FSP

Forages for Smallholders Project

Technical Report No.3

Forage Seed Supply Systems

Proceedings of a Workshop held at the Animal Nutrition Research Centre, Tha Pra, Khon Kaen, Thailand 31 October and 1 November 1996

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Published as
CIAT Working Document
No. 175, 1998

Correct citation:
Horne P.M., Phaikaew C. and Stür W.W. (eds) 1998. Forage Seed Supply Systems - Proceedings of a workshop held at Tha Pra, Thailand on 31 October and 1 November 1996. CIAT Working Document No. 175, Los Baños, Philippines, 80 pages.

The Forages for Smallholders Project (FSP) is a partnership of the governments of Indonesia, Lao People's Democratic Republic (PDR), Philippines, Vietnam, Malaysia, Thailand and People's Republic of (P.R.) China. It is funded by the Australian Agency for International Development (AusAID) and is coordinated by Centro Internacional de Agricultura Tropical (CIAT) and the Commonwealth Scientific and Industrial Research Organisation of Australia (CSIRO).

The objectives of the FSP are to increase the availability of adapted forages and the capacity to deliver them to upland farming systems in Indonesia, Lao PDR, Philippines, and Vietnam, and to develop close linkages in forage development activities between these countries and Malaysia, Thailand, and tropical areas of P.R. China.

The main implementing agencies are

Indonesia - Directorate General of Livestock Services (DGLS), Department of Agriculture;
Lao PDR - Department of Livestock and Fisheries (DLF), Ministry of Agriculture and Forestry;
Philippines - Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD);
Vietnam - National Institute of Animal Husbandry (NIAH), Ministry of Agriculture and Rural Development;
China P.R. - Chinese Academy of Tropical Agricultural Science (CATAS);
Malaysia - Malaysian Agricultural Research and Development Institute (MARDI);
Thailand - Department of Livestock Development (DLD), Ministry of Agriculture and Cooperatives.

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COVER PHOTOGRAPHS: Front page upper left and right photographs by Jim Holmes — *Centrosema pubescens* seed pods held by Mr. Ruslan in Makroman, Indonesia; front lower photograph by Werner Stür — Collection of *Panicum maximum* cv. Purple Guinea seed using net-bags in Thailand; back page photograph by Jim Holmes — Mr. Soulivanh Novaha checking inflorescences of *Setaria sphacelata* for seed maturity in Xieng Khouang, Lao PDR.

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Introduction

Few smallholder farmers in Southeast Asia are primarily livestock producers. More commonly, livestock production is integrated within crop-based farming systems, taking advantage of otherwise wasted feed resources (such as grasslands and crop residues) to provide esential inputs and benefits to farming families (including draft power, capital accumulation, and manure for crops). This traditional approach to livestock production is coming under increasing pressure as grazing areas are converted to crop and forest land, or feed resources become diminished from overuse. Planting and managing forages as a sustainable feed resource is a new idea to smallholder farmers but one that many are embracing once they experience substantial benefits.

In Southeast Asia, the Forages for Smallholders Project (FSP) works with farmers to identify suitable forage species and incorporate these species into their farming systems. Once forages have been adopted in project locations, planting material of these species must be made available to the wider farming community. Farmers must be able to access the 'right' planting material easily and cheaply. In most countries and for many forage species, this has meant access to seed but for some species it means access to vegetative planting material such as stem cuttings, rooted tillers, and stolons.

This workshop was held to share experiences from around the world about the benefits and disadvantages of existing forage seed supply systems and to discuss options for the development of future seed supply systems in Southeast Asia. The workshop was hosted by the Thai Department of Livestock Development at the Animal Nutrition Research Centre, Tha Pra, Khon Kaen, Thailand, on 31 October and 1 November 1996. Thirty-five participants attended from Thailand, Lao PDR, Indonesia, China, Bhutan, Vietnam, Philippines, Malaysia, Australia, and Colombia.

Summary of workshop outcomes

The workshop highlighted the diversity of forage seed supply systems that exist around the world. Different systems have evolved in response to the different conditions in each country. The sessions focused on the mechanisms of forage seed supply in different countries, followed by structured discussions on the similarities, advantages, and disadvantages of the major production and supply systems. The structured discussions covered the following main questions.

Is there a demand for forage seed?

The starting point in any discussion on seed supply systems is the question 'Is there a substantial and sustained demand for forage seed and who are the main buyers?' In particular:

- Do the species fulfill the needs of the farmers?
- Could vegetative propagation be a better option?
- Is there a demand for a large volume of seed?

The buying and selling of seed on the open market is a strong indication of demand. In the majority of countries represented at the workshop, however, the main demand for forage seed comes from rural development projects and government departments. The workshop concentrated on the challenges of moving beyond these clients to meet the needs of smallholder farmers.

In many countries, seed is distributed to farmers free of charge or at highly subsidised rates by projects and government extension agencies, making it difficult to assess the 'real' level of demand. Most participants agreed that subsidies are essential in initial stages for stimulating seed production and supply but, once in place, are difficult to eliminate. Subsidies should be used only as a catalyst to stimulate the supply system.

Given the logistical and institutional difficulties associated with seed supply systems, vegetative propagation, where technically possible (most grasses and some legumes), may be the best option for expansion of forage areas on remote smallholder farms.

Should each country produce forage seed?

Given a significant demand for forage seed, the next questions might be:

- Is it technically feasible to produce seed?
- Is it cheaper to produce seed than import it?
- Are there reliable sources of suitable seed in other countries?

The participants generally agreed that there are opportunities to produce high-quality seed in Southeast Asia and that seed imported from outside the region was often costly and unreliable.

Who will produce the forage seed?

The diversity of experiences presented in the workshop served to illustrate that there should be no preconceptions about who will ultimately be the most efficient seed producers. Many factors come into play. For example, in remote areas, centralised seed production is unlikely to be able to meet the demands of farmers. Local, informal supply systems are likely to be more successful. Socioeconomic studies assessing the relative costs and benefits of seed production and distribution by different groups (farmers, nongovernment organizations, government) are useful at this stage.

Most participants agreed that seed production by government stations was unsustainable. It was strongly agreed that the role of government stations should be in initial multiplication of seed rather than commercial production. Well-organised seed multiplication generates

(i) seed for research purposes,
(ii) basic seed of new cultivars for distribution to seed producers,
(iii) a production technology profile of new species for growers, and
(iv) training opportunities in seed production.

New species are of an unknown agronomic quantity and it is a risk to the private grower to find out how to produce seed from a starting point of no knowledge. The knowledge gained through early multiplication by government stations greatly reduces that risk and cost. In Thailand, early involvement of government stations in commercial seed production was seen as essential when there was not yet a guaranteed demand for seed and when the production system was still experimental.

Involving small farmers in seed production requires a reliable demand for seed; otherwise, the risk of production is too high for resource-poor farmers. A variety of different approaches to involving smallholders in seed production were discussed. The motivation of farmers to become involved in seed production needs to be carefully assessed. In some cases, seed production has replaced other crops as the main income-generating activity of farmers. In others, seed production provides multiple benefits to farmers in the form of fodder, green manure, and seed production.

Who will market or distribute the seed?

In the majority of cases presented, seed is bought through a formal market by government and private agencies and distributed to the end user. There were only isolated examples of successful farmer-to-farmer exchange and sales of seed through the open market. This is not to say that informal supply does not exist, rather that little attention has been paid to it.

A variety of channels and outlets are needed to ensure that seed is distributed as widely as possible. The private market may be the most efficient and cost-effective way to distribute seed if demand is substantial. At this time, however, demand from smallholders for forages is sparse and scattered, creating a serious limitation to commercial seed production and marketing. Government agencies can play an important role in supplying seed to widely scattered smallholder farmers, who would not be serviced by private agencies. In many cases, vegetative propagation may be the best option for local expansion of promising forage species.

What support services are needed for seed producers?

Ongoing support to smallholder seed producers is critical. A successful production system will need a support service capable of responding to problems identified by farmers. Support for storage, processing, and marketing were identified as key areas. Government agencies can provide support through research and development (R&D), technical advice, and credit.

Are seed quality standards necessary?

Certifying seed quality is expensive. Many of the participants felt it was necessary to have some control of seed quality, especially when there is a potentially large market. If supply systems are small-scale and informal, seed producers will have a local reputation to maintain and therefore a strong interest in maintaining high quality.

Thailand's experiences with forage seed supply systems

Ruzi seed production. Photo by W. Stür

Thailand's experiences with forage seed supply systems

Chaisang Phaikaew[1] and Michael Hare[2]

The Thai Department of Livestock Development (DLD) has developed a forage seed supply system which involves the production of over 1,000 tonnes of seed annually. The main species produced are *Brachiaria ruziziensis*, *Stylosanthes hamata* cv. Verano and *Panicum maximum* cv. Purple Guinea. Village farmers on contract with the DLD produce 80% of the seed. The seed is distributed for forage establishment to various government and nongovernment agencies and private farmers. The strengths and weaknesses of the present seed supply system are examined and prospects for increasing the involvement of the private sector in the forage seed industry are discussed.

Current Status

Forage seed production in Thailand has expanded steadily over the past 20 years to reach an annual production of over 1,000 tonnes in 1995 (Phaikaew, 1997). In 1995, grass seed made up most of the production with *Brachiaria ruziziensis* (ruzi grass) and *Panicum maximum* cv. Purple guinea (Purple guinea) accounting for 904 and 138 tonnes of seed, respectively (Figure 1). *Stylosanthes hamata* cv. Verano was the major legume produced, with 150 tonnes being harvested in 1995 (Figure 1). Other forage seed, produced in smaller quantities, includes *Paspalum plicatulum*, forage sorghum, *Setaria sphacelata*, *Andropogon gayanus*, *Brachiaria decumbens*, *Panicum maximum* cv. Hamil and cv. Common, *Stylosanthes guianensis* cv. Graham, *Macroptilium atropurpureum* cv. Siratro, *Desmanthus virgatus*, pigeon peas, *Arachis pintoi*, *Chamaecrista rotundifolia*, and *Aeschynomene americana*. Village farmers on contract with the Department of Livestock Development (DLD) produced 80% of the forage seeds in 1995 (Phaikaew, 1997). The remainder of the seed was produced on DLD animal nutrition research centres and forage stations in Thailand.

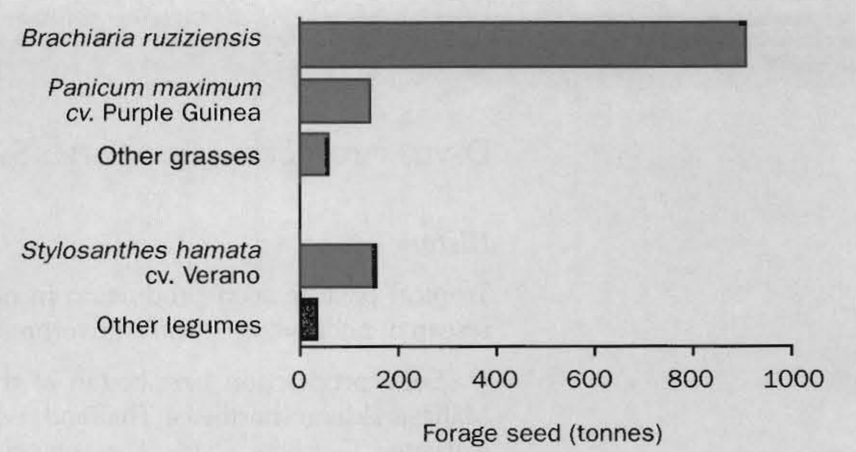

Fig 1. Forage seed purchased from farmers or produced on stations by the Department of Livestock Development in 1995.

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In 1996, almost 1,200 tonnes of forage seed has been produced (Table 1). Government stations produced 220 tonnes, village farmers produced 600 tonnes, and 368 tonnes was purchased from commercial companies. Also, there was a carryover of 167 tonnes from the 1995 seed stock. The commercial hybrid seed, bought from a private company, was used to quickly produce feed in areas which were flooded in 1995.

Table 1. Forage seed produced or purchased from farmers by the Department of Livestock Development in Thailand in 1995 and 1996.

Species	1995			1996		
	Station	Farmer	Total	Station	Farmer	Total
Brachiaria ruziziensis	164	740	904	123	324	447
Panicum maximum cv. Purple Guinea	48	90	138	37	76	113
Paspalum plicatulum	19	-	19	23	-	23
Forage sorghum	20	-	20	9	-	9
Other grasses[1]	19	-	19	3	368[3]	371
Total grass			1100			963
Stylosanthes hamata cv. Verano	20	130	150	19	179	199
Leucaena leucocephala	9	-	9	1	21	22
Centrosema	7	-	7	2	-	2
Other legumes[2]	12	-	12	3	-	2
Total legume			178			225
	318	960	1278	220	968	1188

[1]Includes *Setaria sphacelata, Andropogon gayanus, Brachiaria decumbens, Panicum maximum* cv. Hamil and *P. maximum* (common). [2]Includes *Stylosanthes guianensis* cv. Graham, *Desmanthus virgatus, Macroptilium atropurpureum* cv. Siratro, *Cajanus cajan* and small quantities of *Arachis pintoi, Chamaecrista rotundifolia* cv. Wynn, *Aeschynomene americana* and *Crotalaria juncea*. [3]Commercial seed including forage sorghum Jumbo (3.4 t), and Superdan (50 t), and forage pearl millet Nutrifeed (5 t).

Apart from the DLD managed seed supply, there is also a small (>10 tonnes/year) private market for seeds where farmers produce seed for sale to other farmers. Other government agencies (e.g. Department of Land Development and The Dairy Promotion Organization) also produce forage seed for their own programmes. In addition, *Chloris gayana* grass seed is produced for sale to Japan.

DEVELOPMENT OF THE SEED SUPPLY SYSTEM

History

Tropical pasture seed production in northeast Thailand has evolved through research, pilot projects, and a government-supported seed enterprise.

Seed production first began at the Borabu Land Development Centre, Mahasarakham, northeast Thailand, where small areas of grass seed (*Panicum maximum, Cenchrus ciliaris, P. maximum* var. *trichoglume, Urochloa mosambicensis*) and legume seed (*Stylosanthes humilis, Macroptilium atropurpureum*) were hand-harvested between 1972 and 1976. *Stylosanthes humilis* was proving to be the most useful pasture species in northeast Thailand at that time because it could be used to oversow roadsides and communal grazing areas (Robertson, 1975). In 1974, it was decided to increase the scale of seed production to allow machine harvesting. A large rotating cylinder was built to harvest *S. humilis* seed, together with a steel strap cylinder to clean the seed (Wickham *et al.*, 1977; Hare, 1977). Three thousand four hundred and fifty kg and 4,800 kg seed of *S.humilis* were machine-harvested at Borabu in 1974 and 1975. A cage with a rotating beater was built to harvest *C. ciliaris, P. maximum* var. *trichoglume* and *U. mosambicensis* seed. Approximately 500 kg of grass seed was harvested in 1974 and 1975.

During this period, seed production was also being undertaken at nearby Khon Kaen University. An experiment was established to investigate seed production and hand harvesting methods for *S. humilis*. The best treatments yielded 1,850 kg/ha and 1,420 kg/ha of seed in 1974 and 1975 (Wickham *et al.*, 1977).

Encouraged by these yields, a *S. humilis* seed production pilot project was established with seven village farmers in 1975 under the supervision of Khon Kaen University (Wickham *et al.*, 1977; Hare, 1993). From four hectares, the seven farmers hand-harvested 1,831 kg of clean seed in early 1976. Three of these farmers harvested between 1,000 and 1,250 kg/ha of seed. The results of this pilot project showed that northeast Thailand was well suited to large-scale production of *S. humilis* seed and that there was the potential for a village seed industry to be established.

Unfortunately, the impact of anthracnose in late 1976 prevented any further development of the *S. humilis* village seed project. Fortunately, *Stylosanthes hamata* cv. Verano (Verano stylo) had been imported from Australia in 1976 by the World Bank/Northeast Thailand Livestock Development Project administered by the DLD. Besides establishing well in village oversowing pasture projects, Verano stylo was found to have considerable resistance to anthracnose in northeast Thailand. A pilot project in 1977, under the direction of the Livestock Development Project, investigated the feasibility of Verano stylo seed production by village farmers. Five farmers produced 500 kg of seed in early 1978 at an average yield of 790 kg/ha. Village seed production of Verano stylo expanded rapidly and, by 1981, 187 tonnes of seed was produced by 1,131 village farmers at an average yield 910 kg/ha (Hare, 1985).

In 1982, the Division of Animal Nutrition of the DLD, began to produce ruzi grass seed on forage stations. Market demand for ruzi grass seed grew quickly and village seed production commenced in 1986 (Phaikaew and Pholsen, 1993). Ruzi grass seed production has increased from 18 tonnes in 1984 to over 1,000 tonnes in 1994 (Figure 2).

Panicum maximum seed has also been produced for over 20 years on animal nutrition stations. With increasing demand by farmers for Purple Guinea grass, the DLD started village seed production of this species in 1992. In 1995, farmers produced 90 tonnes of a total production of 138 tonnes of seed (Table 1).

