of the elephant grass.

Table 1. Chemical composition of the plant parts
:

Plant parts	DM (%)	As percentage of DM			GE (kcal/kg DM)
		CP	CF	Ash	
Elephant grass					
Leaf	17.80	14.79	8.65	13.74	3740
Sheath	20.11	7.83	8.28	15.74	3571
Stem	23.40	6.09	8.09	13.03	3434
Whole plant	15.92	7.21	8.72	13.02	3551
Stylo legume					
Leaf	19.0	17.69	5.66	7.08	4089
Stem	25.80	6.67	10.58	4.55	4014
Whole plant	22.20	12.90	9.62	6.78	4041

The CP content of the elephant grass during the wet season was lower than of that the dry season; whereas for the DM and CF, the reverse was true (Table 2). Similar trend was also observed for the stylo legume. This was due to the lush growth during the wet season so that

Table 2. Seasonal variations in the chemical composition of the elephant grass and stylo legume

Attribute	DM (%)	As percentage of DM					GE (kcal/kg DM)
		CP	CF	EE	NFE	Ash	
Elephant grass							
Dry season (May-September)	16.11	7.12	18.49	1.52	59.30	13.58	3852
Wet season (October-April)	18.31	6.47	18.03	1.91	54.44	14.15	3811
Dry season (May-August)	14.33	9.16	22.39	1.54	49.00	17.91	3616
Stylo legume							
Dry season (May-September)	21.23	13.98	17.3	2.02	59.50	7.19	4226
Wet season (October-April)	22.30	12.53	28.09	1.65	50.91	6.82	4255
Dry season (May-August)	21.07	13.14	24.17	1.81	48.91	6.97	4257

cutting during the wet season becomes less frequent. During the dry season, the slow growth resulted in frequent harvesting of the elephant grass and stylo legume to supply forage feed. Consequently, the elephant grass and stylo legume harvests were older in the wet season than in the dry season.

EXPERIMENT 2: GROWTH AND FEED EFFICIENCY OF THE CATTLE

Objective

To study the effect of different levels of stylo legume supplements to the elephant grass diet on the level weight and feed eMciency utilization in yearling Bali steer.

Materials and methods

The completely randomised design experiment consisted of 5 dietary regimes as treatments and 4 replications in each treatment. The basal (control) diet consisted of 100% elephant grass, whereas in the other diets the elephant grass was replaced with 25, 50, 75 and 100% stylo legume. The composition of the diets and their calculated chemical constituents are as described in Table 3. Only the diet consisted of 100% elephant grass was deficient in protein, calcium and phosphorus for 150 kg cattle. Otherwise all the diets contained nutrients that were more than the standard recommendation of NRC (1976).

Fresh elephant grass and stylo legume were cut daily and carried out to the stall. The forage offered was adjusted in such away that always left-over of 2-3 kg daily. Such as amount of left-over was to sure adequate forage for feeding ad libitum. To ease prehension the forage was chopped into 10-15 cm length, before being offered to the cattle. To minimise selection,

Table 3. Composition and chemical constituents of the diets (% DM)

	Treatment					NRC
Ingredient (%)	A	B	C	D	E	(1976)
Elephant grass	100	75	50	25	0	
Stylo legume	0	25	50	75	100	
Calculated						
CP	9.91	11.34	12.76	14.19	15.63	12.4-9.9
TDN	83.57	84.63	85.73	86.74	87.80	62-55
CF	29.83	30.40	30.07	30.20	30.33	-
Ca	0.27	0.53	0.75	1.01	1.25	0.48-0.24
P	0.33	0.33	0.33	0.33	0.33	0.38-0.22
TDN/CP ratio	8.4:1	7.5:1	6.7:1	6.1:1	5.6:1	5.0-5.6:1

A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

the two forages were mixed thoroughly before feeding. Each cattle was fed individually. Drinking water was offered once a day at noon. The forage and water on offered and refused were measured daily. Liveweight of the cattle was recorded every 28 days. The feeding experiment was carried out for 28 weeks.

Results

Increasing the stylo legume supplement from 25-50% increased the daily liveweight gain, even though the differences were not statistically significant (P>0.05) (Table 4). Increasing the stylo legume supplement further to 75% and 100% decreased the daily liveweight gain.

The total forage consumption followed the trend of the liveweight gain. The proportion of elephant grass and stylo legume consumed was in accordance to their percentages in the diet. However, for the two extremes, cattle fed only stylo legume consumed more (P<0.05) than those fed elephant grass only. Water consumption followed the feed consumption pattern. There was a tendency that increasing the stylo legume supplement, decreased the efficiency of feed utilization, even though the trend was not very consistent.

During the 28 weeks of experimental period, cattle C grew faster than the other grass-legume-fed cattle (Figure 1). The loss in the liveweight indicated that the newly weaned Bali steer required 4-8 weeks adaptation period to accustom to the forage diet.

EXPERIMENT 3: FEEDING BEHAVIOUR OF THE CATTLE

Objective

To study the effect of grass-legume mixture on the feeding behaviour of yearling Bali steer kept in confinement.

Materials and Methods

The cattle and feeding regimes of the growth rate experiment described previously were used in this study.The observations were carried out from 7.00 a.m. to 7.00 p.m. by 15 enumerators.

Table 4. Effect of grass/legume ratio on liveweight gain of cattle

Response	Treatment					SE[2]
	A	B	C	D	E	
Initial live wt (kg)	86a[1]	86a	86.3a	85.9a	86.3a	4.4
Liveweight to date (kg)	110.3a	111.5a	119.1a	100.5a	101.4a	6.3
Liveweight gain (kg/day)	0.1a	0.1a	0.2a	0.1a	0.1a	0.0
Roughage composition (kg/DM)						
a) Elephant grass	367a	358a	320b	127c	-	13.3
b) Stylo legume	-	158a	242b	417c	433c	14.3
c) Total (a+b)	367a	516b	562b	544b	433c	17.5
Grass/legume ratio						
a) On offer	100/0	75/25	50/50	25/75	0/100	
b) Consumed	100/0	59/31	57/43	23/77	0/100	
FCR (Feed/gain)	15. 1a	20.2a	17.1	36.9b	28.6ab	4.93
Water consumption (kg)	494a	552a	637b	604a	470a	131

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05)
[2] Standard error of the treatment means.
A (100% pure grass),
B (75% grass: 25% legume)
C (50% grass: 50% legume)
D (25% grass: 75% legume)
and E (100% legume);

Each enumerator observed a cattle at a time for the duration of 6 hr. Every day 5 cattle from one treatment were observed. A day rest was essential before carrying on for another 12 hr observation.

The parameters observed were the duration and frequency of eating, rumination, mastication, urination, drinking and the roughage selection. Each parameter was observed 3 times.

Results

Increasing the stylo legume in the diet increased (P<0.05) the time of feeding without influencing (P>0.05) the feeding frequency (Table 5). Duration and frequency of rumination followed the eating pattern, whereas the time and frequency of masticating on bollus was affected (P>0.05) by the stylo legume level. Different levels of stylo legume in the diet did not also affect (P>0.05) the frequency of defecation but frequency of urination decreased (P<0.05), as the level of the stylo legume in the diet increased.

When either the elephant grass or the stylo legume was offered as the sole diet, cattle spent more time eating the elephant grass compared with the stylo legume (Table 6). A similar trend was also observed when the elephant grass was mixed with the stylo legume (Table 7). In the case of the elephant grass, time spent in eating the leaf was much longer than the stem or the plant as a whole, and this trend persisted even though the level of the stylo legume in the diet increased. Preference to spend more time eating the whole plant than the stem decreased as

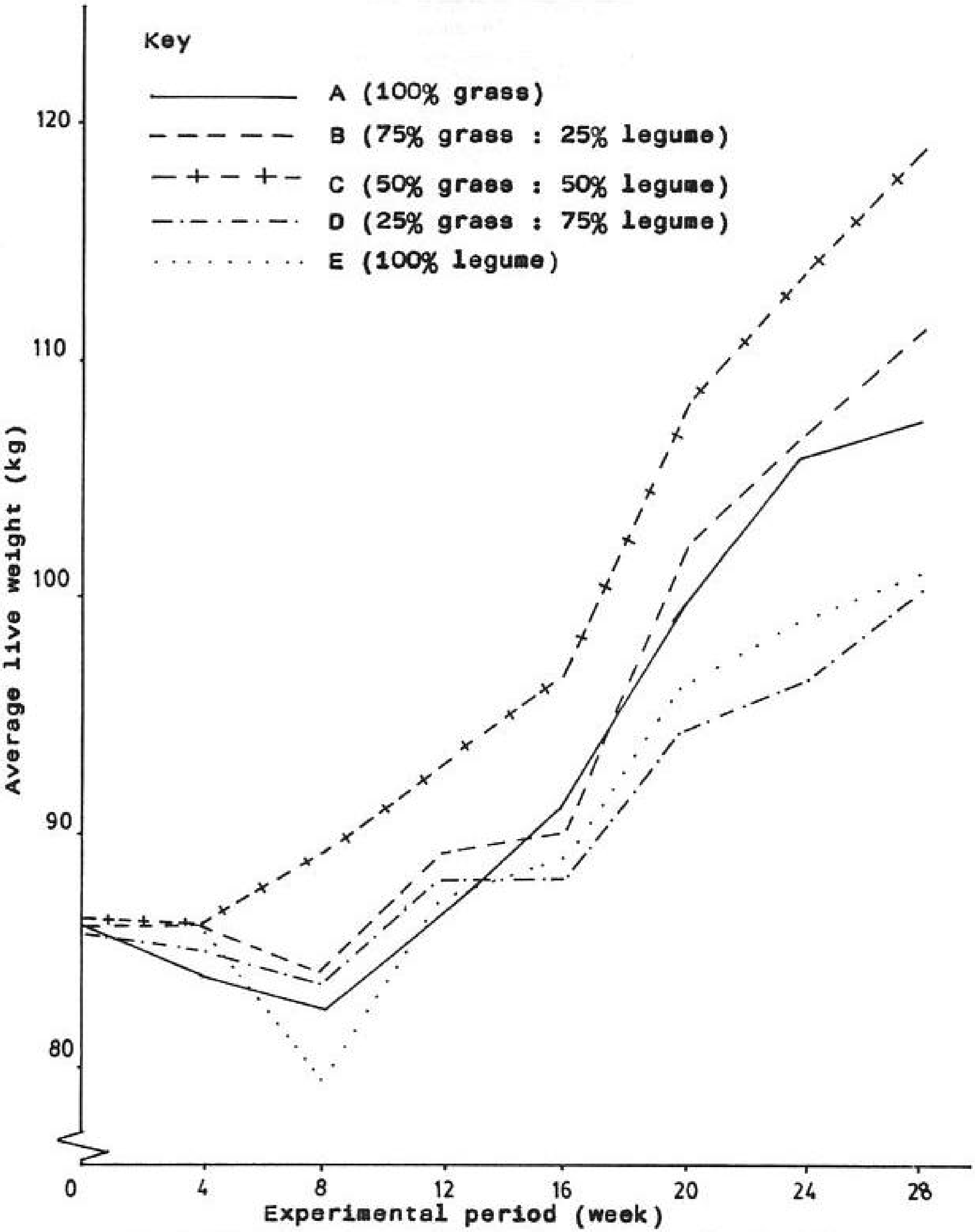

Fig. 1. Effect of grass/legume ratio on the liveweight pattern of yearling Bali steer

Table 5. Duration and frequency of feeding in 12 hr.

Response	Treatment A	B	C	D	E	SE[2]
Eating:						
a) Duration (min)	342a[1]	362b	382c	389c	405d	4.8
b) Frequency	6.3a	5.8a	5.4a	5.4a	5.5a	0.5
Rumination:						
a) Duration (min)	118a	144b	152b	159b	149b	8.9
b) Frequency	5.2a	5.8b	6.5b	6.1b	6.7b	0.5
Mastication of one bollus:						
a) Duration (sec)	35a	36a	37a	36a	33a	1.86
b) Frequency	34a	38ab	37a	41b	36a	2.15
Frequency of defaecation	5a	5.9a	5.3a	5.3a	5.5a	0.3
Frequency of urination	24.1a	26.5a	18.3a	20.5ab	15.6b	4.5

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

Table 6. Duration (min) of eating the plant portion in 12 hr

Attribute	Treatment A	B	C	D	E	SE[2]
Elephant grass						
a) Leaf	272a[1]	192b	113c	74.4d	-	3.1
b) Stem	20.8a	36.3a	39.7a	19.3b	-	2.9
c) Whole plant	51.9a	36.9ab	24.5b	23.7	-	4.6
d) Total (a+b+c)	364a	265a	187c	118d	-	10.2
Stylo legume						
a) Leaf	-	7.3a	21.4ab	41.9b	51.1b	7.9
b) Stem	-	10.8a	4.9ab	2.1b	3.9b	1.8
c) Whole plant	-	73.1a	156.7b	235.2c	362.5d	11.3
d) Total (a+b+c)	-	91.1a	183b	279c	423d	9.9

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pwe grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

the level of stylo legume increased. In the case of stylo legume, time spent to eat the whole plant was more than the leaf and the stem in that order.

Table 7. Preference (min) of eating the elephant grass before eating the stylo legume

Time of the day	Treatment					SE[2]
	A	B	C	D	E	
Morning (7.00-12.00)	-	35.3a[1]	32.3a	16.1b	-	2.3
Afternoon	-	28.2a	24.5b	16.5c	-	4.5

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

Time of the day seemed to have little effect on the preference of eating the leaf than the stem (Table 8).

Table 8. Preference (min) of eating the leaf before eating the other parts of elephant Brass

Time of the day	Treatment					SE[2]
	A	B	C	D	E	
Morning (7.00-12.00)	50.5a[1]	30.3a	32.3a	16.2c	-	3.5
Afternoon	41.0a	18.5b	19.6bc	16.5c	-	3.4

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

Cattle were more often eating directly from the top layer of the roughage rather than either mixing the top or the bottom layers before eating the feed (Table 9). However, as the proportion of the stylo legume in the diet increased, the more often the cattle mixing the different layers before starting to eat the feed.

Table 9. Frequency of selecting forages

Attribute	Treatment					SE[2]
	A	B	C	D	E	
Selecting and eating the top layer	148a[1]	168a	145a	174b	202b	8.9
Selecting and eating the bottom layer	244a	314b	274a	334b	283ab	21.9
Directly eating the top layer	533a	571a	595a	577a	556a	29.7

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

EXPERIMENT 4: DIGESTIBILITY OF THE FORAGE

Objective
To study *in vivo* digestibility of grass-legume mixture fed to yearling Bali steer.

Materials and methods
The feeding regimes of the growth rate experiment described previously were used in this study. Three Bali steers of 225 ± 6 kg average liveweight were used in this study. A preliminary period was carried out for 3 weeks to adapt the cattle to the harness and the roughage. The feeding at each diet was arranged in such that each cattle received a similar diet as a replication for the statistical analysis.

The faecae and urine were collected daily (Maynard and Loosli 1969). To preserve the excrete, the faecae was mixed with 0.5% chloroform (Juko et al. 1961) and the urine with 2% HC1 (Colboume et al. 1968). The feeding period for each tested diet was 7 days followed with 7 days total collection period.

The *in vivo* digestibilities of the various proximate nutrients were detemmined according to the method described by Maynard and Loosli (1969). The true and apparent protein digestibilities were determined according to the methods described by Crampton & Harris (1960), and Stronzski & Candler (1972). The ME was calculated according to the method of Blaxter (1962), whereas the TDN was calculated according to the method of Maynard & Loosli (1969).

Results
Levels of stylo legume supplement in the diet did not affect (P>0.05) the DMD and OM digestibilities (Table 10). Similar pattems were also observed for the TDN and ME values. However, diets containing 75 or 100% stylo legume contained higher DE (P<0.05) than those containing lower stylo legume supplements.

Table 10. In vivo dry matter, organic matter and energy digestabilities of the diets

Attribute	Treatment					SE[2]
	A	B	C	D	E	
DM digestibility (%)	62.09a[1]	62.21a	63.09a	69.12a	67.00a	2.60
DM digestibility (%)	66.15a	66.32a	66.55a	71.65a	71.96a	2.81
TDN (%)	55.75a	58.45a	59.07a	66.07a	62.09a	2.80
DE (kcal/kg)	2090a	2442a	2342a	2796a	2903a	113
ME (kcal/kg)	2011a	2150a	2050a	2972b	2578b	260

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

Apparent and true protein digestibilities increased as the level of stylo legume supplement increased from 25 to 75% (Table 11). Above this level, the value did not vary. The EE and ash digestibilities increased as the level of stylo legume increased from 25 to 100%, whereas the CF and NFE digestibilities have not affected (P>0.05) by the stylo legume level.

