Pasture improvement technologies

based on an on-farm study in Uganda

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Working Paper No. 18, 2002

Regional Land Management Unit (RELMA)

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Published by
Regional Land Management Unit (RELMA)
ICRAF House, Gigiri
P.O. Box 63403 Nairobi 00619
Kenya

Editing and Layout: Kimunya Mugo

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Abbreviations and acronyms

ASL	Above sea level
CAN	Calcium ammonium nitrate
ICRAF	International Center for Research in Agroforestry
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MFPED	Ministry of Finance, Planning and Economic Development
MPTs	Multipurpose trees
NAARI	Namulonge Agricultural and Animal Research Institute
NARO	National Agricultural Research Organization
NGO	Non-governmental organization
NPK	Nitrogen, phosphorus and potassium
RELMA	Sida's Regional Land Management Unit
SAARI	Serere Agricultural and Animal Production Institute
SSP	Single super phosphate
Ushs	Uganda shillings

Foreword

The livestock sector of Uganda is growing fast in response to the Government's Policy on Poverty Eradication and the Plan for Modernization of Agriculture (PMA). To enhance the process, the Ministry of Agriculture, Animal Husbandry and Fisheries (MAAIF) and various development agencies have introduced different pasture improvement technologies in an effort to increase and broaden the livestock feed resource base. Some farmers have adopted various technologies, which they have tested on-farm. However, such information has not been documented and thus achievements in this area have not been shared among the livestock keepers.

During the 1998 RELMA Regional Advisory Committee planning session, the need to document achievements in pasture improvement, particularly for livestock intensification, was brought up. In response to this request, RELMA commissioned the study reported herein, through a fellowship award with the following terms of reference:

- Review literature on pasture improvement technologies in Uganda and from relevant areas within the region (RELMA Region).
- Identify existing pasture management practices, local and those introduced on-farm in Mbarara, Kabale and Mbale districts.
- Conduct a short adoption/impact study on the introduced technologies.
- Suggest potential pasture management technologies for farmers in Mbarara, Kabale and Mbale districts.
- Propose content and material for proposed frontline extension/farmers training on pasture improvement and forage production in the districts.

This report presents the existing on-farm tested pasture grasses, fodder trees and shrubs management practices, with key references to practical applications observed in the field. Major constraints for wider adoption of the different pasture improvement technologies were identified as high prices of pasture seeds, lack of appropriate technology (e.g. spot/strip planting techniques and fodder conservation) and insufficient input and capital. However, it was observed that there is a high use of farmer-to-farmer source of planting material, which is an attribute in the farmer-to-farmer extension approach. This attribute was highly ranked as an appropriate extension methodology in the evaluation report of the RELMA pilot project in Mbarara district, the Uganda Soil Conservation and Agroforesty Pilot Project.

Åke Barklund
Director RELMA

Acknowledgements

This work is a product of a four months study (March to June, 1999). Part of this time was spent in the districts of Mbarara, Kabale and Mbale. I am grateful to RELMA, who provided financial support for this work. The personal interest, constant supervision and technical guidance form the RELMA Animal Husbandry Advisor, Dr. Aichi Kitalyi is heartily acknowledged. The moral support and concern received from Mr. Charles Rusoke, RELMA's Regional Advisory Committee member in Uganda, is highly appreciated.

I am indebted to Dr. Denis Mpairwe of MAAIF for his technical input and moral support in the completion of this report. I am thankful to all district staff and farmers in Mbarara, Kabale and Mbale with whom discussions were held during the field visits. The information provided by staff of research institutions is appreciated. I am grateful to my employer, MAAIF and the Commissioner for Animal Production and Marketing in particular, for allowing me to carry out this work as part of my routine schedule.

I owe special thanks to Asaph, my husband for his encouragement and endurance during the study, last but not least, I give all glory to God who "makes all things including the completion of this report on time possible" for me.

1 Land and livestock in Uganda

Farming systems

Uganda is divided into four major agro-ecological zones (see Figure 1) and sub-divided into seven agro-ecological areas (see Table 1) which have similar economic and social backgrounds and in which ecological conditions (soil types, topography, and rainfall), farming systems and practices are fairly homogeneous. These broad zones are further sub-divided into sub-zones usually identified by similar factors such as crop combinations, size of holdings, average plot sizes and yields. The distribution of the natural pasture resources of Uganda is also related to the agro-ecological zones (see Figure 2).

Generally, the temperatures in Uganda range from 15 to 30°C with an average of 21°C. More than two-thirds of the country lies at 1,000 to 2,500 metres above sea level. Annual rainfall ranges from 500 mm in Karamoja in the northeast to 2,000 mm in areas on the shores of Lake Victoria, around the highlands of Mt. Elgon in the east, the Rwenzori Mountains to the southwest and some parts of Masindi and Gulu.

More than 75% of the country can be utilized for both cultivation and grazing as shown in Table 2. It is estimated that the grazing land is over 16 million hectares, half of which (8.4 million hectares) are rangelands and improved pastures estimated to cover 1.8 million hectares. This land resource, together with the water bodies, forms the basis upon which the 21 million Ugandans (1998 estimates) depend on for their livelihood. The capacity of this land resource to sustain the rapidly increasing population largely depends on the influence of edaphic (relief and soil fertility), climatic and biotic factors and how well they can be managed to increase and sustain its productivity.

The human population and land use in the districts of Mbarara, Kabale and Mbale are shown in Table 3. The table shows that the population density is very high in Kabale and Mbale. These two districts are found in the high altitude zone of the country. This means that farm-holdings are small and intensively cultivated. Mbarara on the other hand falls in the pastoral dry to semi-arid rangeland zone, hence the sparse population.