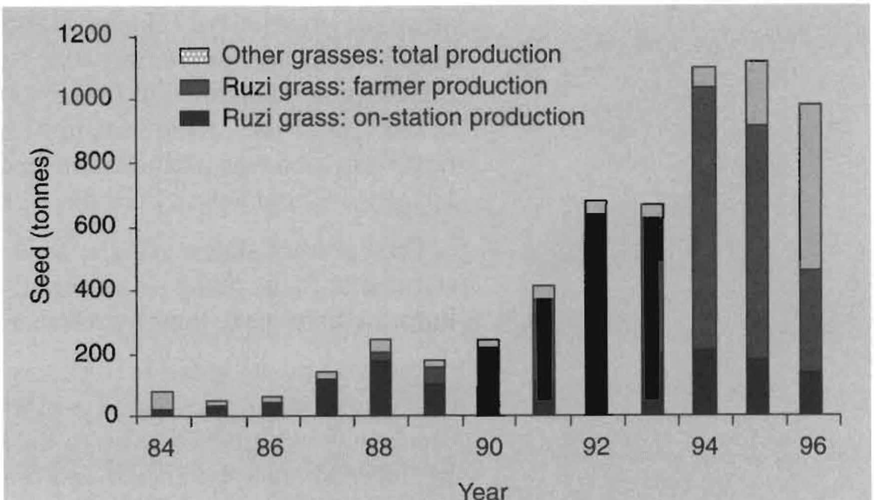

Fig 2. Grass seed production in Thailand, 1984-1996.

Operation of the seed supply system

In Thailand, the Department of Livestock Development's Division of Animal Nutrition has been responsible for the implementation of a government supported pasture seed enterprise. This has now been operating successfully for nearly 20 years. With over 3,000 small farmers producing either ruzi grass, Verano stylo, and/or Purple Guinea seed, the management of the programme is a large undertaking for the DLD.

The following steps are usually followed in seed production programmes:

a) Selection of farmers
Farmers, who were used to growing mainly kenaf (*Hibiscus sabdariffa*) or cassava (*Manihot esculenta*) in upland areas, were requested to set aside about 0.3 ha for ruzi or Verano stylo seed production. These farmers were already known to DLD field officers who regularly visit villages to implement forage improvement, loan bull, and artificial insemination programmes. Farmers were interested in pasture seed production for a number of reasons:
   - Cassava and kenaf crops are labour-intensive at harvest time; often labour has to be hired. Ruzi grass and Verano stylo seed usually can be harvested by family labour.
   - Sometimes field workers on government stations have seen pasture seed production in operation, and have encouraged farmers in their own villages to try to grow seed crops.
   - The guaranteed prices and high seed yields made pasture seed production economically more viable than cassava or kenaf. Prices per kg were worked out on the average seed yield per rai (1,600 m^2) to give a gross income per rai greater than that of other upland crops. This is an incentive to the farmers to produce high yields.

b) DLD staff then visit the villages, talk with the interested farmers, and inspect the areas to be sown to forage seed crops.

c) Farmers receive training at a nearby DLD station on establishment, management, harvesting, and cleaning of the seed crop.

d) DLD signs a contract with farmers, guaranteeing to buy back seed at a pre-arranged price (55 baht/kg for ruzi grass, 80 baht/kg for Purple Guinea grass and 45 baht/kg for Verano stylo; at the time US$1 = 25 baht). Seed for establishment is loaned to farmers and this quantity is deducted at the time of seed purchase. In the past, fertilizer was also supplied to farmers and the fertilizer price was deducted at time of purchase. This is not done now as farmers are able to buy their own fertilizer.

   The contract states that the seed has to pass certain purity and quality standards. In the past, seed cleaning screens were also supplied free to farmers, but now they make their own screens.

e) A quota is now included in contracts for each species 100 kg of ruzi grass seed or 100 kg of Verano stylo seed per farmer per year. This is because the farmers produce very high yields (up to 450 kg/ha of ruzi grass seed and up to 1,000 kg/ha of Verano stylo seed) and often plant in more than 0.3 ha. The DLD only purchases the quota amount; excess seed is sold directly to other farmers in surrounding villages or provinces.

f) DLD staff regularly supervise the seed crops from planting to seed harvest. This supervision has been an important factor in the success of the village seed programme particularly at the start of the programme. Now many farmers have well over 10 years' seed production experience, so less supervision is needed.

g) After harvest, farmers clean the seed and DLD staff either come to the village to collect the seed or the farmers bring the seed to the local DLD station. The seed is tested for purity and seed moisture content before a final payment is made to the farmers. Germination tests are done at a later date before the seed is sold by the DLD.

h) Seed is cleaned further at a central DLD station, seed quality is tested and the seed is packaged for sale to farmers and government agencies. Present sale prices are 60 baht/kg for ruzi grass seed, 80 baht/kg for Purple Guinea grass, and 50 baht/kg for Verano stylo seed. Most of the seed produced is sold for planting the following wet season.

Management of village seed crops

Ruzi grass seed, in particular, is now an important crop in many villages in northeast Thailand. In the past, fields were solely planted to cassava or kenaf; ruzi grass is now the dominant upland cash crop, with small areas of Verano stylo or Purple Guinea grass also being grown among ruzi grass. Seed production of these crops fits well into the village farming system. The crops are sown in May to early June, before the rice crops are planted in July. In some areas, second-year and older seed crops are not resown, but regrow from existing plants (ruzi grass) or fallen seed (Verano stylo). Some farmers resow their seed crops every year because they believe that seed yields are higher from newly sown crops. Once established, seed crops only have to be weeded and fertilized.

Ruzi grass seed is harvested in November, either just before or after the rice harvest. In nearly all villages, ruzi grass is harvested by the "living sheaf" method (Kowithayakorn and Phaikaew, 1993; Phaikaew and Pholsen, 1993; Phaikaew *et al.*, 1993). Seedheads are tied into groups 1-2 weeks before harvest. At harvest, seedhead groups are shaken every 2 or 3 days into a large seednet receptacle (Kowithayakorn and Phaikaew, 1993). Seed harvesting is quick and efficient, with one person capable of harvesting 10 kg of ruzi grass seed per day.

Ruzi – Living sheaf method. Photo by W. Stür

The harvest of Verano stylo is in late January or February, after rice threshing has finished. Seed is allowed to fall to the ground and, as there is no rain for several months, seed is not spoiled. Seed is harvested by the "cut and roll" method (Hare, 1985; Kowithayakorn and Phaikaew, 1993). The crop is removed and the fallen seed swept into heaps and cleaned. The method is labour-intensive, but because rice harvesting and threshing are completed, family labour is available. Also, there is no urgency because rain will not fall until May.

Storage and distribution of the seed

All the seed produced by the DLD is stored in sheds on government stations for up to 1 year. Nearly all the seed is distributed and used within 1 year, so there has been no need to build large cool rooms for long-term storage. The seed is either packed in hessian bags or in smaller labelled plastic bags if only small quantities are being sold.

Major users of forage seed are

- government projects involved in dairy promotion. There are many government projects each year which encourage farmers to take up dairying. The school milk programme has established a huge market for fresh milk.
- beef and dairy promotion programmes in the Project of "Restructuring Agricultural Systems" by the Ministry of Agriculture and Cooperatives.
- DLD livestock extension projects. A consider able amount of seed is sold through the provincial livestock offices who have many field extension officers.
- private farmers and other agencies.

Research and evaluation

If a new crop is being introduced to farmers for seed production, research on seed crop management is carried out on animal nutrition stations for 2-3 years. This enables management practices to be developed and establishes a basis for working out a reasonable contract price for seed producers. This year the DLD is researching seed production of *Paspalum atratum* and *Macroptilium gracile* cv. Maldonado (Llanos macro) with emphasis on establishment and methods of harvesting.

If there is a demand for seed of a new species, existing seed producers are asked whether they would like to try out a new seed crop. At Ubon Ratchathani University, this has been done this year with Llanos macro and *P. atratum* cv. Ubon (BRA 009610). An experienced farmer who was growing ruzi, Verano stylo, and Purple Guinea seed crops was approached and asked whether she would like to grow about 1,000 m^2 each of these two crops for a price of 100 baht/kg. Without hesitation, she said yes and she is growing five forage seed crops this season. Ubon paspalum has just been harvested and the yield was approximately to be about 300 kg/ha. She has also made trellises for Llanos macro.

The DLD usually asks 10-20 experienced seed growers to try to produce seed of a new species. These farmers are very good operators and their fields are usually not far from the research stations, so that research officers can visit the crops regularly. If the new species produce high seed yields in the villages and the farmers are happy with the crop, then production will expand in the following years. Already with Ubon paspalum, without the seed having yet been purchased by Ubon Ratchathani University, other village farmers are keen to grow it next year. They feel that Ubon paspalum is a fairly easy crop to harvest, as seed set is well synchronized and harvesting is completed within 7-10 days. Also, at the time of harvest in late September to early October, farm labour is available to harvest the seed. Even with the difficulties of heavy rain during this period and birds competing for the seed, farmers still believe that Ubon paspalum is a good crop to grow after seeing only one farmer grow the crop.

Strengths and weaknesses of the seed supply system

Strengths

The DLD seed supply system has encouraged the large-scale planting of pastures on large farms, government stations, and in backyard forage programmes in villages. It has enabled many thousands of kilometres of roadsides to be oversown with Verano stylo. These programmes would not have been possible if seed had to be purchased from private companies and then sold to the endusers. Thus, government subsidisation of seed has enabled these programmes to take place. Many farmers, while willing to buy concentrates to feed to dairy cows, believe that grass is a free commodity which nature supplies and that to buy grass seed is money not well spent. However, this attitude is changing as more and more farmers realise the economic benefits of growing good forage rather than buying expensive concentrates.

Village seed production has brought economic benefits to many small farmers and it enabled them to grow crops that do not deplete soil fertility. The extensive network of DLD field officers and stations has enabled village seed production to expand rapidly and pasture development to take place.

Weaknesses

The present seed supply system involves many DLD personnel who could be utilised more fully in research and extension rather than production. The role of the DLD should be breeding, evaluation, and initial seed multiplication. Once a promising species is ready to enter the market place, an agreement should be established with a private seed company and basic seed handed over to them for large-scale multiplication.

The present seed supply system has concentrated on a limited range of species, mainly ruzi grass, Verano stylo, and Purple Guinea grass. More species may have entered the market place if the DLD had encouraged more seed production evaluation and research on the stations rather than multiplication.

In the present system, a lot of seed is still given away free. Sold seed is subsidised since it is priced at only 5-10 baht/kg above the purchase price. In many cases farmers, have not looked after their new pastures since cost of seed was very low. Pastures are overgrazed in the dry season and the farmers are not worried as they know they can replant at the beginning of the wet season. For many farmers, pasture establishment is an annual event.

Future seed supply systems

There are presently well over 100 seed companies in Thailand involved in the seed production of rice, field crops, vegetables, horticultural crops, and flowers. While these companies have exported 2,250 tonnes of seed in 1993 to 32 countries (Anon. 1994 and 1995), none is involved in forage seed production. On the other hand, private companies are involved in producing fodder of para grass, pangola grass, and leucaena. These species are dried and exported as roughage to Japan. Each year Japan purchases large amounts of *Chloris gayana* grass seed from Kenya, Zimbabwe, Zambia, and Malawi but, as far as we know, only a very small quantity from Thailand.

If local and international seed companies can be involved in production of small seeds like flowers, tobacco, and vegetables, then we believe they can be involved in the production of forage seeds. One model, based on New Zealand, is for dairy product companies to become involved in the forage seed industry. Initially, the market would be for domestic use but, if forage seeds were to become certified, export markets could develop.

We believe that the time is right for the involvement of the private sector in forage seed production in Thailand. Demand for forage seeds is high because of the rapidly expanding dairy industry, which must reduce the use of expensive concentrates to boost profitability by using high-quality fresh forages. DLD's role would continue to be research and evaluation. Additionally, DLD would supply breeder's seed to seed companies and actively promote forage development among farmers to ensure that the forage seed market develops and expands.

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Forage seed supply systems in Hainan

Stylo leaf meal. Photo by W. Stür

Forage seed supply systems in Hainan

Liu Guodao, Bai Changjun, and Huang Huide[1]

Hainan is the major seed producer of tropical forage species in People's Republic of China. Seed production started in 1982 and expanded rapidly. Currently, about 20 tonnes of *Stylosanthes guianensis* Reyan II seed is produced annually with only small quantities of other forage species. This paper describes the development of the seed production and marketing system and discusses the limitations and prospects of tropical forage seed production in Hainan.

Forage seed produced in Hainan

Hainan Province is the main area for tropical forage seed production in China. In the past 14 years, more than 300 tonnes of forage seed was produced in Hainan (Table 1). The main species cultivated for seed production is *Stylosanthes guianensis* cv. Reyan II (CIAT 184), a species used widely for leaf meal production and for use as a cover crop in tree plantations. Commercial seed production of this species started in 1988 (Table 1).

Table 1. Forage seed production in Hainan (1982-1995).

Year	Legumes				Grasses					
	Stylosanthes spp.		Other legumes		*Melinis minutiflor a*		*Paspalum plicatulum*		Other grasses	
	Area (ha)	Seed (tonnes)	Area (ha)	Seed (tonnes)	Area (ha)	Seed (tonnes)	Area (ha)	Seed (tonnes)	Area (ha)	Seed (tonnes)
1982	9	2	6	0.1	0	0	<1	0	<1	0.1
1983	23	4	11	1.3	2	0.3	<1	0.4	2	<0.1
1984	46	15	14	2.6	0	0	16	3.5	1	0.3
1985	52	12	15	4.4	1	<0.1	5	3.3	8	1.1
1986	78	15	1	0.4	3	0.3	6	3.7	<1	0.1
1987	92	18	<1	0.2	1	0.3	<1	0.3	2	0.4
1988	103	21	0	0	6	2.7	0	0	0	0
1989	118	33	0	0	3	1.5	0	0	0	0
1990	132	55	0	0	4	1.6	0	0	0	0
1991	162	36	<1	<0.1	4	0.7	3	0.4	<1	0.2
1992	80	24	<1	0.1	7	2.3	0	0	0	0
1993	90	21	0	0	0	0	0	0	0	0
1994	65	15	0	0	0	0	0	0	0	0
1995	101	21	0	0	0	0	0	0	0	0

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Seed of other legumes (*Stylosanthes hamata* cv. Verano, *Stylosanthes scabra* cv. Seca, *Macroptilium atropurpureum* cv. Siratro) is produced in small quantities (Table 1). Grass seed production is based mainly on *Melinis minutiflora, Paspalum plicatulum, Setaria sphacelata* cv. Kazungula, and *Brachiaria decumbens* cv. Reyan III (CIAT 606).

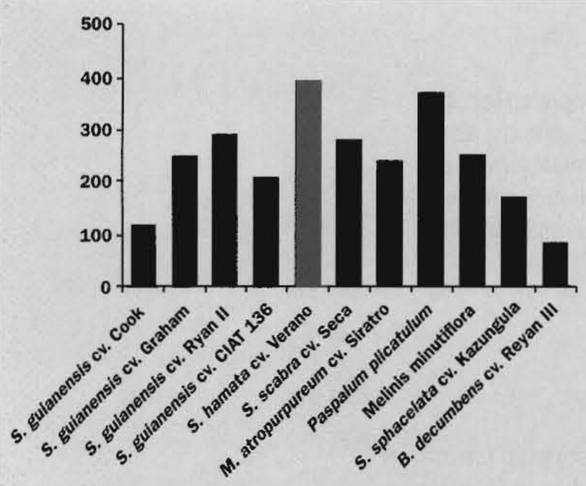


Fig. 1. Mean seed yield of forage species in commercial production systems.

PRODUCTION SYSTEM

The Ministry of Agriculture of the People's Republic of China started commercial forage seed production on state farms in 1982. Production of *S. guianensis* increased from 2.1 tonnes in 1982 to 55 tonnes in 1990 (Table 1). It has since stabilised at 15-25 tonnes/year. State farms operate as autonomous units that produce and market forage seed independently. State assistance is given only in emergency.

Seed yield of forages in commercial production is comparable to yields obtained elsewhere (Figure 1) but seed yield varies considerably from year to year.

STYLOSANTHES CULTIVATION

Seed is treated with hot water (80 °C) for 3-5 minutes to break hard seeds. Seed is also dressed with a fungicide before sowing in a dense seed bed at 40 kg/ha. Seedlings are transplanted into the field 45-50 days after sowing when seedlings are 15-20 cm high. Seedlings are planted (2 seedlings/hill) at a spacing of 70 × 70 cm. Phosphate fertilizer is applied at a rate of 125 – 150 kg/ha as single superphosphate. A well-established seed bed of 10 m^2 is sufficient to plant approximately 1 hectare.

Newly planted fields are weeded for the first 2 months after transplanting. These stands can be utilised for seed production, cover crop, green fodder, or leaf meal production.