Table 11. In vivo digestibility of the proximate composition of the diets

Digestibility	Treatment					SE[2]
	A	B	C	D	E	
Apparent protein	66.3ab	66.4ab	75.5ab	85.7d	80.9cd	2.6
True protein	77.8a	65.9b	72.9a	81.7a	80.5a	4.2
Crude fibre	67.6a	65.3	61.5a	63.8	60.9a	5.3
Ether extract	11.6a	22.3d	48.8d	34.0c	55.8b	10.4
Nitrogen-free extract	66.7a	67.5a	63.8a	74.6a	68.4a	2.9
Ash	44.7ab	34.4b	43.3ab	45.7a	50.3a	3.6

[1] values in the same rows bearing similar letter are not statistically significant (P>0.05);
[2] Standard error of the treatment means.
A (100% pure grass), B (75% grass: 25% legume), C (50% grass: 50% legume)
D (25% grass: 75% legume) and E (100% legume)

GENERAL DISCUSSION

Stylo legume has been shown to contain more CP and GE and its digestible DM, OM, CP, CF, NFE, EE, energy and ash were also higher than those of the elephant grass. However, when the two forages were fed as a sole diet, the yearling Bali steer gained less liveweight than those fed 50: 50 grass-legume mixture. The lower liveweight gain of the grass-fed came was presumably due to the lower CP, Ca and P of the diet, while the lower liveweight gain of the legume-fed cattle was attributed to lower intake in spite of the higher CP and Ca of the diet. The lower digestibilities of some of the nutrients in the elephant grass and the higher digestibilities of some of the nutrients in the stylo legume could aggravate intake constraints The present data show that the nutrient balance for maximal growth was reached when the yearling Bali steer were fed with grass-legume mixture at 50:50 ratio.

Cattle supplemented with stylo legume spent more time in eating, ruminating and selecting the feed. Consequently more feed was consumed to compensate for the energy lost for such feeding behaviour activities. The lower efficiency of feed utilization, as the level of stylo legume increased, added support to this suggestion.

Under the traditional system, Bali cattle is stall-fed during the food crop season and tethered grazed on the fallow land. There is the possibility that the weaned calf will consumed sole elephant grass or stylo legume, so that its growth rate may be affected. Growing grass-legume mixture on the fallow land or on the bund of the field can be become an alternative means of overcoming the growth depressing effect of such monospecific forage.

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CRITICAL PASTURE MANAGEMENT AND UTILISATION TO REDUCE FEED SUPPLEMENTATION

F. Y. Chin[1]

SUMMARY
Critically managing and utilising pastures through proper fertilliser application and imposition of proper grazing frequency can achieve production of good quality forages which can reduce concentrate feeding in ruminants. Adequacy and timeliness in nitrogen application and a higher grazing frequency, involving 18 days regrowth between defoliation, and their benefits are highlighted. A Forage Quality Triangle model is proposed as a simple guide to assist in critical pasture management and utilisation.

INTRODUCTION
Good quality pastures can be produced through efficient utilisation of resources and implementation of effective field management and utilisation practices. This has of course to be coupled to a favourable agro-climatic environment for growth whether natural or with human intervention. The resources comprise the four 'Ms' - money, manpower, machines and materials. The latter include agronomic needs such as seeds and fertilisers. The important field practices consist of adequate and timely fertiliser use, proper grazing system and defoliation technique, regular service cutting or mowing, effective weed control, provision of sward spelling as well as, wherever necessary, appropriate adverse season management. The latter, in a drought-stricken situation, involves actions to reduce grazing pressure on pastures already weakened by soil moisture stress.

With the provision of high quality forage to animals, the need for concentrate supplementation is reduced and ruminant production becomes more cost-effective. High quality pastures, although unable to satisfy energy requirements of animals, will definitely reduce need for protein supplementation. To achieve high quality forage production, it is important to practise pasture management and utilisation critically, giving attention to precise harvesting technique and fertilizer rate and timing of application.

The two most crucial field management and utilisation practices are soil nitrogen (N) fertility improvement and proper frequency of defoliation whether by grazing or cutting. These can independently or jointly cause ineffective pasture production or provide farreaching effects towards ensuring high quality forage for feeding. In many other parts of the tropics, including Malaysia, it is felt that N nutrition of pastures can be improved to produce higher quality forage through both an increase in rate as well as timeliness of application. Low frequency of N fertiliser application of 1-2 times a year for improved pastures is not an uncommon practice. Grazing pastures younger for better quality forage is also generally not well taken advantage of. Towards this end, the Department of Veterinary Services Malaysia (DVSM) introduced

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in late 1993 a critical pasture management and utilisation program which emphasised the above two practices as well as field and laboratory work to monitor their effect on forage quality improvement.

This paper examines some preliminary findings of the program and discusses their implications to forage quality and ruminant feeding. It also proposes the use of a simple model to assist in carrying out critical pasture management and utilisation.

THE CRITICAL PASTURE MANAGEMENT AND UTILISATION PROGRAM

The critical pasture management and utilisation program was introduced on DVSM supervised ruminant rearing areas such as cattle and sheep/goat farms, grazing reserves and farmers' grass plots, with emphasis on the former. The aim of the program was to ensure the production of high quality forage for improved livestock feeding and, at the same time, reduce concentrate supplementation. This was by improving management through better adequacy and timeliness in N fertiliser use to boost forage yield and quality as well as by improving utilisation through higher frequency grazing to defoliate pastures younger for better quality forage. The three main aspects of the program were as described below:

Adequate and Timely FertiliserApplication

Nitrogenous fertiliser use was to be upgraded with a target of 200 kg N per ha, in at least 6 split applications per annum. This would ensure better adequacy and improved timeliness. Besides nitrogen, the availability of potassium and phosphorus would also be ensured as per DVSM recommendation.

High Grazing Frequency

To attain a higher grazing frequency, intervals between grazings were targetted at 17-21 days for aggressive rapid regenerating grasses such as the Brachiaria spp. *(B. decumbens, B. humidicola* and *B. ruzkiensis*)*, Digitaria setivalva, Cynodon plectostaychus* and *Setaria sphacelata* (*anceps*) cv. Kazungula. *Panicum maximum* varieties and *S. splendida* were to be grazed from 21-28 days, but an earlier grazing range of 21-24 days was also possible when there was good rain to favour a more rapid regrowth.

Forage Quality Monitoring

The effects of the above two management and utilisation practices on forage quality improvement were monitored through soil analysis, forage nutrient analysis and observation on pasture growth and sward composition. Soil analysis was to detect improvement in soil fertility. Forage nutrients in terms of proximate composition, calcium and phosphorus contents and, on a limited scale, ruminant metabolisable energy using Menke's rumen gas test technique were determined to indicate forage quality. Observation on plant growth and sward composition was to examine the resistance of the various species to defoliation, their consequential long-term vigour and persistence under conditions of critical management and utilisation.

Both the soil and forage samples were derived under *in-situ* field conditions from forage production areas which had achieved different levels of improvement since the implementation of the program.

RESULTS

From the monitoring, it was obvious N fertiliser use was gradually improved in many of the areas concerned. One or two areas did well to achieve 5-6 split applications a year for some fields, particularly those utilised for grazing high producing dairy animals. Generally, however, most fields in most areas which had embarked on the improvement program managed 3-4 split applications a year. This in itself was an improvement for fields which previously received only 1-2 split applications a year. A greater awareness towards the benefit of grazing pastures younger was generally achieved and there existed a general tendency towards practising it. However, up till end of 1994, achievement was mixed.

By end of 1994, 236 forage samples of mainly *B. decumbens, B. humidicola, D. setivalva, P. maximum, S. (anceps) sphacelata* cv. Kazungula and *S. splendida*, were obtained from twelve government ruminant farms, one grazing reserve project and one farmer's grass plot. Among these were some samples of the *Pennisetum purpureum* varieties (Napier, Uganda Napier and King grass) used mainly for cutting. Tables I and 2 present data on crude protein contents of the samples which ranged from a low of 3.3% to a high of 18.8%. Twenty percentage of the samples analysed had more than 13% crude protein, while 33.5% had above 10% to 13 % crude protein (Table I & Figure 1). The major proportion of the samples (46.5%) had values of crude protein of 10% and less while 8.4% of these had less than 7%.

Preliminary assessment of the monitoring results showed that high levels of crude protein, above 13%, could be attained if pastures had improved nitrogen nutrition and were defoliated early ie. 17-21 days. The poorer levels of below 10% crude protein obtained in some pastures are invariably due to late defoliation and/or improper fertiliser application. Reasonably improved pastures could achieved values between 10% and 13% crude protein. Well fertilised varieties of *P. maximum* and *Pennisetum purpureum* which were defoliated at the recommended age of maturity of 21-28 days and 28-35 days could also manage to attain crude protein levels above 10%. The P. maximum varieties when defoliated at the earlier range of 21-24 days could also attain 13% and above of crude protein.

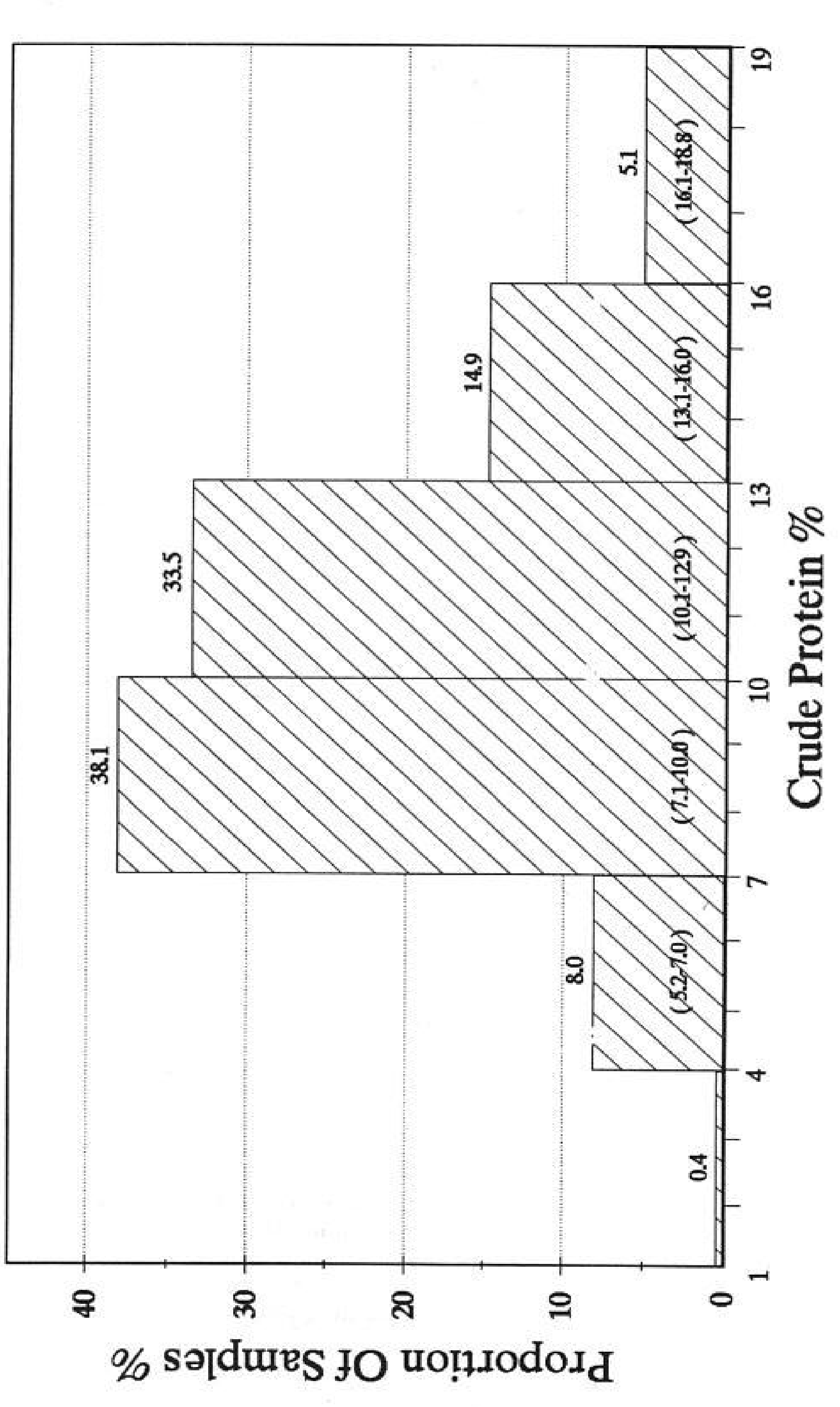
Results tended to indicate that improved N fertility and grazing younger pasture had both to come into play to provide high quality forage. One without the other might not give the desired effect. Some samples from grasses defoliated early did not give expected protein levels because N fertiliser improvement had not been fully achieved in terms of rate, timeliness or both. It was noted too that applying N at a frequency of 3-4 split applications a year might not sustain improved forage quality over the period between two applications. In a rotational grazing system done in cycles of 17-21 days, there would be roughly 4-6 regrowth between two such applications. Only the immediate and second pasture regrowth after fertilisation seemed ensured of the benefit from added N, responding well to give higher crude protein. The beneficial effect from the added N became less apparent from the third regrowth onwards and this was reflected in lower crude protein levels.

DISCUSSION

From the above, it is important to note that, if pasture grasses are to produce better quality forage, greater attention would have to be given to proper age at defoliation, backed by a proper N fertiliser management practice which emphasises both better adequacy and improved timeliness in application. The reasons are outlined below:

Table 1. Crude protein (CP) contents and their frequency according to prescribed range limits

Prescribed range for CP%	Frequency			CP analysed				
	No. of samples	%	Cumulative %	Minimum	Maximum	Mean	Standard deviation	Standard error of mean
<5.0	1	0.4	0.4	-	-	3.31	-	-
5.01 - 6.0	6	2.5	2.9	5.19	5.96	5.71	0.279	0.114
6.01 - 7.0	13	5.5	8.4	6.16	7.00	6.56	0.293	0.081
7.01 - 8.0	27	11.4	19.8	7.10	7.98	7.40	0.209	0.040
8.01 - 9.0	39	16.5	36.3	8.10	9.00	8.59	0.271	0.043
9.01 - 10.0	24	10.2	46.5	9.10	10.00	9.61	0.273	0.056
10.01- 11.0	33	14.0	60.5	10.1	10.90	10.49	0.230	0.040
11.01 - 12.0	32	13.6	74.1	11.06	12.00	11.51	0.303	0.054
12.01 - 13.0	14	5.9	80.0	12.01	12.90	12.36	0.257	0.069
13.01- 14.0	11	4.7	84.7	13.10	13.70	13.41	0.202	0.061
14.01 - 15.0	13	5.5	90.2	14.28	14.80	14.56	0.17	0.047
15.01 - 16.0	11	4.7	94.9	15.02	16.00	15.67	0.305	0.092
16.01 - 17.0	5	2.1	97.0	16.10	17.00	16.60	0.385	0.172
17.01 - 18.0	3	1.3	98.3	17.48	18.00	17.65	0.246	0.142
18.01 - 19.0	4	1.7	100.0	18.20	18.79	18.55	0.226	0.113



Note: Figures in parentheses are the ranges of actual crude protein % determined

Fig. 1. Range of crude protein according to proportion of samples

Table 2. Summary for crude protein (CP) analysis

Range of CP analysed	3.31 % - 18.79%
Mean of CP analysed	10.60%
Standard deviation	2.958
No. of samples	236
Standard error of the	0.190

BENEFITS OF EARLY DEFOLIATION

Improved tropical pastures are predominantly pure grass swards. These pastures are often not utilised to the fullest potential for the effective production of milk, beef and mutton. One weakness in their utilisation is in the grazing frequency as governed by the rest period between grazings for recovery and production of new tillers and leaves. In earlier years, shorter intervals between defoliation have not always been recommended although in practise feeding value is highest during the early period of rapid growth when new leaves are rapidly being produced. By continuous close defoliation at very frequent intervals, the nutritive value of the herbage may be kept at a relatively high level but unfortunately such treatment if not carefully carried out may seriously reduce the yield and vigour of the plants. Schofield (1944, 1945) comparing the effect of 1,2 and 3 monthly intervals, had shown that though cutting at 1 month frequency gave the highest crude protein content the vigour of the plants had been markedly reduced at the end of 2 years. Similar results were obtained in Trinidad and Hawaii respectively by Paterson (1933, 1935) and Nordfeldt *et al.* (1951), both cited by Whyte *et al*. (1968).