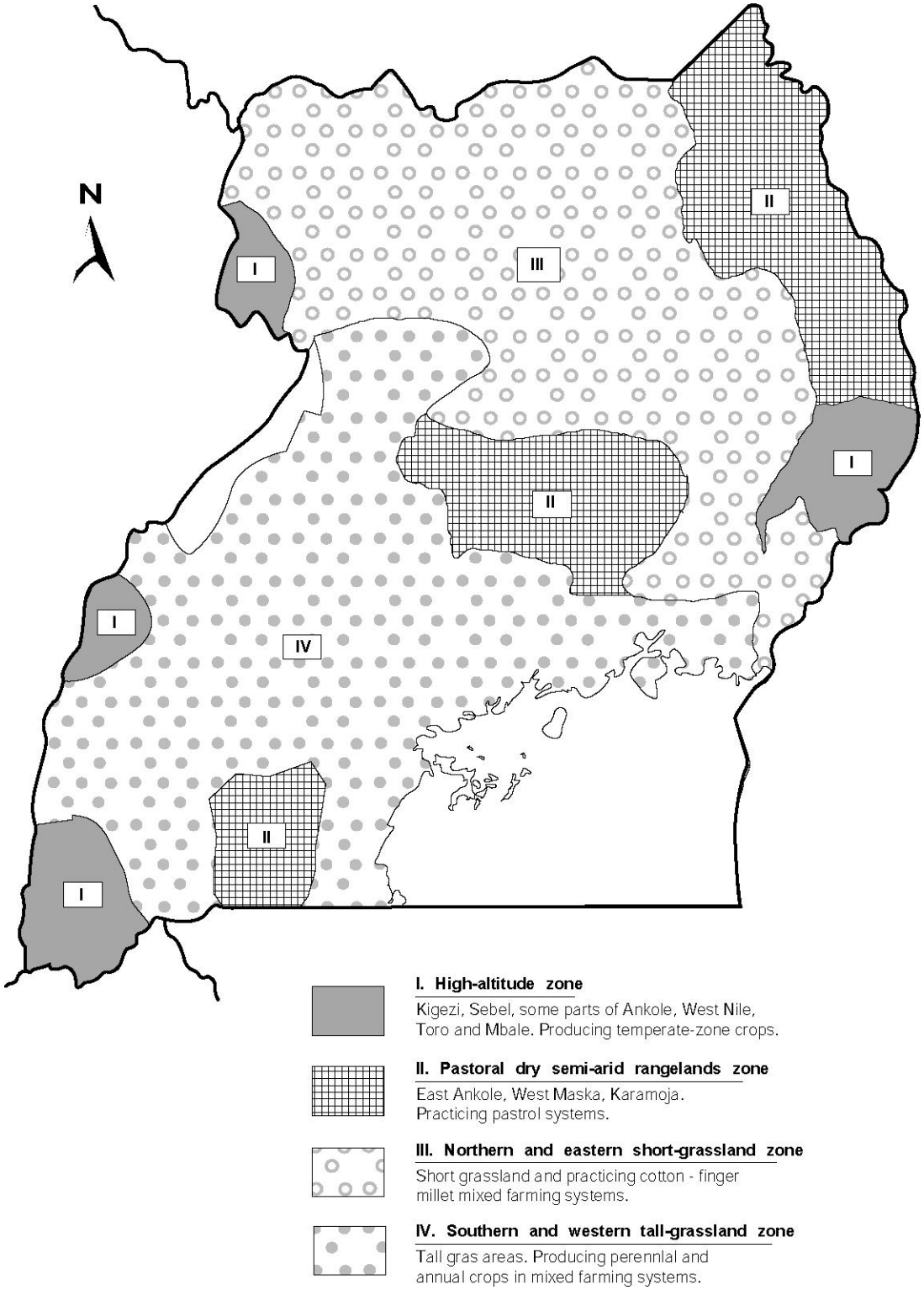

Figure 1 *Distribution of the four major agro-ecological zones of Uganda.*

Table 1 *Agro-ecological sub-zones and farming systems of Uganda*

Zone	Characteristics
Banana-coffee systems (Southern and western tall-grasslands zone)	**Districts:** Kalangala, Kampala, Kiboga, Luwero, Masaka, Mpigi, Mubende, Mukono, Rakai, Iganga, Jinja, Kamuli, Hoima, Kabarole, Kibale, and Masindi. Evenly distributed rainfall (1000 to 1500mm) on medium to high productivity soils. The vegetation is mainly forest/savannah mosaic with pastures suitable for intensive livestock management. Tall grassland with high biomass production. The grasses comprise of *Pennisetum purpureum* and *Hyperrhenia* spp. with the under-layer of *Panicum maximum, Brachiaria* spp. and *Chloris gayana*, mature very fast and have very low drought resistance. Cultivated areas are less than 2 acres. Banana and coffee are the main crops with root crops on the increase. Livestock was not generally part of this system, but now dairy cattle production is gaining prominence.
Banana-cotton system (Southern and western tall grasslands zone)	**Districts:** Kiboga, Luweero, Mukono, Iganga, Kamuli, Pallisa, Tororo, Bundibugyo, Hoima, Kibale, Masindi, Bugiri. This is largely under the moist Combretum/Terminalia/ Butyrospermum savanna with moderate biomass production. The important grasses include *Hyperrhenia rufa*, *Panicum maximum* and *Setaria sphacelata*. Greater reliance on annual food crops (millet, sorghum and maize), since there is a less stable rainfall condition than the Banana-Coffee System. In the drier areas, livestock is a main activity.
Montane system (High altitude zone)	**Districts:** Kapchorwa, Mbale, Bundibugyo, Bushenyi, Kabale, Kabarole, Kisoro, Rukungiri. Higher elevations with cool weather, high effective rainfall and cloud cover. High population density with small-sized holdings. Banana is a major staple as well as sweet potatoes, cassava and Irish potatoes. Arabica coffee is prevalent above 1,600 metres. It is found in the East (Mbale, Kapchorwa) and the Southwest (Kabale, Kisoro, Rukungiri) and the Rwenzori mountain range. The grasses are influenced by altitude and no known grasses of value to livestock occur above 1,750 metres ASL. Below 1,500 metres ASL, valuable grasses are common which include *Pennisetum clandestinum, Digitaria abyssinica, Cynodon dactylon* and *Panicum maximum.* Feeding crop residues to livestock is practised.
Teso system (Northern and eastern short grassland zone)	**Districts:** Soroti, Kumi, Katakwi. Bi-modal rain on sandy-loam medium to low fertility soils. Main staple foods are millet and maize. The vegetation association is moist Combretum/Butyrospermum and grass savannas. It has short grassland that is ideal for grazing. Use of crop residues is very common. The grass layer is composed of *Hyperrhenia* spp., *Panicum maximum*, *Themeda triandra, Setaria aequlis* and *Sporobolus* spp. Livestock are kept extensively in tsetse free zone. Cultivation by oxen was prevalent in the past.
Northern system (Northern and eastern short grassland zone)	**Districts:** Apac, Lira, Gulu, Kitgum. Mono-modal annual rainfall (1,000 to 2,000 mm) is adequate for most crops, but the intensity of the dry season requires that drought tolerant annuals are cultivated (finger millet, sesame, cassava and sorghum). Tobacco and cotton are major cash crops. The vegetation comprises of Butyrospermum and moist Combretum savannah. The understorey consists of *Hyparrhenia* spp., *Setaria* spp., *Andropogon gayanus, Panicum maximum, Brachiaria* spp., and *Sporobolus* spp. It is a short grassland where communal grazing is abound.
West Nile system (High altitude zone and northern and eastern short-grassland zone)	**Districts:** Arua, Moyo, Nebbi, Adjumani. Rainfall patterns similar to the Northern system, with greater rain at higher elevations. Intercropping is common with a wide variety of crops. The system is sub-humid where the vegetation community is moist Butyrospermum/Combretum/Terminalia grassland with a grass layer comprising *Panicum maximum, Hyperrhenia* spp., *Andropogon gayanus, Brachiaria* spp., *Setaria sphacelata, Themeda triandra* and *Sporobolus pyramidalis*. Livestock activities are limited by the presence of tsetse flies.
Pastoral system (Pastoral dry to semi-arid-rangeland zone)	**Districts:** Kotido, Moroto, parts of Mbarara, Masaka, Rakai, Nakasongola, Mpigi. In Kotido to Moroto, the vegetation community is dry Acacia/Combretum/Terminalia with the underlayer consisting of *Hyparrhenia* spp., *Themeda* spp., *Chrysopogon* spp. and *Sporobolus* spp. In Mbarara-Rakai-Masaka-West Mpigi-Nakasongola; the vegetation association is comprised of dry *Themeda triandra, Brachiaria* spp., *Panicum maximum, Chloris gayana* and *Laudetia kagerensis*. The pastoral system is prevalent in the short grasslands where nomadic extensive grazing is practised. Multi-species grazing is common but appropriate livestock species rations for optimum utilisation of the grassland are yet to be in use.

Source: The World Bank; Uganda Agriculture Study, Washington DC. 1993; AACM and MPW (Australia) Pty LTD (1989); The Livestock Services Project Preparation Report, Meat Production Master-plan Study, 1998.

Table 2 *Current and potential grazing areas in Uganda*

Land classification	Area ('000,000 ha)	%
Grassland	5.1	21
Farmland	8.4	35
Woodland	4.0	17
Bushland	1.4	6
Total potential grazing land	19.0	78
Total	37.9	100

Source: Statistical Abstracts (MFPED, June 1997).

Table 3 *Human population and land use in Mbarara, Kabale and Mbale Districts*

	Mbarara	Kabale	Mbale	Uganda
Population	931,000	417,000	711,000	16.7 million
Population density (persons/km^2)	88	246	284	85
Total land area (km^2)	7,350	1,970	2,550	241,000
Arable land (km^2)	4,750	1,820	1,660	66,700
Land under cultivation (km^2)	3,500	740	890	----

Source: Population and Housing Census (1991). Statistics Department, Ministry of Planning and Economic Development, Entebbe, Uganda.

Livestock husbandry

Livestock in Uganda—and more specifically in the districts of Mbarara, Kabale and Mbale—include cattle, sheep, goats, pigs, rabbits and poultry (see Table 4). The improved breeds are kept under intensive management on small to medium-scale farms and in zero grazing units. The indigenous breeds, on the other hand, are reared under extensive traditional production system (see Plates 1 and 2).

Eighty percent of the national cattle herd is currently found in southern and western Uganda where the average number of cattle per household is 2.11 as compared to northern Uganda at 0.67 and the national average of 1.37.

Table 4 *Livestock population in Mbarara, Kabale and Mbale Districts.*

Districts	Cattle	Goats	Sheep	Pigs
National Total	5,500,000	3,800,000	1,350,000	1,200,000
Mbarara	1,170,000	321,000	64,000	6,700
Kabale	85,000	39,000	26,000	41,000
Mbale	154,000	60,000	21,000	129,000

Source: Annual Report (1998), Department of Animal Production and Marketing, MAAIF.

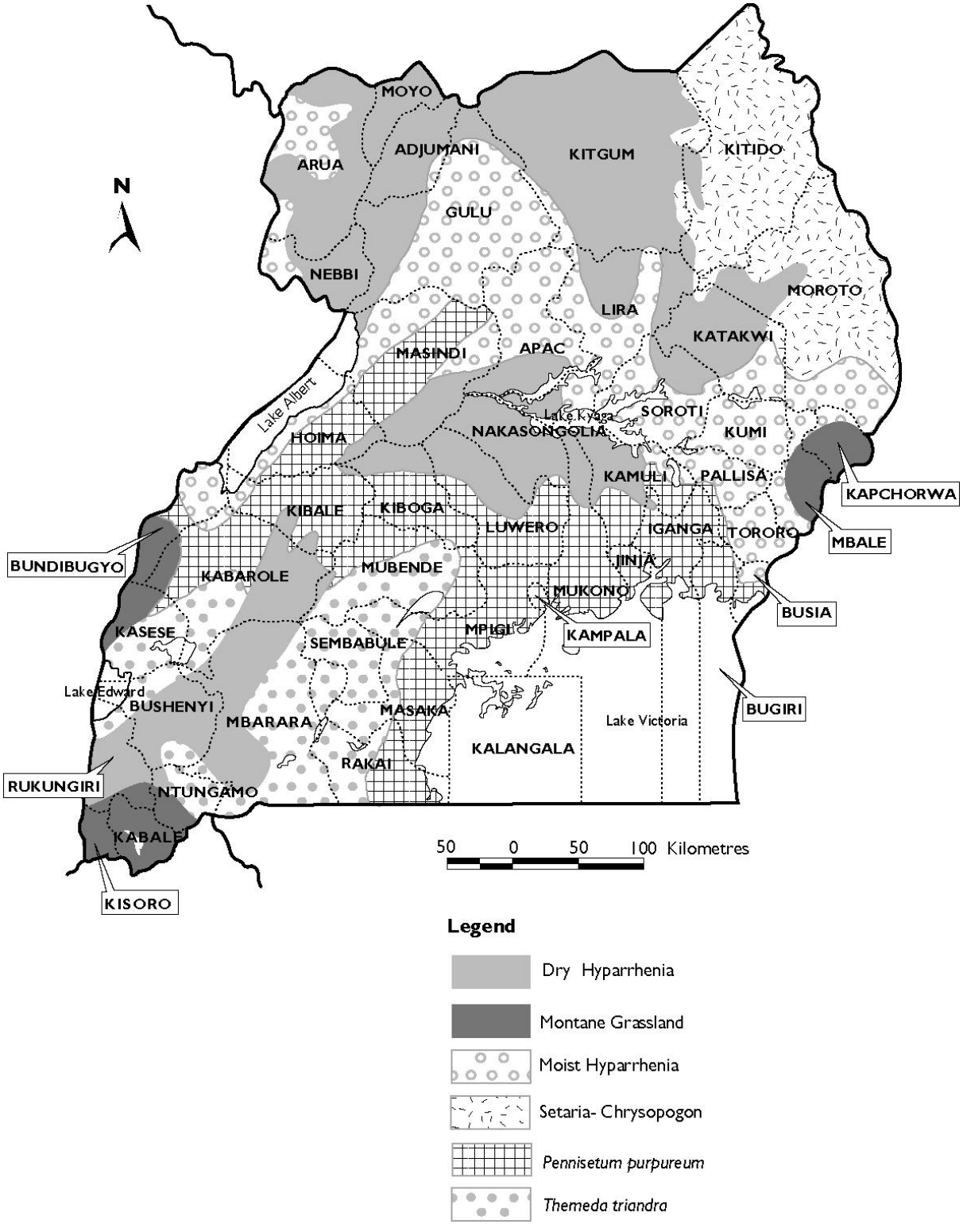

Figure 2 *Pasture systems in Uganda.*

Figure 3 *Districts where studies were carried out, Uganda (July 1997).*

2 Problem statement and justification

There is inadequate knowledge and skills on pasture establishment, management and use among many farmers in Uganda. This need was clearly spelt out in the planning meeting for Uganda Land Management Programme (ULAMP) in September 1998. The Uganda ruminant population depends on natural pastures, browse and crop residues for their nutrient requirements. Based on this fact, the pasture development section of the Ministry of Agriculture, Animal Industry and Fisheries in collaboration with other related institutions have developed a number of pasture improvement technologies, some of which have been tested on farm. It was thus suggested that training material based on on-farm adopted pasture improvement technologies be developed for extension workers and farmers. This could be used to raise the productivity of livestock and promote better integration of livestock into the farming systems with a special bias on improving the production of fodder.