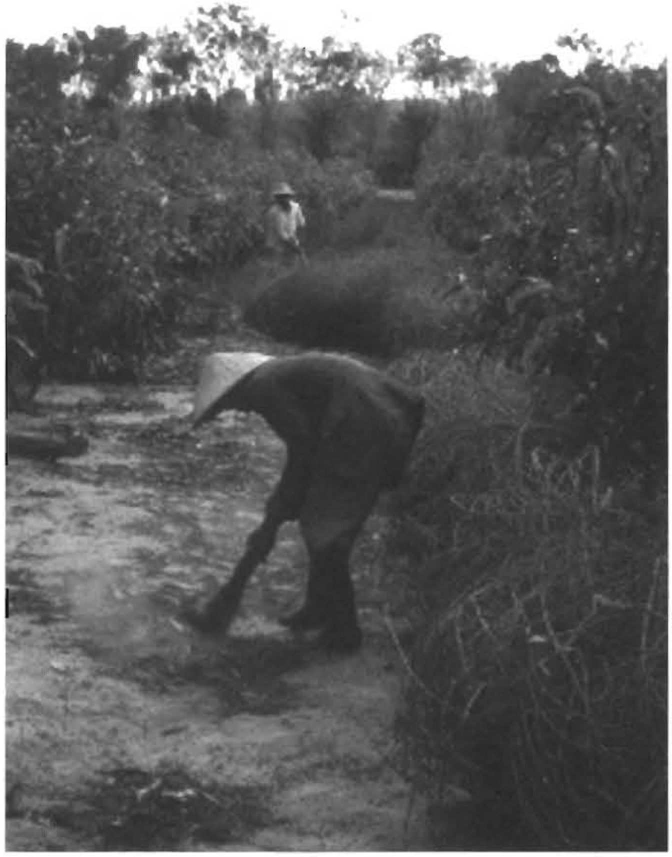
STYLOSANTHES SEED PRODUCTION

Seed of *Stylosanthes guianensis* cv. Reyan II ripens after the onset of the dry season in February. Plants are cut close to the ground when 85% of the seed is ripe. Approximately 30% of the seed is obtained from threshing the plant and 70% of seed is collected from the ground by sweeping the soil surface. The seed is cleaned by hand and dried until the moisture content is less than 12%. In most years, commercial yields are in the range of 150 - 350 kg/ha clean seed. The first kilogram of Reyan II, harvested in 1986, was used to produce 150 kg seed in 1987. Cost of production is approximately US$ 3-4/kg and seed is sold for US$ 5/kg.

Marketing

There is no coordinated marketing of forage seed. In some years, farmers produce more seed than they can sell, which dampens enthusiasm of seed producers. In other years, demand is higher than production and the producers cannot satisfy the demand. Recently, the price of Reyan II seed has increased to US$6/kg because of short supply.

There is a need for policy to guide the marketing of forage seed, which should include quality control. Initially, the Chinese Academy of Tropical Agricultural Science (CATAS) tested forage seeds for sale but, in recent years, state farms have sold seed directly without quality assurances.



Stylo seed production. Photo by W. Stur

Prospects

Hainan island is well suited environmentally to produce tropical forage seeds. Hainan also has a skilled workforce with experience in forage seed production. If the government were to establish additional national seed farms in the region, all the seed needed in southern China could be produced in Hainan. For the development of a forage seed industry, it would be important to set up a seed laboratory, which monitors quality of forage seeds. Cost of seed may be reduced by appropriate government policies, which regulate the production and marketing of seeds.

Experiences of forage seed systems from Latin America

Experiences of forage seed systems from Latin America

John E. Ferguson[1]

A perspective of seed systems in Latin America is attempted via some snapshots of both seed production and marketing, and also of the research and development environment. The former is presented via a description of the lead products of the seed industry in Brazil (*Brachiaria spp.*) along with case histories of two contrasting seed enterprises. The latter is described with reference to seed multiplication, the release process for new cultivars, pilot projects with NGO involvement, seed project management, and the promotion of forages and individual cultivars. The components and processes of seed supply systems in general are defined followed by a resumé of three basic systems: conventional, farmer saved, and integrated community-based. The major elements of the challenge to develop community-based systems are discussed.

Introduction

Tropical Latin America is both huge and diverse. No attempt has been made to cover the full spectrum of forage seed issues within the continent. For more detailed and recent descriptions of the nature and status of forage seeds in tropical Latin America, the reader is referred to Ferguson (1992 and 1994a), Ferguson and Sauma (1993), and Hopkinson *et al.* (1996).

The background for this paper comes from working as a research agronomist and team member of the Forage Program of CIAT between 1974 and 1994. While based in Cali, Colombia, my travels and project participation allowed me to visit most tropical countries in the region. While these activities were predominantly within the research environment, they extended to the research and development (R & D) "interface" with early commercial seed production of several new cultivars.

This paper provides a few case histories of different perspectives, components, and processes of forage seed systems in Latin America, and highlights some relevant themes for evolving seed projects oriented towards small farmers.

Seed Production and Marketing

Brachiaria spp. in Brazil

The largest forage seed industry in Latin America is in Brazil. It has evolved in a dramatic fashion from prolonged and expanding demand for a range of grass species to provide large-scale pasture plantings for beef cattle over a 30-year period. From beginnings around 1970 based mainly upon *Panicum. maximum*, a dynamic seed industry has developed supplying a wide range of species. In recent years, this market has been dominated by *Brachiaria decumbens* and *B. brizantha* with

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recent annual production estimates of 40,000 tonnes/year of which some 10% is exported around Latin America.

The agricultural sector in Brazil is large and the agricultural frontier for both crops and pastures has been continually expanding. In many parts of the cerrados, the farming systems are mixed with crops and cattle in close association. This has been very beneficial both for the production and marketing of forage seed. While most forage seed enterprises also market crop seed, some focus exclusively on forage seeds. Most also market other agricultural inputs. While these seed enterprises were originally concentrated around the state of Sao Paulo, they are now spread across the central cerrado region.

In the early 1970s, seed of *B. decumbens* cv. Basilisk was imported into Brazil from Australia. Demand was strong because this species was well adapted to the infertile, acid, high aluminium-saturated soils of the savannas of central Brazil. Additionally, the grass was very palatable and the large commercial farmers were happy with animal performance, especially in the dry season. It was soon realised that seed could be harvested from these pastures and local seed production soon replaced importation. Initially, harvesting was conducted by combine harvesters present in the region for crops such as soya bean. Seed was processed at central processing plants and marketed following seed testing. The forage seed industry began to expand, driven also by demand for *B. humidicola*.

One major limitation to the utilization of these species as forages was their susceptibility to spittle bug (Homoptera: Cercopidae) especially in more humid areas.

This prompted research into other *Brachiaria* species and led to the release in the mid-1980s of *B. brizantha* cv. Marandu which has some resistance to spittle bug. With the huge farmer appreciation of *Brachiaria* spp., the market appeal of cv. Marandu was tremendous. All previous experience on seed production was still relevant to cv. Marandu and a more sophisticated seed industry made rapid progress in applying their skills to cv. Marandu. There was more deliberate choice of favourable geographic regions for seed production, more intensive crop management (including row planting and nitrogen applications) and greater attention to higher seed quality by harvesting fallen mature seed from the ground. Seed of high purity and germination came on to the market in huge volumes.

The Brazilian forage seed industry is very dynamic and successful. Many private seed enterprises procure seed from the pastures of cattlemen by conducting harvesting, processing, and marketing. In the mid-1980s, this industry rapidly included production and marketing of *Andropogon gayanus*, a species novel to the region. Up to the present, the market for legumes remains small. *Brachiaria decumbens* and *B. brizantha* are the lead seed products which dominate the domestic market and are also exported throughout tropical Latin America.

Semillano Ltda. in Colombia

Semillano Ltda. is a private seed enterprise in Colombia based in the eastern plains or "llanos" Its origins are in seed production and marketing of various rice cultivars which it grows on its own farm. In the early 1970s, Semillano foresaw the potential market for seed of *B. decumbens*. At that time, virtually nothing was known of seed production in the local region within either the research or commerce sectors.

With exceptional foresight and accepting considerable financial risk, Semillano pioneered the establishment, management, and harvesting of *B. decumbens* seed crops in the Villaviocencio - Puerto Lopez region. Several years later, it began to market seed. In a break with tradition, Semillano marketed seed of *B. decumbens* which was acid scarified and with high purity (over 95 %) packaged in small (1 kg) lots.

In marked contrast to Brazil, the cost of machinery in Colombia, especially combines, was very high. Semillano again showed ingenuity by designing a low-cost harvester mounted on a tractor. Semillano entered into share farming agreements for seed production with selected cattlemen who were planting *B. decumbens*. Semillano received a proportion of the seed crop in proportion to the value of their contributions to establishment, harvesting, processing, and marketing of seed. Additionally, because of their expertise in pasture establishment, Semillano was able to market not only seed but a package of services to establish areas of pasture. This was very attractive to many cattlemen who were without experience or machinery to conduct pasture establishment (up to this time local cattlemen had no experience in planting pastures).

Seed yields and seed quality, however, were low relative to those in Brazil and more variable between years. In the late 1980s, good-quality seed from Brazil began to be imported into Colombia. From a seed enterprise point of view, it was less risky and more profitable to import seed from Brazil than to produce them locally. Semillano suffered competition from new seed enterprises who simply imported. Market realities had changed and could not be ignored, so even Semillano began to import seed from Brazil. In so doing, they also transferred their skills in acid scarification techniques to the Brazilian seed sector.

Apart from their leading entrepreneurial role with *B. decumbens*, Semillano also played a key role with other new forages released by the research sector in Colombia. They multiplied basic seed of several new cultivars under contract to CIAT. In the post-release phase, the opinion of Semillano regarding the merit of the new cultivar was highly regarded by local cattlemen. Forage researchers soon learned that if they could not convince Semillano of the role and merit of a new cultivar, it would not be promoted in the market and cattlemen would not buy it. Semillano was often critical of researchers for releasing new cultivars, especially legumes, without sufficient knowledge of their field performance.

SEFO-SAM in Bolivia

SEFO is a private seed enterprise with headquarters in Cochabamba, Bolivia (Ferguson and Sauma, 1993). It is a somewhat unusual seed enterprise in that its major shareholders are a local university, an international development organisation (COTESU), and local seed farmers. The local university did the initial forage research and then wanted to see the benefits of this research reach farmers. They joined forces with COTESU who provided both financial and technical assistance for approximately 15 years to get SEFO established as a viable seed enterprise. COTESU is now gradually transferring its shares to successful seed farmers. SEFO focuses on a range of both temperate and tropical forage species.

In addition to seed production and marketing by and for small farmers, SEFO also conducts forage research and promotion as well as a range of community service activities. Whereas in the 1970s their initial clients were international and government social aid programs, today 80% of sales are to small farmers.

Seed production is conducted by selected small farmers in various geographic regions chosen for their climatic suitability for the target species. In each region, SEFO provides a range of support services to seed farmers. These include a seed purchase contract, basic seed, technical assistance, key inputs (fertiliser, insecticide), key field equipment (threshers, pre-cleaners) and a seed collection service to the central facility. Seed conditioning, storages and quality assessment is centralised at the cool dry location of Cochabamba .

A key strategy is the provision of technical assistance by local or indigenous technicians with customs and language similar to the small farmers. These technicians have a rural background and forage seed production experience complemented with other organizational skills. They also reside within the same region as the farmers.

After successfully developing the production and marketing of a range of temperate species, SEFO expanded its product range to include tropical species. In 1985, SEFO began the purchase of *Pueraria phaseoloides* (kudzu) seed from families who collected seed from roadsides and fallow areas in the Yapacani region. Since 1991, SEFO has organized the production of seed of *Arachis pintoi* even before it was released in Bolivia. Farmers provide land and labour for weed control, harvesting and pre-cleaning. SEFO provides basic seed, technical assistance, small screens, takes delivery on-farm, and conducts final drying and cleaning at Santa Cruz before transferring seed to Cochabamba for quality assessment and storage.

Farmers were very quick to identify the multiple benefits of *A. pintoi* as a forage, seed crop, weed control, improved fallow, and human food (de la Cruz *et al.*, 1994). At last report, SEFO is now exporting *A. pintoi* seed to Brazil and Central America.

R & D Environment

This refers to a diverse range of institutional settings and activities to promote the transition from a research idea or result to a viable commercial application for farmers.

Participatory research on forages and seed

This is the contemporary method by which forages are evaluated with farmers. As the benefits of individual forage cultivars are perceived by more farmers, demand for their propagating material (seed or vegetative material) begins to increase. At some level of demand, it will become economical to invest resources in production of seed or vegetative material.

Initial seed multiplication

Seed multiplication is first and the most fundamental component of any seed system. It is the responsibility of the research sector and usually starts off as a service or support activity for forage research. The objective is the purposeful increase in availability of seed or vegetative material of selected priority materials (introductions, lines, selections) as rapidly as possible. Because it is applied mostly to experimental materials and conducted within a research environment, it must not be confused with commercial production.

Production targets may range from 100 g of seed from each of five accessions (starting from a stock of 5 g per accession) within one growing season to 10 kg of one accession (starting from a stock of 0.5 kg) during the next two growing seasons. Obviously, the range of combinations of number of accessions, quantity of stock seed, and management methods is infinite. In common with any agricultural activity, seed multiplication in the field suffers from all the common climatic risks and pest hazards. These have to be taken into account when defining where to multiply the seed and how much seed to multiply (production targets).

Seed multiplication projects usually focus initially on the multiplication of selected accessions destined for further evaluation and the generation of seed-for-research purposes. With time, experience and appropriate resources, the project can then easily conduct the multiplication of basic seed of an accession destined for release as a new cultivar. By focussing on experimental materials, seed multiplication projects are very dynamic with continual changes in the spectrum of what is currently "promising" as a forage. Additionally, by the time some production targets are reached, some of the materials have been downgraded (become obsolete) and the hard won seed may be useless.

A well-conducted seed multiplication project also provides a perfect environment for the progressive definition of a seed production technology profile of a new species. This can be pieced together by a combination of observation, experience, deduction from the results of seed multiplication and, where resources allow, complemented by some formal experimentation. Similarly, first experiences from on-station seed multiplication can provide experience for technicians to evolve to providing seed farmers with technical assistance.

Release process for new cultivars

The release process is one of the most important process of any seed system. Descriptions of the formal process for public cultivars has been described by Hopkinson (1981) and Ferguson (1985).

In recent years many countries have passed plant breeders rights (PBR) or plant variety rights (PVR) legislation, which has added new dimensions to the process. The driving forces for the adoption of PBR usually comes from the crop and private sectors. Within each country, the release process, with or without PVR, needs to be defined and understood so as to be as efficient as possible. In countries where there is no tradition of formal release pathway, considerable time can be lost in getting good materials to farmers if the necessary processes for release are not in place.

In the last decade, there have been a number of releases of new cultivars of both grasses and legumes in Latin America. These have been very significant events and while not all have been immediately successful, farmers now have a wider range of options.

On-farm pilot projects with NGO participation

A case history of a forage seed project with small farmers in Peru is provided by Ferguson *et al.* (1993). The project conducted activities in seed procurement and distribution (initially by seed multiplication on station and then by seed production with small farmers), technical assistance, training and revision, and applied research (agronomic and systems development).

Over a 5-year period, two regional project nuclei were formed in complementary geographic regions and consolidated via analysis of experience gained, training, and the acquisition of equipment. During the same period, the institutional organisation evolved from a research-oriented project to where a seed-oriented NGO became project leader. The project was reviewed annually with the participation of an external consultant with elements of reporting, analysis, training, and planning. This recurrent exercise developed the skills of key participants as well as provided a forum to widen linkages with relevant new actors. From 24 novice farmers, four farmers became experienced and produced seed under contract with the project. A rotating seed fund was a key financial mechanism that provided operational flexibility to the nuclei to promote seed production and rent equipment. Marketing risks were shifted from the producer to the project, forcing the latter towards a market orientation and finally to include other crops in the product range.

Some farmers were very innovative in their management of seed crops. On the research station, seed crops of *Stylosanthes guianensis* were grown in pure stands. One farmer, however, successfully intercropped *S. guianensis* for seed with maize and achieved satisfactory yields of both crops along with reduced labour for weed control. This showed the advantage of farmers integrating the new crop into their farming system.

The following factors influenced seed supply development by this project:

- as negatives: national socioeconomic environment, decline of funding in public research institutions (the period1987-1992 was very difficult in Peru), and limited demand for seed of the various forage cultivars.
- as positives: two complementary and very dedicated project nuclei, the rotating fund, annual review workshop, external funding and consultant, and the success of on-farm forage research.

A more generalized list of positive and negative forces in seed supply development is provided by Ferguson and Sauma (1993).

Forage seed project management

Ferguson (1994a and b) advocated the term "bridging mechanisms" for a conglomeration of contrasting mechanisms or strategies which can be relevant at different times within seed projects. These included

1) Apply and/or develop market forces. Researchers tend to expect that the seed necessary for their field experiments is to be supplied free of charge. This bias can be very damaging in an on-farm context as it hides both the farmer and researcher from real economic values and market forces. If possible, farmers should pay (perhaps in kind) for all or part of seed or the on-farm project should pay the seed project. Too much donation is bad business.