Thus, many had tended to forsake forage quality in pursuit of higher yields and greater vigour and persistence. Some graze pasture grasses at 6-10 weeks of maturity. Defoliation at such long intervals may not be a sound feeding practice due to the much reduced quality and palatability. When defoliated at 10 weeks regrowth, Djafar and Chin (1972) showed that three P. purpureum varieties (Napier, Hybrid India and Merker) had crude proteins ranging 6.5 to 6.8% while Chin and Hong (1975) found an even lower value for Napier of only 4.1 %. Chin *et al*.(1974) found that the crude protein of grasses at 7 weeks regrowth could decline to as low as 6.3%.

The advent in the cultivation of nitrogen responsive, aggressive, fast regenerating, persistent and high yielding grasses such as the stoloniferous Brachiarias (*B. decumbens, B. humidicola, B. mutica* and *B. ruziziensis*), *D. setivalva* and *C. plectostachyus* and tufted, rhizomatous types with large crown and robust spreading culms such as the *S. (anceps) sphacelata* cv. Kazungula now enables a much higher grazing frequency as well as intensity of grazing to be practised on pastures. Such stoloniferous and rhizomatous grasses with a high level of basal green leaves are resistant to defoliation and are of good persistence.

In Malaysia, Chin (1982) had put forth argument for grazing pastures early, stating that maximum benefit in terms of protein nutrition comes from grazing or cutting grasses at early maturity of even less than 4 weeks. He also stated that it was a misconception that good grass swards should look luscious thick and tall as, most usually, such sward would have lost much of its nutritive value due to advancing maturity. It is now even possible to graze some of these grasses as early as 17-18 days of regrowth given favourable soil fertility, climatic conditions and intensity of grazing (in terms of stocking density, period of grazing and height at defoliation). This has been supported by the work of Choo (1993), | also reported by Choo *et al*.(1993).

It is known that tropical grasses mature rapidly with a corresponding decline in qyality. Quality is high during the early stages of growth and low as the grasses mature. Age of maturity or cutting interval was found by Altom (1978), cited by Skerman and Riveros (1990), to definitely affect the quality of *C. dactylon* hay crop in a 3 year study.

Higher Crude Protein

Crude protein contents decline as grasses mature in the field (Figure 2). Milford and Minson (1966) have shown that crude protein percentage of tropical grasses which could be increased through nitrogenous fertiliser application fell rapidly when they were allowed to mature and grow to the limits of the nitrogen supply. In their study, crude protein percent fell rapidly from 15%-20% at 2 weeks to 10% at 4 weeks and fairly rapidly from 4-13 weeks. Chin *et al*. (1974) reported a crude protein as high as 25% at 2 weeks and as low as 6.3% at 7 weeks maturity. A similar declining trend is observed by Chin *et al*. (1979) and Yusoff (1994) in their analysis of grasses. The results of Chin *et al*. (1974) and Yusoff (1994) showed that grasses at 3 weeks of maturity generally had good crude protein contents of above 13%, with some as high as 19%. Watkin and Sukpitaksakul (1992) found in their study that strip grazing adequately fertilised *B. ruziziensis, P. maximum* and *P. maximum* var. trichoglume every 24-27 days during rainy season provided forage of relatively high crude protein values ranging between 12% and 15%.

Lower Crude Fibre

Grasses in the tropics are generally known to have high crude fibre contents which increase with advancing maturity (Figure 2). Lim (1968) reported this as a great disadvantage common to grasses grown in Malaysia. His value averaged between 30-40% of dry matter. Chin *et al*. (1974) and Yusoff (1994) obtained ranges of 25-36% and 21-47% respectively in grasses. These high levels compare unfavourably with those of such poor roughage such as rice straw or bagasse which has crude fibre of 30% and above. Grazing younger pastures will avoid higher fibre forage.

Higher Palatability and Voluntary Intake

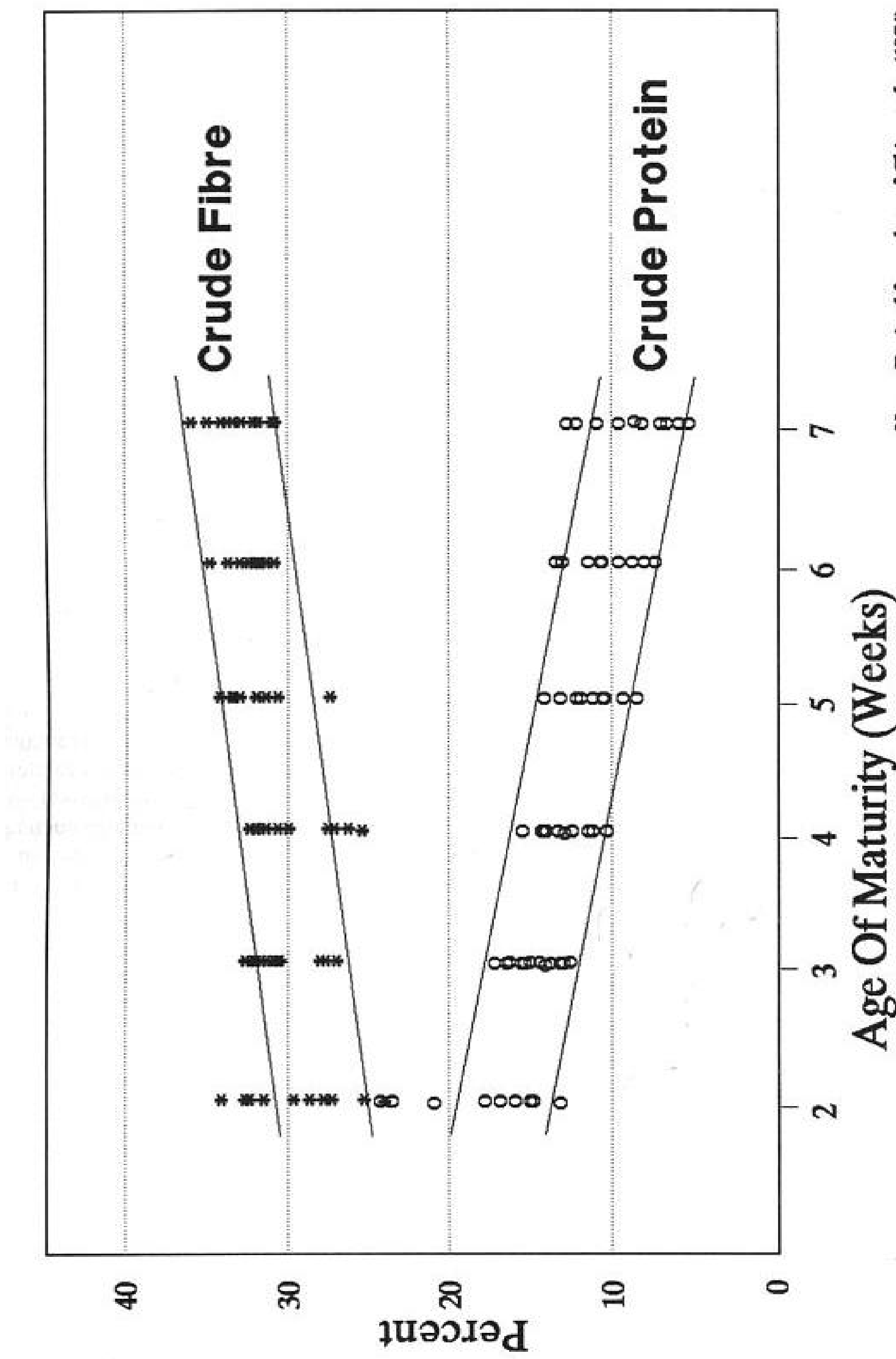
Voluntary intake of pasture also declines with age and this had been shown by Minson (1971a) in his study on 6 varieties of Panicum including Green Panic, Coloniao guinea and Harnil guinea. Grazing younger grass takes advantage of more palatable, less fibrous, forage thus resulting in better voluntary intake.

Better Dry Matter (DM) Digestibility

Minson (1971b) studied the effect of age on the DM digestibility for a number of tropical species and generally found a decline ranging 0.1 - 0.7 of digestibility % per day. Earlier defoliation thus takes advantage of a better DM digestibility.

Increased Milk Production

A study on the relationship between milk production and the grazing frequency of grass pastures (Choo, 1993; Choo *et al*. 1993) had shown that pastures, with upgraded N nutrition,



Note : Derived from data of Chin et al. (1974)

Fig. 2. Trend of crude protein and crude fibre according to age of maturity

could be grazed at an early age of maturity of between 17 and 19 days to provide better quality forages of higher crude protein and lower crude fibre which helped to increase average daily milk production. In the study, milk production generally increased after the cows changed over from grazing pastures at 28 days of maturity to grazing pastures of between 17 and 19 days of maturity. Increase in milk yield was assumed due to the better quality forage of 11-14 % crude protein and 27-34% crude fibre at the earlier defoliation. Compared to this, herbage from the 28 days regrowth had higher crude fibre content of 31 38% and only 5-9% crude protein.

BENEFITS OF PROPER NITROGENOUS FERTILISER USE

The application of N fertiliser to tropical grasses usually increases the level of crude protein but has no consistent effect on DM digestibility. Skerman and Riveros (1990) cited results of work done by Milford (1960), Alexander *et al.* (1961), Chapman and Kretschmer (1964), Owen (1964), Webster *et al*. (1965), Minson (1967), Fribourg *et al*. (1971), Chacon *et al*. (1971), Minson (1973) and Carver *et al*. (1975) in support of this conclusion. Some results showed increase in DM digestibility while others showed decrease, but, invariably all reported a definite increase in crude protein with the N fertiliser. The more dramatic increases were shown by Carver *et al*.(1975) with an increase from 9.6% to 16.65 in 18 days old C. dactylon and Webster *et al.* (1965) with an increase from 11.2% to 21.1% in the same grass at 21 days of regrowth. Even with 28 days old *D. decumbens*, Minson (1973) managed to achieve an increase in crude protein level from 8.1 % to 13.2%. Caro-Costas *et al*. (1960), Whitney and Green (1969) and Hendy (1972) also found that crude protein content and crude protein production could be both increased in the latter grass with N increment. Chin (1979) reported a similar trend while working with *B. decumbens, B. mutica, D. decumbens, P. maximum* and *S. sphacelata* cv. Kazungula at incremental levels of N fertiliser application in the form of urea containing 46% N.

It is thus important to consider improved N fertiliser application in efforts to increase forage quality. However, it should be noted that pasture production is easily increased with N improvement, even with small increment, but it is more difficult to get positive responses in terms of DM and crude protein contents. In his work, Chin (1979) found that resultant increases in crude protein levels became significant only when nitrogenous fertiliser was applied at the highest level of about 40 kg N/ha in split applications after every 4 weekly grazing. On the other hand, he obtained significant responses in yields of green fodder, DM and protein even with 10 kg N per ha, applied in a similar manner. In fact, Ketschmer *et al*. (1973) found that increasing the rate of N application had no effect on the DM and crude proteins of grasses in their study. However, Whitney and Green (1969) and Salette (1965) were of the opinion that, with N fertiliser, the first increment of N essentially raises DM yields thus elevating crude protein production and further increment increases the N content of the grasses.

In order to obtained maximum benefit from N fertiliser, both adequacy and timeliness in application are equally important. The monitoring showed that, although N fertiliser was improved in terms of rate or quantity applied, the frequency of applications, if still low, ie. about 3-4 annual split applications, did not provide a desired sustained longer term improvement even if defoliated early. The N source used was fertiliser urea and the N could easily be lost through soil reaction, leaching and volatilization after application. Thus, the more split applications the better would be the N availability in the soil for plant uptake. Tudsri and

Sawasdipanit (1993) said that most grasses respond to annual N topdressing level of as high as 750 kg N per ha but regular amount of 60-90 kg N per ha per defoliation can optimise forage production on the local soils of Thailand.

REDUCED SUPPLEMENTATION WITH QUALITY FORAGES

Increasing forage crude protein means a reduction in concentrate supplementation to ruminants thus saving feeding cost. This has also been suggested by Choo (1993) and Choo *et al*.(1993) where a reduction of dairy concentrate supplementation was achieved, ie. from 0.5 kg to 0.25 kg concentrate for every litre of milk produced. With this reduction in concentrate supplementation, there was an effective annual feed cost saving of 42% for the 350 animals studied or 23 % for the whole dairy population on the farm. If a forage crude protein level of 13% can be attained through critically managing and utilising pastures, then protein requirements of ruminants can theoretically be satisfied so that only energy needs to be supplemented. This makes supplementary feeding more economic and convenient as the supplement can then be in the single ingredient form of corn gluten feed, feedgrain maize, tapioca chips, sago pith/waste or molasses. It is preferable to feed forage protein because at a production cost of 1.8-2 sen per kg of fresh grass, it is worked out that the cost of forage protein on dry basis is 80 sen/kg or less. This price of forage protein is relatively cheaper than the prices of protein supply from conventional proteinous feedstuffs readily available in Malaysia. Bimer and Idris (1992) cited the prices/kg protein for groundnut cake at RM 1.21, sesame cake at RM 1.11, brewer's spent grain at RM 1.09, and soya waste at RM 1.37. Theoretical estimates for a lactating cow, growing steer and growing replacement sheep in terms of nutrient requirement, forage nutrient availability and need for concentrate supplementation are outlined below:

<u>Lactating Cow</u>

a. 400 kg bodyweight producing 8 kg of milk with 3.6% butter fat

b. Nutrient supplied by quality forage of 20% dry matter (DM), 13% crude protein (CP) and 8 megajoules (MJ)/kg metabolisable energy (ME)

Fresh forage consumed @ 10% bodyweight	-	40 kg
DM consumed	-	8 kg
Forage CP supplied @ 13% CP	-	1.04 kg
Forage ME supplied @ 8.0 MJ/kg	-	64.0 MJ

c. Nutrient demand of cow/day (based on NRC figures)

	CP (kg)	ME (MJ)
For maintenance	0.358	42.9
For 8 kg milk produced	0.656	40.0
Total	1.014	82.9

d. Assessment of nutrient supply vs demand and supplementation need

- CP requirement is satisfied
- ME requirement is only partly satisfied; short of 18.9 MJ to be supplemented with energy feed

<u>Growing Steer</u>

a. 200 kg bodyweight growing at 0.5 kg liveweight gain per day

b. Nutrient supplied by quality forage of 20% dry matter (DM), 13% crude protein (CP) and 8 megajoules (MJ)/kg metabolisable energy (ME)

Fresh forage consumed		
@ 10% bodyweight	-	20 kg
DM consumed	-	4 kg
Forage CP supplied @ 13% CP	-	0.52 kg
Forage ME supplied @ 8.0 MJ/kg	-	32.0 MJ

c. Nutrient demand of cow/day (based on NRC figures)

CP	-	0.54 kg
ME	-	46.87 MJ

d. Assessment of nutrient supply vs demand and supplementation need

S CP requirement is roughly satisfied

S ME requirement is only partly satisfied; short of 14.87 MJ to be supplemented with energy feed

<u>Growing Replacement Sheep</u>

a. 40 kg bodyweight growing at 0.1 kg liveweight gain/day

b. Nutrient supplied by quality forage of 20% dry matter (DM), 13% crude protein (CP) and 8 megajoules (MJ)/kg metabolisable energy (ME)

Fresh forage consumed		
@ 10-12% bodyweight	-	4 - 4.8 kg
Forage DM consumed	-	0.8 - 0.96 kg
Forage CP supplied @ 13% CP	-	0.104 -0.125 kg
Forage ME supplied @ 8.0 MJ/kg	-	6.4 - 8.64 MJ

c. Nutrient demand of cow/day (based on NRC figures)

CP	-	0.124 kg
ME	-	11.55 MJ

d. Assessment of nutrient supply vs demand and supplementation need

S CP requirement can be satisfied but, critically, with longer daily hours and/or timing for grazing to increase DM intake being stressed.

S ME requirement: short of 2.91 - 5.15 MJ to be supplemented with energy feed.

