Forages for Plantation Crops in Sri Lanka

L.V.K. Liyanage*

Abstract

The greatest potential for integration of animals and plantation crops in Sri Lanka exists in young rubber and mature coconut plantations. Despite experimental evidence of the suitability of improved pasture species for integration into these plantation areas, only a small proportion of the land available for forage production has so far been planted to improved species. Major constraints for forage development are low income from dairying compared with cash crops, high initial capital investment. scarcity of land due to competition from other enterprises, slow rate of development of forage programs and seasonality of forage production in certain climatic zones. Strategies must be developed to improve forage-livestock production through strengthening research extension work and improving farmers' skills.

SRI LANKA has a population of 16.5 million and is a tropical island located between latitude 5º 55' N and 9º 51' N. Topographically, the island has a crown of mountains rising to 2000-2400 m in the south-central region which is surrounded on all sides by fairly flat lowlands. The three major agroclimatic zones are the wet zone (> 1875 mm annual rainfall with highest falls during May to September), the intermediate zone (1500-2000 mm annual rainfall) and the dry zone (875-1875 mm annual rainfall). Major soil types are alfisols, ultisols, oxisols, histosols, vertisols and various entisols. Soil acidity is widespread in many parts of the country.

Of the total land area of 6.6 million ha, almost I million ha are under plantation crops. Tea plantations (222 000 ha) are grown up to an elevation of nearly 2300 m. Rubber plantations (200 000 ha) are situated mostly in the low country wet zone and are grown up to an elevation of 700 m. Coconut (416 000 ha) is the most widely cultivated plantation crop and is second only to the paddy crop area of 865 000 ha (Anon. 1989). Coconuts are grown up to an elevation of 1000 m in the low-country wet and intermediate zones and to some extent in the dry zone wherever facilities for irrigation exist.

Tea is the major export crop with an annual production of 227 million kg and export earnings of Rs 12 299 million (Anon. 1989). The tea industry is operated predominantly on an estate basis with more than 80% of estates more than 5 ha in size. Rubber is Sri Lanka's second-largest export earner with an annual production of 122 million kg and exports of 99 million t amounting to Rs 3706 million. Smallholders own about 70% of the rubber-growing land in the country. Coconut constitutes the third-largest export of Sri Lanka, although about 70% of the total coconut production is used for domestic consumption. Of the annual production of 1933 million nuts, only 224 million are exported with earnings of Rs 1538 million. The smallholdings comprise nearly 85% of the total coconut area. It has been estimated that nearly 70% of the coconut area of 200 000 ha) has the potential for successful intercropping. Although coconuts thrive well in all parts of the low country, about 70% of the coconut area is concentrated in the 'Coconut Triangle' formed by districts of Colombo, Gampaha, Kurunegala and Puttalam where almost 40% of the indigenous cattle population is located.

Like many other developing countries, Sri Lanka is not self-sufficient in livestock production. In 1982, the ruminant population was approximately 1.7 million cattle, 0.9 million buffalo, 0.5 million goats and 0.03 million sheep (Anon. 1985). More than 70% of these animals are located in the lowland dry zone. National milk production is around 450 000 L/day, which supplies approximately half domestic consumption (Rajaguru 1986). The majority of dairy farmers are smallholders with 1-2 milking cows kept as a subsidiary occupation to supplement income. Milk production in smallholdings is based on cut-and-carry systems but productivity is relatively low as a result of poor management.

Natural grasslands occupy 4% of the total cultivable land of the island. However, other areas (e.g. coconut plantations) also contribute significantly to the available forage resources (Table I). Of the 700 000 ha of forage resources, only 17 000 ha are planted to improved forage species. In fact, one of the main causes of low production of the local livestock

*Council for Agricultural Research Policy, Sri Lanka.

herd is poor nutrition due to shortage of forage. If this shortage is to be overcome, a further 200 000 ha of improved forages need to be planted. Unfortunately, land development projects (e.g. Mahaweli Diversion Scheme) have removed some of the more fertile land previously available for forage production. In other instances, high-value crops with export potential have emerged, which has changed land-use patterns.