2) Practice alternative seed procurement mechanisms. There are various ways to procure seed including barter/swaps, open market purchase, self-multiplication, share-farming production, and contract production. Each modality has its implications and limitations but what is needed is the application of the most relevant modality at each stage in the project life (reflect how the Peru seed project applied this to advantage).

3) Use rotating funds for seed purchase and distribution. In a research institution, "spend only" budgets are the norm and there is no income or rotation of funds. A rotating fund for the purchase and sale of seed can facilitate the supply of seed as well as promote the application of market forces and the practice of alternative procurement mechanisms.

4) Identify the project nucleus and champions. A seed project has to have a heart (or core or nucleus) as well as the driving force of dedicated individuals (i.e. "champions") who are willing to champion a cause over a long period and motivate others. Give your project a recognisable human nucleus and foster some participants to become "champions" according to their skills and style. Do not stifle a project in proposals, reports, paper, and dogma.

5) Apply a balance of both research and development. The multi-institutional and multidisciplinary-type seed project implies a dynamic balance of both research and development initiatives.

6) Conduct recurrent multipurpose workshops within a network. As part of RIEPT (a forage evaluation network in Latin America) and also in seed projects in both Peru and Central America, the use of recurrent multipurpose workshops (as opposed to training courses) was extremely effective. Participants must participate in a way that is highly relevant to their immediate work plans. Programmes and venues should change. Objectives can be multiple and include training, review, planning, study tours, linkage development, information diffusion, and reporting.

Promotion of forages in general and individual identity of cultivars

For farmers to appreciate the merit and benefits of forages, there has to be an information flow from and between researchers and farmers. This is especially the case when forage species are new to the local region and more critical when the forage is novel even to the researchers. The importance and magnitude of this task is frequently underestimated by researchers. Only if forages are being promoted individually as specific cultivars with a particular name will farmers seek their seed and create the level of demand necessary to attract some farmers to enter into seed production. While some initial promotion is conducted by researchers conducting participatory research, the challenge has to be continued and expanded by other players such as extension agents, milk or beef development projects, NGOs, local farmer groups, and seed enterprises.

Seed Supply Systems in General

'Systems' is a buzz word and is relatively new in the context of seed. So why talk of seed supply systems? The main reason is to acknowledge their complexity and avoid over-attention to some parts and a blind eye to others. If you already work within an efficient system, you are very fortunate but you may not even appreciate why your system works and you may not be able to apply it to other circumstances. The systems' viewpoint tries to be holistic. With seeds, this means recognition not only of the classical seed production chain plus seed technology but the market influences that reflect the clients and their socioeconomic setting.

Three broad types of seed systems can be defined for crops in general

1) Traditional farmer-saved: Historically, farmers conserved a fraction of their own harvest of land races of grain, stems, or roots to serve as "seed" for the planting of their next crop.

2) Conventional: The modern-day icon of the seed industry is the range of special hybrid cultivars sold each year to large commercial farmers willing to pay cash for improved seed of a range of crops grown off-farm (and often in a different region). This market is large, stable, and important to the national economy. Efficient seed enterprises produce seed (often certified) and attain profits from their seed marketing. Governments provide strong support to research and industry services. The system is driven by strong demand for the seed product and profits generated in the production and marketing chains. Most of the success stories with forage seed to date are consistent with this system.

3) Integrated community-based: This is a recent innovation and is a response to the reality that most small farmers are not well served by either the conventional or the traditional systems. This system aims to build on elements of the traditional farmer-saved system but with other strategies involved (e.g. improving soil fertility, human nutrition, water catchment management, food security). A socioeconomic blend of community and seed-related issues are linked and promoted concurrently. This is mainly an on-farm system but external support is required to develop the system. Obviously it is not a seed-only system.

These three systems are not mutually exclusive in any one country or time. On the contrary, the aim should be to promote their complementarity.

Forage Seed Supply Systems for Small Farmers

In Latin America, small farmers have been targeted to benefit from improved crop seed supply (Camargo *et al.*, 1989; Garay, 1992). New perspectives on (crop-based) seed systems for small farmer have emerged from Cromwell *et al.* (1993), Louwaars (1994), and Sperling *et al.* (1995).

Forages have received scant attention in this regard but recently Ferguson (1994b), Ferguson and Sauma (1993), and Ferguson *et al.* (1993) described some relevant initiatives.

In Latin America, small farmers are not well served for seeds of forages. The entire image of the volumes of seed of *Brachiaria* spp. from Brazil is consistent with the conventional system supplying the needs of large farmers and driven by opportunities therein for profit. Any small farmers who do benefit are those in close proximity to the conventional system (spillover rather than primary clients).

In the very challenging task of improving seed supply for small farmers (or developing some form of integrated community-based seed system) the following elements are critical:

- farmer and community participation
- building on traditional farmer knowledge and practices
- complementation from on-farm participatory research with forages
- complementation from new technology, especially adapted or new cultivars
- external support is required but must be transitional and build upon community strengths
- responding to issues of scale (machinery, packaging)
- promoting seed consciousness (consider grain marketing as an example)
- decentralise and maximise distribution points
- widen distribution modalities (swaps, barter)
- promotion of market forces
- promotion of institutional linkages and networks (including NGOs)
- integrate the role of forages into broader environmental and social context, e.g. soil conservation, improved human nutrition, integrated watershed management, need for food security (seed of crops and forages).

Implicit in this list of essential elements is that forage seed cannot be a singular focus (as it can be with the conventional system) when the target clients are small farmers. Also, while seed technology will always be important, it does not and cannot drive the system. Unless there is real demand from farmers (adapted, productive species/cultivars with multiple benefits to farmers), the integrated community-based system will not function. The development of this system will have a long formative stage, where a wide range of support mechanisms, including pilot projects and efforts to widen participation (to include NGOs and small seed enterprises), will be required.

Choice of location for seed production is critical, especially when commercial production is contemplated. In the case of small farmer seed systems, however, these options may be restricted making it all the more critical that the forage has good propagation potential within the region of use as a forage.

Efforts to date to increase the delivery of forage seed to small farmers are very restricted, as is the documentation and analysis of the outcomes. There is a real need for *research* on seed supply systems for small farmers *per se*. This would best be done by a comparative case study analysis of seed projects and seed enterprises in different countries. In the conduct of such research, inputs and participation are needed from socioeconomists and farming systems specialists.

The long-term nature of the challenge to meet the needs of small farmers requires both continuity of effort and dedicated hard work by a new generation of forage seed champions.

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Australia's experience with tropical forage seed supply systems

Combine harvesting of grass seed. Photo by W. Stür

Australia's experience with tropical forage seed supply systems

John M. Hopkinson[1]

The Australian tropical pasture seed industry is 30-35 years old, with a current annual value of about Australian $10 million in off-farm sales to perhaps 200 producers supplying mainly about eight major merchants. There are usually about 40 types of seed on sale, of which about 10 have sales exceeding 100 tonnes annually. Most are public cultivars, though recent releases have been marketed under plant breeders' rights (PBR). About 2/3 of released cultivars succeed. Failures attributable to technical difficulties or inadequate supply systems occur, but infrequently. Most failures are due to the cultivar being unacceptable commercially. An open, unprotected marketing system exists. It is effective, although it cannot prevent imbalance in supply and demand, which results in price fluctuation. Export sales improve industry security by increasing overall seed flow. PBR has had mixed success, with no general benefit and no great return to the breeder. Little seed is certified. Official standards have recently been abandoned, leaving much to truth-in-labeling and buyer discrimination. Seed testing is mostly conducted by private companies. Technical advances, achieved by both private initiative and formal R & D, have been crucial, allowing real price reductions of seed to 40% of former values in 20 years.

Introduction

The Southeast Asian reader, looking for lessons to learn from countries with longer histories of tropical pasture seed production, should view Australia's experience with caution. The circumstances differ too greatly for it to be translated without qualification. My task is only to outline that experience: it is the reader's task to determine the relevance to his or her own conditions.

Although the title specifies Australia, the experiences described apply predominantly to the State of Queensland where there has been a continuously viable tropical pasture seed industry for more than 30 years.

Background

There are two quite separate seed industries that service livestock producers in the Australian tropics. One of these — supplying forage sorghum and millet seeds — can be excluded from present consideration. It is essentially an offshoot of the grains seed industry, is similarly dominated by multinational corporations, and has little present relevance.

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The other is the tropical pasture seed industry. By comparison with the forage grain seeds, or temperate pasture seed industries, the tropical pasture seed industry is small and disorganised. Even internationally, it is probably too disjointed and unprofitable to be attractive to the big multinationals for, with one abortive exception long ago, they have not become involved in it. If any Australian activity has relevance to forage seed production in Southeast Asia, this is the tropical pasture seed industry. Partly because Australia pioneered much of the seed production technology, partly because the industry itself is still in an early stage of development and only a little further along the road than those of its northern neighbours.

NATURE OF THE INDUSTRY

Tropical pasture seed production only came into being, as a recognisable industry, a little over 30 years ago. It is presently worth perhaps Australian $10 million annually in sales. It may have about 200 suppliers marketing most of their seed through about eight major (national and exporting) merchants and a host of local merchants and agencies. The edges of the industry are blurred because most growers are mixed farmers for whom seed provides less than half their income; because rotation and green manure tropical legumes are usually considered with pastures; because merchants deal in other seeds (e.g. fodder, temperate pasture seeds, field crop seeds); and because retailers are commonly general farm-supply agencies.

It is convenient to think of there being four groups of people as the core of the industry: growers, merchants, retailers, and users. In fact, there is some overlap, but it can be overlooked for simplicity without distorting the basic picture.

- The growers include very few specialist seed producers, many mixed farmers who grow seed deliberately as a crop, and some graziers who harvest seed opportunistically. Typically the farmers own the farms they run and employ little or no outside labour, working 100-500 ha as family enterprises under intensely mechanised, highly capitalised systems.
- Growers at times band together in associations intended to represent their interests. These sometimes function effectively for a while but, on the whole, they have limited power and effect. The time and expense of travelling long distances makes it difficult for working farmers to unite, even if they wanted to (many do not). Thus the growers seldom present a serious, united force.
- The merchandising sector is diverse. It includes true seed merchants (who buy, often process, and sell), brokers (who sell on behalf of others on commission), and farm equipment supply companies that include a seed marketing branch. The true merchants are the most important. They may be single-owner private ventures or public companies who specialise in tropical pasture seed or the tropical pasture seed may be merely one division (usually the least profitable) of a broader based enterprise. They are part of the Seed Industry Association of Australia (SIAA), which represents the trade at state, national and international levels. It too is beset with problems. The complications of both domestic business and modern international trade have become too much for management on the former honorary, voluntary basis, and the SIAA is in the process of transition to a professionally run body. It has, however, often lobbied governments successfully to its advantage - for example, in getting plant breeders' rights (PBR) introduced.

- The users — dairy farmers, mixed farmers with rotation systems, and cattlemen graziers — are the ultimate customers. Historically they have been curiously indifferent towards the product they buy. They have been preoccupied with price and have cared little for the details of quality. This is changing, and the dairy and mixed farmer customers become progressively more sophisticated. The cattlemen, however, who provide the bulk of the present market, are slower to change. This is partly a cultural trait, a reflection of an isolated life and a traditional preoccupation with animals rather than grass; partly because a cattleman only buys seed a few times in a lifetime, and so gets little opportunity to gain familiarity with the skills of doing so.

The seed

At any one time, there are about 40 different lines of pasture seed listed for sale. They include both grasses and legumes with a great diversity of species but seldom more than four cultivars of one species and often only one or two. The majority are public cultivars or "common" types, many of which have been in use for over 30 years. Recently, however, most new cultivars have been registered under PBR, their exclusive marketing rights then being leased to a chosen licensee.

About 30 lines have an annual sale of more than 10 tonnes, meaning that they are not in imminent danger of extinction. Of these, about 10 lines usually command a market of greater than 100 tonnes. But since at least 130 different varieties of tropical pasture plant have been released, a high proportion failed. It is instructive to consider why. Any assessment is necessarily personal and subjective. Mine is that about 66% have had significant value, even if some have been eventually discarded; 21% failed essentially because there was not a commercial role for them (the release system erred); 5% failed because they did not live up to hopes (e.g. got a new disease too soon after release); 4% were just too difficult to get cheap seed from for genetic or technical reasons; and 4% were victims of supply problems within the industry. Clearly, failure of seed production has been a minor problem, but failure to select the right plants has been serious. This is not an indictment of the decision makers, for release is known to be a gamble because success is highly unpredictable, and the only alternative to gambling is to do nothing. Indeed, uncertainty can work both ways, as in our recent experience of *Digitaria milanjiana* cv. Jarra (Jarra). Jarra was evaluated for survival in harsh dryland conditions; it was released because it had escaped in the role of a banana rotation grass and the public decided (once it was available) that they wanted a seeding successor to pangola grass for high-input pasture in benign environments.

Markets, marketing, and subsidies

Markets exist only when the grazing industry decides that it wants seed of a particular pasture species, and has the money to pay for it. There has never been government intervention in marketing in pasture seed, whether to facilitate distribution, sell at subsidised prices, or guarantee growers a payment. In the early days of pasture improvement, there was a direct subsidy scheme to help dairy farmers (at the time impoverished) to move to higher levels of production. It took the form of a once-only grant for purchase of seed and fertiliser. It achieved its aim quickly and successfully. It no longer exists, nor is it needed. The only other government support for seed production is the maintenance of its research teams, who produce small quantities of new cultivars. This is mostly done before commercial release (and therefore before a market exists), and on a scale too small to be practicable for private farmers.

Such government-supported early seed multiplication serves as a subsidised insurance policy for subsequent commercial seed production. Each new species and, to a lesser degree, each new cultivar of an already used species, is an unknown agronomic quantity. It is a risk and a cost to a commercial grower to find out how to produce seed of it from a starting point of no knowledge. The knowledge gained through early public multiplication greatly reduces that risk and cost.

The only other government involvement in marketing is in regulation of seed standards, certification, and plant breeders' rights, all discussed separately. In every other respect, marketing is left to private initiative and market forces.

Marketing has never been collectively organised. There are no marketing boards or cooperatives, no cartels or other communal buying or selling groups. Very little seed has been grown under contract. Growers produce their seed and look for somewhere to sell it. There is no industry-driven assessment of market size, or organisation of production to meet demand. Individuals adjust their production on hunch, or on what little market intelligence they can glean. Exceptions to this occur with PBR licensed cultivars, for which the licensee tries to fit production to perceived demand, but such cultivars are as yet of minor importance. The overall consequence of general disorder is frequent imbalance between supply and demand, accompanied by volatility in price.

Before the early 1970s, merchants routinely bought most of the seed they hoped to sell. They had a quantity of money for this purpose, and the faster they turned it over, the more profit they made. Inflation, bringing rapid loss in value of idle money and high interest rates on borrowed money, brought about a change in this practice. Much more seed is now taken "on consignment"(received and stored by the merchant, but not bought until and unless there is a sale for it). The grower thus bears the marketing risks. A merchant takes seed on consignment when it is abundant; he only buys seed if it is scarce, fearing that rival seed companies corner all available seed.

The markup on seed bought off-farm is approximately 50%. That is, the advertised retail price is usually 50% more than the price paid to farmers. Sales within the trade or negotiated sales of large quantities may have smaller markups. A 50% markup may appear excessive, but in fact there are so many risks attached to marketing (fall in market value with price fluctuation and diminished salability through seed quality deterioration from aging are the main ones) that it is accepted as reasonable.

A characteristic of marketing of tropical pasture seed in Australia is that it has been predominantly passive. The merchant has waited for the client to come and buy the seed, rather than gone out looking actively for a sale. It seems that the economic returns are insufficient to justify much outlay on promotion and this has therefore been left to government extension officers.

Until about 1973, most markets were domestic. Since that time, a variable and largely unrecorded proportion of sales has been exports. Export sales have been very important in having kept the seed industry alive during domestic recessions in the grazing industry. All sectors tend to look on a healthy export component as a great asset to the seed industry. Export markets themselves have been notably volatile, with massive rises and falls in sales to, for example, Brazil in the1970s and the Arab states more recently.

Markets, particularly domestic markets, have the curious property of destroying themselves through the success of their product. Most pastures are perennial, and are sown with the hope that they will last a lifetime. Each is adapted to only a limited range of environments. If the plant is so successful that it lasts forever and is soon sown on all appropriate country, then the market for its seed ceases to exist.

We have reached a point where there are relatively narrow openings for new cultivars, and therefore relatively small new markets. Some niches remain to be filled and there are always deficiencies in existing cultivars, prompting hopes of superior successors. Also, pest and disease problems arise which may eliminate whole species from the market place and leave opportunities for others. Changing demands for pasture types also open up new prospects. There is thus a constant turnover in the types of seed required, but the changes become progressively less dramatic as time progresses.