THE FORAGE QUALITY TRIANGLE

A Forage Quality Triangle model, as shown in Figure 3, is proposed to serve as a simple guide for the critical management and utilisation of pastures for the production of good quality forage to attain better cost-effectiveness in ruminant feeding. The model summarises basic requirements, management and utilisation factors and targetted forage quality and cost of production.

A right choice of pasture species, a suitable agro-climatic environment and the availability of necessary resources are the 3 important basic requirements. If these basic requirements are

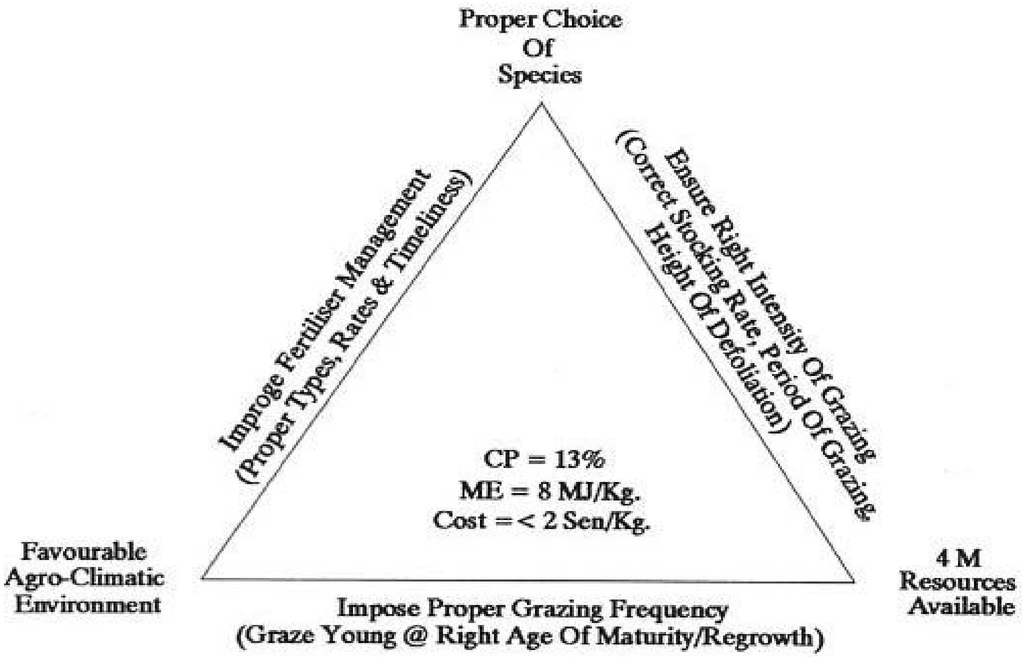


Fig. 3. Forage quality triangle for critical pasture production

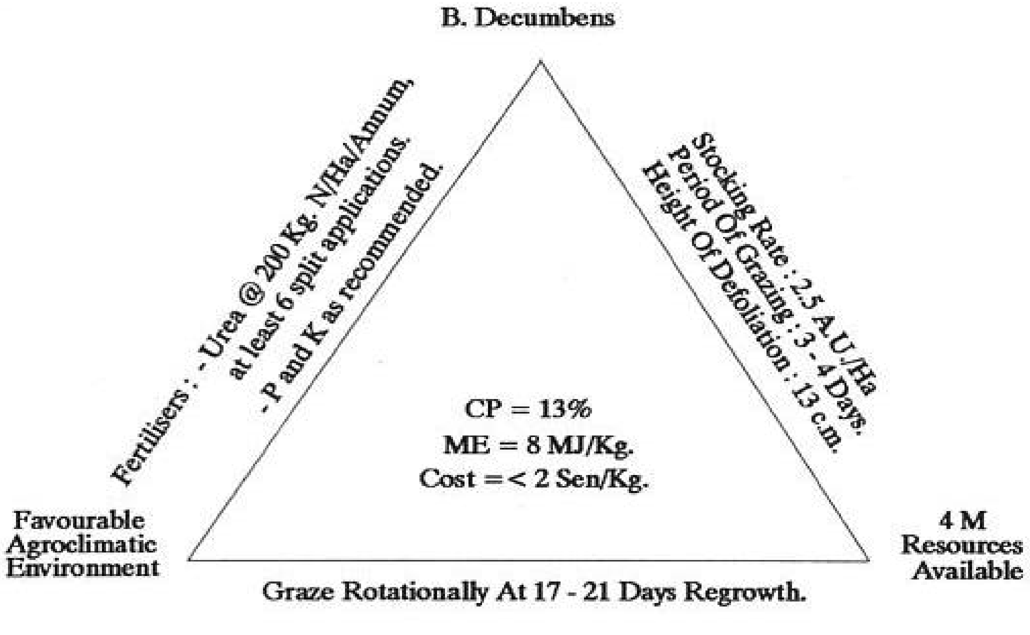


Fig. 4. Forage quality triangle for *B. decumbens* pasture

met, then looking critically at the following management and utilisation practices can achieve the target set for both forage quality and cost of production;

Maintain suitable soil fertility through effective fertiliser use in terms of proper types, rates and timeliness of application.

Ensure the right intensity of grazing in terms of stocking rate, period of grazing and height of defoliation

Impose proper grazing frequency (as determined by age of maturity/ regrowth or interval between grazings)

In Malaysia, the target is to be able to produce forages of sufficient quality containing at least 13 % crude protein and 8 megajoules/kg of metabolisable energy at a cost not more than 2 Malaysian sent With the imposition of a higher grazing frequency, it may also be useful to consider a periodic sward spelling (ea. end of every 2 years or whenever a need arises) so that the pastures can rejuvenate by completing a biological cycle. Figure 4 represents a Forage Quality Triangle Model set up for critically managing and utilising *B. decumbens* pastures.

CONCLUSION

Tropical pastures can be used to a fuller advantage to provide greater cost effectiveness in the feeding of ruminants through critically managing and utilising them with emphasis on proper nitrogen fertiliser use to increase forage yield and quality and higher frequency of defoliation to take advantage of younger, better quality and more palatable forage. With sheep, another advantage of earlier defoliation is the provision of shorter sward to suit their grazing habit. This is now possible with the robust, persistent, aggressive, nitrogen responsive and greater drought-tolerant stoloniferous and rhizomatous species being cultivated. Thus, the general perception that tropical pastures have a weakness in their quality and palatability may not be true anymore as this can now be overcome through critical management and utilisation. For the latter to be successful, however, there is also a great need to look at problems that exist in the field including availability of resources and variable agro-climatic conditions.

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PRODUCTION AND UTILISATION OF UREA-MOLASSES MINERAL BLOCK IN THE PHILIPPINES

Hemando F. Avilla[1]

SUMMARY
The development of urea-molasses mineral block technology (UMMB) in the Philippines and the use of UMMB in Mt. Pinatubo affected areas were discussed. It also highlights significant researches on the technology and proves that the UMMB supplement has beneficial effects in improving the efficiency of livestock production. Efforts of the government on the technology transfer and adoption to attain sustainability were also described.

INTRODUCTION

The eruption of Mt. Pinatubo in 1991 brought severe damages to both people and livestock in the provinces of Bataan, Pampanga, Tarlac and Zambales. The massive ashfall and the subsequent lahar flow have covered vast areas of crop lands and have resulted in shortage of feed and fodders to livestock. As one of the emergency measures to save the livestock in the area, the Bureau of Animal Industry (BAI), produced and distributed UMMB in the affected areas. The Food and Agriculture Organization of the United Nations (FAO) saw this activity and granted BAI a financial assistance to mechanise its production, improve the formula and increase the production to cover wide areas of distribution to benefit many smallholder farmers in the affected area.

In the early eighties, several nutritional studies were conducted at Central Luzon State University (CLSU) which revealed that grasses particularly in Central Luzon areas were deficient in protein, energy, and in micro and macro elements needed for animal nourishment. During prolonged drought periods, both quantity and quality of grasses was affected. Similarly, during dry season (December to May), the protein content of grasses declines to as low as 3.5 percent and is not sufficient to meet the nutritional requirements of large and small ruminants. It was in this light where abundant and locally available feed resources were utilised in the development of technology on feed supplementation. Thus, the Urea-Molasses Mineral Block Technology for the Philippines was developed.

PRODUCTION, DISTRIBUTION AND UTILISATION OF UMMB

Composition of UMMB

The multi-nutrient block was formulated on the basis of availability and cost of local ingredients. The principal ingredients are rice bran and molasses. In general, rice bran which

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is the major component of the block is available in almost all parts of the country throughout the year. Molasses, a by-product from sugar factory is also available in all regions even if it is far away from the factory. Other ingredients like urea, salt, cement and minerals are commercially available.

The following formulations were developed by BAI based on the nutritional deficiencies of common grasses and traditional feeding practice of smallholding livestock farmers (Table 1). Table 2 shows the average chemical composition of the formulations.

Table 1. Composition of UMMB developed by BAI

Ingredients	Dry Season (December to May)	Wet Season (June to November)
	Part per 100 kg. mixture	
Molasses	40	40
Rice bran, D1	37.3	38.3
Urea (46-0-0)	8	6
Cement	9	10
Salt (Na Cl)	5	5
Tricalcium phosphate	0.5	0.5
Trace minerals**	0.2	0.2
**Zinc sulfate (Zn S04)	75 g	75 g
Potassium iodide (KI)	50 g	50 g
Copper sulfate	75 g	75 g

Table 2. Nutrient composition of blocks

Nutrients	Proximate analysis (%)
Crude Protein	23.0
Crude Fiber	6.0
Ash	24.0
Calcium	4.5
Phosphorus	2.0
Zinc	195 ppm
Copper	175 ppm
Iodine	trace
Moisture	NMT 13%

Production and distribution

The UMMBs were distributed as a supplement to relief feeding operations in the affected areas. Mass production of the blocks was undertaken by BAI at Diliman, Quezon City. The site for production was selected in consideration of the proximity from the suppliers of ingredients and the availability of work area and storage. Blocks were then hauled by trucks and distributed to farmers raising livestock affected by Mt. Pinatubo in the provinces of Pampanga, Bataan, Tarlac and Zambales.

There were more than 5,000 animals owned by more than 3,000 farmers in the four affected provinces. Nearly 70,000 blocks were produced and distributed to these farmers.

Technology transfer and adoption

Training and extension

Training and extension works were simultaneously undertaken by the project staff to promote the UMMB technology. Agricultural technologists, members of cooperatives, ranchers other livestock raisers were trained on the aspect of production and utilisation of blocks. During the training each participant was given instructional materials and handouts about the importance and uses of the supplement.

A total of 208 farmers belonging to 9 cooperatives were trained on the aspects of UMMB production and utilisation. Of the 9 cooperatives three adopted the technology (Table 3). These cooperatives are now engaged in commercial producdon to serve their members.

Table 3. Number of cooperatives trained and participants, by region

Region	No. of Cooperatives	No. of participants
Luzon	5*	100
Visayas	2	68
Mindanao	2**	40
Total	9	208

*Two cooperatives are now engaged in commercial production of block
**One cooperative adopted the technology

Technology Transfer

After the farmers were taught on the importance and uses of supplement, they were also informed that the relief assistance is only temporary. They were encouraged to produce their own blocks through the cooperatives or farmers' groups.

Technology transfer activity of the project also included farmer-members of selected dairy cooperatives in Luzon and Mindanao. Demonstrations were also conducted for members of ranchers association and cooperatives in the Visayan region.

ANIMAL PERFORMANCE AND OTHER OBSERVATIONS ON THE USE OF BLOCKS

Methods employed by farmers in giving UMMB

Table 4 shows the methodologies employed by farmers in feeding the blocks to their animals. Personal interviews conducted among 100 farmers who had used the blocks showed that 90 percent of them used an improvised wooden case (size to fit the block) placed adjacent to the feeding trough and the animals were allowed to conveniently lick on.

On the other hand, five (5) percent of them chopped the blocks into small pieces and then dissolved in drinking water while 3 percent used plastic container, size to fit the head of the animals. Hanging the blocks with rope over the hay rack was pracdsed by 2 percent of the farmers interviewed.

Table 4. Methodologies used by farmers in feeding the blocks

Methodologies	Number of farmers reporting
Used improvised wooden	90
Chopped the blocks	5
Used plastic container	3
Hanged the blocks	2
Total	100

Feedback on the use of UMMB

At the height of the distribution of blocks, feedback on the effects of the supplement was gathered from farmers and agricultural technologists. Notable improvement of the body condition of the animals, improved meat and milk production, improved animal reproduction, increased feed and water intake and improved draft power were among the feedback received (Table 5).

Table 5. Feedback on the Use of UMMB

Feedback	Number of farmers reporting
Improved body condition	60
Improve draft power	25
Improved reproduction	9
Increased milk yield	6
Total	100

Feeding trials were conducted by the Philippine Carabao Research and Development Center (PCRDC) to determine the effect of UMMB on weight gain, feed intake and digestibility of both cattle and carabaos. The trials involved various animal age groups and different schemes both for grazing and tethered animals to develop a practical feeding system under range condition.

Another study was conducted by BAI on growing calves using the formula it has developed. There were 10 growing cattle with an initial weight that ranged from 172.6 to 180.2 kg were used in the grazing trial. The animals were divided into two treatments with 5 replications. Both groups were allowed to graze for eight hours and resumed to night shed in the afternoon. Experimental animals were allowed to lick the supplement. Experimental animals showed a significant increase in average daily gain (Table 6).

Table 6. Performance of growing cattle with and without UMMB during dry season

Treatment	Ave. Iiveweight Initial (kg.)	Total liveweight gain (kg.)	Ave. daily gain (g)
Grazing	180.2	23.4	195
Grazing + UMMB	172.6	66.8	556 **

** Highly significant

A grazing trial to determine the effect of UMMB on the growth performance of growing buffaloes was reported by Aquino et al. in 1984. Supplementation of UMMB along with urea-treated themeda hay when fed to 6-12 month old carabaos resulted in significantly higher in average daily gains (ADO) compared to other treatments applied to both age groups. The increase in ADG through supplementation were 9.45 % and 2.10% in the 6-12 and 12-24 months old, respectively. Similar findings were reported in their previous study where supplementary UMMB and concentrate feeding resulted in a significant increase in ADG of caraheifers and caracows during dry season.

Another grazing experiment to determine the effect of UMMB with supplementary concentrate on grazing caracows during wet season was conducted by Neric et al. in 1984. The average daily matter intake of grazing caracows without supplementation was significantly lower ($P<0.05$) than the treated groups. The animals were given concentrates and UMMB supplementation at the rate of 1.70 percent of the body weight. Supplementation with rice bran on damage paddy improved the weight gain by 14 and 15 percent, respectively. Addition of UMMB as supplement increased the daily gain by 20.8 percent and 21.7 percent, respectively.

A follow-up study conducted by Neric et al. (1984) revealed that supplementation increased the dry matter intake particularly in group receiving rice bran + UMMB (2.35% BOO). A slight increase in average daily gain of the supplemented group was also noted over the control.

In another feeding trial conducted by the Bureau of Animal Industry to Holstein X Sahiwal cows indicated that supplementation of UMMB increased the milk yield of cows by 21%.

PROSPECT OF THE TECHNOLOGY IN THE PHILIPPINES

Technology is ready for adoption

The UMMB technology is now available for adoption. Based on several feeding trials conducted in the country, it brought beneficial effects to animals in terms of improved weight gains, increased meat and milk production, improved draft power and reproduction. In addition, it will help improve existing traditional practices of feeding animals to ensure better and efficient animal production.

Market

There is a potential market for the block considering the growing demand for blocks by many users as evidenced by the several inquiries and purchases from the BAI. Cooperatives engaged in block production can also have an access for market expansion.

Resources

Feed ingredients like rice bran and molasses from the by products of rice milling and sugar factories. Other ingredients are also commercially available.

Equipment needed for the production of blocks is so simple and low cost that it can be fabricated locally.

Labour is also available and the process involved in the manufacture can be easily adopted.

CONCLUSION AND RECOMMENDATION

Considering the abundant, cheap and locally available ingredients for the production of blocks, the beneficial effects on improving the productivity of animals and the growing demand for the supplement, there is a potential that the technology will attain its sustainability. It has been proven that the block is a handy supplement that can be immediately given to animals in the event of calamities where availability of feeds and grasses for animals are affected. Concerned agencies, both government and private must work hard together to ensure sustainability. Technology promotion through training and information dissemination should be supported further by the concerned agencies to enhanced its adoption.