Table 1. Forage resources in Sri Lanka.

Farming system	Area (ha)
Non-irrigated highlands in the dry zone	325 000
Villu and similar lands in the dry zone	80 000
Coconut plantations	140 000
Marginal tea land in the mid-country	40 000
Hill country tea estates	4 500
Patna lands in the hill country	55 000
Herbage from paddy fields	30 000
Roadsides. etc.	5 500
Other areas forming part of mixed fanning homestead systems in the wet zone	20 000
Total	700 000

Source: Siriwardena and Clarke (1986).

Forage Opportunities in Plantations

Tea

Opportunities for forage production in tea plantations are limited. Forages are used for soil amelioration during the replanting phase, for soil conservation between the tea bush rows and as shade trees for tea. It is established practice to rehabilitate old tea lands by planting either Guatemala grass *(Tripsacum laxum)* or Mana grass *(Cymbopogon confertiflorus)* for a period of 18 months to recondition the soil before replanting the area to tea (Sandanam et al. (1987). While these grasses are well suited for soil amelioration, they are of poor feed quality. The practice of growing leguminous covers such as *Crotolaria* spp., *Stylosanthes guianensis* or *Desmodium ovalifolium* in the interrow spaces is beneficial for conserving soil. *Gliricidia sepium serves* as a valuable shade crop and green manure as well as for soil conservation. Trees are lopped prior to dry periods and spread over the soil to conserve moisture. While forages are used in tea plantations, their use and management is primarily directed at soil conservation and the requirements of the tea crop.

Rubber

It normally takes 6-7 years for new rubber plantings to attain the tappable girth of 50 cm. Unless intercropped in some manner, the land is unproductive and is an economic burden to the grower until tapping commences. The present method of avenue planting of rubber with wide row spacings (10 m) facilitates cropping of interrows until the developing rubber canopy at about four years of age begins seriously to limit production. Vacant patches in mature rubber plantations caused by loss of trees from White-root disease *(Rigidoporus lignosus)* constitute about 8% of the total land under rubber in Sri Lanka (Liyanage 1978), and forage cultivation in these patches would be possible. However, the smallness of these patches and their wide scatter in plantations suggests that fodders for cut-and-carry feeding rather than for grazing are more appropriate.

As much of the rubber is planted on steep slopes, annual cropping is often not possible. The creeping cover-crop legumes puero *(Pueraria phaseoloides)*, centro *(Centrosema pubescens)*, *Calopogonium* spp. and *Desmodium* spp. are widely used and these are also good forage crops. There is a need to integrate these with compatible grasses. Some investigations into the suitability of various forage grasses and legumes have been carried out by Waidyanatha et al. (1984), who reported results of a study of zero-grazed pasture over six years in immature rubber. The grasses *Panium maximum* (Guinea B), *Brachiaria brizantha* and *Brachiaria miliiformis* were planted alone or in mixtures with the two legumes puero and centro. Yield declined sharply as light transmission decreased, especially after the fourth year. Guinea B grown alone outyielded both *Brachiaria* species while *B. brizantha* yielded significantly more than *B. miliiformis* in the third and fifth years. Guinea B-puero was the outstanding mixture and it outyielded pure Guinea B as well as the Guinea B-centro mixture.

In another experiment, three grasses, Guinea B, *B. brizantha* and napier *(Pennisetum purpureum)* were cultivated alone or in combination with four legumes, puero, centro, and stylo *(Stylosanthes guianensis)* cv. Schofield and cv. Oxley. Of the mixtures, the highest yields were obtained from the two napier-stylo associations, but no mixture significantly outyielded the pure grass treatments. Legume component yields were much higher for the stylo cultivars than for puero or centro. The highest legume content was in the Schofield stylo-Guinea B association (33%) and the lowest in the puero- *Brachiaria* mixture (4%).