Release of new cultivars and PBR

Formerly, release of a new cultivar was an important event. In the early days of tropical pasture improvement, when a new cultivar stood a strong chance of creating massive new opportunities for pasture improvement, there were big profits for those first into production and sale of seed. Now, with many good cultivars already established, widespread realisation that release does not guarantee demand, and the law of diminishing returns applying to pasture plant improvement, there is less excitement. New cultivars have to be sold at competitive prices. They are no longer necessarily profitable to grow or to market.

Also, systems of release have changed as a result of the enactment of national legislation providing PBR. Formerly all tropical pasture cultivars released in Australia were public cultivars that could be marketed by anyone. Now they are mostly covered by PBR. This means that the nominal breeder, almost always a government agency of some kind, acquires a kind of patent on the genetic material that constitutes the cultivar. This enables the breeder to sell or lease an exclusive marketing license for the cultivar to a seed company which pays an initial license fee and agrees to pay a royalty on the sale of seed to the breeder.

In the days of public cultivars, the central body mediating the release of cultivars was a Herbage Plant Liaison Committee (HPLC), and each state in Australia had one. An HPLC was a gathering of representatives of most interested parties including the seed companies, the producers, and the research and extension agencies. It had no official powers but, because it was in everybody's interest to comply with its decisions, it had great influence. It met annually to decide what new cultivars to release and how to release them. Usually it established voluntary Seed Increase Committees (SIC) to regulate the process of commercialisation that followed release. It was a fair, honest and economical system.

However, there is always change. Australia increasingly accepts that private interest should come ahead of public good. It is also under pressure to reduce public spending, and these two forces combine to weaken both public power and public initiative. The introduction of PBR and the reduction in government extension services are two consequences of these effects. PBR appeared to offer a way to raise revenue. It also promised an increase in power for seed marketing companies over both buyers and sellers. The loss of extension officers, the former main promoters of new cultivars, shifted initiative for promotion of seed to the new licensees of PBR-protected cultivars.

The consequence has been that the role of HPLCs, where they have survived, has been reduced to endorsing release after the owner of the cultivar has already made the decision to commercialise, and SICs have disappeared. The owner now negotiates, by whatever means he chooses, to find a commercial "partner" who will pay a license fee in return for exclusive rights to market the cultivar, and agree to collect a royalty (probably a little over 5% of the sale price) on seed sales on the owner's behalf. The partner must convince the owner that he is capable of successfully marketing the seed, and he is therefore often a merchant.

It is still too early to judge the success of PBR in relation to tropical pasture species. It has not benefited the breeder in producing significant net revenue gains to his organisation. Indeed, even the costs of the extra work involved in obtaining PBR registration have sometimes not been covered. The popularization of at least one potentially useful plant has been considerably delayed by unwillingness of the licensee to expand production, leading to shortage and high-priced seed. The extra costs of PBR are inevitably passed on to the user, who is only willing to pay the higher price for his seed if he is convinced of its superiority over existing public cultivars. Few PBR-protected cultivars have been superior enough to convince buyers, and sales have consequently largely been disappointing. The extra costs are usually estimated at about Australian $2/kg for seeds that retail at about Australian $12/kg, so they are significant to the user. The earlier mentioned uncertainty about the success of a new cultivar is another cause of low revenue to the breeder, since it leads the bidder for a license to exercise caution over how much he will pay.

Where seed production has been contracted to producers, their main cause of dissatisfaction has been the fact that, if the licensee decides he does not want their seed, they cannot sell it elsewhere. Whether or not the licensee can choose not to take their seed depends, of course, on the terms of the contract. Producers are still very inexperienced at negotiating terms that favour them, and have allowed licensees this loophole. Otherwise, growers are finding advantages in contract production, especially when foreknown markets and prices allow them to plan and budget with more certainty than before.

The main tangible general benefit of PBR so far has been not with cultivars perceived to have potential for widespread use and big sales, but with niche cultivars with annual markets of only a few tonnes. Formerly it was difficult to get these launched, and they were apt to founder for lack of a determined champion. No one was prepared to put the effort into developing production systems when rivals could copy them and enter a market that was not big enough for more than one producer. The protection of the monopoly conferred by PBR has been enough to stimulate individuals to develop their systems and markets.

There have been many fears about the downside of PBR. The power of monopoly, of course, invites exploitation. It also introduces a risk of neglect of a cultivar and consequent reduction in seed supply (despite nominal legislation designed to prevent this). So far, however, the power of monopoly has been weakened by the availability of competitive public cultivars, and the fear of exploitation has not materialised. But there has been one case of popularisation of a good cultivar, and the only one of its type, being frustrated through seed shortage attributable to problems of production technology, which might have been overcome in a more competitive milieu.

PBR is not always appropriate for tropical pasture cultivars. Being designed with field crop and horticultural varieties in mind, the legislation places great store on genetic stability. This is often the last thing that we want, particularly for legumes sown into harsh, variable environments, where some genetic plasticity is vital for widespread adaptation.

Pitfalls of release

Some patterns recur in the release of new cultivars that are unrelated to the actual release mechanism. For one, there is the time lag between a cultivar being released and its being accepted as useful by the public. This may be a period of several years, and it is to some extent inevitable. A cattleman or dairy farmer is cautious when faced with decisions about spending money on pasture improvement. He often likes to watch how a new cultivar performs for a more adventurous neighbour before he decides to sow it. Also, a perennial pasture takes a few seasons to show its worth. Meanwhile, a licensee has committed investment to the cultivar and is anxious to get a return before interest payments take all his profit. It is not uncommon for the seed industry to lose heart before the grazing industry decides that it wants something, and this often puts supply and demand seriously out of phase. This phenomenon is more common now that we have a wide suite of existing cultivars than in the days when we had only a few; because then the greater promise of improvement justified a greater risk to the user.

Another problem is the lack of prior experience of growing new species and much has to be learnt quickly about seed production. This is more of a problem with completely new species rather than with new cultivars of species already in the market. The learning process can be financially disastrous for the seed producer, and can set back an individual, a cultivar and indeed the whole industry for years. It was because of this that, many years ago, we developed the policy of using the early seed multiplication phase to try to identify and eliminate potential problems before they arose commercially. The joint targets of providing both enough available seed and a commercially robust production technology by the time of public release have been the focus of our government research teams.

Seed certification

Pedigree certification has existed for many years, and has been encouraged by government agencies, but has attracted singularly little enthusiasm from industry. As a consequence, and because certification has a cost, only a small fraction of seed is certified. The reason for the indifference is that the customer has never been seriously worried about the fine details of genetic purity. This may be interpreted as lack of sophistication, but it may equally be seen as an intuitive realisation that such properties are of negligible importance when judged against the background of permanently looming catastrophe which is the cattleman's lot. What the customer has been interested in is protection against being cheated by adulteration or substitution of expensive seed of a desirable cultivar with cheap seed of an inferior cultivar. It is only where this risk is real that certification has been successful (e.g. *Chloris gayana* cv. Callide and *Setaria sphacelata* cv. Narok).

Seed quality standards

Standards of physical and vital quality, as distinct from genetic purity, are generally accepted as necessary. They are widely maintained by systems of compulsory minimum standards, which make it illegal to offer substandard seed for sale. Such a system operated until recently in Queensland and was regarded by most people in most sectors of the industry as a good thing. Unfortunately, minimum standards of purity and germination on uncertified seed were dropped as a consequence of otherwise useful agreements reached between states on uniformity of government regulations. Standards still apply to prescribed prohibited seeds and labeling regulations remain intact. Truth-in-labeling is now the main bulwark against dishonest practice and the regulations governing it are indeed important. Within the trade, certain informal minimum standards have been loosely accepted as a substitute for the old compulsory standards, especially in the purchase of off-farm cleaned seed, and it must be admitted that the change has not reduced the overall average quality of the marketed product.

Seed testing

Impartial, efficient, and reliable seed testing is an absolute necessity in any marketing system. It was formerly the province of a government laboratory in Queensland, which, however, proved too tempting a target for a government intent on cost cutting. It is now wholly conducted, apart from a small minority of official tests (for export certificates and certification), by two private laboratories. In the short term, this has provided an entirely satisfactory substitute, since both are highly efficient. In the long term, opportunities for training in seed testing, divergence in methodology, absence of policing of standards, lack of research into updating testing techniques, and vulnerability of private laboratories to purchase by interested parties, such as big seed companies, will be causes for concern, and will eventually need attention.

Technical improvement

The seed industry has received substantial technical support for a long time in terms of academic research (University of Queensland), applied research, extension and new cultivar seed multiplication (QDPI field units) and seed technology research (QDPI Standards Branch). It has also itself been both innovative and ready to adopt innovation from other branches of agriculture, particularly with machinery, and most especially in matters of harvesting. The combined effect of all these influences has been to reduce production costs per unit of seed, and hence seed prices. Adjusted for inflation, sales prices of seed had by 1990 fallen to 40% of their 1970 values. Without such falls, it is safe to deduce, pasture improvement in northern Australia would have been stifled. Ongoing technical improvement has thus proved to be vital.

The immediate objective of individual seed grower or merchant initiatives to increase production efficiency has, of course, been greater personal profit. The flow-on to reduced seed prices has then been a consequence of the openly competitive nature of the industry. The value of such reductions is generally only perceived in retrospect by the individual innovators. It is foreseen most clearly by the representatives of the industries that benefit directly from it — the customers in beef production and dairying. Understandably, it is they who were most influential in getting technical support established, and it is their objectives (essentially, to ensure a reliable supply of cheap, high-quality seed) that have been those of the technical support groups. In pursuit of these objectives, my own research group has had the following targets:

- to understand the mechanisms of crop development, attainment of seed quality, and seed deterioration sufficiently to achieve these objectives;
- to use this understanding to help the industry to develop effective supply systems;
- to develop a knowledge base of general industry experience and information available to all;
- to conduct the early seed multiplication of new cultivars ourselves, to ensure not only a supply of pre-commercial seed, but also enough knowledge of production methods to launch commercial production safely.

Sources

Although the present subject matter has been written about elsewhere at various times, recent developments in my own views have owed most to the discipline of having to share with industry members the task of identifying issues for public debate. The results are recorded in Rains *et al* (1993) and collectively in the Proceedings of the 5th Australian Tropical Pasture Conference (various authors, 1996).

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The Kerala experience with forage seed production and supply systems

The Kerala experience with forage seed production and supply systems

K. Krishnan[1]

Kerala lies between 8° and 12° in southern India. It has three broad natural divisions running from north to south: the highlands in the east, undulating midlands in the center, and the flat lowlands bordering the coast. Dairying is important in Kerala. The Kerala Livestock Development Board (KLDB), formerly the Indo-Swiss Project, organises the production and supply of forage seeds in Kerala. The development strategy of the KLDB has been to introduce and evaluate new forage species to promote the use of successful ones and to organise distribution of seed to farmers. The species now popular among farmers are *Brachiaria ruziziensis*, *Panicum maximum*, *Centrosema pubescens* and *Stylosanthes hamata*. Seed production of *B. ruziziensis* and *P. maximum* is organized through the dairy farmers. *Centrosema pubescens* and *S. hamata* are procured from other agencies. The present system of seed production has evolved as resources have become available and farmers and the KLDB have gained experience. Annually, about 50 tonnes of seed of perennial forage species is distributed through the State Dairy Development Department and Milk Unions.

Introduction

Kerala, in southern India, occupies a long, narrow coastal strip between the Arabian Sea and the Western Ghats and lies between 8° and 12°N. It is 580 km long, 120 km wide in the middle, and 30 km in the extreme north and south. Kerala is one of the smallest states in India with an area of 38,863 km^2 with a population of about 29 million people. Topographically, Kerala has three broad natural divisions running north to south: the highlands in the east, the undulating midlands in the center, and the flat lowlands bordering the coast in the west. The highlands west of the Western Ghats range in elevation from 1,000 to 2,500 m. The mountains are covered with evergreen forests; the lower elevations are suitable for plantation crops such as tea, coffee, cardamom and, to a limited extent, rubber. These highlands are sparsely populated with about 250 people/km^2. The lowlands, in contrast, have a population of 1,685/km^2. There, in addition to agriculture, the main occupations are coir making, fishing, and cashew processing.

The lowland region consists of a strip of land along the coast not more than 30 km in width at any point, having a near-level topography, with sandy to sandy loam soils. Rice is grown in wetland areas and coconuts are grown in higher elevations. Intercropping under coconut is common and a great variety of crops, including pepper, are grown in coconut plantations.

[1]Kerala Livestock Development Board Ltd., Dhoni, Palakkad, Kerala, India.

Between the highlands and the lowlands are the midlands with elevations under 1,000 m. The hills become flatter with gentler slopes and the valleys become wider. The soil in this region is lateritic. The midlands produce a variety of crops including rice, cassava, banana, ginger, lemon grass, pepper, areca nut, cashew, coconut, and rubber. This region has a population density of 878 people/km^2.

Seasons in Kerala are defined by the southwest and northeast monsoons which are a distinct feature of the west coast of India. The southwest monsoon occurs from June to August and the northeast monsoon from October to December, having a rainfall spread of 6-7 months. The annual precipitation averages 3,000 mm with a small annual variation of less than 20%. Within Kerala, the variation in rainfall is substantial. In the Trivan-drum District (southern Kerala), the average annual rainfall is about 2,000 mm while it is as high as 3,580 mm in Ernakulam District and 3,450 mm in the northern districts of Kozhikode and Cannanore.

High humidity throughout the year keeps evaporation low and hence reduces the demand for irrigation water but also favours the incidence of pests and diseases.

Extremes of temperature are not experienced in most parts of the state. The mean minimum temperature moves within a range of 19°C and 26°C while the mean maximum varies between 27°C and 37°C. However, from the Western Ghats to the seacoast, within 120 km, the climatic conditions vary remarkably from humid temperate to humid tropical climates, which enables Kerala to grow a wide variety of crops.

Fodder development program of KLDB

The cattle breeding program of the Indo-Swiss Project, Kerala (now the Kerala Livestock Development Board - KLDB) developed a new breed of cattle suitable for the conditions in Kerala. Along with a breeding programme, the project also undertook applied research for improving the natural grasslands and introducing fodder species suitable for the farming systems in the state. The area of operation, initially confined to the highlands, was extended to other parts of Kerala.

The effort of producing a new breed of cows with high milk yield potential is pointless if these cows are starving. Without a parallel improvement in nutrition, the genetic potential would be wasted. Formerly, cattle subsisted on rice straw and other crop residues of poor nutritional value. A programme of fodder improvement was therefore started. The strategy was to introduce and evaluate new fodder crops, promote the use of the successful species, and ensure their distribution to farmers. This began with the provision of vegetative material but necessarily shifted to seed production as demand grew.

Plant introduction and evaluation

The main sources of forage species were Australia, South America, and Africa. They were made procured through the Indo-Swiss project. Forage species were tested in various locations with differing agroclimatic conditions.

A range of forage species/cultivars were selected for different climatic zones (Table 1).

Table 1. Forage species/cultivars selected for different climatic zones in Kerala.

Climatic zone	Species/cultivar
Lowlands and midlands	*Andropogon gayanus*
	Brachiaria decumbens cv. Basilisk
	Brachiaria ruziziensis
	Brachiaria humidicola
	Panicum maximum cv. Makueni
	Panicum maximum cv.Riversdale
	Setaria sphacelata cv. Kazungula
	Centrosema pubescens (local)
	Leucaena leucocephala cv. Cunningham and K8
	Lablab purpureus cv. Rongai
	Stylosanthes hamata cv. Verano
High ranges	*Chloris gayana* cv. Katambora
	Dactylis glomerata
	Lolium multiflorum
	Lolium perenne
	Melinis minutiflora
	Pennisetum clandestinum
	Setaria sphacelata cv. Kazungula and cv. Narok
	Desmodium intortum
	Desmodium uncinatum
	Trifolium repens

The beginning of forage seed production

During the late 1970s, we experienced a complete failure of imported seed, causing loss of time and money. During this time, we investigated producing seed locally. The initial problem was how to develop the technology to produce grass seed in large quantities.

During a pilot phase of the seed production programme selected forage crops were Introduced to dairy farmers and promoted for feeding to cattle. Elite forage-cultivating farmers were selected and registered as seed growers. A contract was drawn between the KLDB and the seed growers, in which the seed growers agreed to abide by the guidelines fixed by the KLDB for the production and supply of the seed. The KLDB gave an undertaking to buy all good-quality seed produced by the farmers at an agreed price. During the pilot period, trained technical staff closely supervised the seed crops. The farmers were also given practical training on various management aspects of seed crops. During the pilot phase of the programme, financial assistance was given to seed growers to meet the establishment costs during the first year and maintenance costs during the second year. All seed produced by the growers was bought at fixed rates. By the end of the pilot period, all the interested farmers became active and registered seed growers.

The forage seed program of KLDB

The strategy employed by KLDB has been to encourage production of seed by the private sector with KLDB providing technical support. The service provided by the KLDB includes assistance with production aspects, sampling, testing, procurement, storage, processing, and distribution of seeds.

The present system of seed production has evolved progressively as resources have become available and experience has grown. The main principle has always been that the forage seed is produced commercially (governed by market factors) by private growers.