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FODDER TREE SUPPLEMENTATION FOR BEEF CATTLE ON IMPROVED GRASSES

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SUMMARY
A field experiment was conducted to compare liveweight gains of Kedah-Kelantan cattle rotationally grazed on *Setaria sphacelata* var splendida pastures with and without supplementation of leaves of *Leucaena leucocephala* and *Gliricidia sepium*. In the first five months when grass on offer was limited, the supplemented animals attained an average daily gain (ADO) of 562 g/head which was significantly greater than the control (433 g/ head). Both groups received an additional supplement of 1 kg PKC per head daily. When animals had access to a bigger grazing area and grass on offer was not limiting, the supplemented group hardly consumed the leguminous fodder and liveweight gains between the two groups were not significantly different. Results indicate that animals have a preference for the grazed grass rather than the leguminous fodder.

INTRODUCTION
Fodder trees have been extensively used in feeding of ruminants in Southeast Asia. Leguminous fodder trees such as leucaena (*Leucaena leucocephala*) provide protein supplementation for cattle on native pastures in the Philippines, Indonesia and Malaysia. In regions where the dry periods extend for more than two months, fodder trees are used for drought feeding where their deeper root system enables green foliage to be retained longer than the shallower-rooted grasses. In most instances fodder trees are used in conjunction with native or naturalised grasses whose feeding value is constrained by low protein and digestible energy. Whether animals grazing on improved grasses will benefit from supplementation from fodder tree leaves has not received enough attention. This experiment was conducted to assess the consumption and performance of local Kedah-Kelantan cattle grazed on nitrogen-fertilized Splendida setaria (*Setaria sphacelata* var splendida) when they were offered leaves of leucaena and gliricidia (*Gliricidia sepium*).

MATERIALS AND METHODS
A trial was carried out at the UPM's Department of Animal Science Research Farm beginning in April 1994. An area which had previously been established with Splendida setaria was divided into four paddocks of equal size of 0.1 ha. The pasture received 200 kg ha-' yr' of nitrogen in four split applications. Eight newly-weaned male calves (6-8 months old) raised at the University Farm were introduced to the area about two months from the beginning of the trial. The calves were of the local Kedah-Kelantan breed and initial live weight ranged from 113 to 175 kg. They were divided into two roughly equal groups based on liveweight. Due to various reasons one animal from each group had to be discarded leaving only three animals per group.

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Feeding
Both groups of animals were rotated between two paddocks at 4-weekly intervals. The effective stocking rate was 15 animals/ha. Besides grazing, both groups were given a daily supplement of palm kemel cake (PKC3 at the rate of I kg per animal. The PKC was placed in a common feed tray located at one end of the paddock at about 11.00 am. With the high stocking rate imposed, the available pasture could provide enough feed for the animals during the first week that they were brought into the paddock. To augment the forage needs, *Splendida setaria* from an adjacent paddock was cut daily and fed to the animals after the first week. The control group was supplemented with about 40-50 kg of fresh grass daily while the supplemented group had one-third of the cut fodder in the form of leaves of leucaena or gliricidia alternately. This feeding regime was continued for 5 months until 8 August 1994. Subsequently two new paddocks, each of size 0.4 ha were fenced up to provide extra grazing resources for the animal. The effective stocking rate was reduced to 5 animals/ha and this obviated the need to cut grasses to provide enough forage. The supplemented group was still offered a daily supply of leucaena and gliricidia leaves.

Measurements
The animals were weighed at monthly intervals. Pasture growth and consumption was monitored in the grazed paddocks using the caged-quadrat method ('t Mannetje, 1978). Three caged quadrats measuring lm x lm were used for each paddock and at the beginning of a grazing cycle 3 samples of grass on offer were taken adjacent to each of the caged quadrat. At the end of a grazing cycle, herbage within and outside the caged-quadrats were harvested and these data together with the herbage yield taken initially gave an estimate of pasture growth and intake.

RESULTS AND DISCUSSION

Weather parameters
Rainfall data followed the normal pattem of two annual peaks as shown in Figure 1. The animals were brought in during a relatively wet period of the year. From then on rainfall declined to a trough in July followed by a steady increase towards November. Total annual rainfall for the year was 2292 mm which was normal for the area. Mean maximum and minimum temperatures did not vary more than 2^{o}C between months, reflecting typical humid equatorial climate.

Pasture growth and intake from grazing
Using the exclusion technique, pasture growth during the period of the trial is as shown in Table 1. The yield reduction during June-July can be attributed to the dry weather in July. Otherwise there does not appear to be any meaningful relationship between the amount of pasture growth and climatic variables. The intake of pasture for the first 3 months was around 3 kg DM/head/day but in the 4th month it declined to about 0.53 kg DM~ead/day, reflecting mainly the low pasture growth rate during that period (Table 1).

Nutritive value of the grazed pastures was monitored each time that pasture samples were taken. Table 2 shows the concentration of crude protein and neutral and acid detergent fibre of Splendida setaria during various periods of the trial.

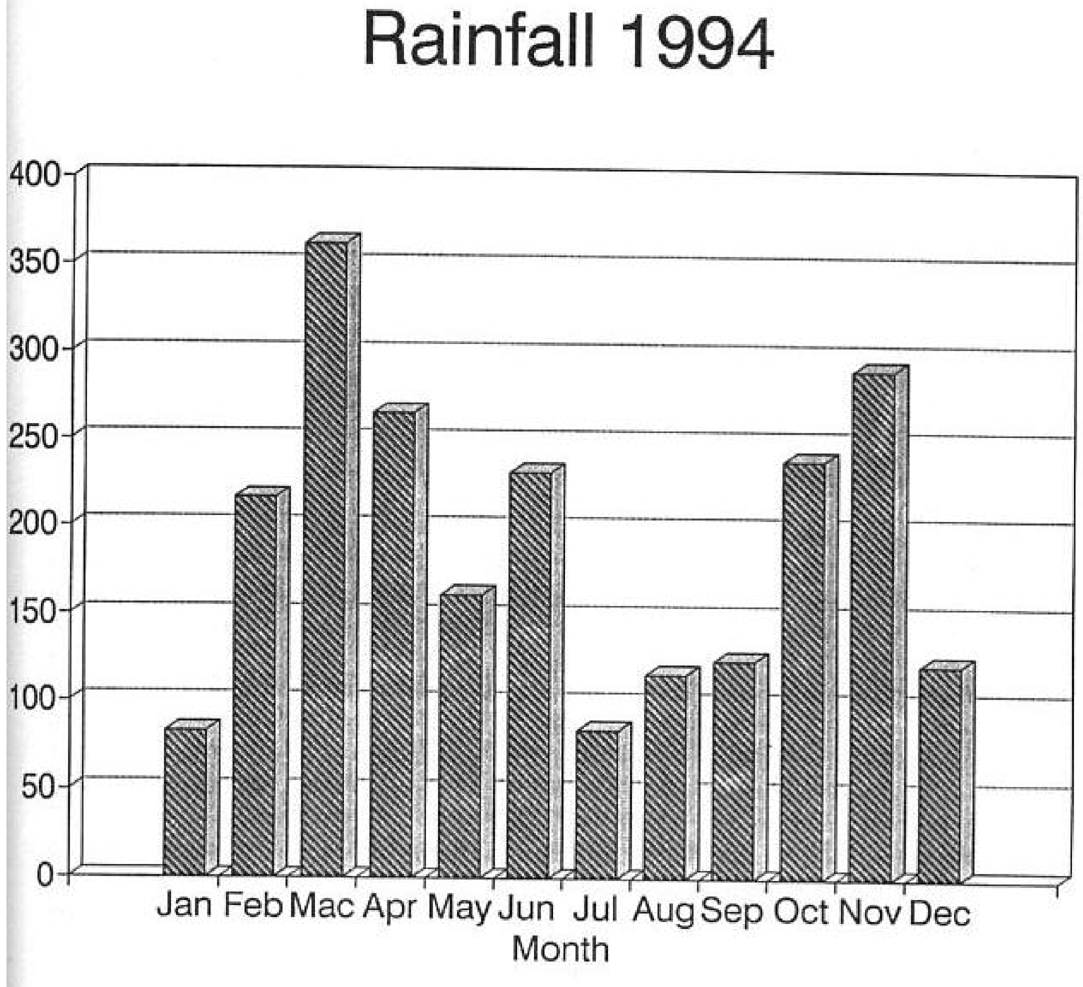

Fig. 1. Monthly rainfall (mm) and mean monthly maximum and minimum temperatures recorded for the year 1994

Table 1. Growth rate and intake of Spendida setaria at different periods

Period	Growth kg /ha DM	Intake kg DM/head/day	Intake g DM/kg LW^{075}
9 March - 8 April	1974	2.88	66.6
8 April - 9 May	1819	3.07	64.4
9 May - 9 June	2994	3.19	63.3
14 June - 7 July	3471	2.75	48.2
	Total = 10953	Mean = 2.48	Mean = 50.5

Table 2. Crude protein and fibre concentrations in grazed grasses

Period	Crude Protein g/kg (DM)	NDF g/kg (DM)	ADF g/kg (DM)
9 March - 8 April	95.5	722.8	384.2
8 April - 9 May	121.6	681.3	401.7
9 May - 9 June	130.2	746.7	401.1
14 June - 7 July	126.3	716.8	386.6
8 July - 8 August	113.6	740.5	396.8
Mean	117.4	721.6	394.1

Supplemented fodder

To make up for the low available dry matter under the high stocking density, cut fodder grasses from adjacent paddocks of Splendida setaria were supplemented. This was done usually after a week of the animals being moved to a new paddock when available forage becomes limiting. The amount of fodder given daily and the number of days that cut fodder was provided are shown in Table 3. The animals consumed about 92-95% of the herbage offered. The group which were supplemented with fodder tree leaves consumed almost all the leafy parts leaving only the larger stems and twigs. This group showed equal preference for grass and legume leaves and there was no obvious difference between the intake of gliricidia and leucaena. Crude protein concentration in leucaena and gliricidia were 282.2 and 264.8 glkg DM respectively. This feeding practice was continued from April up to 8 August after which animals had access to an extra 0.4 ha of Splendida setaria for grazing. The supply of cut grasses was terminated but PKC was provided at the same rate. One group was offered 15 kg of fresh leucaena or gliricidia daily, but because of the ample feed supply, the animals hardly consumed the fodder tree leaves.

Animal liveweight gains

Table 4 and Figure 2 show the liveweight changes of the two groups of animals and their average daily gains (ADG) in g/head. From April to August, mean ADG for the supplemented group (562 g/head) was significantly greater than that of the control (433 g/head) ($P<0.05$). This difference in animal performance can largely be attributed to the higher nutritive value of leguminous fodder tree leaves especially in nitrogen content compared to the grass.

Table 3. Cut fodder (fresh weight kg/day) given to the groups of animals at various periods:

Period	Duration (days)	Control (Grass only)	Supplemented	
			Grass	Fodder legume
19 Feb-8 March	18	37.3	35.0	-
22 March-9 Apri	19	40.7	40.4	-
21 Apr-9 May	18	41.9	32.9	11.3
19 May-8 June	20	39.5	24.9	11.7
16 June-8 July	22	46.3	45.5	12.6
17 July-8 Aug	23	43.3	47.6	13.1

Table 4. Animal live weight changes for the control and supplemented group

Animal No. Supplemented	9 Apr	9 May	9 Jun	8 Jul	8 Aug	9 Sep	8 Oct	ADG g/head (Apr-Aug)	ADG g/head (Aug-Oct)
1	113.0	131.0	146.5	161.0	180.0	194.0	205.0	553.7	409.8
2	174.0	199.0	211.0	229.0	241.0	251.0	265.0	553.7	393.4
3	168.0	188.0	201.0	217.0	238.0	246.0	257.0	578.5	311.5
Mean	151.7	172.7	186.2	202.3	219.7	230.3	242.3	562.0	371.6
Control									
1	173.0	185.0	199.0	214.0	226.0	242.0	261.0	438.0	574.0
2	175.0	184.0	192.0	198.0	220.0	230.0	241.0	371.9	344.0
3	157.0	171.0	180.0	208.0	216.0	227.0	245.0	487.6	475.0
Mean	168.3	180.0	190.3	206.7	220.7	233.0	249.0	432.5	464.3

After the fifth weighing on 8 August 1994, two new paddocks, each of 0.4 ha were made available for grazing, thus reducing stocking rate to 5 animals/ha. With the low grazing pressure and greater forage-on-offer the animals were not attracted to consume the fodder tree leaves provided daily to them. The PKC supplement was still readily accepted by both groups of animals. This shows animals had a preference for grazing grass under conditions of ample feed while the fodder tree leaves was consumed only when grass became limiting.

Mean ADG of the two groups of animals was not significantly different in the 61 days following the opening up of new paddocks (372 and 464 g/head for the supplemented and control, respectively). Mean ADG for the supplemented group after the opening the new paddock declined from 562 g/head to 372 g/head. In contrast the mean ADG for the control group was not significantly different between the two periods (433 vs 464 g/head).
Animal growth rates in our experiment was higher than that reported by Sukri *et al.*

(1990) for Kedah Kelantan calves given calf feeder rations (132 g/kg crude protein) where ADG of 380 g/head was achieved. Similarly animal performance was better than that

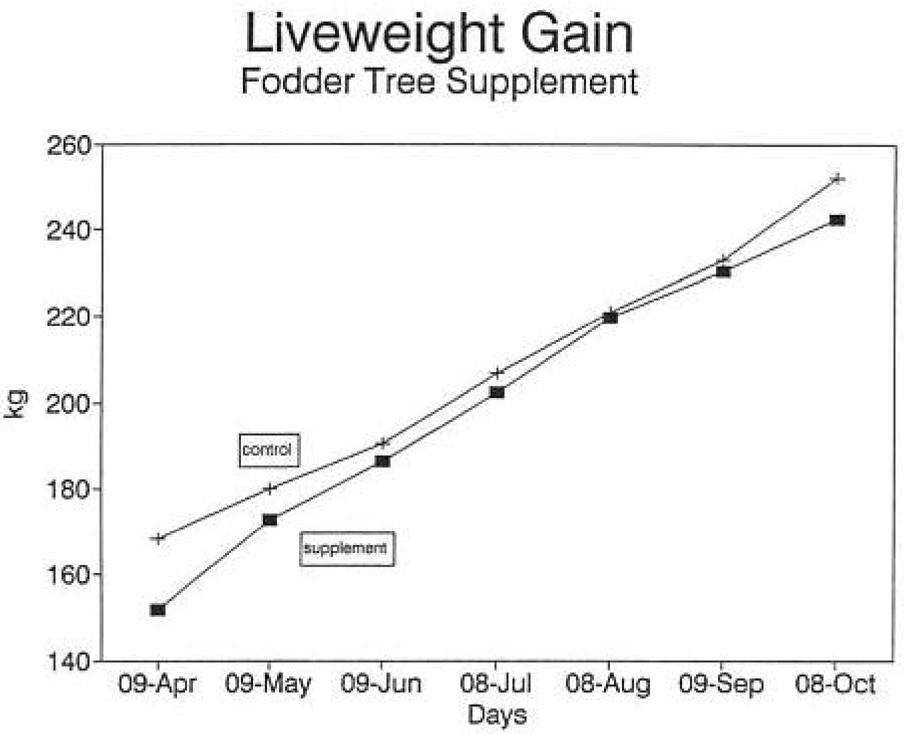

Fig. 2. The liveweight changes of Kedah-Kelantan cattle fed with cut grass and supplemented with and without control fodder tree leaves

obtained by Izham *et al*. (1984) where Kedah-Kelantan cattle were grazed on a mixed *Brachiaria decumbens*/leucaena pastures. Animals within the same age group as in the current trial maintained an ADG of about 325 g/head compared to the 562 g obtained in our experiment. The supplementation with PKC may have contributed to the higher ADG attained. The same work also showed no significant difference in ADG between animals grazing pure grass pastures with that mixed with leucaena. This may be explained by the fact that forage on offer from the grasses was adequate to maintain animal growth and protein content in grasses was not limiting. In our experiment it was also shown that when grass supply was ample the animals preferred to graze the grass rather than consume the fodder tree leaves. On the other hand, Leng *et al*. (1992) quoted results of work done in Colombia which showed that supplementing cattle grazed on *Brachiaria decumbens* with gliricidia foliage increased ADG from 580 to 717 g/head while supplementing with urea/ molasses elevated ADG to 751 gthead. The higher growth rates obtained may be a reflection of the different breed of cattle used. Despite the beneficial effects of leguminous fodder trees its utilisation is constrained by the apparently lower palatability compared to the grazed grasses. Only when the availability of grass becomes limiting did the animals consume the legume foliage in substantial amounts. The use of PKC supplement in our experiment may also be the cause of the reluctance of animals to consume fodder tree leaves. The high protein content of PKC (180 - 240 g/kg DM) may adequately supply its protein requirements. Hamali (1993) showed that protein requirements for Kedah Kelantan cattle was 20% less than that recommended by the National Research Council. Results from our trials lend support to the contention that the primary role of leguminous fodder trees is in supplementing basal diets low in protein and energy especially under conditions of low pasture availability. This work is being continued for another season with a new set of animals.