Objectives of the study

This study had the following objectives:

- To identify pasture improvement technologies that have been tested on-farm within the livestock farming communities of Mbarara, Kabale and Mbale districts.
- To examine and screen the technologies which have been successfully integrated within the livestock farming systems, and develop proposals for their promotion elsewhere as a means of achieving better utilization of pastures.
- To assess the environmental implications of identified pasture improvement technologies within the farming communities.

Methodology of the study

Study approach

The following methodology was adopted to address the terms of reference set out above:

- Literature review.
- Discussions and consultations with staff at Faculty of Agriculture, Makerere University, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), two animal production research institutions of National Agricultural Research Organisation (i.e. NAARI and SAARI) and NGO's involved in livestock production.
- Field visits and discussions with district staff in Mbarara, Kabale and Mbale.
- Farm visits to assess what is on the ground and the impact of tested technologies.
- Survey of selected farmers within the three districts using the questionnaire.

Target group

The content and material of work in this report can be used as a source of basic guidelines for pasture and fodder development and management in the highly intensive dairying districts of Mbarara, Kabale and Mbale in Uganda (see Figure 3). Front-line extension workers in farmer training workshops and seminars can use the material and farmer-to-farmer training in community based organisations. MAAIF staff involved in livestock production/ soil and water conservation will find the material useful.

3 Results, observation and discussion of findings

Characteristics of the surveyed farms

The survey findings revealed that the number of small-scale farmers with 0 to 5 acres was high in Kabale and Mbale districts with 43% and 39% of the respondents, respectively (Table 5). This could be attributed to the high human population pressure in these highland areas as shown in Table 3, which has led to land scarcity. This is also reflected in the land cleared from forest and swamps for grazing (43 and 65%) within that category. With the landowners holding less than 5 acres, the land can either be partially cleared, or completely cleared with intensive land-use. In Mbarara district, 72 % of the respondents had more than 20 acres of land. The population pressure in Mbarara is much lower than in the other two districts (see Table 3) and 64% of the respondents had more than 10 heads of cattle, hence the need for more land; and the clearing of more land. In the three districts, the observable effects of clearing forests and swamps for grazing are less trees, soil erosion and higher local temperatures.

The literacy level of the farmers interviewed was high in all districts (see Table 5). In each district, the number of farmers with crossbred and exotic animals was high due the fact that farmers in these districts are mostly dairy farmers interested in high milk production. Literate farmers keep livestock as a commercial enterprise with the intention of earning money from selling the milk produced. However, some farmers kept local cattle breeds.

Table 5 *General characteristics of dairy farms surveyed*

	District		
Category	**Mbarara (%)**	**Kabale (%)**	**Mbale (%)**
Size of land holding			
0–5 acres	18	44	39
6–10 acres	9	16	26
11–20 acres	0	11	17
More than 20 acres	73	29	18
Land cleared for grazing			
0–5 acres	27	44	66
6–10 acres	9	16	14
11–20 acres	28	24	10
More than 20 acres	36	16	10
Number of cattle			
1–5	27	26	48
6–10	9	30	35
More than 10	64	44	17
Cattle breeds			
Local	27	13	28
Cross/exotic	73	87	72
Farmers level of education			
Educated (P7 level and above)	91	81	96
Never attained primary education	9	19	4

Agronomic practices and tools used

Table 6 shows the agronomic practices and tools used in pasture and fodder establishment. The most common manual tools were hoes, rakes, pangas, slashers and sickles. These are low cost tools that are adequate for the pasture/fodder establishing being done in these districts. In areas like Mbarara where most of the respondents (73%) had the land holdings of more than 20 acres and also 64% of respondents had herd sizes of more than 10 animals, it will be imperative to use modern equipment like tractors to open up land for pasture and fodder establishment.

The survey revealed that farmers obtain planting materials from farm shops, fellow farmers, research institutions, district veterinary offices, and NGOs (see Table 6). The present cost of grass and legume seeds is UShs 10,000 and UShs 6,000 per kg respectively. Buying of seeds from farm shops was low in all

districts because of prevailing high prices. For this reason, most farmers rely on each other for planting materials as shown in Table 6. There is need to have farmers equipped—through training—with pasture/fodder seed production techniques. The other sources of planting materials, particularly the research institutions should continue to be source of foundation seed.

Table 6 *Agricultural tools and agronomic practices used*

	District		
Category	**Mbarara**	**Kabale**	**Mbale**
Tools used			
Manual tools	100	95.2	100
Tractors	0	0	17.4
Source of seed/planting materials (%)			
Farm shop	45.5	19.0	30.4
Other farmers	90.9	85.7	78.3
Public and private sectors	63.6	23.8	60.9
Methods of planting (%)			
Vegetative propagation	81.8	85.7	82.9
Broadcasting	54.5	0	60.9
Spot/strip planting	18.2	9.5	13.0
Fertilizer use (%)			
Farm yard/cattle manure	63.6	85.7	73.9
Chemical fertilizers	0	0	34.8
Seed treatment (%)			
Hot water	27.3	14.3	52.2

Farmer mainly used vegetative propagation to propagate grasses and legumes mainly due to the fact that the seeds are expensive and not readily available or because fodder grass establishment, which is a widely adopted technology, can only be done from vegetative material. Although vegetative propagation is labour-intensive and slow, good establishment is still achieved.

According to the survey results, spot/strip planting, which is the most suitable way for improving natural pastures, is not widely used. There was no definite reason for this. It could be assumed that the high cost and lack of appropriate pasture seeds and that farmers have not internalised the importance of pasture improvement has heightened the need for more training of the farmers.

The survey revealed that most farmers used farmyard manure for improving or sustaining soil fertility in their fodder gardens and crop gardens. The use of inorganic fertilizers was low because many farmers felt that their soils were fertile enough and fertilizers are expensive; except in Mbale, farmers have easy access to inorganic fertilizer from Kenya.

Pasture/fodder species

Natural pastures covered over 80% of farms surveyed in Mbarara and Kabale (see Table 7). Mbale, on the other hand, had more fodder grasses and legumes. This is related to the grazing systems used in the districts where open grazing is dominant in Mbarara and Kabale while zero grazing dominates in Mbale (see Table 9).

Intercropping fodder grasses with legume forage and fodder trees (multi-purpose trees) has been adopted in the three districts irrespective of the grazing system. The most common and popular fodder grass is elephant grass. The availability of planting materials of improved elephant grass varieties from research institutions, coupled with farmers being able to get planting material from each other, has been of great help.

Fodder conservation, as hay or silage, is a technology that many farmers said they had heard about in different training programmes. However, the survey results indicated that the rate of adoption was low. This means that a lot of forage goes to waste during favourable seasons. Farmers, therefore, need practical

training in this area so that they can gain skills and begin conserving forage for ruminant feeding during periods of feed shortage.

Supplementary feeding

Compounded concentrate feed, crop residues and agro-industrial by-products are used as supplementary feeds in the three districts as shown in Table 8. The survey results showed that farmers interviewed use industrial by-products. This was more pronounced in Mbale (100%) where zero grazing is the dominant grazing system. Farmers in Mbarara do not use a lot of concentrate feed (9%) nor industrial by-products (9%). This is attributed to lack of accessibility to these feeds.

Table 7 *Type of pastures/fodders and forage conservation (% of surveyed farms in each district)*

	District		
	Mbarara	**Kabale**)	**Mbale**)
Natural pastures	82	86	39
Grass/legume mixture pastures	82	48	22
Fodder grasses intercropped with legumes	82	77	96
Fodder legumes (MPTs)	73	43	74
Fodder conservation:	9	0	13
	36	0	0

Table 8 *Crop residues and supplementary feeds (%)*

Type of supplement	District		
	Mbarara	**Kabale**	**Mbale**
Compounded concentrate feeds alone	9	5	22
Compounded concentrate feeds and crop residues	64	24	78
Industrial by-products (Maize bran, wheat bran and rice bran and husks)	9	52	100
Crop residues alone	18	67	0
Mineral supplements	100	86	100

Pasture/fodder development technologies, level of adoption and constraints

Table 9 shows pasture and fodder development and management technologies that have been extended to farmers within the three districts. Perimeter and paddock fencing have been adopted, with the level of adoption being highest in Mbarara and Kabale where the open grazing system is more dominant than in Mbale.

All farmers weed their pastures and fodder as indicated by the response. Oversowing with forage legumes seems to have been adopted in Mbarara district (73%) as compared to the other two districts. This, however, is because the natural pastures of Kabale and Mbale are dominated by Kikuyu grass (*Pennisetum clandestinum*) which cannot be easily oversown and which under good management is a grass with high nutritive value.

Although there were only a few pasture leys before, Mbarara and Kabale districts had made commendable efforts in establishing some small areas. Lack of large pasture leys was attributed to high cost of land clearing, high seed prices and availability.

Table 9 *Adoption of pasture/fodder growing and management practices (%)*

Technology	District		
	Mbarara	**Kabale**	**Mbale**
Fencing:	100	91	44
Paddock	100	81	35
Weeding	100	95	100
Over sowing	73	24	26
Pasture leys	36	48	9
Fodder:	82	71	96
Legumes	64	52	87
Fodder conservation:	46	24	0
Silage	18	29	26
Grazing systems:	18	24	65
Semi-zero grazing	27	0	17
Rotational grazing	73	76	22
Continuous grazing	9	0	17

According to the survey, farmers indicated a need for training in fodder conservation (see Table 10).

The most common grazing system is open grazing, where farmers had adopted rotational grazing. Due to the increasingly intensive use of agricultural land, zero grazing was becoming very popular especially in the highland areas of Mbale (65%) and Kabale (24%). Continuous grazing seems to be phasing out as farmers realize that commercial livestock husbandry has many more advantages.

Lack of inputs and capital were identified as the main constraints in pasture and fodder development (see Table 10). The inputs include appropriate and affordable pasture seeds and fertilizers. However, even when inputs were available, many farmers could not afford to buy them.