Production of basic seed

A seed multiplication programme starts with the production of basic or foundation seed, which is then used by registered seed growers for commercial seed production. This is essential to guarantee the genetic purity and identity of cultivars.

A 10-ha seed farm of the KLDB is located at Palakkad. Pedigree seeds of selected cultivars are multiplied here and the seed is distributed to selected seed producers for multiplication.

Commercial seed production

Commercial production of fodder crops is carried out by registered seed growers in selected areas. These areas were chosen on the basis of their agroclimatic suitability for seed production and that seed production was an acceptable enterprise to the farmers. These areas tended to be in poorer districts where more profitable, traditional plantation crops were not successful.

Commercial seed production has only been able to thrive as a component of an integrated programme, which included cattle breeding, fodder production, and milk marketing. Before launching a seed programme in an area, it is necessary to conduct a close study of the agroclimatic constraints, the existing cropping system, and the relative economics of forage seed production.

Forage seed production was a new concept to farmers and nothing would have happened without very active extension. Farms are very small and the quantity of seed produced per farm was also small.

Seed-growing areas

The seed production areas of the KLDB are located in the high ranges. The area is in a rain-shadow as a result of mountains to both east and west; it is relatively sunny and dry. Chakkupallom, Nirmalacity, Rajakumari, and Rajakkad are located in the high ranges at 850 – 1,000 m in elevation (Rajakkad being the lowest and Chakkupallom the highest and coolest). Chakkupallom receives an average annual rainfall of about 1,600 mm; Rajakkad and Rajakumari are wetter, averaging 2,500 mm.

Brachiaria ruziziensis is the major seed crop produced in this area and accounts for 90% of the total production in Kerala. Other seed crops produced in these areas are *Stylosanthes guianensis* and *Panicum maximum.*

Another site of seed production is located at Palakkad, which is in the midland region. This area is drier than the highlands. The major grass grown in this area is *P. maximum* cv. Riversdale. Production of this species commenced in 1991.

Support development

There are two regional offices, which organise forage seed production in Kerala. Providing local infrastructure in the target area has proved important. This includes facilities for the collection and short-term storage of seeds.

As the seed producers in the target area are a low-income group, financial assistance was initially given for establishment of the seed crop during the first year and its maintenance during the second year. Technical guidance on agronomic practices of crop production and seed testing are also provided to seed growers. Banking institutions have started to advance short-term loans to producers to stabilise the seed production enterprise.

Seed quality control

A seed testing laboratory is in operation at Dhoni, Palakkad, capable of handling 5,000 samples per year. This laboratory provides a sampling and collection service. Seed growers harvest, process and bag the seeds using traditional methods. An officer, trained in sampling techniques, visits the seed growers and draws two official samples from the seed lots of individual farmers after sealing the bags. Both the official samples are sealed and one of the samples is deposited with the grower and the other taken to the seed testing laboratory. Samples are tested using standard ISTA (International Seed Testing Association) procedures for purity analysis and either a germination or viability test (tetrazolium test). Minimum seed standards have been adopted and are the same as those previously used in Queensland, Australia. If the test value complies with the standards, a certificate is issued to the procurement officer in the field, who is responsible for the safe procurement and transport of seed to the central seed store.

Procurement and storage of seed

There are two sources of seeds — seed growers of KLDB and other agencies inside and outside Kerala. KLDB is concentrating on the production and distribution of pasture seeds, which are not available from other agencies. Major species procured from other agencies are *S. hamata* and *C. pubescens*, while seed of *B. ruziziensis* and *P. maximum* is produced by seed growers (Figure 1).

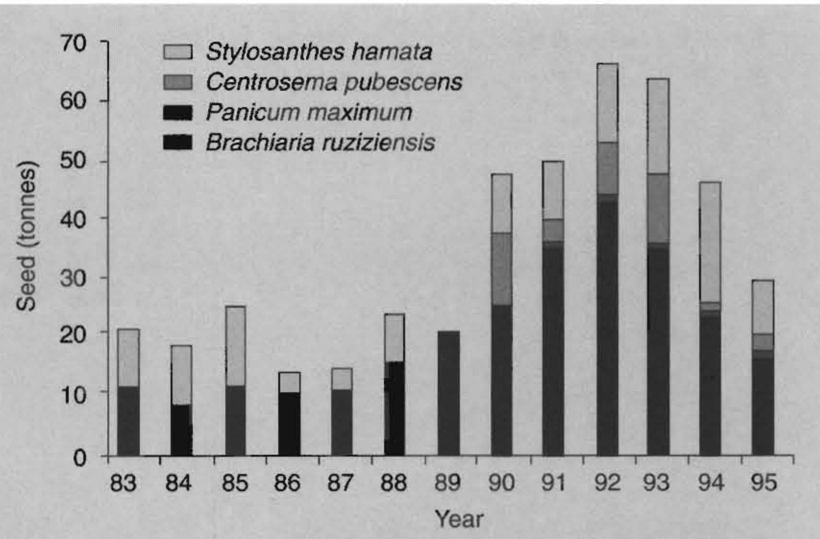

Fig 1. Seed production and procurement of the four most important forage species in the KLDB programme, 1983-1995.

A seed storage facility, with a capacity of 100 tonnes, has been constructed at Dhoni, Palakkad. This seed store is equipped with seed graders, cleaners, seed drying units, and cold storage. Seed is stored in open storage for short periods and, for longer periods, in cold storage where humidity and temperature are controlled. Usually, the storage period is about 6 months. When all the seed of a particular cultivar has been collected, it is blended in the seed store to provide a uniform product.

Seed distribution/seed marketing

The main consumers of perennial forage seeds are Kerala farmers. The seeds are supplied through various organisations, but mostly through the State Dairy Development Department and Milk Unions.

Brachiaria ruziziensis, P. maximum, C. pubescens, and *S. hamata* were the major species supplied during recent years. Small quantities of other forage species were also produced by growers or purchased from other agencies (Table 2). The seeds are supplied pure or in mixtures according to the requirement of the consumer. Seeds are sold in plastic bags of varying sizes. Each packet contains a leaflet with management introductions in the local language and a quality label showing the expiration date of the seed.

Table 2. Seed of minor forages produced or purchased (kg) in the KLDB programme, 1983-1995.

Species	Year												
	83	84	85	86	87	88	89	90	91	92	93	94	95
Grasses													
Andropogon gayanus							17	34	313	133	167	257	148
Brachiaria decumbens	140		35	129	120	74	125	166	46	65	128	92	104
Brachiaria humidicola										45	103	6	45
Cenchrus ciliaris							28	24					
Chloris gayana	10												
Melinis minutiflora	990	430	1100	171	32	30	19	20	55	21	53	22	26
Setaria sphacelata cv. Narok, Kazungula, Solander	14	6	18	12	7	6					24	50	48
Legumes													
Desmodium intortum cv. Greenleaf			25	20	6	6	43	10	10	10	4	7	47
Desmodium uncinatum cv. Silverleaf			20	14	16	16	15	1				1	12
Lablab purpureus cv. Highworth							70	144	191	31	189	86	70
Lablab purpureus cv. Rongai			71	57	3	30		14					
Leucaena leucocephala cv. Cunningham			35	178	381	64	70	263	206	50	48	100	115
Leucaena leucocephala K8			22	51	83	67	41		21	9		29	8
Macroptilium atropurpureum cv. Siratro						36	18	23	34	12	18		
Macroptilium lathyroides							7	22	49	84	52	58	69
Macrotyloma axillaris								6	11				
Stylosanthes guianensis CIAT 136									54	89	183	228	62
Stylosanthes guianensis cv. Graham			12	12	12	12							
Stylosanthes guianensis cv. Schofield	2003	1913	1258	917	658	180	4561	72					
Stylosanthes scabra								128	130	113	110	272	292
Trifolium repens							2		3				

Economic considerations

The economics of the seed program is complex. The grower produces seed at a certain cost. Thereafter the seed is procured by the KLDB, transported, tested, packed, and sold to a buyer.

Three very different parties are involved in this process. The producers are mostly small farmers. Their decisions are probably the most rational in the scheme; they will produce seed as long as the procurement price is higher than their production cost. The KLDB is in the strongest, but also the most responsible, position. The KLDB determines the prices for buying and selling seed. If the buying price is fixed too low, the producers will be reluctant to produce. If the sale price is too high, the buyers will be reluctant to buy. The selling price is currently double the procurement cost (100% markup) assuming that this markup covers the cost of the KLDB. The buyers are the third party in the programme and probably the most difficult to predict. They are mostly institutional buyers rather than endusers. They do not buy according to the benefit they expect to get from the seed, but according to the money they are allotted under government schemes.

The forage seed business is a comparatively new economic activity in Kerala. The seed market has not reached the stage where it can be privatised, since there is no such thing as a free forage seed market in Kerala. Market forces cannot play a role because the KLDB holds monopolistic control over the forage seed market in Kerala.

Conclusions

1. A smallholder forage seed production industry has been successfully developed in Kerala, providing additional income for poor farmers.
2. Forage seed production thrives only as a component of an integrated and effective programme for cattle breeding, fodder production, and milk marketing.
3. Developing a forage seed production industry with farmers requires a lot of time and effort. It is a new activity for farmers and, initially, they are predictably cautious. An active field programme is needed for many years to encourage the involvement of sufficient farmers for the industry to have "critical mass".
4. Kerala State, with its tropical wet monsoon climate extending over 7 months, is not ideal for forage seed production. Seed crop failures, because of adverse climatic factors, are common.
5. Like any other seed crop, forage seed production is a specialised activity which requires the support of trained field staff.
6. It is essential to study the following aspects before a seed production scheme is launched in a new area:
   - agro-climatic constraints on the new seed crop proposed for the area
   - existing cropping structure and relative economics of crops
   - breeding facilities and availability of improved cattle for economic milk production
   - milk marketing facilities
   - availability of family labour

Beyond the formal sector: fodder and forage seed networks in India

Beyond the formal sector: fodder and forage seed networks in India

Cate Turton and Pari Baumann[1]

Research by the Overseas Development Institute (ODI) on seed has concentrated on the needs of smallholder farmers in complex, diverse, and risk-prone environments. Major conclusions include the fact that services offered by the formal sector are inappropriate to the needs of such farmers, who have developed complex seed supply systems to meet their needs. The seed needs of farmers and organisations involved in fodder production are relatively specialised in comparison to major grain crops. This paper outlines how, in India, the majority of fodder and forage seed is generated outside the formal sector and describes the complex and sophisticated networks that have developed for the production and distribution of such seed.

Introduction

This paper begins with an outline of previous ODI research on seed systems in developing countries, followed by an analysis of the systems in operation for the production and distribution of fodder seed in India. This is based upon field research carried out, under the auspices of a collaborative project between the Indian Grassland and Fodder Research Institute (IGFRI) and the Institute for Grassland and Environmental Research, UK, during January to April 1996. The purpose of the project is to develop an enhanced institutional capacity at IGFRI, to orient its research to the technical and socioeconomic needs of its client farmers and agencies concerned with wasteland rehabilitation (GOI/ODA, 1993). A key objective of the Indo-UK project is to make quality seed available to farmers and these implementing agencies.

History of ODI seed and biodiversity research

Early ODI research on the performance of the seed sector in developing countries was conducted in the context of the changing economic environment in sub-Saharan Africa. The adoption of structural adjustment programmes had led to pressures for the reform of, the often heavily subsidised, agricultural input sector. An analysis of the potential impact of these reforms on the availability of seed to smallholder farmers in three case study countries, Zimbabwe, Malawi and Zambia, was undertaken (Cromwell *et al.*, 1992; Friis-Hansen, 1992; Cromwell and Zambezi, 1993). The major conclusion of these studies was that changes in the macroeconomic environment had little effect on the availability of seed to smallholder farmers, who were predominantly served by informal, often community-based, seed systems. For many years, farmers have relied on methods

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such as retaining seed on-farm from harvests, farmer to farmer seed exchange based on barter and social obligation, and limited local trading to meet their seed requirements (Cromwell, 1990). The term 'informal sector' was used to describe activities relating to seed production and distribution which take place outside the official institutions which are involved in the development, multiplication, processing, and distribution of seeds of released or notified varieties. A useful summary of key characteristics of this sector is given by Cromwell *et al.* (1992):

- it is *informal* or *semi-structured* in its organisation, changing between location and over time and not subject to the same rigidities of ownership and control as formal sector organisation;
- it operates mainly, although not exclusively at the *community level*, although lines of supply may extend over a relatively wide geographic area;
- a wide variety of *exchange mechanisms* are used to transfer seed between individuals and households including cash, barter, and transfers based on social obligations; and
- the individual *quantities of seed* exchanged are often very small compared to the amounts formal sector organisations typically deal in.

These findings were substantiated by further work in Nepal and case studies from Asia, Africa, and Latin America which emphasised the complex, often sophisticated, nature of the so called informal sector (Cromwell, 1990; Cromwell and Green, 1992).

Since these initial studies, ODI work has focused on the seed systems in operation for farmers in complex, diverse, and risk-prone (CDR) environments, which are often difficult to reach through the services of the formal seed sector. Cromwell *et al.* (1993) investigated the potential role of non-government organizations (NGOs), in supporting local seed production systems. However, although isolated examples of successful schemes were apparent, many of the schemes were heavily subsidised and NGO efforts were characterised by their random distribution and resource-intensive nature. The problem of scaling up NGO efforts to reach larger numbers of farmers is a challenge familiar to other areas of agricultural research and development. Furthermore, seed produced by smallholder farmers acting as 'contract growers' (usually better resourced farmers) is sometimes bought up by the organising agency and transported outside of the area for processing, certification, and distribution (Cromwell and Tripp, 1995). The work concluded that NGOs and related organisations offered one alternative to the formal seed system in improving the availability of quality seed to farmers in CDR environments, but NGOs find it difficult to address all the seed needs of these farmers.

Current work is exploring how these needs can be met, focusing on the nature of the planting material available to farmers and the impact of the regulating environment on seed supply and the economies of local-level seed production and distribution. At the local level, work in Zimbabwe concentrates on the economic, social and environmental factors influencing farmers' willingness and ability to conserve crops and varieties on-farm. This complements recently completed work which aimed to increase the understanding of factors influencing farmers' decisions to grow multi-purpose trees (MPTs). It also investigated the mechanisms by which farmers obtain germplasm for MPTs, and the potential for improving the availability of MPTs to farmers, through external channels and through selection, multiplication and distribution of germplasm at community level (Cromwell *et al.*, 1996). Research is also being carried out on ways of speeding up the process of variety notification and release through farmers' participation in plant breeding.

At the policy level, a review of seed regulatory frameworks addressed the context for seed development activities in a number of case study countries (Tripp, 1995). The review questioned the appropriateness of the laws, regulations, norms, and standards that govern varietal release and certification. It concluded that they are often unnecessarily strict and can severely limit the availability of seed, particularly in the case of minority crops such as forages which receive little official attention and investment. Finally, recently conceived work will look at the potential for supporting and developing seed enterprises in the private (commercial and voluntary) sector.

Fodder and forage seed systems in India

The remainder of this paper reports the findings of a study carried out to assess the strengths and weaknesses of current systems of seed production and distribution of both fodder crops (such as pearl millet and forage sorghum) and forage species. The mechanisms, both formal and informal, through which farmers and agencies obtain seed, will also be discussed.

Background

The study consisted of three major components:

1) a postal survey of the principal organisations involved in the seed chain;
2) interviews with key actors involved with fodder and forage seed production and distribution, including plant breeders, members of research institutions, representatives of government ministries and departments at the national, state, and local levels, non-governmental organisations (NGOs), and private companies and seed agencies; and
3) case studies to gather details of the views and perceptions of farmers and communities involved in either the production or use of fodder seed. The case studies were based on interviews with key informants, limited household surveys, group discussions, and selected participatory research methods.

India has the highest livestock population in the world, with a bovine population that has increased 31% over the past 30 years; from 198 million in 1951 to 259 million in 1987. Sheep and goat populations have increased from 47 to 144 million during the same period (Poffenberger, 1996). Despite a general agreement in policy circles that there is a critical feed shortage, estimates on the extent, nature, and effect of this vary widely. One estimate is that only 60% of the total feed requirement is being met at present, with high mortality rates and low productivity as an inevitable consequence (Hazra, 1995). The main sources of feed are crop residues, cultivated fodder crops, stall-fed and grazed grass and legumes, and tree fodder. Concentrates and agricultural byproducts provide additional nutrition for a limited number of livestock. Relative dependencies on these sources vary considerably from region to region, but a broad distinction can be drawn between irrigated areas and rainfed areas. In irrigated areas, crop residues and cultivated fodder crops are important sources of feed, while in the latter, there is a heavy dependence on grazing land.

In line with the general concentration of agricultural policy, research and development on fodder and forage crops has focused on meeting the needs of medium- and high-income farmers in irrigated or reliably rainfed areas and more specifically, on the development of high-yielding varieties of fodder crops. The shrinking area of common grazing lands and their declining productivity suggests, however, that feed deficits may be more critical for farmers in rainfed areas. As a result, and in response to increasing environmental concerns, the Government of India is currently investing around £100 million/annum in wasteland rehabilitation and watershed development projects.

