PASTURES IN SRI LANKA

A. Brian P. Jayawardana*

ABSTRACT

The Republic of Sri Lanka is a tropical island with low variations in temperature, heavy rainfall and a wide range of soils. The total production of roughage is insufficient to meet the nutritional requirements of the animal population numbering about 1.7 million. The major part of the feed comprises natural pastures and crop residues. The average size of farm with livestock is 1.2 hectares. Government policy is aimed at expanding the dairy industry by increasing the forage base and reducing the use of provender feed and nitrogenous fertilizer. Several programs and incentive schemes are in operation and since 1981 there has been an increase in forage production. Well-adapted grass varieties have been identified for growing in the different agro-ecological zones. The main cultivated forage species are *Brachiaria, Panicum, Paspalum, Pennisetum, Stylosanthes* and *Desmodium*. Legume shrubs and tree fodder like *Gliricidia, Leucaena* and *Erythrina* are widely used. The main constraints to forage production are the small size of holding, difficulty in persuading the small farmers to cultivate fodder, inadequate farmer contact and insufficient emphasis on forages by village level staff, and insufficient number of pasture scientists and technicians.

Introduction

The Republic of Sri Lanka is a tropical island with a total land area of 6.5 million hectares, lying between latitudes 6-10°S. Topographically the island has a crown of mountains rising to 2,000-2,400m in the South-Central region, surrounded on all sides by fairly flat lowlands. Rivers radiate out from the highlands following geological faultlines in their upper reaches.

Climate

Sri Lanka is situated on the border of the equatorial belt and its climate is characterized by low variations in temperature and heavy rainfall. There is considerable variation in the amount and reliability of monthly rainfall between zones and between locations within a zone. Rainfall frequently occurs as high intensity precipitation, leading to excessive runoff and erosion. Only 50-60% rainfall is "effective".

Agro-ecological regions

Three major zones, i.e. the wet zone, the dry zone and intermediate zone have been defined based on rainfall, elevation, soil and natural vegetation. There are 24 sub-divisions. The wet zone comprising 25% of the island, receives 1,875-5,000mm rainfall/year. The dry zone receives 875-1,875mm during the November-February period. Nine out of the 10 soil orders, are encountered within the island, the more important and widespread are the Alfisols, Ultisols, Oxisols, Histosols, Vertisols and various Entisols.

* Head, Division of Pastures, Veterinary Research Institute, Gannoruwa, Peradeniya, Sri Lanka.

Local resources

Table 1 Land use

Land use	Million hectares
Total cultivable land	6.58
Permanent agriculture	2.02
Under forest	2.83
Shifting cultivation	1.00
Natural grassland/open scrub	0.61 (4%)

Table 2 The total area available for grass/herbage production*

Land class	Area (1,000ha)
Unirrigable highland in the dry zone most suitable for pastures	324
Flood plains and similar land in the dry zone	81
Coconut lands (33%)	146
Marginal tea land in the mid-country	39
Five percent of the hill country tea land comprising ravines etc.	4
Natural grassland (patana) in the hill country intermediate zone (25%)	178
Herbage from fallow paddy lands and bunds (5%)	28
Railway embankments and roadsides (50%)	4
Total	804

* FAO Country report-Sri Lanka 1979. FAO Seminar on dairy development and related manpower training.
The extent under cultivated pasture and fodder is estimated at 15,000ha (Personal communication, D. B. P. Ranasinghe, 1983).

Table 3 Fibrous crop residues available for ruminant feeding*

Crop	Area (ha)	Yield (MT)	Straw grain ratio	Crop residues	Quantity available (MT)
Cassava	33,548	365,100	—	leaves	—
Maize	26,617	26,100	2 : 1	stover	52,200
			1 : 4	husk	5,200
Groundnut	5,054	5,400	5 : 1	straw	27,000
Greengram	12,196	9,700	1 : 1	straw	9,700
Sorghum	200	200	2 : 1	stover	400
Soybean	1,221	1,300	1 : 0.5	straw	650
Finger milet	10,838	10,800	1 : 1	straw	10,800
Sesame	16,717	17,200	—	—	—
Foxtail millet	165	100	1 : 1	straw	100
Cowpea	30,280	18,800	1 : 1	straw	18,800
Blackgram	8,741	6,100	1 : 1	straw	6,100
Red gram	69	50	1 : 0,5	straw	25
Sweet potato	6,389	42,600	5 : 1	straw	8,520
Paddy	782,647	2,113,000	1 : 1	straw	2,113,000
Sugarcane	100	456,000	1 : 3	tops	30,400
Total	931,792	3,072,450			2,282,895

* Asian Development Bank 1981-Report on the Livestock Development Project, Sri Lanka.