Dissanayake and Waidyanatha (1987) investigated the competitive effect of ten grasses and an uncut puero cover crop on the growth of young rubber trees. The average yield for all species was about 8 t/ha/year for the whole period, with Guinea A and Guinea B yielding the highest (IO t/ha/year) and Green panic *(Panicum maximum* cv. Petrie) yielding the lowest (6 t/ha/year). Both height and girth of trees were reduced when crops were planted 1.0 m away from trees compared with 1.5 m. With regard to tree height and girth, *B. brizantha*, *B. decumbens* and Guinea B were the most competitive whereas *Paspulum, Setaria,* Green panic and B. *miliiformis* were the least competitive. Guinea A, napier and *B. ruziziensis* were moderately competitive. It seems unlikely that competition is a major limitation when considering the economic feasibility of forage production under young rubber.

Coconut

The majority of coconut lands in the wet and intermediate zones is suitable for forage growth and already there are several species of native grass growing under these plantations. Most are weed species giving a low herbage yield of poor quality which supports only a low carrying capacity of around 0.4 cattle/ha. In 1955, the Coconut Research Institute of Sri Lanka pioneered research on improved forage production under coconut. Satisfactory pasture growth can be obtained under new plantings up to the fifth to eighth years and again from about 20 years onwards in mature stands spaced 7 m apart or more. The effect of the fertilised grasses *Brachiaria brizantha, B. miliiformis* and *Guinea B* on coconut yield was investigated by Santhirasegaram (1966a). *Brachiaria brizantha* and *B. miliiformis* gave a coconut yield increase of 235 and 545 nuts ha/year respectively, while Guinea B caused a reduction of 245 nuts/ha/year. Herbage yield of Guinea was twice as high as those of the two *Brachiaria* spp. and resulted in heavier competition for nutrients. In another experiment, a B. *brizantha* pasture reduced nut yields by 13% when manuring was not done (Santhirasegaram 1966b). Because of its shade tolerance and lower competitiveness, *B. miliiformis* has been recommended for coconut plantations since 1967. Fertilizers recommended for *B. miliiformis* are (in kg/ha) 50 N, 25 P and 50 K, applied in two split applications at the start of each monsoon (Appadurai 1969). For fodder grasses, half this dose has been recommended immediately after each cut. In addition, palms have to be manured separately with 3 kg of adult palm mixture fertilizer.

A number of new forage species has been introduced and *Brachiaria dictyoneura* produced 40% more herbage than *B. miliiformis* (Table 2). It also responded well to added nitrogen. Another desirable characteristic observed in B. dictyoneura was its high degree of drought tolerance. It was also more than 50% digestible. Some of the other promising species are green panic and *Panicum maximum cv.* Hamil for cut-and-carry systems. Pangola grass *(Digitaria decumbens)* is well suited to areas with a light transmission of more than 85%, particularly where sheep are reared. However, this grass is not very shade-tolerant and has not persisted in more shaded grazed pastures.

The beneficial effects of legumes in pastures have been well established. The main difficulty with legumes is their lack of persistence. Calopo

Table 2. Productivity of various grasses grown for three years under coconuts at two levels of nitrogen.

Species	Yield (kg DM/ha/year) 26 kg/ha N	52 kg/ha N
Brachiaria miliiformis	7 611	7 920
Brachiaria brizantha	8 550	9 397
Brachiaria dictyoneura	10 392	11 317
Brachiaria ruziensis	7 342	7 636
Digitaria decumbens	6 434	7 011
Panicum maximum cv. Petrie	655	7 744
Panicum maximum cv. Guinea B	7 119	7 997
Setaria sphacelata	7 407	8 862
Pusa giant NB 21	4 705	5440

LSD (P<0.01) between species = 1045; LSD (P<0.05) between levels of N = 494.
Source: lbrahim and Ferdinendez (1984).