Users of fodder and forage seed

Before examining the systems in operation for the production and distribution of fodder and forage seed, it is useful to look more closely at the characteristics of the main users of seed and their needs. It is helpful at this point to make a distinction between *cultivated fodder production* and *forage grasses and legumes*. This paper will focus only on tropical and subtropical species of forage grasses and legumes. Demand for seed of fodder crops comes mainly from farmers in irrigated areas, who are often involved in commercial dairy production. Popular crops include berseem (*Trifolium alexandrium*), fodder millet/maize/sorghum, oat, cowpea, and lucerne. Demand for forage grasses and legumes comes from individual farmers for planting in uncultivated areas of farmland such as wastelands, field boundaries and bunds and, more importantly, from agencies involved in the regeneration of wastelands and grazing areas.

Formal seed systems

Only a few sentences are needed to describe the role of the formal seed system in relation to the supply of fodder and forage seed. National priorities have concentrated on self-sufficiency in food crops and institutional means ensuring feed supply for animals have not been developed. There is no department or agency within the Ministry of Agriculture responsible for the supply of fodder or forage seed.

Although there are over 100 released varieties of fodder crops, it is estimated that less than 5% of farmers who cultivate fodder crops use certified seed of these varieties. This is considerably less than for food crops but comparable to other minor crops. The majority of these farmers receive their seed through the National Dairy Development Board (NDDB) and various government programmes. Private company involvement is limited to trading in hybrid sorghum, maize, and millet. If we look at the supply of seed for forage grasses and legumes, it is evident that the formal sector is barely functioning. Apart from small amounts of breeders seed of grasses produced by the Central Arid Zone Research Institute in Rajasthan, all activities relating to seed production take place in the informal sector.

Although not strictly belonging to the formal sector (defined as certified/truth labeled seed of released varieties), the activities of the following are worth noting here. A few organisations produce and distribute truthfully labeled seed. These include state agricultural universities, government agricultural stations, and research institutes and the Kerala Livestock Development Board (Krishnan, 1998). The only centrally organised scheme for forage seed production is the National Afforestation Board Seed Production Project initiated in 1990. Seed is produced at different agricultural research institutes and the price of seed is based on covering the cost of production on a no-profit, no-loss basis. Over the 5-year life span of the project, over 150 tonnes of seed of (in descending order of importance) *Stylosanthes* spp., *Cenchrus ciliaris, C. setigerus, Atylosia* sp. and *Dicanthium annulatum* have been produced.

The production of certified and truthfully labeled seed by official agencies is thus limited in scale and scope. Furthermore, production is focused around a narrow range of species which do not suit all environments.

Informal seed systems

The majority of fodder and forage seed consists of uncertified seed, usually of local varieties, being produced and distributed by farmers, seed merchants, and merchants. Yet, despite their overwhelming importance, few studies of informal systems of fodder and forage seed production and distribution have been carried out. Basic questions such — from where do the majority of farmers and users obtain seed? what channels do they use and why? what problems do they experience? — remain unanswered. The seed systems in operation for cultivated fodder crops and forage grasses and legumes are considered separately here.

Cultivated fodder crops

This section is based on a series of discussions held with farmers and seed merchants in and around the town of Dabra, Madhya Pradesh. It is suggested that the issues it raises may have wider relevance. Within the informal sector, there are basically three sources of seed available to farmers. In order of preference these are

1) retaining seed on farm from previous harvests;
2) farmer to farmer exchange within the local area on barter/exchange/cash basis; and
3) private merchants in local market.

For centuries, farmers have produced seed of all crops by saving and selecting part of their harvest for the following growing season. However, several factors, many specific to fodder crops, affect farmers' abilities to save enough quality seed for the following year:

- Most fodder crops have been bred to give high vegetative yield and seed productivity is low;
- Harvesting the crop for vegetative yield means that the end production of seed is often not realised. Similarly, fodder crops often do not achieve full maturity due to their place in intensive cropping patterns of irrigated areas;
- If farmers allow a small area of the crop to reach maturity, they will not be able to use traditional well-established practices of selecting seed according to the desired characteristics of the parent plant;
- There is a ready market for fodder seed and many farmers, particularly those in need of immediate cash, sell seed after harvest.

The combination of such factors results in relatively high replacement rates for cultivated fodder as compared to other crops; this has been estimated at 50% (Hazra, pers.comm.). The farmer looks to obtain seed from within the community or, more frequently, will buy on the open market. Although no formal organised structure exists, the open market consists of a well-established and complex network of seed merchants and traders. They are located in all major towns and stock or are able to procure seed of a range of crops. The seed is bought direct from local growers or from collection traders and middlemen. More established merchants will sell truthfully labeled seed.

The example of berseem seed in Dabra (Madhya Pradesh) illustrates the complex nature of the seed network. Relatively low cropping intensities in Dabra (rice-berseem) allow time for the crop to reach full maturity. Favourable climatic conditions result in high seed yield, with one *bigha* yielding 80-100 kg of seed; medium farmers can produce 0.4-0.5 tonnes of berseem seed a year and larger farmers up to 0.6 tonnes. Almost the entire demand for berseem seed comes from the Punjab state, where intensive cropping patterns do not allow the crop to reach seed-setting stage. The institutional links between the merchants in Dabra and the Punjab are well-established and based upon reputations; local seed merchants explained that they have to maintain standards to remain in business. Merchants buy directly from the farmer at the time of harvesting, sort the seed, and pay according to seed composition. For example, chicory seed is commonly mixed with berseem, but is also valued and therefore the payment is calculated according to the proportion and the prevailing rates. The Punjab merchants use a rough rule of thumb method to check for quality; seed turns from yellow to red to black as it ages. Farmers will look for the yellow colour, which usually has a germination rate in excess of 90%. In years when demand is high merchants come from Punjab and Delhi directly and buy seed without any quality checks.

The informal seed systems for cultivated fodder crops are paradoxically highly organised and will continue to meet the majority of farmers' fodder seed requirements. The role of the farmer and his/her access to different sources depends, to a large extent, on the place of fodder in the cropping system; in intensively cultivated areas, farmers are almost entirely dependent on the services provided by private merchants. Opinions on the quality of the seed supplied by the private market were mixed. Berseem farmers in Dabra were satisfied with the quality and price paid for seed, but less so with the fodder sorghum and maize seed. Some questionnaire respondents pointed to low standards of seed quality in the private market. However, there is insufficient evidence to form any conclusion and there is unlikely to be any clear pattern. Seed quality is liable to be heavily influenced by the level of competition in the market and standards are likely to vary with different crops (depending on reproductive characteristics, seed viability, *etc.*), and local environmental conditions.

Forage grasses and legumes

In India, increasing investment in wasteland rehabilitation as one means to reducing feed shortfalls in rainfed areas has led to a rapid rise in the demand for forage seed. Less prominent has been the potential for increasing feed production through the planting of forage grasses and legumes on private farmland. The vast majority of seed is produced and distributed without any formal controls. The main species being produced and distributed include *Cenchrus ciliaris, C. setigerus, Stylosanthes hamata, S. scabra, Dicanthium annulatum,* and *Pennisetum pedicellatum.* Other species such as *Lasirius sindicus, Chrysopogon fulvus* and *Heteropogon contortus* are of more localised importance.

The majority of the seed is not "produced" in the strict sense of being planted specifically for seed production. Instead, the seed is "collected," harvested either by being hand-stripped into containers or by being cut, stacked, and threshed from existing pastures. This distinction has important implications on the organisational structures required (such as the closing of pastures) and on the levels of investment and risk incurred in seed production and has influenced both the amount and type of seed that is produced, and the institutions that are involved.

The forage grass and legume seed system is characterised by a complex decentralised network of organisations and individuals, who play multiple roles in the generation, distribution and utilisation of seed. The main actors can be grouped into the following categories: (i) the public sector, (ii) NGOs and cooperatives, and (iii) the private sector. Considerable flows of seed take place both within the separate spheres of activity and also between them.

Public sector agencies involved in wasteland development are the biggest producers and users of seed. It is difficult to assess the amount concerned as records, if they are kept at all, are distributed over hundreds of local offices of the Forest Department, the Department of Soil and Water Conservation, and others. However, an indication of the quantity of unlabelled seed produced in the public sector is that all the representatives of the government departments contacted during our survey were involved in collecting seed. The quantity of seed required by the various agencies has spiraled in recent years and in response to rising prices and the dubious quality of seed available, Forest and Soil Conservation Departments have developed their own systems of seed procurement with the aim of becoming self-sufficient.

The degree to which departments are able to achieve self-sufficiency depends on the area of grasslands under their control, the history and degree of department involvement in grass planting activities, and the species required. The advantage that some of these public sector agencies have over other institutions, is the vast areas of land that they own or have access to. There are three main methods of organising seed collection: (i) employing labourers at a daily rate to collect seed, (ii) organising user groups for the collection of seed, and (iii) making seed collection a condition for the use of common land.

The majority of seed is collected by daily labourers or through local user groups with which the department is managing the area. With an increasing area now coming under joint forest management agreements, the latter approach is becoming more common. As well as ensuring the supply of quality seed to the department, the practice of paying user groups and individuals to collect seed has important socioeconomic implications for local livelihoods. The collection of nontimber forest products has traditionally provided a source of income to the rural poor, particularly tribal and landless people, and there are signs that the collection of grass seeds is adding to this source.

The local collection of seed enables departments to obtain grasses and legumes well adapted to the prevailing environmental conditions and preferred by the local people, instead of having to rely on the limited range available in the market. For example, some communities have very negative perceptions of *S. hamata*. Many district forestry officers are well aware of the favoured indigenous grasses and avoid the concentration on species such as *Stylosanthes* spp. and *Cenchrus* spp., that is a common feature of many wasteland development programs all over India.

NGO interests in seed production and distribution stem from two objectives: (i) to ensure a secure source of seed for their wasteland development activities, and (ii) to secure a fair return to producers/collectors of forage seed. Government grants are available to NGOs for watershed and wasteland development activities. NGOs do not own the land on which they are implementing projects and therefore have less autonomy to organise seed production. They therefore rely heavily on the private market and there is a considerable flow of information between NGOs regarding reliable sources of seed. Several NGOs are also promoting organised seed collection as a remunerative activity for local communities. The Aravalli Beej Vinimay Company in Rajasthan is an interesting example of a cooperatively run company, which organises seed collection and marketing of *Cenchrus* spp., ensuring reasonable returns to its collectors and high-quality seed to the market.

Although wasteland development agencies and NGOs try to meet their own seed needs, the vast scope of the private trade in seed indicates that they still have a long way to go to reach self sufficiency. The private sector responded rapidly to the escalation in demand for forage grass and legume seed that emerged at the end of the 1980s and continues to dominate production and distribution of seed. Private farmers and rural communities play important roles in seed production.

An interesting example of farmers' response to a market demand is that of smallholder *S. hamata* seed farmers in Andhra Pradesh. The escalation of demand and the encouragement of the Department of Animal Husbandry has resulted in the evolution of an industry that is now worth over Rs. 30 million annually to the farmers. In 1995/96, the seed production area was conservatively estimated to cover 25 villages and a total of 1100-1200 ha (Ramesh, pers. comm.). In comparison to seed production for other crops, *S. hamata* seed production is not the preserve of the wealthier farmer. Small and medium farmers, often set aside 50-100% of their land to the crop and poor households and the landless work as labourers. It is estimated that 90% of the labour requirement is met by women, who play the dominant roles in weeding, harvesting, and cleaning of seed. However, farmers' ranking revealed that problems associated with credit availability, marketing, seed processing, and health are threatening to undermine future production (Table 1).

There was considerable variation in opinion between the five groups. For example, wealthy farmers are more interested in the problems of marketing and securing bank loans, whereas poorer farmers and women are more interested in harvesting, sweeping, and processing problems. The health problems arise from the inhalation of the dust generated during seed cleaning, which causes asthma, bronchitis, fevers, body pains, and menstrual problems.

Table 1. Farmers' ranking of problems associated with seed production.[a]

Problem	Women group			Men group		Total
	1[b]	2[c]	3[c]	1[b]	2[c]	
Weeds	4	0	0	6	0	10
Pests	0	0	0	0	0	0
Disease	0	0	0	0	0	0
Availability of cultivars	0	0	0	0	0	0
Harvesting	27	4	8	10	4	53
Sweeping	10	6	11	1	0	28
Processing/cleaning	14	13	3	7	3	40
Labour availability	3	0	0	3	0	6
Marketing	0	0	0	11	0	11
Bank loan	4	0	0	14	5	23
Health	1	19	3	9	6	38

Notes:
[a]Three female and 2 male groups of farmers ranked the problems associated with seed production by placing 3, 2, and 1 stones on the first, second and third most serious problems. [b]Indicates that ranking was carried out during the village meeting. [c]Indicates that ranking was carried out in the field, mainly by labourers and small farmers.

A complex network of middlemen, merchants, and traders located at different points throughout the country provide the link between the seed collectors/producers and end users. This is illustrated for the case of *S. hamata* seed in Figure 1.

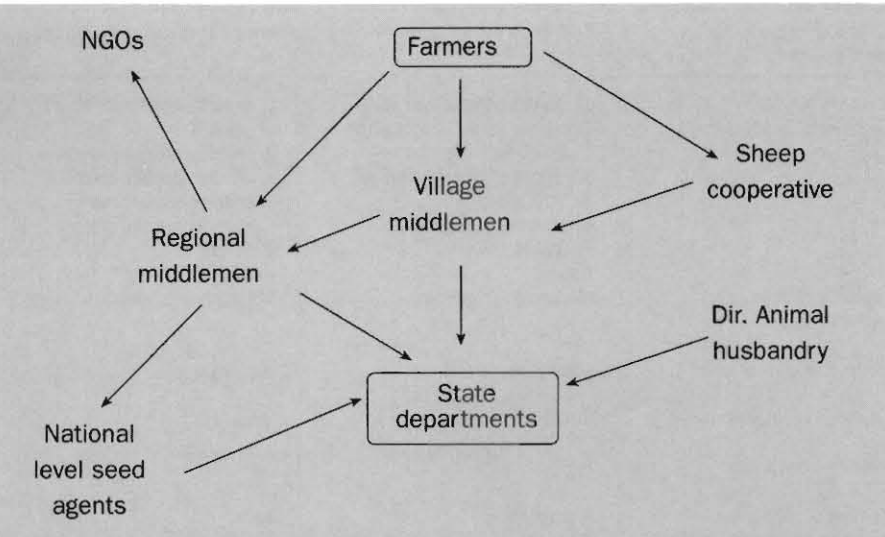

Fig. 1. Seed marketing channels for *Stylosanthes hamata* seed.

Seed merchants have established collection points in a number of areas, particularly those endowed with large areas of natural pastures such as in Rajasthan. At the first level are middlemen based in villages, who act as a nodal point for the accumulation of seed. People bring the seed to the collection point and are usually paid by weight. Second-order middlemen in larger villages or district headquarters coordinate seed collection from the network of villages and supply the seed to city-based traders, who in turn distribute it to the endusers. They often liaise with other traders located in urban centres throughout India, ensuring the movement of seed from production areas to those where it is required. Thus seed traders in Bangalore supply *Stylosanthes* spp. to areas as far ranging as the Andaman and Nicobar Islands and Himanchal Pradesh, and *Cenchrus* spp. seed moves from Rajasthan to Maharashtra, Madhya Pradesh, and Orissa. The whole system functions on a trust basis, using contacts built up over a number of years. The number of intermediaries, the seed passes through, determines to a large extent the proportion of remuneration that actually reaches the seed producer and in cases where many intervening links exist, farmers only a receive a fraction of the final seed value. The quality of seed may also deteriorate due to adulteration at different points in the chain. Traders keep a range of species in their availability list, but follow a policy of obtaining orders first, then procuring seed to meet orders from whatever sources.

In addition to "on the spot" requests, private traders also respond to tenders floated by government departments to supply seed through the following process: (i) estimates are submitted for the tenders floated to supply a certain quantity of seed; (ii) these are evaluated by the respective departments and accepted on a lowest cost basis; (iii) the seed is then delivered to the department who carries out a germination test; and (iv) full payment is received only after the department is fully satisfied with the seed.

Discussion

The overriding conclusion of this study is that the seed systems that have developed for fodder and forage species are fundamentally different from those for food crops. Both in terms of sources of seed and the desired seed characteristics (cultivar, quality, quantities required etc.), the factors that influence seed supply are unique (Table 2).

Table 2. Comparison of cultivated fodder crop and forage seed systems.

Characteristic of seed system	Cultivated fodder crops	Forage grasses and legumes
Sources of seed (in order of importance)	1. private unregulated market 2. farmer-saved seed/farmer to farmer exchange 3. regulated private market 4. NDDB 5. Government agencies 6. Others	1. enduser collected/saved seed 2. private unregulated market 3. official sources (including seed schemes, intra-government transfers) 4. others
Need for genetic purity/ new varieties	Moderately important	Not important (species level)
Physical quality of seed	Important	Important
Quantities required	Small	Large
Replacement rates	High	Low
End users' ability to maintain and disseminate new varieties	Questionable	Weak
Smallholder involvement in seed production	Better resourced farmers only	Resource-poor farmers and rural communities (especially women and elderly)

For fodder-crop cultivating farmers, physical purity and good germination percentage are valued. However, genetic purity is not a priority. In the case of forage grass and legume seed, endusers are reluctant and often unable to meet the extra costs incurred in meeting genetic purity.