Table 4 Total animal population*

Types of livestock	Number	Percent of total
Cattle	987,003	57.9
Buffaloes	381,016	22.4
Goats	284,045	16.7
Pigs	41,139	2.4
Sheep	10,334	0.6
	1,703,537	100

* Director, Department of Census and Statistics 1973, General Agricultural Census.

Natural grazing grounds

Natural pastures are found extensively in the dry zone and hill country intermediate zone and to a lesser extent in the main coconut growing region.

(1) Dry zone pastures

There are 2 distinct types of natural pastures on which 50% of the national herd depend.

(a) The "villus"-are the flood plains of the main river, the Mahaweli which floods for 3-4 months of the year. Rich pasturage is available for 8-9 months, the species found being *Brachiaria mutica, Digitaria longiflora* and *Cynodon dactylon.*

(b) The highland areas-mainly scrub jungle interspersed with open parkland which are used when the "villus" are flooded. A small extent has been planted with *Br. brizantha.* The management of these resources does not come under the purview of any specialized agency, thereby leading to deterioration of these pastures by overgrazing.

(2) Hill country pastures

Most of these grasslands, known as "patanas" fall within the intermediate zone and carry coarse grasses that are burnt just before the monsoon. The tender growth provides good grazing for a short period but this practice has led to severe soil erosion over the years. There are 3 main plant communities here-*Cymbopogon confertiflorum, Chrysopogon zeylanicus* and *Themada tremula* dominant communities.

(3) Coconut pastures

About 1/3rd of the coconut land is suitable for pastures as an intercrop due to the favorable rainfall of over 1,300mm/year. A large percentage of these lands has not been improved but most coconut estates and small holdings carry cattle for manuring and draught purposes. The natural pastures here are a grass legume mixture composed of *Brachiaria* species, *Desmodium* species and *Centrosema pubescens.*

Other areas where forages can be integrated into existing systems (Jayawardana, 1981) have been identified as follows:

(1) Plantation sector

Dairy production in the hill country tea estate sector is generally based on natural grasses growing on wastelands. The main grasses here are *Panicum repens* and *Ischemum indicum.* They are poor yielders of low nutritive value. Experiments conducted by the Tea Research Institute have shown that *Setaria anceps* and *Pennisetum purpureum* can be successfully grown after the native species were eradicated.

In certain mid-country rubber estates large herds of goats and some sheep are grazed on the legume cover crops like *Centrosema, Pueraria* and *Desmodium ovalifolium.*

Mid-country tea estates-There is a large extent of degraded tea lands many of which were taken over under the Land Reform Act and which could be rehabilitated by bringing them under pasture for a few years before replanting.

(2) Forest pastures

Integration of grazing animals with tropical forestry has good potential provided tree density can be decreased.

(3) Orchard pastures

This is not common in Sri Lanka but banana, mango and cashew can be combined with pastures.

(4) Paddy lands

Areas where irrigation is not available could be sown with pasture species before the water is drained off from the paddy crop. However, line planting of the paddy has to be done so that the legume seed can be broadcast easily. Animals are grazed on the volunteer growth in fallow paddy fields and the natural herbage on the bunds is cut by hand for stall feeding.

(5) Railway embankments are leased out and are fully utilized. Landless cattle owners also make full use of roadside herbage on which they graze their animals.

Size of holding

Of the total of 1.65 million holdings covering 154,000 hectares (Director, Department of Census, 1973) there were 591,182 which contained any kind of livestock. Of this number 9,510 (0.5%) were holdings with livestock but without land while 581,672 were farms. The average size of farm with livestock is shown in Table 5.

Table 5 Distribution of farms with livestock between zones and regions*

Zone		Number of farms	Average size of farm (ha)
Wet zone			
	Low country	153,939	0.96
	Mid-and hill country	81,226	0.96
Intermediate zone			
	Low country	77,486	1.80
	Mid-and hill country	34,330	1.12
Dry zone			
	Sinhala speaking	108,446	1.72
	Tamil speaking	126,245	0.96
	Total	581,672	1.20

* FAO 1980. Consultancy report-Structure of small farms in Sri Lanka.

The dry zone and low country wet zone have a much larger proportion of farms which contain livestock and there is a clearly marked indication that cattle are located on larger farms. Fifty percent of all farms with livestock and 55% of all cattle are contained in farms over 0.8 ha and under 4 ha in size.

In certain districts in the dry zone and low country intermediate zone, the cattle linked to the land holding are permitted to range freely in the surrounding forest and waste land in search of fodder. Table 6 shows the number of holdings and livestock population without land.

Table 6 Livestock holdings without land*

Type of livestock	Number of holdings	Livestock population
Cattle	2,944	8,639
Buffaloes	553	1,983
Goats	1,795	7,987
Sheep	21	361
Pigs	511	2,003
Poultry	7,330	150,994
Total	13,154	170,994

* FAO 1980 Consultancy report-Structure of small farms in Sri Lanka.