Table 10 *Constraints and training needs for pasture/fodder development and management (%)*

Category	District		
	Mbarara	**Kabale**	**Mbale**
Constraints:	55	48	87
Lack of capital (cash)	36	52	65
Source of training:	73	33	83
NGOs	36	43	44
Farmers' groups	-	24	57
Training needs:	18	33	17
Fodder establishment and management	36	14	39
Fodder conservation	27	19	13

Government departments were responsible for many of the farmer training activities in all the districts, mostly involving the district veterinary and agriculture offices. This means that field staff should continuously have in-service training on pasture and fodder development so that they are able to confidently deliver appropriate messages to the farmers. Some international organisations and NGOs have been involved in training farmers in pasture and fodder development. These include Heifer Project International (American based NGO), Send-a-Cow (British based NGO), ICRAF, CARE International and World Vision. It would be recommended that training programmes should seek to incorporate these organisations so that consistency of messages going out to farmers is achieved.

4 Strategies for improving pastures/fodder production

Forages are the cheapest source of livestock feed. Ruminant animals have the ability to convert forages into milk, meat, hides and skins and draught power needed by man for food and drawing income.

Natural pastures form the main source of livestock feed in Uganda. Overgrazing of these pastures is a serious problem to livestock environment. The pastures are grazed so intensively that their vigour is reduced, less productive grasses and weeds invade the pastures, and soil erosion and reduced soil fertility become prevalent.

This work proposes practical strategies that can be used in Uganda for improving pasture and fodder production. Alternative strategies given to meet the different categories of farmers; those that are low cost and those that may need some capital input.

The importance of pastures and fodder

- Pastures and fodder crops are the cheapest form of animal feed available (in term of quantity and quality). A constant supply of good quality forage in sufficient quantities is a basic necessity in livestock farming.
- Pastures and fodder, particularly the leguminous types, improve soil fertility through their ability to fix nitrogen.
- If well managed, planted pastures help control soil erosion.
- Pasture seed production and sale of excess fodder can be a good source of income.

General guidelines for improving pastures

Selection of the most suitable pasture species involves the identification of grasses and legumes with the following desirable characteristics:

- The pasture species must be adapted to the climate and soil where they are to be sown and suitable for their intended use (for grazing or for cut-and-carry).
- The grass or legume should be highly productive and persistent.
- The grass or legume should be able to provide good soil cover and easily compete with weeds.
- It should be palatable (desirable to livestock).
- It should have a high nutritive value, that is, provide enough energy and protein and have no toxic substances.
- The species should be easy to establish from seed or vegetative propagation. Pasture plants that can be established from roots and cuttings are good because planting material can be built up with time, particularly with small-scale farmers, given the high cost of pasture seed.
- The species should be an early and heavy seeder.

Table 11 shows the forage legume and grass species that are adapted in the three districts.

Table 11 *Recommended forage species and mixtures*

District	Grasses	Legumes	Forage species for cut-and-carry system	Possible Grass/Legume mixtures
Kabale	*Chloris gayana* *Pennisetum clandestinum* *Melinis minutiflora* *Brachiaria brizantha*	*Trifolium semipilosum* *Trifolium repens* *Desmodium intortum* *D. uncinatum*	*Pennisetum purpureum* *Setaria splendida* *Medicago sativa* *Lablab purpureus* *Calliandra callothyrsus*	i) *C.gayana* *B.brizantha* *D.intortum,* *D. uncinatum* ii) *P. clandestinum* *M. minutiflora* *T. semipilosum* *T. repens*
Mbarara	*Chloris gayana* *Brachiaria ruziziensis* *Panicum maximum* *Themeda triandra* *Setaria anceps* *Cynodon dactylon* *Cenchrus ciliaris*	*Desmodium uncinatum* *D. intortum* *Macroptilium atropurpureum* *Centrosema pubscens* *Stylosanthes guyanensis*	*Pennisetum purpureum* *Setaria splendida* *Tripscum laxum* *Lablab purpureus* *Calliandra callothyrsus* *Sesbania sesban* *Cajanus cajan*	i) *Chloris gayana* *P.maximum* *D.uncinatum* *M.atropurpureum* ii) *B. ruziziensis* *S. anceps* *C. gayana* *S. guyanensis,* *D. intortum* iii) *C. ciliaris* *Chloris gayana* *P. maximum,* *M. atropurpureum* *Centrosema pubscens*
Mbale	*Pennisetum clandestinum* *B.brizantha* *Panicum maximum* *Chloris gayana* *Setaria anceps*	*Desmodium uncinatum* *D. intortum* *Macroptilium atropurpureum* *Trifolium repens* *Centrosema pubescens*	*Pennisetum purpureum* *Tripscum laxum* *Setaria splendida* *Calliandra calothyrusus* *Cajanus cajan* *Lablab purpureus* *Medicago sativa*	i) *P.clandestinum* *Desmodium uncinatum* *T.repens* ii) *B. brizantha* *P. maximum* *M. atropurpureum* *C. pubescens* iii) *C. gayana* *P. maximum* *S. anceps* *D. intortum* *M. atropurpureum*

Source: Farmer questionnaires (April–May, 1999), Sabiiti and Mwebaze (1989); Jameson (1970).

Improvement of natural pastures

Most farms visited in Kabale, Mbale and Mbarara had natural pastures, were well fenced and paddocked. High quality grasses that were identified as being the most dominant included Guinea grass (*Panicum maximum*), Signal grass (*Brachiaria* spp.), Rhodes grass (*Chloris gayana*), Dog's tail (*Setaria anceps*), and Kikuyu grass (*Pennisetum clandestinum*). Efforts to improve the quality of these pastures by inclusion of forage legumes were evident on a number of farms. However, due to poor management, weeds like *Sporobolus* spp., *Imperata* spp., *Eragrostis* spp., *Loudetia* spp., *Lantana camara*, *Solanum incanum* and a wide range of broad-leaved weeds have invaded some of these pastures.

Practical methods of improving natural pastures

Fencing

Fencing is important for:

- Excluding non-farm animals' access to the pastures.
- Controlling grazing.

- Allowing for paddocks hence rotational grazing.
- Helping farmer to implement pasture improvement techniques.
- Protection of fodder banks.

Fencing posts and barbed wire

These are quite expensive, in terms of cost and erection. They cannot be transported easily. Bush poles are cheaper but are attacked by termites and need frequent replacement. Treating these poles with used engine oil reduces termite attack and reduces rate of damage. Suitable tree species like *Ficus* spp. can be used as live fence posts because they root and require no frequent replacement. Treated posts, if affordable, with barbed wire make a durable fence.

Live hedges

These are cheaper and last for a long time. When well established, they also keep intruders away. The maintenance costs, in terms of trimming, may be high. Trees for live hedges include *Euphorbia tirucalli*, *E. candelabrum* and *Erythrina abyssinica*.

Practical Application No.1: *Live fences*

All farms in Mbarara District and a few in Kabale had live perimeter fences of either *Euphorbia tirucalli* or *Erythrina abyssinica*. In some instances, the live fence was combined with barbed wire and fencing posts. Noticeable on these farms was that those farms that had paddocks; the paddock fence lines were mostly of barbed wire and fencing posts. Many of them said that the perimeter fence being of live trees served several purposes, namely:

- Demarcation of own land holding.
- Animals do not stray into neighbours land and so no conflicts with neighbours.
- Add to the beauty of the farm.

Farmers said they preferred using *Euphorbia tirucalli* as live fence because it was very easy to propagate. They use cuttings. The species was also said to be hardy and unpalatable to all livestock. In response to questions about the latex exude from this species, farmers said that it cured ringworms; but could damage the eyes if it fell in accidentally.

Live fences could therefore be used in all the Districts. In Mbale where zero grazing is the main grazing system, fodder trees like *calliandra* and g*liricidia* could be used so that they serve the purpose of land demarcation and provide fodder.

Bush and weed control

Bushes and weeds reduce grass productivity while some are poisonous. Food reserves in the root systems are exhausted by frequent uprooting and slashing, leading to their stunted growth and eventually death.

Hoes, pangas or slashers are very useful tools for this activity. The hoe, in particular, is a good tool because its action on the soil ensures sustainable soil management. Uprooting and slashing should be done, preferably, before the plants begin to shed seed.

Practical Application No.2: *Bush and weed control*

Ms. Nyakwenegura is an agricultural graduate who works in Kampala. A farm manager takes care of her farm in Isingiro County Mbarara. The farm with a good Rhodes grass/signal grass/siratro mixture did not have many weeds yet it had only a few animals. The farm manager said that whenever they graze the animals in a paddock, which he said was never more than 4 days, they would always slash the stubble once the animals are removed. This takes care of broad-leaved weeds. He said that during school holidays, particularly the August holiday, all boys that Ms. Nyakwenegura pays school fees for would all use hoes to uproot stubborn grass weeds like *Sporobolus pyramidalis* and *Cymbopogon afronadus*.

These activities are done continuously, hence the relatively good bush and weed control achieved on the farm.

Provision of water

In the open grazing system, water should be evenly distributed on the farm to avoid overgrazing and soil erosion around the watering point.

Where only one watering point is available, paddocks should be constructed in such a way that animals can access the water while they are in any one paddock. In areas with water shortage, harvesting rainwater should be.

Practical Application No. 3: *Water harvesting*

Mrs. Goretti Kato in Isingiro County is one of those farmers who harvest water from the roof. Isingiro is a quite dry place that receives less than 700 mm of rain annually. It is very hilly and the few rivers in the area deep in the valleys do dry up during the dry season.

Mrs. Kato keeps four crossbred animals. With financial assistance from an NGO and some family savings, she constructed two tanks and harvests about 30,000 litres of water from the corrugated roofs of her main house and servants' quarters. She said that this water is usually enough for the livestock and home use. Locking the tank and rationing the water avoids wastage.

Another farmer from Mwizi Parish in Mbarara has harvested water from a nearby spring for watering the animals and also irrigating a pasture stand of Kikuyu grass.

Soil conservation

Soil erosion occurs in hilly areas of Mbarara, Kabale and Mbale Districts. The causes of soil erosion are rain, wind, patchy grazing and overgrazing. This can be corrected by:

- Planting stoloniferous grasses like star or Kikuyu grass (see Plate 6), the use of dry grass or tree branches put over the affected places.
- Construction of bunds along contour lines to control water run-off.
- Construction of terraces and planting them with fodder grasses/legumes.