(Calopogonium mucunoides) is sometimes used as a pioneer legume in mixtures with centro or puero to give early cover, but this legume has low palatability, is shot-t-lived and has poor drought tolerance. Centro is deep rooted, has a high degree of drought tolerance, and is able to produce more than 10 t/ha/year of dry matter under coconuts. It also mixes well with *Brachiaria* spp. and is adapted to many soil types. It is readily accepted by ruminants. Puero grows on a wide range of soils but prefers heavy soils in the high rainfall areas. Apart from its forage value, it has served very effectively in the conservation of soil and moisture coconut lands with large additions of leaf litter amounting to 8-10 t/ha/year. Siratro *(Macroptilium atropurpureum* cv. Siratro), being deep-rooted. has good drought tolerance and is suited particularly to dry areas. It has produced around 10 t/ha/year of dry matter with satisfactory yields of leaf litter. It has mixed well with *Brachiaria* pastures, particularly *B. brizantha*, under coconuts. A problem with siratro is its low productivity and susceptibility to *Rhizoctonia* leaf rot in the wet and intermediate zones. The suitability of stylo and *Desmodium* spp. for coconut areas is still not conclusive and wider testing is needed.

The use of nitrogen-fixing trees as multipurpose trees in coconut plantations has received increasing attention in recent times. Several trials have been conducted to study their growth and yield performance and their specific uses under various management conditions. The most widely studied tree legumes are gliricidia *(Gliricidia sepium)* and leucaena *(Leucaena leucocephala).* Gliricidia and leucaena, planted 2.0 x 0.9 m in double rows in mature coconut plantations and lopped at three-monthly intervals, produced 7-10 t/ha and 12-16 t/ha green matter and 8-15 t/ha and 14-20 t/ha fresh firewood during the first and second years of planting at four sites in the Coconut Triangle (Liyanage and Jayasundera, 1987).

In the intermediate zone, an integrated farming system of 0.8 ha was established in a 45-year-old coconut stand, planted at 137 palms/ha (Liyanage et al. 1989). The area was divided into six paddocks. One served as a control, while the other five were planted with rows of leucaena and gliricidia (2500 trees/ha) and a mixture of *B. miliiformis* and puero. Along the boundary fence, leucaena and gliricidia were planted alternately 1 m apart. Coconuts in the control plot received (kg/tree/year) 0.8 urea, 0.6 superphosphate and 1.6 muriate of potash while those in the other five paddocks received 0.75 muriate of potash and 0.18 superphosphate. One year after planting, four 6-month-old Jersey x local cross-bred heifers were introduced to the experiment. A 30-day rotational grazing system was used in the five paddocks. In addition to the feed from the pasture, cattle were fed with gliricidia and leucaena leaf of up to 5 kg fresh leaf/head/day. During dry periods, urea-treated rice straw was fed at 4 kg/head/day (160 g urea/animal/day). Copra yields in the integrated system were similar to that of the control plot. Three years after establishment of the system there was no drop in critical nutrient levels in coconut leaves. It appeared that the total nitrogen requirement was met by the addition of urine and dung from the cattle. The actual nutrient returns from the dung and urine (kg/palm/year) amounted to 0.8 N, 0.1 P and 0.7 K.

In the control plot (monoculture system), a total expenditure of Rs 8.10/palm/year was made for inorganic fertilizers. In the integrated system, the nitrogen was provided by dung and urine, and only Rs 2.49/palm was spent on fertilizer. This clearly demonstrated that the integrated farming system resulted in a saving of 69% on the cost of inorganic fertilizer while increasing the productivity of the farming system. Average daily liveweight gain of the heifers was 306 g/head during the first year.

In another feeding trial, gliricidia leaves were fed with *B. miliiformis* at a ratio of 50:50 to Jersey x local heifers and produced daily liveweight gains of 700 g during the wet season (Liyanage and Wijeratne, 1987). Chadhokar and Lecamwasam (1982) also found that gliricidia could be used successfully as a high-protein supplement.