Research and development activities

Research on pastures and fodder is being conducted by the Pasture Division, Veterinary Research Institute, Peradeniya and the Department of Animal Science, Faculty of Agriculture, University of Peradeniya. Investigations by the Cropping Systems Project of the Agriculture Department, the Asian Development Bank-sponsored Livestock Development Project and Sri Lanka-Swiss Dairy Development Project in the Eastern Province are also under way. Pasture research work under coconuts which has been continuing for more than 35 years at the Coconut Research Institute has been terminated and research on coconut agronomy has been given priority. The fodder experimental project of the Tea Research Institute has also been brought to a close. The FAO Tropical Pasture Program under the National Livestock Development Board has also been wound up after running for 6 years.

1 Current research activities

1) Measurement of biological nitrogen fixed by legumes in coconut pastures using ^{15}N tracer technique

Coconut pastures were selected for these studies because the results would have a greater impact than in other areas. *Stylosanthes scabra* cv. Seca and *Brachiaria ruziziensis* are the 2 species being used. Labelled sulfate of ammonia containing 5% atomic excess will be applied to the isotope sub-plot after establishment. Nitrogen fixed by the legume will be differentiated from that derived from soil and fertilizer.

2) Economical techniques in ameliorating steep infertile natural grassland

Strips of natural grassland were left uncultivated between the contour terraces to arrest soil erosion. Erratic rainfall makes establishment hazardous, therefore, sowing of the legume seeds was done close to the embankment to make use of the protection to the overhang. No nitrogen fertilizer has been used. After 5 years, soil sampling showed a significant increase in P, K, organic matter and pH values. The feeding value was also improved. The next stage is the introduction of better grasses. Green panic and Petrie panic have done well in trial plots in combination with the *Desmodium intortum, D. uncinatum* and *Stylosanthes* used in the main experiment.

3) Introducing legumes into grass pastures and fodder in the hill country

In the hill country state farms the main pasture is *Pennisetum clandestinum* (Kikuyu). *Paspalum urvillei* and Napier are the fodders grown in the valley bottoms and highlands respectively. A program of legume introduction was commenced with the objective of increasing the protein and minerals in the diet in order to reduce concentrate feeding. Drastic reduction in the root volume of the Kikuyu is required for successful establishment of legumes into the pure grass sward. Haifa white clover and greenleaf *Desmodium* were the most successful legumes. *Lotus corniculatus* and *Desmodium* grew best on the valley bottoms in combination with the coarse natural grasses. In the highlands Napier was grown in strips 2m apart with *Desmodium* between. This mixture was ideal for ensiling.

4) Sylvi-pastoral program

A joint project between the Forest Department and Animal Production and Health Department has been initiated in order to determine the feasibility of integrating grazing with forestry. Three tree spacings will be compared for their effect on forage establishment and persistency under grazing and cutting. *Pinus, Eucalyptus* and teak are the forest trees to be used.

5) Economics of forage-based integrated small holder farms

Farm sizes ranging from 0.25 ha to 1 ha in the mid-country wet and intermediate zones are being tried out for their ability to support a family.

6) In the dry zone, *Leucaena* and grasses at different densities under zero grazing

management are being tested out for small farmers.

As an alternative to pure *Brachiaria* pastures, grass-legume combinations using Siratro, *Stylosanthes,* Buffel grass, Panics are being tested under grazing.

7) Different methods of ensiling the ubiquitous wild Guinea grass are being tried out. This variety of *Panicum maximum* was not introduced but is thought to have come in through a seed sample. It produces seed profusely but becomes rank if not harvested as soon as 10-14 days.

8) Plant introduction studies in the acid soils, cool hill country with *Leucaena diversifolia* and *L. shannoni* have been initiated in order to identify a suitable browse legume for this zone.

9) Survey of the mineral content of natural forages

Samples of forage actually consumed by animals of small farmers are being collected. Their mineral contents will be determined by the autoanalysis method.

10) Survey of non-conventional and conventional feedstuffs

This UNDP-sponsored project which is about to commence will cover the whole island and random sampling of farmers will include a certain minimum percentage in each district. All details of local resources being used will be recorded and samples will be analysed for their mineral contents and proximate composition.

11) A large number of introduced species of grasses and legumes were compared with locally available species in the mid-country dry zone and coconut growing regions under the Sri Lanka/IDA Dairy Development Project. Techniques of establishment, effect of fertilization, forage conservation utilization of fodder trees were investigated and recommendations made.