Oversowing/Reseeding

Oversowing (the introduction of improved pasture species of grasses or legumes to a natural pasture) as a method of improving natural pastures requires minimum cultivation and little or no use of fertilizer. The natural pastures in the three districts had low legume content.

Oversowing increases forage quality and productivity of natural pastures. It is the simplest and cost-efficient pasture development strategy. Although both grasses and legumes could be used during oversowing, the most suitable are legumes. Grasses generally have poor germination and are slow to establish on compacted soils. Benefits of oversowing are evident after about two years.

Over sowing should be promoted in areas where:

- Soils are poor and where a higher cost system of pasture improvement cannot be justified.
- Soils are light and loose.
- Pastures lack good legume content.

Advantages of oversowing are:

- Very low cost for land preparation and seed purchase
- Requires less seed and little labour
- Needs minimal management
- Improves forage production
- Maintains/increases soil fertility and reduces dangers of soil erosion.

Species suitable for oversowing

There are suitable species that can be easily established on poor seedbeds, tolerate heavy grazing and able to set seed and spread even under heavy grazing. For Mbarara, Kabale and Mbale, these are: stylo, siratro, greenleaf desmodium and *Wynn cassia*.

Methods of over sowing

Broadcasting involves spreading seeds over the area that is to be improved. Before broadcasting the seed, the pasture in the area should be grazed "hard" to reduce competition due to existing pasture as the new seeds germinate. A low legume seed rate of 1kg/ha is recommended.

Strip sowing is the digging and planting seeds along narrow strips, about 1m wide, across the area that needs to be improved. The area should be "hard" grazed before sowing as above. The strips can be 3m apart, and the seeds can be sown on these strips. A seed rate of two to three kg/ha is recommended.

The oversown species will eventually spread to the rest of the pasture. The legume component in the pasture increases gradually and will be very evident by the end of the second year.

Spot sowing requires the preparation of dugout patches within the area to be improved. These patches can be 60x60 cm in size and about 3 m apart. Before the seed is sown, the pasture should be grazed to a very low height to reduce competition, and the seed sown on the prepared patches.

A seed rate of 2 to 3 kg/ha is recommended. Strip and spot sowing are very efficient ways of oversowing and therefore improvement of natural pastures.

Practical Application No. 4: *Spot-sowing*

Ebenezer Dairy Farm is in Ibanda County of Mbarara District and has 25 heads of crossbred cows. The natural pastures of this farm include signal, star, buffel and red oat grasses and no legumes. It was the desire of the management to improve the pasture, in quantity and quality.

The method chosen was spot sowing. Spots of various sizes were prepared using the hand hoe. Stylo, greenleaf desmodium, siratro and centro seeds were sown in the spots. There was generally slow and poor establishment. The farmer decided to close the paddock for six months. The best of the legumes were stylo, desmodium and siratro. The oversown paddock was at its best 18 months after planting.

Mrs. Bangirana of Mbarara District spot-sowed her natural pastures using cuttings of green and silver-leaf desmodium that she harvested from the roadside. The establishment according to her was good because she put cattle manure on the patches to be sowed and she did it during the second rains (September to November). This season is always followed by a short dry period before the first and heavy rains (February to May).

5 Establishment of permanent grass/legume pastures

When the existing pasture is heavily invaded by weeds, bushes and shrubs—and is lacking in or has few desirable grass species—the farmer has no alternative but to prepare a good seed bed and buy seed for planting. This particular strategy is important where high monetary returns are expected. It requires high management and is costly. Permanent grass/legume pastures have the following advantages:

- They produce a high yielding, high quality pasture.
- The legumes improve soil fertility.
- They allow a high stocking rate and high levels of animal production.

Permanent pastures are recommended in the three districts, because:

- The soils are good and easy to cultivate.
- Dairy farming on intensive scale is on the increase.
- There is a long growing season (about 4 months).
- Management can be good, given the high literacy of the farmers (see Table 5).

Land preparation

A well-prepared seedbed is required for:

- Creating a favourable environment in which seeds will germinate, emerge and grow. If vegetative material is being used, it is good for starting new roots and shoots.
- Destroying unwanted plants and weeds.
- Time the seedbed preparation aiming at striking a balance between achieving adequate soil moisture for germination and minimising the risk of high intensity rainfall.

If the land has some kind of a slope, work across the slope. Avoid an unnecessarily fine seedbed, which may render the soil highly susceptible to water and wind erosion.

If the soils are shallow and likely to be highly susceptible to erosion, leave strips of undisturbed soil across the slope to reduce the potential for soil erosion.

Selection of right pasture species

The pasture species, grasses and legumes, selected should be those adapted to the area (for Mbarara, Kabale and Mbale, these are shown in Table 11). The characteristics of pasture species to be selected are shown in Section 4.2.

Establishment conditions

- Pasture grasses and legumes are very small seeded and so require a good and firm seedbed.
- To ensure that seeds receive enough moisture, enough oxygen and favourable temperature, sowing should be done after about three good rains.
- Fertilizers, particularly, phosphate-based fertilizers will give high production. A rate of 150 kg/ha is recommended. Well-composed organic manure could also be applied to the seedbed before planting. The use of fertilizers will however depend on location.
- Fencing and paddocking, to help in the control of livestock should be provided.

Seed quality

- Poor quality seed will lead to poor and prolonged pasture establishment.
- Seed germination and contamination with weeds should be checked.
- Seeds should not be stored for too long, they should be planted as soon as possible to ensure a high germination rate.

- Good pasture seed should have a germination percentage of about 30% for grasses and at least 70% for legumes.

Seed treatment

Most pasture legumes have hard seed coats that prevent permeability of water. The seeds should be treated so that:

- Germination can be increased.
- Rhizobia bacteria ensure the development of nitrogen fixing nodules.

Suitable pasture seed treatment methods are outlined below.

Hot water treatment

- Soak the seed in warm water overnight.
- Dry in the shade in the morning before planting.
- Plant the seed and never store such seed.

Scarification

Rub small quantities of seed between two sheets of sand paper; or put the seed on a concrete floor and rub with sand paper.

Inoculation

Some pasture legume seed require inoculation for proper nodulation. The appropriate inoculant should be supplied with the seed (see Table 12). It consists of a suspension of bacteria in charcoal. The bacteria are living and so the inoculant should be stored in a cool dark place. Inoculated seed should be planted on the same day.

Seed inoculation should be carried out as follows:

- Spread the seed out on a clean surface.
- Sprinkle water on the seed.
- Mix the water and the seed until the seeds are uniformly moist and sticky.
- Scatter the inoculant over the seed and mix well.
- Sow the seed.

Dormancy

This is important in grass seeds. Store grass seed for 3 to 6 months in a cool dry place to overcome this.

Seed rates

Sowing rates will be determined by:

- The pasture species to be planted
- The method of sowing to be used

It is important to sow the seed evenly. Dividing the area to be planted into small strips, and dividing the seed into the same number of portions will ensure that this is achieved. Table 12 gives seed rates recommended for the adapted species in the three districts.

Table 12 *Inoculum requirement and pasture seed rates.*

Pasture type	Inoculum type	Seed rate (kg/ha)	Minimum rainfall (mm)
Grasses			
Rhodes grass (*Chloris gayana*)	N/A	10–15	650
Dog's tail (Setaria anceps)	N/A	10–15	750
Signal grass (*Brachiaria spp*)	N/A	10–15	1,000
Buffel grass (Cenchrus ciliaris)	N/A	10–15	750
Guinea grass (*Panicum maximum*)	N/A	10–15	1,000
Kikuyu grass (Pennisetum clandestinum)	N/A	10–15	1,000
Legumes			
Verano Stylo (Stylosanthes hamata)	CB82	2–4	600
Cook Stylo (Stylosanthes guyanensis)	CB82	2–4	850
Glycine (Neonotonia wightii)	CB1923	2–4	1,200
Greenleaf Desmodium (*Desmodium intortum*)	CB627	1–2	1,200
Silverleaf Desmodium (*Desmodium uncinatum*)	CB627	2–3	900
Wynn cassia (Cassia rotundifolia)	CB1923	2–4	750
Shrubby Stylo (Stylosanthes scabra)	CB82	3–6	750
Centro (Centrosema pubescens)	CB1923	3–4	1,200
Siratro (Macroptilium atropurpureum)	CB1923	2–4	750
Lablab (Lablab purpureus)	CB1024	10–30	650
Clover (Trifolium repens)	TA1/CB782	5–7	1,200

Source: Sabiiti and Mwebaze (1989) N/A: Not applicable

Sowing

Sowing from seed

- Grass and legume seeds to be planted should be mixed.
- The mixed seed can be sown by broadcasting or sow in rows.
- Broadcasting is quicker and cheaper.
- Row planting gives better establishment and weeding is easier.
- Spacing for row-planted seed is 30 cm between rows.
- Planted seed must be lightly covered with soil using a rake or leafless branch to ensure good seed and soil contact and for protection from birds and being washed away by rain.

Vegetative planting

- This is necessary where pasture seeds for some species are not constantly available and/or are very expensive.
- Vegetatively planted pasture takes longer to establish.
- The method is more labour intensive.
- Species like signal, star and Kikuyu grass, and silver-leaf desmodium can be vegetatively planted. All fodder grasses are vegetatively planted.
- The older stolons or stems with new root growth are the best planting materials.
- Planting can be done by hand using a hoe. Runners, splits or cuttings can be used.
- Planting should be in a moist seedbed and the runner should be covered with soil.

Practical Application No. 5: *Pasture establishment from seed*

Mr. Kamugasha of Nyakisharara in Mbarara District established a Rhodes grass/stylo pasture in a 5-acre paddock 5 years ago. He had two reasons for establishing the pasture. One was that he could have a good permanent pasture and secondly, that he could harvest the grass seed for sale.

He said that he hired a tractor to prepare the seedbed twice in order to ensure that he has a good seedbed. Although tractor hire was expensive, it was quicker and more thorough and it helped him to plant in good time, before the onset of the second rains (Sept–Nov). He got both the grass and legume seeds from the Dairy Development Project of the Ministry of Agriculture, Animal Industry and Fisheries, and was also given 250 kg of NPK fertilizers. He hired casual labour and the seeds (mixed) were broadcasted onto the seedbed. The fertilizers were broadcasted onto the pasture eight weeks later.

Mr. Kamugasha said that about 800 kg of Rhodes grass seed was harvested in the first year. Some of the seed was sold to other farmers in Mbarara and beyond and some was planted on other parts of the farm. He has not continued with seed production because it is more involving but said that the grass is available and if he got some fertilizer input for topping up, he would close the paddock and allow the grass to seed again. He said that that particular paddock is especially reserved for his good milking cows for the dry season.