Constraints for Forage Development

Despite government assistance for forage development, only 17 000 ha are planted to improved forages. The area under plantation crops (particularly coconuts) which could be used for forage production is not fully utilised. The relatively slow progress is largely due to the following economic, social and technical constraints facing the growers (Liyanage 1989).

- Farmers produce very little of their own forage. They are reluctant to grow forage on their own land as their priority is for food and cash crops. Many farmers do not have their own land for cultivation.
- Competition from other enterprises, various land development projects, sudden changes in policies towards high-value crops with export potential results in the unavailability of land for forage production.
- The income from dairying in terms of land and capital invested is generally lower than that from crops.
- The task of changing the attitude of the farmer and promoting better forage management is a formidable one, as animals generally are a sideline to farming operations. Also, when forages are introduced, the paddy farmers expect the same growth rates obtained for paddy and when this is not evident, they lose interest.
- It cannot be tried out by the farmer on a small scale as can other crops.
- High initial capital investment is required (cows, sheds, etc.).
- Farmers have been heavily dependent on concentrate feeding which, with the escalation of feed prices, has become uneconomical.
- Slow progress in herbage development programs has resulted in the continuing use of low-quality forages. Many farmers who have planted improved forage under assistance schemes do not show sustained interest, and their plots show evidence of neglect.
- Planting materials (cuttings and seeds) are not readily available to the farmer. The current production of seeds is concentrated in the private sector and the level of production is largely determined by advance orders.
- Forage production is seasonal due to the bimodal rainfall pattern in the intermediate and dry zones. Forage conservation programs are insufficient. Silage preparation in pit silos has limitations for farm use. Haymaking is difficult as the time of surplus forage which would be available for conservation coincides with the period of high rainfall.
- Lack of strategic development centres and extension services. The links between researchers, extension workers and farmers have been poor.
- Capacity development for forage research has been inadequate.
- There has been a rapid diminution in the funding for research with the result that there is inadequate maintenance of research-related supporting services.

Future Research Priorities

The constraints identified above call for research on both biological and socio-economic aspects, and the development of an efficient extension service in order to make these forage production systems more productive, economically adaptable and successful. The following priority areas are suggested for future research.

- Improvement of pasture grasses, fodders and legumes through selection of varieties specifically adapted to the various climatic and soil conditions;
- further study of nutrient uptake and recycling in forage-plantation systems (particularly coconuts);
- further research into establishment, compatible mixtures and management techniques for forages:
- the agronomic requirements of nitrogen-fixing tree crops when they are grown in plantation crops need to be standardised, and the production of tree legumes in waste lands and fences should be promoted:
- research is needed on concentrate mixtures to address and alleviate deficiencies in forage quality;
- development of simple and economical methods of forage conservation is required; and
- active research on all aspects of integration needs to be initiated.
- It is of the utmost importance to realise that the prime objective of efforts should be to develop the skills of the farmer, rather than to concentrate on improving the farm. Concurrently, the links between the researcher, extension worker and the farmer need to be fortified.

Agricultural development in Sri Lanka has been moving from predominantly rainfed extensive cropping to intensive irrigated cropping, from monocropping to multiple cropping, and from pure cropping systems to integrated crop-livestock production systems. The future of the forage- livestock industry depends to a large extent on how successfully this subsector will be able to co-exist with the changes that are taking place in the entire agricultural sector.

Acknowledgments

The author thanks the Executive Secretary of the Sri Lanka Council for Agricultural Research Policy (SL.CARP) for granting permission to present this paper. The co-operation extended by the Coconut Research Institute of Sri Lanka in the preparation of the paper is also gratefully acknowledged.

Thanks are also due to Dr. U.P. de S. Waidyanatha, Director of Perennial Tree Crop Development Project, Kandy and Dr. M.U. Jayasekara, Senior Scientist of SL.CARP for the help given during the preparation of this paper.