12) Under the auspices of the World Bank a Dairy Development Federation has been set up. One of the important aspects of this scheme will be setting up of task forces in 5 selected milk shed areas with potential. Each task force will include a fodder development officer. Demonstration farms will be set up where investigations on (1) methods of establishment and cultivation, (2) seeding and planting rates, (3) optimum use of fertilizer, and (4) strategies for year round forage supplies will be carried out. The other aspects that will be studied under this program will be ways of reducing costs of establishment, and developing techniques for establishing rotational farming systems in the dry zone (World Bank, 1984).

2 Development

Government wishes to expand the dairy industry by increasing forage availability and use, and reducing dependence on compounded feeds and the use of nitrogenous fertilizer.

A pasture Development Committee at national level was set up in 1979 at the Ministry of Rural Industrial Development and meets 4 times a year, chaired by the Hon. Minister, to set targets and review progress. All State organizations concerned are represented, i.e. the Department of Animal Production and Health, the National Livestock Development Board (NLDB), the State Plantations Ministry, the Coconut Development Authority, Department of Agriculture, Forest Department, Oils and Fats Corporation, etc.

Small farmers in the mid-country region are being encouraged to construct silo pits by a subsidy scheme run by the NLDB. So far about 200 farmers have benefitted. A simple inexpensive trench silo was developed of 6.5m^3 volume which could provide good quality silage to 2 cows for a period of 60 days feeding at the rate of about 20kg/animal/day.

A pasture subsidy scheme has been in operation for several years, where farmers are encouraged to establish pasture under coconut, in uneconomic tea lands, home gardens, etc. Apart from this the Sri Lanka-Swiss Dairy Development Project which operates in the Eastern Province helps farmers to establish plots in their own lands. Nestle Ltd. who have opened a milk powder factory in the coconut growing region also give grants to milk producers to establish pastures. Also Lanka Milk Foods, a State sponsored body which imports milk powder and retails it in small packs, have also started an extension program

to encourage farmers to supply their factory with milk so as to substitute and reduce imports.

The Asian Development Bank-sponsored Livestock Development Project envisages the setting up of forage resource centers in different regions for demonstration and extension purposes. For the purpose of increasing the supply of dried *Leucaena* leaf meal to the Oils and Fats Corporation, the State-owned provender plant, large blocks of land are to be developed with this variety. A start has been made with one 200 ha block. The Corporation also purchases leaf meal from small holders and other suppliers.

The veterinary surgeons in charge of the different ranges, numbering 102, are responsible for forage development among the farmers. They are required to maintain an inventory of the extents brought under forages.

The trend in production can be gauged by the establishment figures in Table 7. The fresh matter yield of the grasses ranges from 50-75 MT/ha/year under moderately good management. The dry matter content varies from 11-12% in *Setaria* and Napier to about 20%

Table 7 Pasture and fodder establishment and conservation achievements

	Pasture (ha)	Fodder (ha)	Silage MT	Hay MT
1980	600	230	Nil	Nil
1981	820	410	700	30
1982	600	220	1,236	1,385
1983	1,140	310	2,340	900

Personal communication, D. B. P. Ranasinghe, 1983, Ministry of Rural Industrial Development.

in Guinea grass and the *Brachiarias*. The crude protein content is 9-12% of the dry matter.

The legume content in pastures is insignificant, but legume trees are grown on fences for lopping and feeding.

The Mahaweli Development Project: The main river, Mahaweli, will be dammed at several locations and excess water will be diverted to hitherto rainfed areas in the North Western Provinces and electricity generated. Ten thousand families will be settled in new land that will be brought under irrigation. Some of these soils which are not suited for irrigated paddy and highland crops are recommended for pastures. Under the Draught Cattle Program, it is planned to provide each family with draught animals to cut down costs of cultivation, therefore, provision of grazing lands is envisaged.

Pasture Lands(Reservations and Development) Act No. 4 of 1983: This Act "provides for the reservation of certain State land, for the leasing of such land for the recovery of possession or occupation thereof and for matters connected therewith or incidental thereto". According to the regulations framed under this Act the leasee will have to follow the guidelines laid down in developing the land for pasture and maintaining it.

Establishment, maintenance and utilization

For this purpose the island has been divided into 4 main agro-ecological zones (Ministry of Rural Industrial Development, Sri Lanka, 1982).

The quantity of fertilizers applied is the minimum amount necessary for the maintenance of forage plants and is based on the assumption that animal excreta are returned to the land and that farmers as a rule are reluctant to spend on fertilizer purchase.

1 Coconut triangle and wet zone (low country)

Satisfactory growth of pasture could be obtained under new plantings up to about the 4-5th year, and again from about 30 years onwards in mature stands spaced 7 meter. There are no adverse effects on nut yield by intercropping with pasture, provided both crops are adequately fertilized and grown in regions with a more favorable rainfall regime (over 1, 375mm). There is also a long-term beneficial effect under such conditions.