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SHEEP PRODUCTION IN RICE-BASED FARMING SYSTEM WITH FODDER TREE SUPPLEMENTATION

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SUMMARY
The rice producing areas in the Philippines offer some potential for raising sheep. Progress of an on-going study in a rice farming village in Central Luzon is reported. Four farmer-cooperators were selected two of whom were required to use fodder trees as feed supplement. The study reveals that generally farmers raised sheep by tethering in roadsides, fallow lands, park and harvested ricefields in the area during the dry season. It also reveals that sheep raised in the traditional way with fodder tree supplementation had significantly higher average daily gains (ADO) of 74 grams in liveweight followed by the traditional practice (both had 53 grams) and those tethered in park had the lowest ADG of 24 grams. Likewise liveweight gain of sheep raised the traditional way plus fodder tree supplement continuously increased through out the observation period.

INTRODUCTION

Rice is the major agricultural crop grown in the Philippines. About 3.7 million ha are planted to rice, 60% of which is irrigated while 40% are rainfed. In 1994, unmilled rice production reached l0.5 M metric tons contributing P61.3 B or 15% of the P400.9 B gross earnings of the agricultural sector.

While crop production is the primary farming enterprise in the country, livestock raising serves as an auxiliary activity to crop production. About 90% of livestock population are in the hands of the smallholders where adequate supply of high quality forage is a common problem. In the rice-growing regions of the country for example, animals subsist mainly on rice straw and other weed species particularly during the crop growing season and on rice stubbles and other crop residues during the dry season. The supplement the available feeds in smallholder rice-based farms, the utilization of fodder trees should be considered. In addition to the present standing trees found in roadsides and homeplots, additional fodder trees could be planted in backyard and a year round supply of high quality forage can be obtained.

Raising of small ruminants is now getting popular among smallholders due to the relatively lower capital investment and risk involved as compared to cattle. Goat and sheep can also be easily attended to by women and children.

This paper examines the prospects and limitations of integrating sheep into the ricebased farming system in a Philippine village.

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SMALL RUMINANT PRODUCTION IN RICE-BASED FARMING SYSTEM

Native or indigenous grass species growing on bunds and in backyard and vacant areas are the major feeds for ruminants in rice-based farming system. Feed supply is usually scarce during the rice growing period while rice stubbles are used after harvest. Research had been conducted to increase biomass and improve quality of feeds through forage crop integration and utilization of fodder tree as supplement to rice straw feeding.

A. Forage Crops Integration

In rice growing areas, levees/bunds comprise about 5-10% of the total land rice area and is the major source of feed during the wet season. Feeds found in bunds are indigenous species of grasses which are generally low in both quantity and quality.

Desmanthus (*Desmanthus virgatus* (L.) Willd.) a forage legume species can be used to improve the quality of available feeds in rice-based farming system. Tengco et al. (1990) revealed that it can be used to replace the native grasses in bunds without affecting the rice crop. When cut at 45 days interval desmanthus had a CP of 14.25% which is far more nutritious than the native forages. Likewise, among the 7 forage grasses and legumes tested it obtained the highest forage yield of about 1.37 t DM/ year assuming that 7% of the area is occupied by bunds. In addition, the same authors claimed that desmanthus when fed to goats at 1% level of supplementation to grasses could attain an ADG of 36.16 grams. Similarly, Battad et al. (1990) demonstrated that when supplemented at o.5 and I % of the goats body weight, higher ADG could be obtained than those with concentrate supplementation.

Weeds gathered from rice fields during the growing period of rice are likewise given to ruminants. Approximately 29 kg dry matter per day can be collected from lowland irrigated rice fields during the juvenile stage of rice growing (Furoc and Javier 1975). In their subsequent study they demonstrated planting of paragrass (*Brachiaria mutica*) in marginal areas on the same field condition and obtained a high herbage yield of 24 tons DMlha/year.

Intercropping grain and forage legumes was also found to be a better way to improve quality and quantity of feeds. Tengco et al. (1991) revealed that Siratro (*Macroptilium atropurpureum*) when intercropped to mungbean would not affect the latter's grain yield. Moreover, higher rice yield was obtained than from the monocropped legume plots and fallow treatment.

B. Rice straw feeding to small ruminants

Rice straw is the main feedstuff given to cattle and carabaos in rice-based farms. However, due to its poor quality, supplementation is necessary. Studies along this line specifically using fodder trees as supplements were conducted by Sevilla et al. (1976) and Marbella et al. (1981) for cattle and carabaos by Acasio and Victorio-Espaldon (1991). However, in terms of small ruminants production only few studies were conducted.

Although low in quality comparable liveweight gain was obtained from feeding rice straw to goats with 20% and 24% crude protein concentrate with that of feeding Napier and 24% crude protein concentrate. Likewise, better liveweight performance was observed by Lapuz (1982) on goats fed with rice straw and urea-molasses supplementation than those without.

A cheap alternative for supplementation is the use of fodder trees. Fodder trees are usually planted for fuel wood, fence lines, wind breaks, to serve as shade and in some instances as animal feeds. They are important sources of feeds in most farming systems during the dry season. However, it is equally important during the wet season in the rice-based farming system. The value of fodder tree supplementation to breeding goats had been demonstrated by Faylon (1981). In terms of liveweight performance Rasjid and Perez (1982) revealed that an ADG of 35.7 g could be obtained by goats fed with 30% rice straw and 70% dried Ipil-ipil leaves. Furthermore, a higher 68.6 g could be obtained by goats fed with 30% rice straw, 50% dried Ipilipil leaves and 20% molasses.

SHEEP PRODUCTION IN RICE-BASED FARMING SYSTEM WITH FODDER TREE SUPPLEMENTATION

It was observed that the above-mentioned research done on fodder tree supplementation was on raising goats under feedlot system and to evaluate the farmer's way of raising small ruminants in an on-farm trial is being conducted on sheep production in a village with lowland rice environment in Central Luzon. The climate belongs to Type I which is characterized by two pronounced seasons; dry from November to April and wet during the rest of the year.
Cattle, carabaos and goats are raised by fammers in the area. None so far had sheep. Carabaos are raised for draft purposes while cattle and goats serve as living banks wherein fammers sell them only in times of needs.

The main feedstuff given to large ruminants is rice straw obtained from their harvested crop and stacked for feeding during the rice growing period. In order to have enough rice straw to meet the requirements of cattle and carabao some farmers assist fellow fammers in harvesting and threshing rice (manual method) without cash payment instead they got all the straw from the quantity of rice they harvested.

During rice growing period native/indigenous species are likewise given.

Unlike in the southem part of Luzon specifically in Batangas, farmers in the area are not aware on the use of fodder trees for ruminant feeding. Very few fammers give fodder trees to ruminants and they feed them only when they cut the trees for fuelwood.

To demonstrate the use of fodder tree as supplement in rice-based famming system, four farmer-cooperators were selected, two of whom were required to supplement fodder trees to their traditional feeding practice. Three heads sheep were distributed to each farmer-cooperator to serve as experimental animals.

Feeding management and feed resources. All farmer-cooperators practised semiconfinement system wherein they tether the sheep on roadsides, rice fields, fallow lands and even in park in the moming and get them back in the aftemoon. It was observed that the 4 cooperators had different management/feeding practice (Figure 1).

Farmer A tethered his sheep in a park and he supplements them with 0.35 kg fresh Leucaena leaves and grasses altemately during the first one month of the trial. However, during the rice harvest period (mid-October to mid-December), no supplementation was

Figure 1. Feeding scheme of sheep practiced by Farmer A & B during the dry season in Tarlac

A. Management	OCT.	NOV.	DEC.	JAN.	FEB.
1. Tethering					
Rice fields					
Roadsides					
Fallow lands					
Park	-----------	-----------	-----------	-----------	-----------
2. Confinement					
B. Supplemental Feeding					
1. Fodder trees					
Leucaena	-----------				-----------
Gliricidia					
Bauhinia					
2. Grasses	-----------			-----------	-----------
3. Other species					
Banana					-----------
4. Crop residues					
Rice straw					

Farmer A

A. Management	OCT.	NOV.	DEC.	JAN.	FEB.
1. Tethering					
Rice fields		-----------	-----------	-----------	-----------
Roadsides					
Fallowlands	-----------				
Park					
2. Confinement					
B. Supplemental Feeding					
1. Fodder trees					
Leucaena					
Gliricidia					
Bauhinia					
2. Grasses	-----------				
3. Other species					
Banana					
4. Crop residues					
Rice straw	-----------				
Peanut hay					-----------

Farmer B

continued

continuation of Figure 1

A. Management	OCT.	NOV.	DEC.	JAN.	FEB.
2. Tethering					
Rice fields		-----------	-----------	-----------	-----------
Roadsides					
Fallow lands					
Park					
2. Confinement	-----------				
B. Supplemental Feeding					
1. Fodder trees					
Leucaena					
Gliricidia					
Bauhinia					
3. Grasses					
3. Other species					
Banana					
4. Crop residues					
Rice straw					

Farmer C

A. Management	OCT.	NOV.	DEC.	JAN.	FEB.
1. Tethering					
Rice fields		-----------	-----------	-----------	-----------
Roadsides	-----------				
Fallowlands					
Park					
2. Confinement					
B. Supplemental Feeding					
1. Fodder trees					
Leucaena	-----------	-----------	-----------	-----------	-----------
Gliricidia	-----------			-----------	-----------
Bauhinia		-----------	-----------		
2. Grasses	-----------			-----------	-----------
3. Other species					
Banana					
4. Crop residues					
Rice straw					
Peanut hay					

Farmer D

done after which supplementation of Leucaena and grasses was resumed. This might be due to the fact that the farmer was busy in the field. In one instance banana leaves was given to sheep as supplement.

Farmer B tethered sheep together with his goats in fallow lands during the rice growing period and after rice harvest sheep were tethered in rice fields. Grasses were likewise given as supplement and at 2 occasions farmer B gave crop residues (rice straw and peanut hay) to his sheep.

Farmer C used to feed the sheep with weeds (average of 4.6 kg FW/head/day) during the rice growing season, and later in harvested rice fields.

Farmer D tethered his sheep in roadsides during rice growing period and then in harvested rice fields. Fodder tree supplementation is being practised. However, it can be observed that he even supplemented weeds alternately with fodder trees (Leucaena, Gliricidia or Bauhinia).

Liveweight performance . The liveweight performance of sheep is shown in Table 1. It can be observed that for the 166-day period sheep raised in the traditional way with fodder tree supplementation had the highest liveweight and average daily gains of 11.35 kg and 74 g, respectively which is significantly higher than those animals without supplementation. On the other hand, sheep tethered in park with fresh Leucaena supplementation have an ADG of 24g.

Table 1. Mean liveweight performance of sheep in rice-based farming system (Oct. 1994 to Feb. 1995)

Farmer-Cooperator	Initial Weight (Kg)	LWG (Kg)	ADG (Grams)
A	11.8	3.63	24
B	10.3	8.10	53
C	12.5	8.17	53
D	14.1	11.35	74

Figure 2 shows the cumulative liveweight gain for 5 months of the experimental sheep. It can be observed that except for Farmer D all other sheep decreased liveweight gain during the month of December. This may be due to the fact that rice harvest was done mid October up to November. Hence rice stubbles were available in the field but during the later part of November mungbean and peanut were planted after rice to use the residual soil moisture. During this time feeds become limited.

The contribution of fodder tree supplementation in the case of Farmer A became evident during the months of November and December. It can be noted that he did not feed his sheep with fodder trees and there was a tremendous decline in the liveweight gain.

A decline was likewise observed during the month of February, at this time rice stubbles and other crop residues (mungbean hay in particular) were drying up.

It is worthy to note that sheep raised by Farmer D (with fodder tree supplementation) shows an increasing liveweight gain all throughout the observation period and this is attributed to the supplementation wherein during the month of December he increased his supplement-

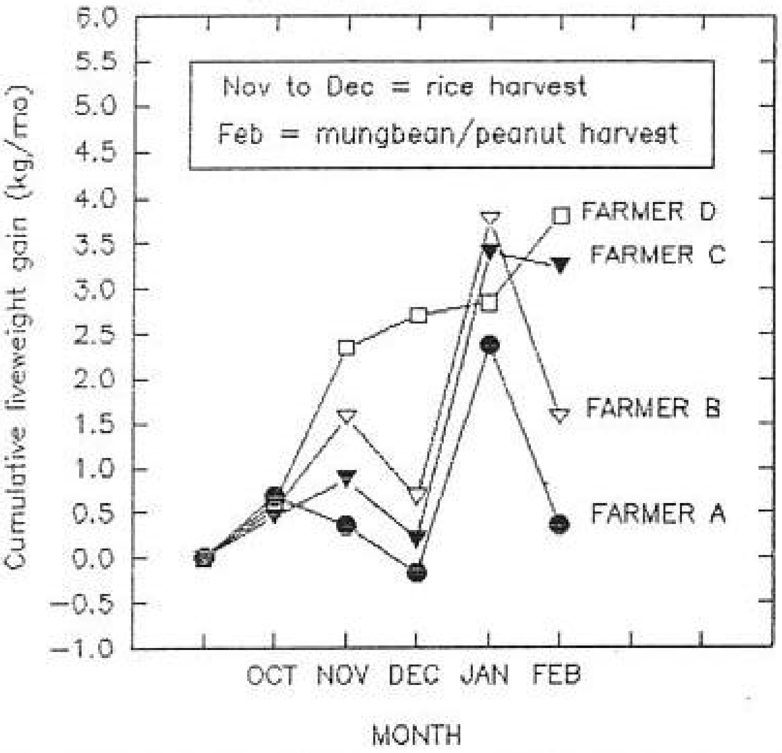

Fig. 2. Monthly cummulative liveweight gain of sheep for five-month period

ation from 0.33 kg/head/day at the first 2 months of the experiment to an average weight of 1.5 kg/head/day fresh fodder trees.

SUMMARY AND CONCLUSION

In rice-based farming system, raising of large ruminants is not commonly practiced as feed supply is limited and fear of crop destruction and source of stock posed problems. Nevertheless, sheep production has great potential as mutton is becoming a popular dish in the Philippines.

In a village in Tarlac, initial study shows that raising of sheep has very bright prospects due to the following reasons:

1. available family labor wherein children and women take charge of tethering and gathering feeds in their own backyard.
2. sheep are less destructive to crops than goats.
3. market is not a problem as mutton is becoming a favorite dish.
4. presence of fodder trees and initial awareness of farmers on its feeding value.

On the other hand sheep raising would compete for the available feeds being given to cattle and carabaos particularly the weeds.

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GROWING *PENNISETUM PURPUREUM* AND *PANICUM MAXIMUM* 1.429 ON GREY PODZOLIC SOILS IN THE SOUTHEAST REGION OF VIETNAM

Dinh Huynh[1]

SUMMARY
The Southeast Region of Vietnam has over l million hectares of grey podzolic soil, which is suitable to grow grasses and legumes for cattle and buffalo production. Pennisetum purpureurn and Panicurn maximum 1.429 were introduced and have been grown under experiments for several years. After a period of time, these two grasses adapted well to the poor nutrient grey podzolic soil area with 6 month dry season. However, the productivity and quality of these two grasses were still rather low (70-l00 tons/ha/year with 9-10% crude protein). Intensive production involving high density planting (50 x 30 cm); basal fertilizer application (20-30 tons manure plus 80 kg K_2O and 80 kg P_2O_5/ha), top dressing application after each cutting (l00 N/ha), irrigation in dry season (two-day frequency)and adequate cutting time (3045 days) was undertaken. During the first two years, yields as high as 300-400 tons of green forage/ha/year from 8-l0 cuttings/year were obtained.

INTRODUCTION

Geographic information

The southeast region of Vietnam consists of 5 provinces, namely Tay Ninh, Song Be, Dong Nai, Ba Ria-Vung Tau and Ho Chin Minh city. This area has high potential for the development of ruminant livestock production.