References

Anon. 1985. Livestock population in Sri Lanka in 1982. Statistical abstract of the Democratic Socialist Republic of Sri Lanka. Department of Census and Statistics, Ministry of Plan Implementation. 148 p.

1989. Sri Lanka Socio-economic data 1989. Statistics Department. Central Bank of Sri Lanka.

Appadurai, R.R. 1969. Prospects for grassland farming in Ceylon. World Crops, 1969, 347-349.

Chadhokar, P.A. and Lecamwasam. A. 1982. Effect of feeding *Gliricidia maculata* to milking cows. A preliminary report. Tropical Grasslands, 16, 46-48.

Dissanayake, S.N. and Waidyanatha, U.P de S. 1987. The performance of some tropical forage grasses interplanted with young Hevea trees and their effect on growth of rubber. Tropical Agriculture (Trinidad), 64, 119-122.

Ibrahim, M.M.M. and Ferdinendez, D.E.R. 1984. Productivity and nutritive value of different pasture species grown under coconut. Proceedings of 3rd Annual Workshop on Australian-Asian Fibrous Agricultural Residue Research Network held in Peradeniya, Sri Lanka, April 1983. 109-116.

Liyanage, A. de S. 1978. Report of the Plant Pathology Department. Rubber Research Institute of Sri Lanka. Annual Report 1977, 67-97.

Liyanage, L.V.K. 1989. Pasture and fodder production in Sri Lanka-Present status and future trends. Paper presented at the Consultation Meeting on Tropical Pastures, Los Baños, Philippines. May 1989.

Liyanage, L.V.K. and Jayasundera, H.P.S. 1987. Potential of use of nitrogen fixing trees in coconut plantations. Proceedings of a workshop on nitrogen fixation and soil fertilizer held in Peradeniya, Sri Lanka, December 1987. 78-87.

Liyanage, L.V.K., Jayasundera, H.P.S., Mathes, D.T., and Fernandos, D.N.S. 1989. Integration of pasture, fodder and cattle in coconut small holdings. Coconut Research and Development Journal 5, 53-56.

Rajaguru. A.S.B. 1986. Livestock development policy plan for Sri Lanka. Report of the Society for Researchers on Native Livestock, No. 11, 37-64.

Liyanage, L.V.K. and Wijeratne, A.M.U. 1987. Uses and management of *Gliricidia sepium* in coconut plantations of Sri Lanka. In: D. Withington, N. Glove. Y.L. Brewbaker, ed., *Gliricidia sepium* (Jacq) Walp: Management and Improvement. Proceedings of a workshop held at CATIE, Costa Rica, June 1987. Nitrogen Fixing Tree Association Special Publication. 87, 95-101.

Sandanam. S., Somaratne, A.R., Amarasekara, S.T., Yatawatte, S., Samarajeewa and Ananthacumaraswamy. 1987. An assessment of the suitability of five graminaceous species for soil reconditioning before replanting tea. I. Effect of species on enrichment of organic matter status by top and root residues. Tea Quarterly, 51, 99-107.

Santhirasegaram, K. 1966a. The effect of pasture on the yield of coconuts. Journal of Agricultural Society of Trinidad. 66, 183-193.

1966b. Utilization of space among coconuts for intercropping. Ceylon Coconut Planters' Review, 4, 43-46.

Siriwardena, J.A. de S., and Clarke, V.J. 1986. Briefing paper on animal nutrition in a report on the dairy development foundation project II of Sri Lanka. Proceedings Workshop on Dairy Development Foundation, 14-17 July 1986, Colombo, 140.

Waidyanatha, U.P. de S., Wijesinghe, D.S. and Stauss, R. 1984. Zero grazed pasture under immature *Hevea* rubber Productivity of some grasses and grass-legume mixtures and their competition with *Hevea*. Tropical Grasslands. 18, 21-26.