Natural pastures under coconut can only maintain one animal per 2-3 ha whereas improved pastures can maintain one animal per 0.5-0.8 ha.

1) Forage species

Grasses—*Brachiaria milliformis, B. brizantha, B. ruziziensis, Digitaria decumbens*-for the coconut triangle only. *Panicum maximum* (Guinea B), Green panic (short variety of Guinea B). *Setaria anceps*, Pusa giant Napier. Another promising grass is *Brachiaria dictyoneura.*

Legumes—are beneficial but can be recommended only for specific soil and climatic conditions. *Centrosema pubescens, Pueraria phaseoloides, Macroptilium atropurpureum, Stylosanthes* species, *S. guianensis* and *S. hamata. Leucaena leucocephala* for soils with higher pH. *Gliricidia maculata* for poor acidic soils.

2) Establishment

A light ploughing followed by disking of the soil should be first performed. *Brachiaria* species and other pasture grass cuttings should be spread and disked or furrows opened and cuttings spread so that the next furrow slice covers them, leaving only the tips exposed. The cuttings should be 30cm long and spaced out at 30×30cm. Fodder type cuttings should be planted in holes at the appropriate spacing of around 60×60cm.

A 0.4ha nursery will provide sufficient cuttings to plant 6-8ha. About 4,000 cuttings of pasture grasses and 16,000 cuttings of fodder grasses are required to plant 1ha.

Pasture legume seeds are directly sown at the rate of about 5kg/ha after scarification and inoculation with the appropriate bacteria. Legumes are sown in lines spaced at 60cm and after they are well established grass cuttings can be planted between the rows of legumes 60cm apart.

Ipil ipil and *Gliricidia* can be established as a hedge along the fences or in the pasture in two rows 2 meter apart.

3) Fertilization

Adequate manuring of both coconut palms and the pasture intercrop should be done.

For pasture grasses, broadcast 50kg ammonium sulfate (or 25kg urea), 25kg saphos phosphate and 25kg muriate of potash per 0.4ha at the beginning of each rainy season. In the case of fodder grasses 25kg ammonium sulfate (or 12.5kg urea), 12.5kg saphos phosphate and 12.5kg muriate of potash per 0.4ha after each cutting.

These fertilizers have to be applied in addition to 3.2kg of requisite coconut fertilizer mixture per palm per year.

4) Management

Most pasture grasses under coconut are ready for grazing once every 6 weeks at which time they will be about 45cm high. They should be grazed or cut to a height of 10 to 15cm from ground level. Fodder grasses should be cut every 30 to 45 days to a height of 20-30cm.

5) Conservation

There is little need for conservation in this zone as the rainfall is evenly distributed. If necessary excess production of forage could be ensiled.

2 Dry zone

This zone covers about 2/3rd of the land mass of the island and carries the largest number of cattle (about 60%).

The soils in general are classified as reddish brown earths which range from heavy clays to sandy loams.

1) Forage species

Grasses—*Panicum maximum*-Guinea B, Guinea A, Hamil, Green panic; *Brachiaria* species, *B. brizantha, B. ruziziensis, B. mutica* (on waterlogged lands), *B. decumbens, Cenchrus ciliaris*-Nunbank, Gayandah; *Setaria anceps*-Nandi *Setaria.*

Legumes—*Macroptilium atropurpureum, Stylosanthes guianensis, Stylosanthes hamata, Stylosanthes scabra, Centrosema pubescens* (on wet lands only), *Macrotyloma axillare.*

Fodder trees-*Leucaena leucocephala, Gliricidia maculata, Erythrina indica.*

2) Establishment

Grasses are generally established by root cuttings but certain varieties like Hamil, Buffel, Green panic, Siratro and Stylo can be seeded.

Planting should be performed before the heavy rains set in. The amount of cuttings required would depend on the quality of the material. A quantity of 1.8-2.2kg of grass seed or 1.3kg grass plus 0.9-1.3kg legume seeds (mixtures) is required per acre.

The seeds should be covered with a thin layer of soil and pressed down for better establishment.

3) Fertilizer

For establishment kg/ha- 50 Triple super-phosphate (TSP),
75 Muriate of potash (KCL)
10 Sulfur

For pure grass swards in addition to the above apply 75kg urea/ha.

4) For maintenance

For pure grass swards apply 100-200kg urea/ha/year in split doses, twice in Maha and once in Yala. If organic manure is available apply 5ton/ac/year (5 MT/ha/year) and reduce the quantity of fertilizer.

5) Management

Cutting and/or grazing should be more frequent during the wet season. Manuring should be carried out regularly and weeding performed when necessary.