6 Management of improved natural and permanent pastures

The reason for improving natural pastures or establishing permanent pastures is to provide feed of good quality for livestock through out the year. The improved or established pastures will still have seasonal growth and production with periods of lush, high nutritive feed and periods of shortage and low nutritive feed.

Therefore, good pasture management should include controlled use (grazing or cutting) and conservation strategies. The needs of the livestock and the plants, particularly the legumes, and the soil must be taken into consideration. Sometimes, it may be necessary to temporarily sacrifice the needs of one or the other in order to create a balance that will achieve good results.

Early grazing

- Grazing should not be allowed until the grasses and legumes are well established and have developed a strong root system.
- Uncontrolled early grazing may lead to plants being pulled out of the soil and the soil may be compacted by the livestock.
- The first grazing, which should be light, is done 2 to 3 months after the seed has germinated.
- Light grazing allows the grass to develop more shoots (tillering) so that the legumes are not shaded by the grass and grow well.

Efficient use of pasture

- This refers to how many animals are allowed into a given area of pasture and at any given time. This is the stocking rate.
- The stocking rate should be flexible such that the number of animals kept are increased or lowered to match pasture availability.
- Given the annual rainfall, the soil fertility and potential pasture productivity in the districts of Mbarara, Kabale and Mbale, for efficient use of pastures, a stocking rate of 1 tropical livestock unit (TLU) that is equivalent to a 250 kg bovine animal is recommended.
- High quality grass/legume pasture should not be allowed to become too mature.
- Grazing should not be lower than 20 to 30 cm high.
- Conservation (hay or silage) of excess pasture produced during the growing period, or the purchase of feed or sale of animals, will all lead to efficient use of pastures.

Plant vigour and species balance

- In grass/legume pastures, the legume component is most important yet most vulnerable. The grass and legume components should be kept in balance. Legumes fix nitrogen in the soil and provide protein to the animals. Legumes are slow growing, intolerant of shade and greatly liked by grazing animals. Occasionally, the grasses and legumes in the pasture should be allowed to flower and produce seed as much as possible. Whenever the grass seems overgrown, grazing pressure should be increased to protect legumes from the shading effect of the grasses.

Weeding

- The pasture should be kept weed-free.
- Some weeds are poisonous. These include *Lantana camara* (tick berry or sage brush), *Solanum incanum* (Sodom's apple) and *Phytolaca dodecandra*.
- Weed control should be done using the panga and hoe. This is the cheapest option for most farmers.

- Continuous cutting of the plants and digging out of roots of all types of weeds will reduce their population and weaken the plants until they are eliminated.
- Weeding of pastures is a continuous activity to which a farmer should pay particular attention.
- Good grazing management will control weeds in a pasture.

Paddocking

- Fencing enables the farmer to control grazing. Ways of fencing and what to use have been described in section 4.4.
- Paddock construction is the subdividing of the pasture area into portions. The recommended paddock size is 2.5 acres but this can be varied depending on the land available and the number of animals on the farm.
- Paddocking enables rotational grazing. It is possible to limit the use of pastures to specific periods and particular animals.
- Rotational grazing ensures pasture re-growth and helps to maintain or improve the condition of the pasture.
- Graze any given paddock for a period of 1 to 2 weeks followed by a 4 to 8 week of rest period. This will result in optimum production of pasture and force a break the life cycle of most internal parasites that may be present. The grazing and resting periods should be flexible depending on weather conditions.

7 Establishment and management of fodder crops

Fodder crops are high yielding, high quality crops grown specifically for providing feed in intensive livestock grazing systems. These fodder crops are to be cut-and-carried to the animals. The technology of fodder crops and their use has had a very good impact with both zero-grazers and open-grazers in all the Districts.

Fodder crops are important because:

- They provide a large quantity of high quality and palatable fodder within a short time.
- They are acceptable to the farmer (already adopted).
- They are easy to grow; the husbandry requirements are similar to other crops that are familiar to the farmer.
- They provide a way of introducing farmers to the concept of improved livestock nutrition.

Disadvantages of fodder crops:

- They are costly to produce especially in terms of cultivation costs.
- Land is exposed to erosion for part of the year.
- Fodder crops require a high level of management and husbandry practices.

Useful fodder crops include:

- Elephant grass (Pennisetum purpureum)
- Guatemala (Tripscum laxum)
- Giant Setaria (Setaria splendida)
- Lablab (Lablab purpureus)
- Lucerne (Medicago sativa)

Elephant grass

This is the most popular fodder grass in all the districts. Elephant grass is best adapted for planting in well-drained fertile soils. It is very drought resistant and can be used as a dry season reserve in all areas.

Establishment

A well-prepared seedbed (not fine) without weeds like couch grass is required. If farmyard manure is available, it should be worked into the soil before planting.

Planting is by using whole canes, cane cuttings or rooted shoots. The cane planting material should be obtained from plants about to flower. The stems should be green and disease free.

Planting should be done during the rainy season. Canes having 3 to 4 inter-nodes should be inserted in the soil leaving one inter-node uncovered. Whole canes should be put in furrows of about 4cm deep and covered with soil.

Row planting is recommended with widths of 1 to 2 m between rows and 0.5 to 1 m between plants. The spacing can be varied to suit different levels of soil fertility and rainfall. With poor soils and dry conditions, the spacing should be wider, and narrower with rich soils in wet conditions.

Varieties

A number of superior varieties are currently in use. These are KW_4 and P.99. These varieties are leafier, hairless, higher yielding than the local variety. The planting material can be obtained from Namulonge Agricultural and Animal Research Institute or the Makerere University Farm, Kabanyolo.

Management

Cutting is best done when plants are 1 to 1.5m tall. The cutting height should be 2 to 5cm above the ground. A first cut is possible 8 to 10 weeks after planting. Depending on the soil fertility and moisture, a cutting interval of 8 to 12 weeks is recommended.

After cutting, all weeds should be removed and cow dung manure applied in furrows between the rows of elephant grass. This will ensure improved and prolonged productivity of the elephant grass.

Fertilizers: Elephant grass is highly sensitive to soil fertility conditions and will respond well where farmyard manure or nitrogen fertilizer is applied. NPK (nitrogen, phosphorous and potassium) fertilizers can be applied at the rate of 100 to 200 kg/ha. Calcium Ammonium Nitrate (CAN) and Urea fertilizers can also be used. However, these fertilizers are not readily available and are very expensive.

Farmyard manure is the cheapest option for majority of the farmers. The slurry (cow dung and urine) should be applied after each daily cut. If, however, only the dung is available, this should be put into small furrows dug along the elephant grass rows and covered with soil.

Weeding and inter-row cultivation: Weeding is essential during the establishment of the crop and later on during growth. This will maintain the grass vigour and productivity. It is a good practice to weed after each cut. Weeds stunt the growth of elephant grass.

Intercropping with legumes: Vigorous forage legumes are is recommended for planting between rows. Examples are silver-leaf desmodium, centro, and siratro. The legumes improve the feeding value of the elephant grass, control weeds, increase herbage production and improve soil fertility. A seed rate of 1 to 4 kg/ha should be used and planting should be near the grass rows.

Diseases

Two diseases have been observed on cultivated elephant grass.

Stunting disease: This is a viral disease spread by insects. Part or the entire grass stool becomes stunted, pale green, has very many branches and eventually dies. The disease can be transmitted through the planting material. Planting material should be selected from healthy plants, and any stunted plants should be uprooted and burnt.

White spot: This is a fungal disease that appears on leaves of vigorously growing plants, particularly in wet conditions. The disease has no significant effect on yield.

Feeding management

Elephant grass is best used as a cut-and-carry feed. Grazing elephant grass or any of the other fodders, will lead to their early death.

The cut elephant grass should be chopped using a panga or a forage chopper. This minimises wastage and optimizes the amount that the animal can eat. A dairy animal weighing 250 to 300 kg should be fed on 50 to 70 kg of chopped elephant grass daily. One acre of well-established and managed elephant grass can support one cow and one calf.

Giant setaria

Giant setaria has become a very important fodder crop in the three districts. It was introduced from Tanzania through the District of Masaka and has now spread all over the country. It has a dual purpose of providing feed for livestock and stabilizing soil and water control structures in banana and other crop

gardens. Giant setaria is palatable, establishes well from vegetative material and produces high yields of high quality feed.

Giant setaria grows well on a wide range of soils and is adapted to different climatic conditions of the three districts.

Establishment

This fodder grass requires a well-prepared seedbed. In Uganda, it has been successfully established through rooted cuttings or divided rootstocks.

The spacing used on soil bunds is 50 cm between plants and 50 cm between rows. Where a pure stand of giant setaria is to be established, closer planting of 30x30 cm is recommended.

Management

Giant setaria should be cut at a height of 15 cm from the ground at a cutting interval of 6 weeks.

Fertilizers: Giant setaria responds well to farmyard manure. However, being a grass, it would give increased output if nitrogen fertilizer were used.

Weeding: Weeding is important during the establishment phase. When established, setaria suppresses most weeds. Weeds do not pose much of a problem to the grass in Uganda because it is grown with crops that need weeding. The value given to this crop by farmers who use it means that it is kept weed-free even when it is in a pure stand.

Intercropping with legumes: This is practised in Uganda. Giant setaria combines well with glycine, greenleaf and silver-leaf desmodiums and siratro.

Pests and diseases

General pests such as armyworms and locusts (these attack all pastures) do pause a threat. A fungal leaf spot attacks setaria but with no obvious reduction in yield.

Feeding management

Like elephant grass, giant setaria is used as a cut-and-carry feed. Chopping of the grass reduces on wastage.

Practical Application No. 6: *Establishment of giant setaria*

Mr. Kwesigabo of Nyakayojo in Mbarara District is a zero-grazing farmer who uses elephant grass and giant setaria as the main fodder grasses. His wife brought in the initial giant setaria planting material from another farmer in Nkumba, Entebbe. The rootstock was divided up into smaller pieces and a mother seedbed was established. Composted farmyard manure was worked into the soil before planting. The farmer has used this mother seedbed to produce giant setaria that he has planted on soil bunds in his banana plantation to stabilize the bunds and provide fodder for his cows.