A participatory approach to plant breeding and cultivar development

Considerable resources are being devoted to plant breeding activities in forage grasses and legumes. However, this improvement work is largely being carried out without direct contact with farming communities, the ultimate endusers of this research effort. The focus of research must move from on-station to the field and incorporate a thorough understanding of the functions and characteristics of species desired by farmers and their knowledge and preferences in selection procedures. Investigations of how new planting material can be introduced into informal seed systems are also needed.

Scope of informal sector

Despite much criticism in official circles of the activities of the informal sector (notably the private market), preliminary indications from the field suggest that in some areas at least, the chain of seed production and distribution is working to the seed users' satisfaction. Recent work on the systems in operation for bean seed in central Africa drew similar conclusions highlighting the importance of the private market for subsistence farmers. It concluded that new planting material can be successfully distributed to farmers using already established channels such as through a variety of market outlets and community dissemination. Built-in check mechanisms and the need for merchants to maintain reputations help ensure seed quality. This is not to suggest that such channels function perfectly. The lack of back-up mechanisms can result in variations from year to year and serious shortages following drought years. Closer consideration of ways to support and improve the services offered by the informal sector are important in improving the access of farmers and users to quality seed.

The formal seed sector is incapable of reaching large numbers of farmers and endusers and there are serious questions over its sustainability, mainly as a result of economic parameters. On the other hand, the informal seed sector, which proves valuable in supplying large quantities of seed, appears to neglect some quality parameters. Despite its well established nature, its effectiveness and eventually sustainability, maybe threatened by rapid changes in agroecological or socioeconomic conditions. An analysis of the strengths and weaknesses of the two sectors leads to the conclusion that informal and formal sectors are complementary (Table 3).

Table 3. Complementarity of the formal and informal sectors.

Characteristic	Formal	Informal
Type of seed	• Certified/truthfully labelled	• Truthfully labelled/unlabelled
Type of crop	• New varieties of cultivated fodder crops, particularly cross pollinating/hybrid varieties	• Local varieties of cultivated crops • Forage grasses and legumes
Client profile	• Better resourced farmers • Farmers in milkshed areas	• Farmers outside milkshed areas • Wasteland development agencies (on behalf of rural communities)
Agroecological environment	• Irrigated environments	• Irrigated and rainfed environments
Existing controls	• Same as for other crops	• Largely nonexistent
Main actors	• Public sector • NDDB • Private sector (regulated)	• Private sector (unregulated) • Wasteland development bodies • Farmers

Seed quality and availability

The picture regarding seed availability remains unclear. Government agencies and large projects expressed satisfaction with the quality of seed and usually had no problems with timely supplies. However, this is a conclusion that is based on a limited number of interviews and questionnaire responses, and may be biased by the fact that one of the study areas includes Rajasthan, a state relatively well endowed with natural pastures. Poor seed quality was mentioned as a problem by smaller NGOs and the limited number of farmers who are involved in private pasture development on fallow lands in Andhra Pradesh. This issue needs further investigation; feedback from the field on the performance of seed of different species is urgently needed.

Conclusions

The study highlighted some important principles to be considered when assessing the systems in operation for the production and distribution of fodder seed:

- Look at the whole picture — examples of successful seed production activities must be viewed in the wider context;
- View seed systems as complex networks linking together producers and users of seed. Attempts to improve seed availability and quality start with identifying the key weak links and bottlenecks in the networks;
- The scope of the informal sector extends far beyond the community level. Private traders efficiently move seed around from the point of production to the point of use;
- Supporting the informal sector is a key strategy to improving seed supply;
- Consideration of the nature of the consumer is important. Large agencies and projects can protect their interests and ensure certain quality standards are met. This will not be the case for individual farmers;
- There is a potential for forest departments to take greater responsibility for seed production;
- Seed production can be an important source of income for rural communities if appropriate support (both technical and economic) is available;
- Local knowledge of preferred species and management are an important resource and provide the building block for any pasture development program;
- In the case of forage grasses and legumes, getting quality seed produced (largely at the species level) is the first priority. Large investments in plant breeding and high certification standards are secondary objectives;
- There are no established pathways for dissemination of new varieties to the field. Similarly, there is little feedback from farmers to the research process.

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Mechanisms of forage seed supply systems in Bhutan

Mechanisms of forage seed supply systems in Bhutan

Sangay Dorji[1]

Livestock production is important in many regions in Bhutan. Improving feed supply is critical for improved animal production and the National Fodder Seed Production Centre has an important role in the forage seed production and supply system. This paper describes the current process and discusses the success and limitations of the forage seed supply system in Bhutan.

Introduction

Bhutan lies between 150 m above sea level along the southern border to mountain peaks over 7,000 m in the north and northwest. The monsoon rains start in June and continue until September/October. Temperatures rise in March/April and begin to fall rapidly in October. The crop seasons are thus clearly defined. The topography is mainly mountainous and hilly, and thus often unsuitable for cultivation of agricultural crops. A large part of the country is in temperate and alpine regions where grasslands play a vital role in the economy and general welfare of the inhabitants, since their livelihood is almost entirely dependent upon livestock production.

Bhutan's agriculture is dominated by smallholder mixed farming systems involving cattle rearing and crop cultivation. Cattle play a vital role within the farming system, being kept for draught power, manure for the cultivated fields, and butter and milk for home consumption and sale. Livestock rearing is part of the lives of over 90% of the Bhutanese population.

The success of livestock development in Bhutan largely depends on the availability of high-quality feed and fodder. Therefore, the Royal Government has given a high priority to the development of feed resources. Initially, forage seeds were imported. This had the disadvantages of seed not being available in times of need and placed a burden on the national foreign exchange. In 1981, a trial on grass seed multiplication was initiated and, based on encouraging results, a massive grass seed multiplication programme was launched with contract farmers in 1982. This program has led to the development of the National Fodder Seed Production Centre (NFSPC).

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[1]National Fodder Seed Production Centre, Bumthang, Bhutan.

The role of the National Fodder Seed Production Centre (NFSPC) in the forage development program

The NFSPC belongs to the Ministry of Agriculture and is responsible for producing, procuring, and supplying fodder seeds for fodder development throughout the country (Ministry of Agriculture/Helvetas, 1996). Furthermore the NFSPC, together with the extension agents in the districts, is tasked with encouraging farmers to undertake forage development in order to increase livestock production. With the support and coordination of the Renewable Natural Resources Research Centres (RNR-RCs), the NFSPC is developing practical recommendations for pasture improvement and organises a forage seed production programme.

Forage seed demand and supply

The organisation of the seed supply system under the administration of the Royal Government of Bhutan is illustrated in Figure 1. Local extension agents assess the demand for seed at the district level. The projected need for forage seeds by the Dzongkhags (districts) are entered in the 5-year Development Plan. It is based on land area to be developed for pasture during each year of the plan. It is then forwarded to the Policy and Planning Division, approved by the Ministry of Agriculture, and given to the NFSPC for production planning.

Actual annual requirements for forage seed is forwarded annually from districts, central farms, and projects for cross-checking with the forecast demand in the 5-year plan. This demand and supply system is not without flaws because the demand is created by the national forage development policy and not by market forces. It often happens that the districts do not utilise all the seed that they had requested originally, since the effective requirement is dictated by the available budget. This has led to overstocking and carryover of seeds in some years at the NFSPC. The Centre has therefore reduced the number of contracts dramatically in order to avoid these problems. The fluctuation in the production is disliked by the contract farmers and is hampering the good collaboration between farmers and the Centre.

Seed demand for the current 5-year Plan (1992-1997) was forecast as 135 tonnes. Until now, the districts/farms have used only about 62 tonnes of seed. On the other hand, it has to be acknowledged also that not all forage seed requests can be met by the NFSPC, as in the case for *Desmodium intortum* cv. Greenleaf.

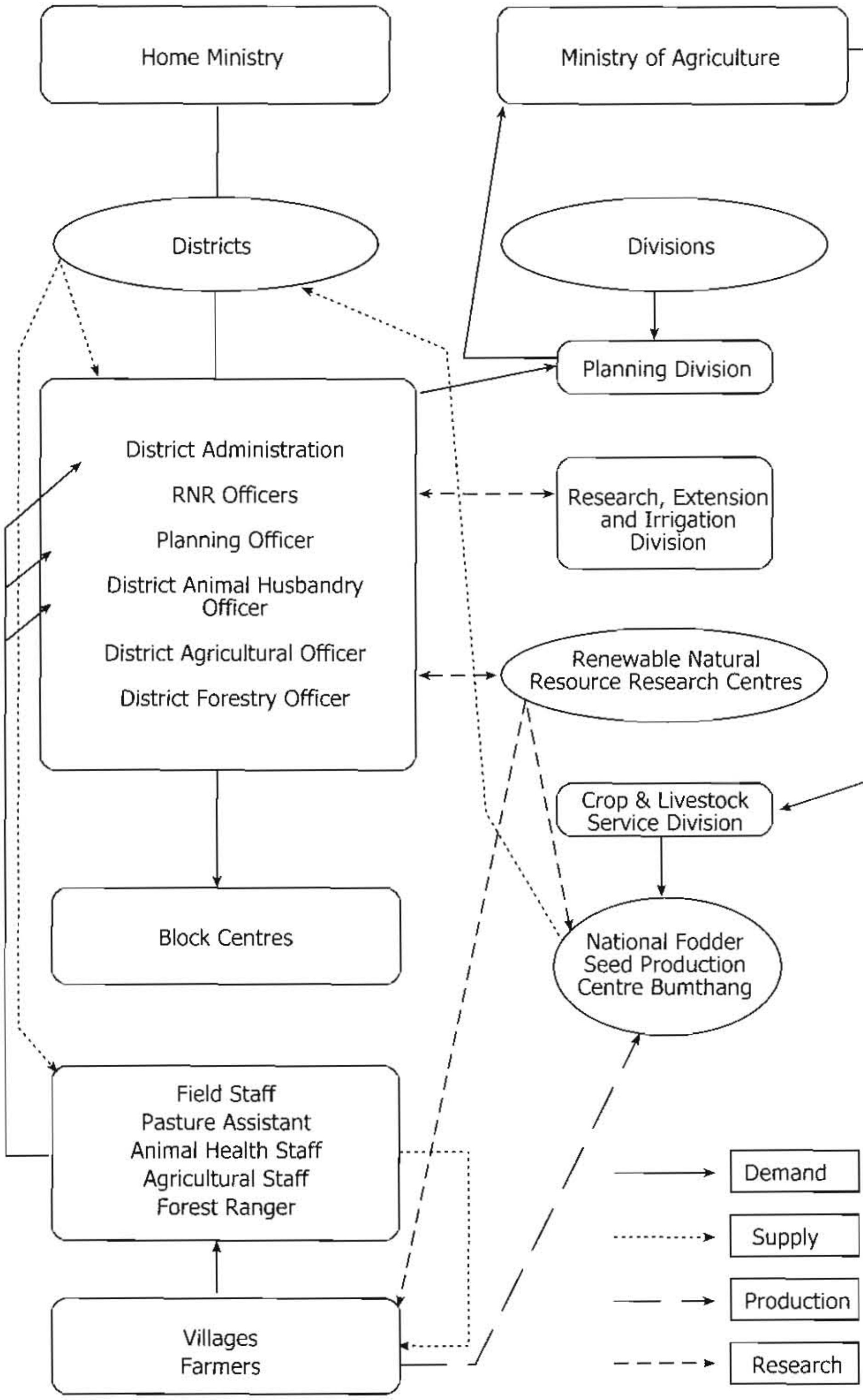

Fig. 1. The forage seed supply system under the Royal Government of Bhutan.

Organisation of seed production

The NFSPC produces seed in collaboration with contract growers (3-year contracts). Under this contract, the NFSPC provides

- free foundation seed and inoculant
- free technical advice
- free fertilizer (375 kg/ha single superphosphate and 250 kg/ha urea)
- market outlet for seed produced at the nearest Livestock Centre
- credit for fencing materials (barbed wire) which is recovered at the time of payment for seed.

The seed growers provide

- land for seed production
- nursery for seed
- labour and motivation

Past experiences have shown that there is good potential for temperate forage seed production in the country. Seed production research for sub-tropical species was initiated only 2 years ago, and already seed of several species is being produced for distribution. The NFSPC has been able to achieve production of seed by farmers with the help of incentives such as credit for fencing and free inputs. Farmers have always used these means as an entry point for the establishment of seed production fields.

In the future, it is hoped that farmers will group themselves into forage seed growers associations and the Centre would be responsible only for quality control and supply of basic seed.

Production technology

The NFSPC is currently producing seed of the forage species needed for different agroclimatic zones (Table 1) and many others are under study.

Table 1. Forage seed produced in Bhutan.

Species for the temperate zone (1,500 – 3,000 m asl)	
Grasses	*Dactylis glomerata* *Festuca arundinacea* *Lolium multiflorum* *Bromus* spp.
Legume	*Trifolium repens*
Species for the sub-tropical zone (500 – 1,500 m asl)	
Grasses	*Brachiaria ruziziensis* *Melinis minutiflora*
Legume	*Desmodium intortum* cv. Greenleaf

Cultural practices for each temperate species of grass have been developed by the Centre and farmers (Sangay and Beiri, 1992). The practices for subtropical species (transplanting, fertilising, irrigation, weeding, gap filling, time and method of seed sowing, closeness of grazing, harvesting and postharvest, threshing, cleaning, drying, and quality control) are still being investigated.

Farmers have modified some of the cultivation techniques to fit into their particular working environments. In the case of white clover, the NFSPC has not been able to develop a satisfactory technology to produce seed in pure stands. The current requirement for white clover seed is met through an open system whereby people collect seed on an *ad* *hoc* basis in pasture fields and sell it to or the Centre. To get the required clover seed, the Centre had to double the price before the seed collection became lucrative to individuals. The NFSPC also appointed white clover procurement agents, who were paid a fee of Nu.10 ($0.3) for every kilogram of white clover seed collected in their area above the cost of the seeds. The agents were provided with advance money to pay farmers on the spot. This strategy helped in producing more seed, but a major handicap of this system is the difficulty of achieving purity and quality standards.

Table 2. Standards used by the NFSPC for germination and purity.

Species	Germination (%)	Purity (%)	Seed purchase price (Nu./kg)*
Dactylis glomerata	66	70	30
Festuca arundinacea	66	75	28
Lolium multiflorum	70	80	18
Trifolium repens	70	90	140
Brachiaria ruziziensis	15	40	50
Melinis minutiflora	30	50	60
Desmodium intortum	70	93	180

*(US$1 = Nu.35)

Seed processing, procurement, and quality control

The seed is procured from contract farmers by the nearest livestock centre and the seed is brought to the NFSPC. The seed price is based on a production cost assessment and on quality standards for moisture content, germination capacity, and purity (Table 2). Once the seed has reached the Centre, every individual seed lot is kept separately until quality testing is completed. After completion of testing, the seed lots of the various farmers are processed and combined. Seed of the different species is mixed in a specified ratio, packed, labeled, and kept ready for sale and distribution (Table 3).

Table 3. Standard seed mixtures for different agroclimatic regions and recommended sowing rates.

	Proportion in species mixture (%)	Sowing rate (kg/ha)
Temperate region		
Dactylis glomerata	40	
Festuca arundinacea	30	28
Lolium multiflorum	15	
Trifolium repens	15	
Upper subtropical region		
Melinis minutiflora	50	15
Desmodium intortum	50	
Lower subtropical region		
Brachiaria ruziziensis	60	18
Desmodium intortum	40	

Constraints

The following constraints into the current seed production and supply system have been identified:

1. Forage crops, such as improved pastures, are not yet integrated in the farming system of the majority of Bhutanese farmers;
2. Markets for animal products such as milk, butter, and cheese are developed only in a very few pockets;
3. Seed demand from the districts is unrealistic, being based on targets rather than actual need;
4. There are no clear policy guidelines to monitor seed utilisation;
5. Providing credit facilities is time-consuming;
6. Withdrawal of the fertiliser subsidy for the seed user is seen to have a negative impact on seed utilisation;
7. At present there is only a narrow range of species suited to the different agroecological zones and cropping systems;
8. The seed production and supply system is not yet cost-effective.

Conclusions

Livestock production will continue to play a very important role in the farming system of Bhutan. With increasing demand for livestock products, the need for improved forage production will increase in importance. With this background, the NFSPC will have a vital role to play in supplying seed for forage development in Bhutan.

The NFSPC is currently capable of meeting the needs of most of the forage seed requirement in the country, except for *D. intortum* cv. Greenleaf. However, for the smooth functioning of the Centre and to avoid unnecessary wastage of time, money and efforts, some of the above constraints need to be addressed urgently.

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