6) Conservation

The long dry season requires provision of alternative feed resources when most grasses and legumes will be dormant. These are: (1) Silage and hay made at a suitable time when there is excess; (2) Tree fodder which is deep-rooted and high in protein can be fed up to 36-40%; (3) Crop residues-paddy straw. Straw of annual legumes is more nutritious; (4) Villus grazing-Grasses like *B. mutica, Cynodon* and *Digitaria* species grow in these low-lying areas.

3 Mid-country

This region lies between 300-1,050m elevation and is sub-divided into wet and dry areas.

Soils are low in fertility due to erosion and are acidic in reaction.

1) Forage species

Grasses—*Panicum maximun*-Hamil, Guinea B, Guinea 435, Guinea A; *Brachiaria brizantha* and *Brachiaria decumbens* for steeper areas; *Brachiaria ruziziensis,* Hybrid Napier NB_{21} for fertile wetter areas.

Legumes—*Stylosanthes guianensis, Macrotyloma axillare, Macroptilium atropurpureum*-drier areas; *Desmodium* species.

Fodder trees—*Gliricidia maculata*-poor acidic soils; *Erythrina lithosperma*-above 2,000ft elevation; *Leucaena leucocephala*-soil with high pH.

2) Establishment

Land preparation—Deep cultivation should be avoided on steep land to minimize soil erosion. In uneconomic tea land carrying less than 50% bushes, planting can be done first and the bushes removed later when the forage species are well established. Very steep lands could be developed in strips and forage planted in 15cm contour furrows.

3) Fertilization—10 MT cattle manure/ha plus the following fertilizer mixture should be

applied for good establishment: (kg per ha).

500-1,000 Dolomitic lime
50- Triple super-phosphate
40- Muriate of potash
5- Sulfur

For pure grass areas 25kg urea should be applied in addition to the above.

4) Techniques

Planting of large areas should not be attempted with vegetative cuttings transported from distances. Instead small nurseries should first be established and during the following season, cuttings from the nursery could be used to plant up an area 10-15 times the extent of the nursery.

Spacing

Grasses—Erect and semi-erect species i.e. Guinea on flat land-45to 60cm x 30cm; on sloping land-30cm x 20cm.

Legumes—15-20cm apart between grass rows 2-3 seeds/hill.

Fodder trees-As a hedge along the fences or in the fodder field at convenient distances.

5) Management

Manuring—Dung and litter should be collected and made into compost and applied once a year. Urine and wash water should be collected in a cemented pit which should be emptied regularly and the slurry applied to the fodder systematically.

Fertilizer application will result in higher forage yields. The recommendation is: (kg/ha/year).

100-Triple super-phosphate
50-Muriate of potash
20-Sulfur

For pure grass areas in addition, apply 30kg urea/ha in splits every 2 months. Harvesting should be done before flowering. During the wet season the intervals should be 3-4 weeks and 6-8 weeks during the dry season.

4 Hill country

This zone is generally defined as the land at elevation of 1,060m above mean sea level. There are 2 major agro-ecological regions in this zone: (1) wet zone, (2) intermediate zone "dry patana".

Soils are moderately to strongly acidic in reaction. Phosphorus is widely deficient and in certain areas potash deficiency is also reported. Dolomitic limestone needs to be added annually. Minor element deficiencies of boron, manganese zinc, molybdenum and copper have also been recorded.

1) Forage species

(1) Wet Zone (A) Below 1,500m (a) For well-drained lands.

Grasses—*Panicum maximum* (Guinea B and A), *Pennisetum purpureum*—local Napier, *Paspalum dilatatum, Paspalum plicatulum, Setaria anceps* (Narok *Setaria*), Hybrid Napier NB_{21}.

Legumes—*Desmodium introtum, Stylosanthes*, Velvet bean (annual), *Desmodium uncinatum.*

Fodder trees—*Erythrina lithosperma, Albizzia molucana.* (b) For water-logged ravines.

Grasses—*Paspalum plicatulum, Paspalum urvillei, Brachiaria mutica.*

Legumes—*Desmodium* species. (B) Over 1,500m elevation.

Grasses—*Pennisetum clandestinum* (Kikuyu), *Setaria anceps* (Narok *Setaria*), *Paspalum urvillei.* Other promising Varieties-Tall fescue, Cocksfoot. Legumes—*Trifolium repens, Desmodium uncinatum.*

(2) Intermediate zone "dry patana" 1,200-1,500m elevation.

Grasses—*Brachiaria brizantha,* Hybrid Napier NB_{21}, *Panicum maximum*-Guinea B, *Setaria anceps* (Nandi *Setaria*), Sorghum (annual).
Legumes—*Desmodium intortum, Stylosanthes* species, Velvet bean (annual).
Fodder trees—*Gliricidia maculata,* Dadap, *Sesbania aegyptica.*

2) Establishment

(1) In the waterlogged ravines—drain excess water, eradicate the couch grass, cultivate, apply basal fertilizer and plant pre-rooted cuttings.