After cutting the grass for feed, he uproots part of the stool and has been able to establish nearly an acre of pure stand of setaria. The crop is planted in rows at spacing of 30x30 cm. Mr. Kwesigabo says he wants many plants so that he gets a good cover and prevents soil erosion. He indicated that he would vegetatively plant greenleaf Desmodium from another part of his farm within the setaria. He provides planting material to other farmers in the neighbourhood. Mr. Kwesigabo says that he cuts his grass to the ground, leaving stubble of about 3 cm. He applies slurry (cow dung mixed with urine) in furrows near the stubble and is able to harvest every 6 to 8 weeks without reducing the productivity of the grass.

Lablab

Lablab is a very popular fodder crop with all livestock farmers, particularly in Mbarara and Mbale Districts. In Kabale, lablab performance has not been very good. Lablab is easy to establish, produces a lot of herbage which when fed to animals improves their productivity and can be cut several times (see Plate 12).

Varieties

Two varieties are grown in Uganda, Highworth and Rongai. Highworth has purple flowers and black seeds. It produces little herbage that is fibrous. Rongai has white flowers and white and brown seeds. It produces a lot of highly palatable herbage; therefore, it's high level of adoption as a fodder crop.

Establishment

Lablab is sown at a spacing of 1x1 m at a sowing depth of 2.5 cm and a seed rate of 10 to 30kg/ha. Two to three seeds are sown per hole. An application of phosphorous fertilizer at 50 kg/ha is necessary to improve the establishment of lablab. Lablab establishes slowly and so weeding must be done frequently.

Management

Lablab should be cut at the beginning of flowering in order to harness its optimum feeding value. The cuts that follow give forage with more stems than leaf, hence a lower feed value (low protein content). The best cutting height is 30 cm above the ground and should be above the branches to allow a re-growth. When properly cut, it is possible to harvest three times a year.

Feeding management

Lablab forage produces off-flavours in milk when fed fresh to milking animals. Wilting the forage or drying it before feeding will take care of this.

Lucerne

In Mbarara, Kabale and Mbale, lucerne is grown for cut-and-carry systems and for haymaking. Lucerne can also be grazed but animals should only be allowed to graze for a short time of about 2 hours before going out to the pasture.

Establishment

A well-prepared seedbed is essential. Planting should be with seed in continuous rows 30 cm apart at a seed rate of 5 to 7 kg/ha. Where irrigation is possible, the seed rate can be increased to 11 to 16 kg/ha.

On new fields, Lucerne should be inoculated (see section 5.5) to enable it fix nitrogen. If an old Lucerne field is being used, inoculation is not necessary.

Management

The first cut is done as Lucerne begins to flower at 15 cm above the ground. The cutting frequency can be 3 to 4 months.

Fertilizers: Single super phosphate (SSP) fertilizer should be applied to the field before planting at a rate of 100 kg/ha. Fertilizer should be applied at least once a year.

Weeding: Lucerne should be kept weed free until a full canopy is developed.

Pests and diseases

There are no obvious pests and diseases for Lucerne in Uganda. This could be attributed to the fact that it is not yet widely used in any one area. In Australia, aphids and root-rot were reported leading to breeding of a resistant variety.

Feeding management

The most common method of feeding Lucerne is as a cut-and-carry feed. In the 1960's, Lucerne hay used to be made at Mobuku Irrigation Scheme in Kasese. Lucerne makes good quality hay and this could be done elsewhere.

Practical Application No. 7: *Lucerne growing and use*

Erisa Kwesigabo is a farmer in Mbarara. One of the fodder crops on his farm is Lucerne. He says that he had always heard other farmers talk about Lucerne. Widely travelled farmers had always told him that Europeans used it a lot. He was also told that in the 1960s and 1970's, it had been introduced in Kasese, Uganda but the project had ended and it was not there any more. He could not get the seed in Uganda and staff from the Ministry of Agriculture, Animal Industry and Fisheries told him that he could only get the seed from Kenya. In 1997, he was among farmers chosen to go for a livestock study tour to Kenya and he used the opportunity to buy Lucerne seed and inoculum from a farm shop in Nairobi.

He prepared a very good seedbed for his treasured fodder. He inoculated the seed according to the instructions given and planted his crop in rows. Before planting, he had been told to apply some little single super phosphate fertilizer to the soil that it would help in the establishment. He bought 5 kg of the fertilizer at Ushs. 1,250 and he broadcast it on the ¼ acre garden that he was going to plant the Lucerne. He also added composted manure to the garden. Mr. Kwesigabo strongly believes that plants also need to be fed. He weeds it regularly and does not irrigate the land.

He started cutting the Lucerne when it was about 2.5 feet high. He feeds it fresh to the cows at milking time. He gives some to the calves. He cuts 6 cm above the ground and cuts every 8 to 12 weeks. The farmer said he experimentally tried to plant root splits of Lucerne and it worked!

8 Establishment and management of fodder trees

Fodder trees are also known as multi-purpose trees. Multi-purpose trees are leguminous and hence a good source of protein for livestock. The common fodder trees grown and used in the three districts are *Calliandra calothyrsus* (calliandra), *Gliricidia sepium* (gliricidia) and *Sesbania sesban* (sesbania). Multi-purpose trees have various uses, which include:

- Provision of firewood.
- Reforestation in areas where many trees have been cut down.
- Soil improvement because these trees are nitrogen fixing. Their deep and lateral rooting habit provides a structure that stabilizes the soil and the leaf fall from these trees enriches the soil.
- Alley cropping whereby the multi-purpose trees are planted as single rows in a field of food crops.
- Hedgerows, contour strips, bund stabilizers.

Climate and soil requirement

Fodder trees will grow in areas with rainfall of 700 mm per year and above. Due to their deep rooting habit, tree can withstand drought. Multi-purpose trees grow in varying soil types ranging from volcanic loamy to acidic soils, hence their wide distribution in the three districts. Calliandra and gliricidia do not grow well in waterlogged soils, as sesbania. The species adapted to Uganda grow well in all the three districts, irrespective of altitude and temperature. (See Plate 5)

Establishment

Use of seeds

Fodder trees are best propagated from seed. Seedlings raised in nurseries are most commonly used.

Raising seedlings

- Plant at least two seeds in plastic bags filled with topsoil.
- Remove the small seedling if both develop.
- Allow seedlings to grow until they are 20 to 50 cm tall.
- Prepare to transplant in cleared and well-prepared seedbeds, which may be strips or spots.

Use of stumps

- Sow seeds on the surface of a prepared nursery bed and cover lightly with sand.
- Allow seedlings to develop to a height of 75 to 100 cm (this takes 2 to 3 months).
- Lift the seedling from the nursery bed, and then prune 30 cm of the top and 20 cm of the root.
- Strip off any remaining leaves so that only stumps are left.
- Store these stumps in a moist, shady place for up to one week before planting.
- Stumps are good for planting in existing pastures, on steep slopes and amongst other trees.
- Plant at beginning of rainy season.
- Spacing for block planting (sole) spacing can be 50 cm between plants and 90 cm between rows.
- For hedgerow planting spacing can be 50 cm from plant to plant.

Cutting management

Fodder trees should be utilised for cut-and-carry to maximize and prolong fodder production. The first cutting should be delayed to allow good root development. This should not be less than six months from the time of planting. This will give high rate of re-growth.

A cutting height of 30 cm from the ground gives high yields and a long cutting interval of 3 to 4 months will increase total yield.

9 Supplementary feeding

This is a technology that has been adopted by dairy farmers in all districts. Supplementary feeds are given to dairy animals mostly and many farmers said that this was done to ensure that animals were satisfied. Many of the farmers interviewed were grateful to the fodder development technology that has enabled them to overcome dry season feed shortages and maintain productivity of their animals.

Compound/homestead residues

Many farmers have planted various grasses on their compounds, which they mow regularly. The residue resulting from mowing compounds is usually burnt. This residue is potential feed if dried well as hay and packed. This can be used during the dry season or for starting off calves.

Cereal and legume crop residues

The most commonly used crop residues are potato and cassava peelings; potato vines, banana pseudo-stems and leaves and sugar-cane tops. These are used all the time in all the grazing systems. These crop residues are low in energy and protein content. Addition of a good source of protein would improve their usefulness. Bean and groundnut haulms (legume crop residues) would be good, as well as conserved forage legumes or where this is affordable, a concentrate like dairy meal, cotton or sunflower seedcake.

Maize, millet, sorghum and rice are main cereal crops in Uganda. Farmers are not aware of the value of stovers in animal nutrition. Cereal stovers are left to go to waste in the field, used as mulch in perennial crops or just burnt. Yet these cereal stovers could contribute significantly to dry season feeding.

Cereal stovers are low in nutritive value. Ways of improving their feeding value include:

- Adding forage or fodder legumes.
- Supplementation with concentrates like cotton or sunflower cake.
- Chopping into small pieces and sprinkling with salt to increase acceptability.

Maize and sorghum are usually intercropped with grain legumes. The majority of farmers in the districts grow these crops and also keep livestock. If the cereal stover is to be used as animal feed, it is advisable that farmers adopt the concept of undersowing. Undersowing involves the planting of forage legumes within another crop after the main crop is established. When the cereal or legume grains are harvested, the forage legumes will have started to climb onto the cereal plants such that the time the stover is harvested, which is normally in the middle of the dry season, the cereal stover and the forage legume are cut together, chopped into small pieces and fed to the animals.

When and what to undersow

- Main crop(s) should be planted in rows.
- Sow the legumes after the final weeding of the main crop(s).
- Use a low seed rate of 2 kg/ha of the forage legume.
- Plant the forage legumes close to the cereal crop row.
- Do not disturb the existing cropping pattern.
- Suitable forage legumes include lablab, centro, siratro and desmodiums.

10 Fodder conservation

The growth pattern of pastures and fodders changes according to the rainfall pattern. There are seasons of surplus feed for livestock and some of shortage. In principle, the surplus feed should be preserved for the season with a shortage. This is called fodder conservation. Fodder can be conserved as hay or silage.

The survey revealed that forage conservation had been covered in the training programmes. This, however, did not tally with adoption level. A few farmers were conserving fodder (7%) as hay or silage.

The most important reason why fodder should be conserved is to provide high quality fodder to the animals during the dry season, and bridge the gap between the feed requirement of the animals and the production of the fodder. Dry season feed shortage affect animal production levels and contribute to overgrazing hence exposing the soil to all agents of erosion.

These dry-season feed shortages can be addressed as follows:

- Grow fodder especially legumes that provide high quality feed for a longer period.
- Conserve fodder.