The region shares the same borders with Cambodia to the west and the north, the highlands and southern central area to the east, and the Mekong Delta and South China Sea to the south.

Topography and pedology

The southeast region has a total area of 2,347,500 ha; of which 771,000 ha is used for agricultural production (Table 1). Podzolic soil is the main soil group for pasture cultivation in the Southeast Region. Podzolic soil is grey or yellowish grey in color, a light texture (mainly sandy) and a massive structure. This water holding capacity, cation exchange capacity and nitrogen content are rather low, and potassium content is on average. Physicochemical properties of this soil group are described in Table 2.

Buffalo and cattle population

[1] Department of Feedstuffs and Animal Nutrition, Institute of Agricultural Sciences of South Vietnam

Table 1. Distribution of cultivated areas in the Southeast region

Provinces	Total (ha)	Agricultural land (ha)	Forest land (ha)	Special use land (ha)	Other land (ha)
Ba Ria-Vung Tau	23,800	4,400	2,000	2,100	l5,300
Ho Chi Minh city	208,900	93,800	31,800	35,400	47,900
Tay Ninh	401,700	178,400	64,900	29,900	134,500
Dong Nai	758,500	292,400	266,800	45,900	153,400
Song Be	954,600	202,000	255,100	39,600	457,900

Source: Vietnam Agriculture and Food Industry (1992)

Table 2. Physico-chemical properties of grey podzolic soil

Location	Texture (%)			pH		Total (%)				Exchangeable (%)		
	Sand	Loam	Clay	H_2O	KC1	C	N	P_2O_5	K_2O	N	P	K
Go yap, Ho Chi Minh City	71.9	10.0	18.1	5.3	-	-	0.13	0.170	0.048	-	28.4	-
Ben Cat, Song Be	-	-	-	4.8	3.9	0.52	0.04	0.030	0.007	-	1.2	1.6
Long Thanh, Dong Nai	78.2	8.8	13.1	4.3	4.0	0.46	0.40	0.014	0.007	87.5	7.0	10.0

Table 3. Population of cattle and buffaloes in the Southeast Region of Vietnam

Provinces	Cattle			Buffaloes		
	Total	Draught	Reproductive	Total	Draught	Reproductive
Ba ria-Vung tau	19,865	10,873	992	2,373	1,273	1,100
Dong Nai	42,255	16,049	26,206	18,012	11,568	6,444
HCM city	40,394	8,511	31,883	29,837	18,346	11,491
Song Be	47,900	24,619	23,281	31,123	16,632	14,491
Tay Ninh	50,132	28,922	21,210	51,648	36,109	15,539

Source: Ministry of Agriculture and Food Industry (1993)

The total cattle and buffalo population in the southeast region are presented in Table 3.

Climate

There are two distinct seasons in the Southeast Region: the dry from November to April and the rainy season from May to October. The area received an average rainfall of 1726 mm, with an average temperature of 26.9°C and a relatively humidity of over 85%.

RESULTS

During 1977-1980, many varieties of *P. maximum* (wide leaf) had been introduced and planted under experimentation in both South and North Vietnam.

The experiment results reported by An, B.X. et al. (1977) on grey podzolic soil area of southeastern region showed that *P. maximum* K.184 and *P. maximum* 1.429 were suitable to grow for green forage cutting.

The experimental results conducted by Ky, N.D. et al. (1985) on the same kind of soil (Ben Cat, Song Be Province) also indicated that P. maximum G.23 and P. maximum 184 were very good to grow for cutting. The author stated that with the application of 5 tons manure, 60kg P_2O_5 and 120 kg K_2O/ha. P. maximum (wide leaf) gave 53.5 - 64.2 tons of green forage in 3 cuttings in the rainy season (Table 4).

Table 4. Fresh forage yield of Panicum maximum at Song Be buffalo and Forage Research Center

Varieties	Yield (tons/ha)			Annual yields (tons/ha/year)
	1st cutting	2^{nd} cutting	3^{rd} cutting	
P. maximum G.23	21.8	27.7	11.7	61.6
P. maximum cv. Hamil	13.8	15.0	17.2	46.0
P. maximum Liconi	17.4	25.0	11.2	53.5
P. maximum Australia	14.9	17.7	22.0	54.6
P. maximum cv. Makueni	16.0	21.8	20.8	58.5
P. maximum K.184	18.0	20.5	19.5	58.0
P. maximum 1.429	26.2	24.0	14.0	64.2

Source: Ky, N.D. et al (1980)

Many varieties of *Panicum maximum* (wide leaf) from CIAT had been planted under experiments (by Huynh, D. and Chau, L.H. 1990-1993) on grey podzolic soil area at Long Thanh district, Dong Nai province. The positive results showed that these varieties were high growing capacity, strong regenerating capacity, stable productivity, good resistance to drought in dry season.

Pennisetum purpureum from Taiwan had been experimentally planted (by Nhon, T. and Huynh, D. et al. before 1985) on grey podzolic soil of southeast region.

Fertilization was the limiting factor to high yield in all the above mentioned grasses planted on grey podzolic soil in rainy season. Therefore when manure and nitrogen were given at increasing levels, green forage, dry matter and nitrogen productivity of these grasses increased proportionally (Table 5).

In general, grey podzolic soil is very poor in nutrient and low in phosphorous (0.0030.004%). Thus increasing the high level of P_2O_5, could enhanced yields of P. purpureum varieties and P. maximum 1.429.

The authors proposed that for *P. purpureum* the rate of P_2O_5 should be 80 kg/ha when manure was supplied, and 120 kg P_2O_5/ha without manure application. For *P. maximum* (wide leaf) in monoculture gave a low protein content despite high yield. In order to increase the crude protein content of green forages, the mixed culture of *P. purpureum*, *P. maximum* and

Table 5. Effect of different manure and nitrogen levels on grass yield and quality

Grasses	Yield	Manure levels (tons/ha/year)				Nitrogen levels (kg/ha/cutting)			
		0	10	20	30	50	75	100	125
Pennisetum purpureum	Green forage (ton)	8.8	11.9	15.6	19.9	9.4	10.5	11.2	12.3
	Dry matter (tons)	1.9	2.4	3.2	4.0	1.9	2.0	2.2	2.4
	Total protein (kg)	197.7	271.9	402.8	501.3	201.0	245.2	271.7	326.7
Panicum maximum Hamil	Green forage (ton)	8.4	12.9	15.6	18.9	8.3	9.1	10.1	10.7
	Dry matter (tons)	2.3	3.3	3.9	4.8	2.3	2.4	2.8	2.9
	Total protein (kg)	263.9	452.9	560.4	680.7	303.1	335.4	404.7	414.5

Source: Huynh, D. and Chau, L.H. (1992b)

Table 6. Effect of cultivation methods of *P. purpureum, P. maximum* 1.429 and *S. hamata* at the rate of 1:1 in pure or mixed swards.

Grasses	Cultivation methods	Yield and quality			Legume rate (%)
		Green forage (tons/ha)	Dry matter (tons/ha)	Total protein (kg/ha	
P. purpureum	Mono culture	56.0	12.7	1467	
P. maximum 1.429		44.9	12.5	1507	
P. purpureum sp. + S. hamata	Mixed culture	56.0	14.5	1984	39.2
P. maximum 1.429 + S. hamata		47.7	13.7	1818	12.4

Source: Huynh, D. and Chau, L.H. (1992d)

Table 7. The yield of P. purpureum and P. maximum 1.429 cultivated at Go Vap district, Ho Chi Minh city (ton/ha/cutting)

Grasses	May	Jun	Jul	Aug	Nov	Dec	Jan	Feb	Mar	Apr	Total productivity (tons/year)
P. maximum 1.429	21.6	33.7	28.3	28.6	35.2	33.9	33.9	24.9	30.1	32.8	300
P. purpureum	17.7	25.5	26.4	32.1	33.5	31.3	35.5	35.5	38.5	-	275

Source: Huynh, D. (1994)

Stylosanthes hamata was particularly studied on grey podzolic soil in Song Be province (Table 6).

Table 6 shows that in the mixed culture (grasses and legumes), there was no significant different in the yield but the protein content increased to about 12-13%.

The results of Huynh, D. and Chau, L.H. (1993b) showed that the adequate interval cutting time to let the grasses express the highest productivity and quality was from 30 to 45 days of age (from 4 to 6 weeks).

The yield of these grasses (*P. purpureum sp.* and *P. maximum*) was recorded only in rainy season, but not through" the whole year.

Research results indicated that with enough fertilizer (organic and inorganic) and irrigation in the dry season (well water and piggery washing water), the P. purpureum and P. maximum 1.429 gave a high yield.

Results of Huynh, D. and Tho, C. (1980-1983) for experiments carried out in smallhouseholds at Thu Duc district, Ho Chi Minh city showed that in the intensive production, with a spacing density of 70 x 30 cm (47,000 hills/ha); irrigation with piggery washing water around the year (equivalent to 50 tons manure/ha/year); with a short period of cutting (21 days for 1 st year and 28 days for 2nd year), P. purpureum could give 450 tons in the first year and 368 tons in the second year.

The chemical composition of *P. purpureum* was; dry matter content; 8.73-9.17%; crude protein content: 16.79-17.52%; ether extract: 4.97-5.56%, phosphorous content: 0.59-0.82%; carotene; 250 mg/kg.

In the case of grasses cultivated in dairy small households with manure (20 ton/ha) and inorganic fertilizers (60 kgK_2O and 60 kg P_2O_5/ha), top dressing application after every cutting (100 N/ha) and well water irrigation, the yield of *P. purpureum* and *P. maximum* 1.429 was lower than that of grasses irrigated with piggery washing water (Table 7).

The authors noted that during the dry season when grasses were sufficiently irrigated (once every two days), *P. purpureum* and *P. maximum* 1.429 were growing fast, therefore, up to 60% of grass productivity was harvested in the dry season and the grass cost was only 40% of market price (80VND compared to 200VNDlkg).

In comparison to the extensive production, *P. purpureum* and *P. maximum* 1.429, the intensive cultivation form gave a much higher yield (70-100 tons compared to 300-400 tons/ha/year).

Until now, in the Southem Vietnam, there have been more than 10,000 dairy cows. The major part of the herd is raised in the Southeast Region. Therefore, a large amount of green forage is needed. To meet this requirement, a lot of dairy small households at Ho Chi Minh city, Dong Nai, Song Be begin to cultivate *P. purpureum* and *P. maximum* 1.429 intensively.

According to the survey data of Department of Feedstuffs and Animal Nutrition (1994), the yield of *P. purpureum* and *P. maximum* 1.429 in the intensive production could reach 290-310 tons/ha/year (with 8 cuttings) at dairy small households at Ho Chi Minh city, and it was 320-350 tons/ha/year (with 9 cuttings) in Dong Nai province.

The cultural practice comprised the followings:

1. Fertiliser application:
   Basal fertilization: 20-30 tons manure/ha, 80 kg K_2O, 80-120 kg P_2O_5/ha
   Top dressing application: l00N/ha/cutting
2. Planting density: 0.50 x 0.30m
3. Weeding: 2-3 times in the first and second cuttings

4. Irrigation in the dry season: once every two days
5. Harvesting: the first cutting at 45 days after growing; the next cuttings after every 30 days for *P. maximum* (wide leaf); - 45 day for *P. purpureum*
6. Planting time: in the beginning of rainy season (on May)

CONCLUSION AND RECOMMENDATIONS

P. purpureum and *P. maximum* 1.429 (wide leaf) were suitable grasses for extensive cultivation on poor nutrient grey podzolic soil of the Southeast Region to supply green forage for ruminant development. These species were suitable for cutting. Unfortunately, the low rainfall and limited fertilization reduced forage yield (70-100 tons/ha/year) in the extensive production area and the grass quality was not high because of high fibre and low crude protein content. During the dry season, grasses stopped growing due to the water stress resulting in no harvest. In recent years, intensive grass production is being practised in many provinces, particularly, in dairy small households at Ho Chi Minh city, Dong Nai, Song Be. The techniques developed in intensive production consist of high density planting (50x30 cm) with high basal fertilization (20-30 tons manure, 80 kg, K_2O, 80-120 kg P2O,/ ha/year), high top dressing application (l00kg N/ha/cutting), irrigation in dry season using well water once every two days and piggery waste water once every 4 days and cutting interval (35-45 days). With such an intensive production, yield of 300-400 tons/ha/year in 8-10 cuttings could be obtained.

The determination of appropriate legume in mixed culture with *P. purpureum* and *P. maximum* 1.429 in order to enhance the green forage quality and partly to improve the grey podzolic soil of southeast region is certainly needed in the future.

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Country Project Proposals

A) INDONESIA

PROJECT: FARM LEVEL SEED PRODUCTION OF A TOP PERFORMING *GLIRICIDIA SEPIUM* IN DRYLAND FARMING AREA IN BALI FROM I.M. NITIS [1]

INTRODUCTION

Background

Gliricidia sepium, a deep rooted multipurpose shrub legume, has been grown widely in the tropics (Wiersum and Nitis, 1972). It has been used as live fence, green manure, livestock fodder, firewood, stakes for the estate crops and protection from soil erosion.

G. sepium is adapted to wide range of soil, rainfall and altitudes (Huges, 1987). It can grow at different climatic zone, topography and land utilization (Nitis et al., 1980).

G. sepium can grow in association with food crop in the alley cropping system (Nitis et al., 1991), and with grass around legumes, shrubs and trees in the Three Strata Forage System (Nitis et al., 1989).

Oxford Forestry Institute has collected seeds of many provenances of *G. sepium* from Latin American Countries (Huges, 1978). Tests from 147 sites across the tropics showed that Retalhuleu of Guatemala and Belen Rivas of Nicaragua performed better than the others (Simons and Dunsdon, 1992). Experiment in Nigeria (Cobbina and Atta-Krah, 1992), in Australia (Bray et al., 1993) and Indonesia (Sukanten et. al, 1995) showed that Retalhuleu and Monterio provenances of Guatemala and Belen provenances of Nicaragua grew faster and produced more fodder than the other provenances of *G. sepium*.

Potential and Problems

For small scale planting or planting not too far from the resources, propagation by cuttings/ stakes is more preferable; while for large scale planting or planting far away from the resources, propagation by seeds is more preferable. Propagation by cuttings can easily be done since cuttings are always available; while propagation by seeds is usually limited by inconsistent seed supply.

In Indonesia no special land is allocated to grow gliricidia to produce seeds. Gliricidia seeds are usually collected from gliricidia grown as fence, as alley cropping, as guard row/ protection or as clusters, when such gliricidia plants are not lopped as livestock fodder. The yield and quality of such seeds are not known.

Objectives

1. To evaluate the growth and seed yield of a top performing *G. sepium* grown as fence, alley crop, guard row and cluster at farm level.
2. To demonstrate to the farmers which of the planting system produce highest seeds.
3. To train farmer to produce high quality gliricidia seeds.

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MATERIALS AND METHODS

Location

The on-farm demonstration plot (demoplot) will be carried out at Bukit Peninsula of South Bali on undulated land, 100 m above the sea leveL The soil is lime-stone based red-brown Mediteran soil with soil pH ranges from 7.2 to 8.4.

The 1,600 mm average annual rainfal with 96 rainy days are distributed during the four months (Dee - March) wet and 8 months (April - Nov.) dry seasons. The temperature ranges from 25 to 29 ^{o}C and the relative humidity varies from 65 to 86%.

Gliricidia sepium seeds

The *G. sepium* used is the Guatemala provenance of Retalhuleu (G14). This G14 provenance has shown the best fodder production among the 16 provenances tested for 8 years at Bukit Peninsula (Nitis et al., 1991).

Design of the Demoplot

The completely randomized block design arrangement consisted of 4 treatments (planting system) and 4 blocks (replications) with 100 plants per replication.

The 4 planting systems are:

1. Fence system (F): Gliricidia is planted in a row at 10 cm spacing between the 2 plants. 10 m row strip is required to plant the 100 gliricidia.
2. Alley system (A): Gliricidia is planted in an alley consisted of 2 rows with 50 cm spacing between plants within the row and 4 m spacing between the 2 rows. Two 25 m row strips are required to plant the 100 gliricidia.
3. Guard row system (G): Gliricidia was planted along the underside of the terrace at 100 cm spacing between 2 plants. 100 m row strip is required to plant the 100 gliricidia.
4. Cluster system (C): Gliricidia is planted in a square plot of 2 m x 2 m for the 4 plants. 400 m^2 land is required to plant the 100 gliricidia.