(2) In well drained lands—control weeds, cultivate in 30 cm contour strips, apply basal fertilizer and plant. Above 1,500m no new land should be opened up.

(3) In the dry "patana" (a) On lesser slopes and better soils, cultivate and prepare good seedbed. Apply basal fertilizer mixture and plant a pioneer crop of sorghum followed by a crop of sunhemp which should be ploughed in. In the following year plant improved pasture and fertilize.

(b) On stony and very steep land, collect surface stones and make contour stone bunds. Construct 60cm wide contour terraces and sufficient drains to prevent soil erosion. Apply basal fertilizer in a band 10cm away from the cutting. Dibble legume seeds suitably pretreated. Cover with soil and compact. A compatible grass should be planted along the edge of each terrace to grow in association vith the legume.

3) Basal fertilizer mixtures

	kg/ha
Dolomite	1,000
Triple super-phosphate	150
Sulfur	10
Muriate of potash	200
Minor elements as required	5-6

In small holdings; compost/animal/poultry manure and green manure can form the basal mixture provided sufficient quantities are added.

4) Management

Manuring (maintenance mixtures) kg/ha/year.

(1) Legume grass pastures

Triple super-phosphate	100-150
Muriate of potash	100-150
Sulfur	5-7
Dolomite	500-1,000

(2) Pure grass

Urea 300-500 in 4 splits, plus mixture No. (1) or T.R.I. grass fertilizer mixture.

Old Kikuyu pastures that have become unproductive should be renovated by disc-harrowing at the end of the dry season followed by collection of all trash and burning. With the rains the basal fertilizer mixture should be applied and legume seeds sown. Later on the Kikuyu will regenerate from the rhizomes and produce a grass legume mixture.

Dry season feeding

Generally farmers do not practice any kind of forage conservation like hay or silage. During the lean season animals are solely dependent on straw and crop residues. A program has been started recently to popularize urea-treated straw feeding. Although there are many constraints, this system is being adopted by many farmers. Legume fodder trees like *Leucaena, Gliricidia, Erythrina*, etc. which can be used as live fences on farm boundaries are a good source of fodder especially during dry seasons. As this system does not interfere with the normal operation of the farm, it is being popularized. Seeds of *Leucaena* are distributed to farmers by the different agencies, and 60,000 seedlings were also distributed last year. Other trees that are used are: *Ceiba pentandra* (kapok), *Acacia* species, *Albizzia* species,

Cadjanus cadjan, Titonia diversifolia (wild sunflower). Several forest trees in the dry zone are also lopped for drought feeding.

Under an assistance scheme, budgetary allocations have been approved for the construction of 115 silo pits and for making of 6,000 bundles of hay (20kg each) by small farmers during the year 1983/84.

Constraints

Sri Lanka has had no tradition of nomadic herdsmen, no tradition of grassland farming and no significant specialization in livestock rearing. Wherever livestock have been reared, they appear to have been associated with crop farming.

Where village settlements are associated with man-made reservoirs, animals are branded and allowed to run in herds to forage for themselves on the fallow rice fields, forests, etc., in a free range system.

It has been estimated that about 90% of the present milk production is contributed by small dairymen practicing a "cut and carry" operation, while the remaining 10% is produced by specialist dairy farmers and government farms. The present total milk production is estimated to be only about 25% of the estimated 15 million litres/day required to meet the average daily recommended consumption of 140ml per person (Rajaguru, 1979).

The small dairymen have been heavily dependent on concentrate feeding in the past. But with the escalation in the price of compounded feed it became an uneconomic proposition, and many animals were sold off. However, these farmers produce very little of their own forage and depend on roadsides, forest reserves, waste lands, etc. They are reluctant to grow forage on their own land as priority is for food and cash crops. Even when they do so they rarely apply purchased fertilizers or manures.

In the mid-country there are many successful small land holders who combine deep litter poultry rearing with stall-fed dairy operations. Once in 6 months the litter is applied to the forage plots. This appears to be a profitable integration that overcomes the constraints in use of fertilizers. The task of changing the attitude of the farmer and promote a more scientific management of forages is a formidable one as his animal enterprise is generally only a sideline and not much attention is paid to it.

Many farmers who have planted improved varieties under assistance schemes do not show sustained interest, and their plots show evidence of neglect after some time.

When forages are introduced to paddy farmers they expect the same rate of growth in the seeded forage as in the paddy plant. As this is not evident, they lose interest. This could be overcome by starting with vegetative propagation.

Planting material—both cuttings and seed are not available readily to the farmer at reasonable distances from the farm. The current production of pasture seed is concentrated in the private sector and meets a local and export demand for seed of leguminous cover crops in rubber and coconut plantations. A total of 78.5t/year is handled by these firms and the level of production is determined by advance orders.