Hay making

This is a process whereby fodder is harvested at a time when the feeding value is high (see Plates 7 and 8).

What can be conserved and when?

- Ideally a mixture of grasses and herbaceous legumes is desirable because legumes increase digestibility and intake of the conserved forage.
- Most grasses are good for hay production and are convenient for cutting.
- The pasture should be cut just before flowering in order to have high digestibility and high protein content.
- Pasture for conservation should be cut 4 to 6 weeks after a paddock is closed.

Guidelines for haymaking

- Cut the pasture before flowering starts.
- Time cutting to be between rains for good drying.
- Dry the cut pasture as quickly as possible. Use a rake and turn the pasture several times this prevents moulding.
- Once dry, heap up the hay into a "stack" which should be protected from the rain. The haystack should be like an inverted 'V'. The use of a tarpaulin or polythene sheet is recommended.

Baling of hay makes storage easier. It requires:

- A bottomless wooden box (baling box) with dimensions of 3ft by 2.5x2.5 ft.
- A 10 ft long sisal string.
- Dry pasture material.
- Have 3 to 4 people tightly pack the pasture into the box, tie it very tightly and remove the box to leave a bale.
- The bales of hay must be stored off the floor; kept moisture free and allow plenty of air circulation to prevent moulding.

Hay requirements

If hay is the only feed available, depending on its quality and excluding any wastage, the requirements will be as shown in Table 13.

Table 13 *Hay requirements for different ages of animals*

Animal	Grass hay (kg/cow/day)	Legume hay (kg/cow/day)
Cow	7–13	3–5
Heifer	5–9	1–3
Young dairy stock	2–3	1

Source: National Agricultural Research Organisation (NARO)

Leguminous hay

- Leguminous fodder trees such as calliandra and gliricidia have high protein content.
- If the leaves are picked and dried, they will provide the requirement for maintenance and production of the animal during the dry season.
- Cut and dry the branches of the trees on a clean floor in a shade.
- Collect the fallen and dry leaves and store in hessian bags.
- Dried leaves are fed as a protein supplement alone or mixed in the grass hay or cereal bran.
- Mix the dry leaves with some water to avoid wastage.

Silage making

Silage is produced though controlled fermentation (under anaerobic conditions) of green forage material with high moisture content. The anaerobic conditions foster rapid fermentation that produces natural organic acids, which prevent further change in plant composition. If silage is made properly, it will contain nearly all the nutritive values present in the forage that is conserved. Ensiling is the process of silage making; while a silo is the container used. It may be a trench, a pit or a polythene bag.

Suitable crops for ensiling

All pasture and fodder crops can be ensiled. The most ideal would be maize and sorghum but these still form the bulk of human food in Uganda, hence cannot be used for that purpose.

High quality silage will be made if:

- Grasses are harvested when flowering.
- Legumes are harvested during pod filling.
- Maize/sorghum are harvested during milk-stage.

Improving silage quality

Pastures under tropical conditions (Uganda inclusive), particularly the grasses, have a low feeding value. The changes that take place during the process of ensiling reduce the value even further. The addition of either molasses, maize bran or cassava flour will improve the quality of the silage by increasing the energy content and also act as preservative.

Table 14 shows the quantities of additive to add for every 1,000 kg of green material to be ensiled. The quantities can be adjusted to match the amount of fodder. Two parts of water should be added to one part of molasses to ease application; and a watering can would be a useful piece of equipment.

Table 14 *Types and quantities of additives for silage making*

Forage	Molasses (kg)	Maize bran (kg)
Legumes	35–40	15
Grasses	15–20	40
Grass/legume mixture	25–30	55–70

Source: NARO

The ensiling process

- Harvest the pasture or crop (material) for ensiling, a panga can be used.
- Chop up the material to 2 to 5 cm pieces that will ensure firm packing to exclude oxygen (air).
- Rapidly fill the silo to be used. The bag silo is commonly used by small-scale farmers in Uganda and is recommended. Medium to large-scale farmers could use circular pit silos. The size of these is 1.5 m deep and 1.25 m in diameter. The capacity of this kind of a silo is 3 to 5 tons silage. Prevent the entry of air by covering the silo with a plastic sheet.
- Protect the silo from water by either covering completely with a polythene sheet over which a layer of soil is placed, or put the bag silos in a pit over which a roof has been constructed. This was being done on Kwesigabo's farm in Mbarara District.

The use of silage

- The silage made should be ready for use in 90 days. Under proper storage conditions, it could even be kept for a longer period.
- About 3 to 5 tons of silage is capable of feeding 2 to 3 crossbred cows for 66 days.
- Feed a little silage at a time until the animals are used to the feed;
- To avoid off-flavours in milk, feed silage to dairy animals after milking.

Different types of stock can be fed silage in quantities as shown in Table 15.

Table 15 *Utilization of silage for different types of stock*

Stock type	Quantity of silage (kg)
Milking cow	10–20
Dry cow	10–15
Dairy heifer	5–8
Beef breeding cows	12–20
Fattening calves	4–8

Source: NARO

Practical Application No. 9: *Hay making and utilization*

Mr. and Mrs. Kwesigabo have a zero grazing unit in Mbarara District and share equally in all activities related to their farm. They feed their animals on home grown fodders, crop residues and conserved feeds, that is, hay and silage.

They make hay from Rhodes grass, which grows on a ¼ acre piece of land, guinea and signal grass. They said that they cut the grass as it begins to flower usually during the rainy season. They dry the grass on the veranda and keep turning it around so that it does not get mouldy. They said that direct sunshine may make the grass lose the green colour and this would reduce the quality of their hay. When the grass is green in colour but dry, it is tied in bundles using banana fibres and stored on poles under the roof.

The couple have 600 calliandra trees planted as a hedgerow around the compound and the banana plantation. During the rainy season, there is a lot of feed and all cannot be utilised. The calliandra is cut to the ground and all leaves and twigs dried and put in sacks and stored. The branches are used for firewood when dry.

During the dry season, the grass hay is fed to the cows. It is sprinkled with salty water to increase palatability. Hay is also fed to calves to help in development of their rumens. The farmers said that when they have lablab or Lucerne, they add it to the hay. As for the calliandra leaf meal, this is mostly added either to dairy meal or maize bran that are fed to the animals at the time of milking.

Practical Application No. 10: *Silage making and utilization*

Mr and Mrs Kwesigabo of Mbarara District make and use silage to avoid dry season feed shortages on their farm. They said that they attended a training course in which they were taught about fodder conservation and its advantages.

They tried it home and got good results especially when their cow Joy liked the silage. This greatly encouraged them and they have never missed making silage. They remember one time in 1996 when there was a bad and long drought, which they went through well because they had silage and hay.

The couple use elephant grass, giant setaria and all forage legumes to make silage. All these plants are grown on their farm. The plants for making silage are cut and allowed to wilt. Using a panga, the wilted material is cut into 3–5 cm pieces. Cassava flour and often molasses are added to the material.

The material is tightly packed into polythene bags. Men use pounding pestles to pack the grass tightly into the bags. When Mr and Mrs Kwesigabo were beginning to make silage, they were using small bags that were taking about 5 kg of material. After gaining experience, they were using big bags that take over 20kg. They said that the method they were using was convenient for them because they are able to remove the amount they want to use, tie the bag again and have no wastages.

11 Recommendations

Given the existing retrenchment of extension staff in the public service, it would be appropriate to use farmer-to-farmer extension services. Farmer trainers should be identified at the sub-county level and be facilitated the exchange of knowledge and experience between the farmers.

Pasture seed production at sub-county level should be promoted. Innovative and willing farmers should be facilitated to have seed multiplication plots, which can be sold to the other farmers. However, support from the government and development agencies would be required, particularly in provision of good foundation seed.

There should be more sensitization programs on importance of fodder conservation in intensive livestock production system.

Appendix: Local names of recommended pasture

Botanical name	Common name	Local name
Pasture grasses:		
Panicum maximum	Guinea grass	Obuterante*, Nabititi†
Chloris gayana	Rhodes grass	Orunyankokore*, Businyande†
Hyparrhenia rufa	Thatching grass	Orukabara*, Likate†
Brachiaria ruziziensis, B. brizantha	Signal grass	Ekijubwe*, Biryama†
Setaria anceps	Nandi Setaria	Orutaratumba*, Amachomesi†
Cynodon dactylon	Star grass	Oruchwamba*, Kalandalugo†
Pennisetum clandestinum	Kikuyu grass	Kikuyu*†
Cenchrus ciliaris	Buffel grass	Introduced, no local name
Themeda triandra	Red oat grass	Emburara*
Pasture legumes:		
Neonotonia wightii	Glycine	Ebikamba*
Desmodium uncinatum	Silverleaf desmodium	All other pasture legumes are
D. intortum	Green leaf desmodium	introduced and like the indigenous
Macroptilium atropurpureum	Siratro	glycine are called ebikamba* or by
Centrosema pubescens	Centro	the common name†
Stylosanthes spp.	Stylo	
Fodder grasses:		
Pennisetum purpureum	Elephant grass	Ebibingo*, Egada†
Tripscum laxum	Guatemala	Gwatamala*†
Setaria splendida	Giant setaria	Tanzania grass*†
Fodder legumes:		
Lablab purpureus	Lablab	All known by common name , all
Calliandra calothyrsus	Calliandra	introduced
Gliricidia sepium	Gliricidia	
Sesbania sesban	Sesbania	

* Species for Mbarara, Kabale (Runyankole/Rukiga)
† Species for Mbale (Gisu)

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Plate 1 *Traditional cattle management in Mbarara district, Ankole cattle.*

Plate 2 *Local and cross-bred cattle breed on semi-intensive production*

Plate 3 *Zero grazing sheds in Mbarara District.*

Plate 4 *Fencing allow controlled and rotational grazing.*

Plate 5 *Calliandra planted in the boundary in Mr. Kwesigabo's farm.*

Plate 6 *Established fodder grass for smallhoder dairy production.*

Plate 7 *Demonstrating hay making using manual baler in a training workshop.*

Plate 8 *Demonstrating hay making using manual baler in a training workshop.*

Plate 9 *Roof water harvesting in Mbarara District.*

Plate 10 *Intercropping fodder grasses and cereal crops.*

Plate 11 *Intercropping grasses, fodder trees and food crops.*

Plate 12 *Lablab bean forage legume in Mr. Kwesigabo's farm.*

Plate 13 *Silage made in polythene bags in Mr. Kwesigabo's farm.*