Farmer Participation

The 16 demoplots are offered to the farmers to select the planting system the farmer prefer. Then 4 farmers for each planting system are selected.

Each farmer will allocate the land for the preferred demoplot.

As an incentive, each farmer will get the seeds and the 100 plants after the demoplot is terminated.

Nursery Preparation

In each demoplot 100 plastic bag pots (PBP) are prepared by filling each plastic bag pot with 1.5 kg air dried soil. The 100 plastic bag pots are located in a shade protected from intruders. Each PBP is watered to field capacity for one week. Two gliricidia seeds are planted at 5 cm spacing and 1 m depth on the surface of the PBP. The PBP is watered and weeded regularly.

Land Preparation and Transplanting

In each demoplot, 100 holes are made in a row perpendicular to the sloping gradient with the size of each hole is 25 cm (depth) x 25 cm (diameter). Spacing between plants depend on the treatment. Transplanting is carried out at the onset of wet season (November).

Observations

The growth observation consists of plant height, number of leaves, number of branch and stem diameter. Observations are carried out 4 times a year, at the end of early wet season (January), at the end of the late wet season (March), mid dry season (July) and late dry season (November). The reproductive observadon consists of flower formation, seed yield and seed quality. This observation is carried out during the flowering and seeding times.

Farmers Training Course

Twenty farmers (16 farmers whose land are used for demoplot and 4 farmers interested in producing gliricidia seeds) are selected to attend the course.

The training consists of 2 phases:

1. One day theoretical aspect of flowering, seed harvesdng, seed quality and seed storage.
2. 4 days practical demonstration on seed ripening, seed harvesting, seed drying, seed quality and seed storage.

Schedule of Activity

The duration of the demoplot will be 18 months (July 1995 - December 1996), with the schedule of acdvity as presented in Table 1.

BUDGET

The estimated expenses is US$ 5,454, consisted of:

1.	Materials for nursery	US$ 308
2.	Equipment and utensil	USS 505
3.	Insecticide and supplies	US$ 525
4.	Labour measurement, seed harvesting and drying	US$ 2320
5.	Field supervision	US$ 700
6.	Farmer training course	US$ 600
7.	Miscellany	US$ 496
	Total	US$ 5454

Detail description for each item as described in Table 2.

Table 1. Schedule of Activity: 1995 - 1996

No.	Period	Activity
	1995	
1.	July	Selecting the farmer, selecting the site of the demoplot
2.	August	Nursery preparation, planting the seeds
3.	September	Watering and weeding
4.	October	Making the holes for the seedling
5.	November	Transplanting the seedling, measuring height, leaf number
6.	December	Tabulating the data, re-planting
	1996	
7.	January	Growth measurement
8.	February	Data analysis
9.	March	Growth measurement
10.	April	Data analysis
11.	May	Farmer training course
12.	June	Flowering observation, farmer demonstration
13.	July	Growth and reproduction measurement, farmer demonstration
14.	August	Data analysis, flowering observation
15.	September	Flowering observation, seed observation
16.	October	Seed observation
17.	November	Growth and seedling observation, seed harvesting, seed drying and farmer demonstration
18.	December	Seed quality, farmer demonstration, writing report

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B) LAOS P.D.R.

PROJECT: PRODUCTION OF *BRACHIARIA DECUMBENS* SEED FOR SMALLHOLDER PASTURE DEVELOPMENT IN LAOS

BACKGROUND AND JUSTIFICATION

To follow up with the TCP/RAS/2361 on fodder and pasture development for smallholders in Lao P.D.R., it is the contention to produce more forage seed for development. Potential grass species which are identified and able to produce seed are ruzi grass, signal grass, guinea grass and gamba grass.

Brachiaria decumbens (signal grass) is a better species in terms of hardiness, drought tolerance, and production when compared with ruzi grass in Laos, but it produces relatively low amount of seed per unit land area (about 58 kg/ha). Seeds are expensive in LAOS and are always beyond the means of farmers. Hence, small amount of "mother seed" is expected in production through exploitation of local environment and agronomic manipulation at Nam Soung Station by trained personnel under the TCP/RAS/2361 project. With the seeds produced, it will then be established at core member farmers' farm identified for seed production.

OBJECTIVES

1. To produce "mother seed" for establishment of signal grass pasture for smallholding farmers.
2. To follow signal grass seed production in farmer land through demonstration of package of technology in seed production.
3. To increase signal grass seed production in LAOS
4. Work plan for 1995-1996 as shown below.

	1995												1996		
	Jan .	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Material preparation				x	x										
Measurement of field				x	x	x									
Planting					x	x									
Fertilizing				x	x	x	x								
Cutting back					x	x									
Fencing															
Field day for farmers								x	x						
Harvesting								x	x	x					
Processing/storage											x	x			
Distribution of seed													x	x	x

5. Local intention involvement
6. Locality of work
7. Duration of work.

Estimated Budget

Material:

Seed	100
Planting	200
Plough	300
Fertilizer	500
Fencing	800
Seed harvesting	300
Field day farmer	800
Operation material	500
Contingency 10%	350
Total	4,850 US$

C) MALAYSIA

PROJECT: ON-FARM DEMONSTRATION OF TECHNOLOGY TO IMPROVE THE NUTRITION OF SMALLHOLDER ANIMALS GRAZING UNDER PLANTATION CROPS WITH DECLINING FORAGE RESOURCES

OBJECTIVES

1. To improve livestock productivity though effective use of available resources.
2. To provide a model farm for the wider adoption of existing technologies by smallholder farmers

JUSTIFICATIONS

1. Need to increase sustainability of livestock production under declining feed supply with maturity of tree crops.
2. Need to integrate existing technologies into the production system.

METHODOLOGY

1. Evaluate on-farm nutrient status of livestock in selected smallholder farms.
2. Determine corrective measures to overcome nutritional deficiencies and limited feed availability.
3. Demonstration of technologies to overcome (2) including:
   a) Use of locally available crop residues and agro-industrial by-products.
   b) Use of locally produced or self-mixed UMMB/UMB or mineral licks/block.
   c) Introduction of grass and shrub fodder in open areas of plantation.
   d) Grazing management to regulate feed utilization.
   e) Introducing of shade-tolerant species.
4. Monitoring and evaluation of animal performance using the technologies, including assessment of economic viability.

LOCATION

2 smallholder Farmer, one each at Segamat, Jempol, Muadzam Shah, Tiang (Johor, N. Sembilan den Pahang) Jengka, Pahang.

INSTITUTIONS

Div. of Vet Services (DVS), MARDI
Univ. Pertanian Malaysia (UPM)

PLAN OF WORK

Year: 1995 – 1996

ACTIVITY	A M J J A S O N D J F M A M J J A S O N D	INSTITUTION
1. Selection of farmers	X X	Dept. of Vet Sciences (DVS)
2. Evaluation of nutrient status	X X X	DVS, MARDI UPM
3. Determination of corrective measures	X X X	DVS, MARDI UPM
4. Demonstration of appropriate technologies	X X X X	DVS, MARDI UPM
5. Monitoring of anim. performance	X X X X X X X X X X X X	-SAME-
6. Mid-term review of progress and intensify front of effective technology	X X	-SAME-
7. Economic analysis and import study	X X X	-SAME-
8. Packaging appropriate technology	X X	

BUDGET

	RM	US$
Travelling & Transport	30000	11500*
Materials:		
Feed	10000	3850
Seeds	2000	700
Lab. analysis	12000	4600
Total equipments and repairs	30000	11500
Labour	10000	3800
Meetings	2000	770
Publications	10000	3850*
Total	106000	40740

Funding contribution: *FAO RWG =US$15,350
Local institutions = US$25,390

D) PHILIPPINES

PROJECT: DEMONSTRATION TRIALS UNDER COCONUTS AND SETTING-UP OF PILOT COMMUNITY-BASED SMALLHOLDER FODDER DEVELOPMENT PROJECT

Rationale

Pasture demonstration trials under coconuts was set up with FAO assistance in Ligao, Albay. These trails served as effective tools for farmers in the provinces of Albay, Sorsogon and Camarines Sur. Initial distribution of forage planting materials has been done but organized smallholder fodder development has to be set up. Where initial distribution has been done, a village has to be selected where concerted efforts on information dissemination and technical assistance to farmers will be extended. The village will be used as a model where other farmers and extension workers from nearby municipalities/provinces will be brought together to share with them the experiences and knowledge gained in implementing the project.

Objectives

1. To maintain pasture demonstration trials in Ligao, Albay.
2. To set up community-based smallholder fodder development project.

Strategies

One village in Albay where fodder development would most likely succeed will be identified. Research staff from the BAI and a technician from the province will be assigned to work closely with he farmers in the village. Coordination of activities will be done by the chief or farmer leader of the village.

Planting materials of available forage species will be given to farmers. Choice of species by the farmers will be considered in the distribution. Farmers meeting and field visits will be done regularly to ensure that problems (even minor ones) are immediately act upon. Farmers field trips to successful pasture/livestock projects will also be organized.

Extension leaflets and bulletins on establishment, management and utilization of forages will be published in local dialect and distributed.

ACTIVITY	MONTHS												
	A	J	A	O	D	F	A	J	A	O	D	F	
Identification of the village		X											
Meeting with local government officials and farmers		X											
Fanners' meeting			X										
Preparation of field activities with farmers			X										
Planting of forages			X										
Follow-up of projects		X	X	X	X	X	X	X	X	X	X	X	X
Publication/distribution of extension leaflets	X			X			X			X			
Field trip			X			X							
Field days													
a) For farmers within village			X										
b) For fanners from other village				X			X			X			

Budgetary Requirement (USS)

Maintenance of Demonstration Trials	1,500
Farmers Meeting, Field Trips and Field Days	800
Publication of Extension Materials	700
Total	3,000

E) THAILAND

PROJECT: DEMONSTRATION ON UTILIZATION OF AVAILABLE FEED RESOURCES FOR YEM ROUND FEEDING SYSTEM: A MODEL DAIRY FARM AT KHON KAEN, UDORN THANI

BACKGROUND

Milk production from smallholder dairy farms in the N.E. of Thailand relies very much on the utilisation of concentrate. Practically during the rainy season (June-Oct.) farmers feed I kg of concentrate for 2.5 - 3 kg of milk production. Whereas during the dry season (Nov-May) when rice straw is the main roughage, farmers feed 1-1.5 kg of concentrate for 2 kg of milk production. The price of concentrate has been rising every year and renders the operation unprofitable to farmers. If farmers can reduce the concentrate utilisation it means more profits to the poor farmers. The results of demonstration trial on utilisation of fodder trees, crop residues and byproducts by small dairy farms from the previous years have shown that utilisation of fodder trees and some agricultural by-products can reduce the cost of milk production. However, it needs a proper management of land use to increase pasture legumes and fodder trees to produce sufficient amount of leaf production for feeding to milking cows during the dry season. In addition, cost of milk production as affected by the application of the tested technologies needs further investigation.

OBJECTIVES

1. To demonstrate on utilisation of pasture legume species and some fodder tree species to minimise the milk production cost in dry season.
2. Maximising feed resources utilisation (molasses, whole cotton seed) which are available in dry season.
3. Enhance pasture growth in dry season by small irrigation scheme
4. Training farmers to adopt the new technology.

IMPLEMENTATION

1. Define target farmers
2. Apply different technologies to the various targets.
3. Monitoring visits by working groups
4. Farmer field day and training

SCHEDULE OF ACTIVITIES

	1995								1996											
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1. Selecting target farmers	X	X																		
2. Pasture legume and fodder tree establishment		X	X	X	X															
3. Establishment of small irrigation system						X	X	X	X	X										
4. Demonstration on utilisation of legume and fodder tree				X	X	X	X	X	X	X	X	X								
5. Demonstration of utilisation of agricultural by products							X	X	X	X	X	X								
6. Field days/training				X	X	X	X	X	X	X	X	X								
7. Economic evaluation			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8. Data collection on reproductive performance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

BUDGET

	Year		T
Activity	1	2	Total (US$)
1. Seed & planting material	2,000	2,000	4,000
2.Demonstration on utilisation of agricultural by product	5,000	2,000	7,000
3.Water pump systems	2,000	2,000	4,000
4.Farmer field days and training	2,00	2,00	4,00
5.Operation cost	2,000	2,000	4,000
Total	13,000	10,000	23,000

LOCAL INSTITUTION INVOLVEMENT

Department of Livestock Development
Department of Agricultural Economics

F) VIETNAM

PROJECT: FORAGE GROWING FOR PROMOTING THE CATTLE AND BUFFALO PRODUCTION IN SMALLHOLDERS

BACKGROUND

Ruminant is very important sector in agriculture. With small arable area, with a high population density, the developing of ruminant production has played a specific role in vietnam.

In the meantime the Government has put big effort and investment to following national project:

Dairy cattle project

Improvement of local cattle herd

Green cover of bare hill

Recently with the development of dairy herd in the big cities like HCM city and Hanoi, the green fodder became tense. It forces our farmers enlarge the growing pasture and establish some green fodder base for away from city.

It is clear that we have consider about this enough green fodder for cattle and buffalo and also to make a small contribution to the green cover of the bare hills. It can be done as concentrate to the selection (screening) of appropriate varieties for each ecological zones.

OBJECTIVES

1. To demonstrate example for the smallholders in forage development.
2. To make better use of the green fodder and agricultural by-product in the ration of the dairy and beef ruminant.
3 To contribute small effort to make green the bare hills by screening and suggesting appropriate forage varieties for growing in the bare hills (poor, dry and acid soil).

ACTIVITIES

1. Selection of appropriate grasses and legumes fit to certain ecological zone. The seed production will be put in high consideration (Ruzi, Guinea grasses) The following varieties should be put in high priority:

   Grasses:
   - Elephant grass
   - Guinea grass
   - Ruzi grass
   - *Brachiaria mutica* (specific for low flood land)

   Legumes:
   - Leucaena
   - Stylo
2. Selection of some specific varieties of grasses and legumes tolerated to acid sulphate soil and poor dry land.

   The following varieties will be tested:
   - Leucaena
   - Stylo
   - Guinea K280

3. Establishing some pilots in household farms in grass and legume growing. More consideration should go to the form of introducing legume to the smallholders (for fence instead of growing in large area)

Institution involved in Experiment and demonstration base

- Bavi cattle and Forage Research Centre (Nadonal Ins of Ani Husb.)
- Song Be Buffalo Research Centre (Inst. of Agr. Sci. South Vietnam)

70 household farms in 3 ecological zones (North midland, South coastal and North East Southland)

BUDGET

Duration: 2 years (1995-1996)

1.	Materials (seed, fertiliser, labor, small equipment, etc.)	3000 USD
2.	Management	2000
3.	Training in abroad	8000
4.	Training and Demonstration in country	8000
5.	Information (books, telephone, photocopy, etc.)	1000
6.	Miscellaneous	2000
	Total	24000 USD

THE PROJECT BUSINESS MEETING

A. NEXT MEETING

In conjunction with the AIDAB/CIAT/CSIRO Forages for Smallholders Project, the Fifth Regional Meeting/Workshop of the Project will be held in Lao P.D.R.

Date : Tentatively February 1996
Venue : Tentatively Vientiene
Theme : Sustainable feeding strategies for Southeast Asia

a) pasture Seed Production
b) Integrated Upland Farming Systems
c) Social-economic factors in technology transfer (demographic and socialeconomic issues and constraints)
d) Utilisation of crop residues and agri-byproducts in forage-based animal production
e) native animals in existing farming systems
f) Forage germplasm in S.E.A. region

B. FORAGE NEWSLETTER

It will be published in collaboration with the Forages Smallholders Project (FSP).

a) Newsletter
Delegates welcome the establishment of a new Newsletter to promote better understanding and communication on progress of current projects and issues and exchange of information among members in the region.

b) Name of Newsletter SEAFRAD (South East Forage Research and Development) for Forage and Feed Resources was recommended.

c) Editing of Newsletter
It was suggested that editing of the Newsletter would be rotated among country member countries.

d) Contribution to Newsletter
Members are welcome to contribute articles to the SEAFRAD Newsletter in both sections of (a) Project, and (b) Regional News in their country languages which will be translated later to English for publication. FSP will provide funding for the publication of the Newsletter.

e) Secretariat and Coordination
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C. PARTICIPATION IN NEXT MEETING

Actual involvement of members from both the projects are sponsored by FAO RWG (3 participants) and FSP (1 participants) totaling to five participants from each country.

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