Small farmers could be encouraged to grow pasture seeds as the demand increases. Sri Lanka could well produce her own requirements of pasture seeds in the future, although some climatic constraints indicate that levels of seed yields will be below the normal average (Humphreys, 1979).

Technology available—Adequate technology in the use of planted grasses is available for the mid-country, highlands and coconut triangle but greater attention needs to be given to the development of both shrub legumes and herbage legumes (Humphreys, 1979).

Nutrient limitations on pasture production—There is a need to obtain information on the micronutrient status of Sri Lankan soils and micronutrient limitations on pasture plant production (Edwards, 1980).

Staff—There is an insufficient number of pasture scientists and technicians working at present (Humphreys, 1979). Scientists with postgraduate training in the subject distributed among the different institutions in the country number 7. Trained technicians are even fewer. Other supporting staff, i.e. an analytical chemist possessing some skills in laboratory instrumentation are also needed (Edwards, 1980). In general farmers do not have enough contact with specialized forage extension officers. The Livestock Development Technicians are the field level officers attached to the range. Veterinary Surgeons are mostly engaged in immunization programs and artificial insemination and have not been trained in forage extension work.

Facilities—A glasshouse for experiments on nutrient limitations in soils should have high priority. Additional laboratory facilities will be also be useful.

Education training and information

Veterinary Surgeons are responsible for forage extension work in the field but the training imparted to the students at the Veterinary Faculty at Peradeniya in this subject is inadequate especially in its practical aspects. A middle level Livestock Development Technician training course commenced a few years ago.

Farmer training is done at 2 locations where courses of one week duration are held. However, the number of farmers covered is small and many genuine farmers are not able to leave their farms for one week.

A newsletter for livestock farmers is issued regularly, also booklets on fodder cultivation, conservation and tree fodder and a guide on forage cultivation and use have been published. Short TV programs on practical aspects of the subject could be produced to make an effective visual impact on farmers.

References

1) Director, Department of Census and Statistics (1973): Census on agriculture.
2) Edwards, D.G. (1980): Nutritional limitations on pasture production and quality in Sri Lanka.
3) Humphreys, L.R. (1974): Dairy pasture development and seed production in Sri Lanka.
4) Jayawardana, A.B.P. (1981): Integration of forages in tropical farming systems. Talk to Symposium on "Recent developments in agrostology".
5) Ministry of Rural Industrial Development, Sri Lanka (1982): Guide to the establishment, maintenance and utilization of forage plants.
6) Rajaguru, A.S.B. (1979): Milk production in relation to food and nutritional needs of Sri Lanka. Paper presented to Symposium on "Agricultural Production in Relation to Food and Nutrition Needs of Sri Lanka", at AR and TI, Colombo.
7) World Bank Report (1983): Proposals for dairy development in Sri Lanka.

Discussion

Mendoza, R.C. (The Philippines): Which of the introduced legume species is more likely to contribute to pasture improvement in the hilly areas of Sri Lanka?

Answer: White clover which was introduced from Denmark and Australia.

Cocks, P.S. (ICARDA): I believe that some of the African clovers native to the highlands of Kenya and Ethiopia could become adapted to the highlands of Sri Lanka. I would also like to ask you what is the effect of pasture production on tree crop production, such as coconuts?

Answer: Usually, when pasture production increases, the yield of copra tends to decrease.

Thus we have to strike a balance in taking into account possible crop competition and we have observed that some grasses such as *Brachiaria milliformis* and *B. ruziziensis* can be used without any adverse effect, including moisture limitation, on the tree crop.

Siregar, M.E. (Indonesia): 1. Which grasses do you recommend for lowland pastures, pastures under coconut trees and pastures in the highlands? 2. Do you encounter any problem when sheep are fed *Brachiaria brizantha*?

Answer: 1. For pastures under coconuts we recommend *Brachiaria milliformis* and *B. ruziziensis*, in the lowlands of the wet country *Panicum maximum*, in the highlands *Pennisetum clandestinum*, in the wetlands hybrid Napier, in the dry zone *Brachiaria brizantha* and *B. decumbens*. Although little work has been carried out on legumes, we find that *Leucaena* is well adapted to the dry zone. 2. In the dry hill country we encounter problems and in the dry season young lambs in particular develop symptoms of intoxication. To prevent the occurrence of such symptoms we feed them with cut legumes in the dry season.

Chen, C.P. (Malaysia): What is the maximum yield of Napier hybrid you can obtain? Is it higher than that of Guinea grass? I would also like to mention that in Malaysia sheep and goats grazing on *Brachiaria decumbens* developed jaundice and photosensitization and that a high mortality rate was recorded.

Answer: In the best areas without moisture limitation and under fertilization a yield of 30 ton DM can be obtained.