Feeding Dairy Animals for a higher Milk Yield

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Supply of and Demand for Milk in Sri Lanka

In view of milk providing so many essential nutrients including the most needed minerals and vitamins, it is termed as a "Protective Food". Milk being one of the chief constituents of the diet of infants, children and adults as well; demand for it increases with the growing population. Although the production of milk is a major activity of the livestock sector in Sri Lanka, it only provides about 15%-20% of the total requirement; the balance is imported as milk powder. In 2005, per capita availability and the total per capita consumption were 9.42 and 40.43 kg, respectively. These figures show that only 25% of the milk products are available in the country while 75% is imported, mainly as milk powder to meet the consumption requirement (Table 1).

Table 1
Per capita availability and consumption of milk and milk products in Sri Lanka in 2000 and 2005

Year	Per capita availability (kg/yr)					Per capita consumption (kg/yr)
	Fresh milk	Tinned milk	Condensed milk	Milk food	Total	
2000	4.96	3.73	0.25	0.08	9.02	36.00
2005	5.37	3.63	0.27	0.15	9.42	40.03

Source: Dept of Census and Statistics, Food Balance Sheet.2000, 2005

It is a well-known fact that per caput milk consumption is very high in developed countries (130.5 kg/person/annum in 2005). In contrast, the milk consumption in Sri Lanka is lower as compared even to other developing countries (60.5 kg/person/annum in 2005) in spite of heavy imports worth Rs.12, 577 million in 2005. Medical Research Institute (MRI) recommends a consumption level of 60-65 kg/person/ annum, but even with the imports, per capita consumption in 2005 was nearly 20 kg below the MRI recommendation.

Total milk production in the country in 2005 and 2006 were 193 and 196.5 million liters, respectively. These amounts consisted of 162 and 164.9 million cows milk and 31 and 31.65 million liters of buffalo milk respectively. The data confirm that the annual growth rate in total milk production was negligible. However, the total milk collection during the same periods (2005 and 2006) was 100 and 109 million liters which were 51 and 56% of the total production (Dept. of Animal Production & Health, Livestock data 2005-2006). From this collected amount, 60-70% was domestically consumed or locally marketed. Only 30% of the total production was processed into milk powder, yoghurt, butter, etc ((Premaratna & Premalal,2008). To satisfy the demand, Sri Lanka imports 75% (approximately 66,792,105 kg) of milk and dairy products involving foreign exchange to the tune of more than 11 billion of Sri Lankan rupees. The government at the same time has an ambitious target to improve dairy production to achieve 50% of self sufficiency in milk products by 2015. At the current population growth rate of 1-2% per annum, the sector will need to grow at about 15% annually for the next eight years, provided there is no increase in total consumption. Total population of cattle has increased from 1,160,900 in 2005 to 1,214,574 in 2006 (4.6%). The increase of buffalo population during the same period was from 307,750 to 314,176 (2.1%). Thus, a total of 1,468,650 dairy animals (cattle plus buffaloes) in 2005 have increased to 1,528,750 in 2006 representing an increase of only 4.1%. (Dept. of Animal Production & Health, Livestock data 2005-2006). Hence, there is an urgent need for increasing production of milk in the country by increasing milk yield. Under these circumstances, attention need be focused on dairy animal nutrition which has been consistently regarded for decades as the most significant limitation for the improvement of national milk production.

Main Feeding Systems in Sri Lanka

Feeding systems in the country are largely determined by the agro-climatic zones and the genetic make up of the animal predominantly available in those agro-climatic zones. Although the feeding of dairy animals should be based on grasslands, only the forage crops and weeds growing on land left unused are available for grazing. They include natural grasslands including dry zone villus, coconut lands, roadsides, waterways, forest areas, off season and uncultivated paddy fields, etc. In fact, considering the type of land available and the economics of milk production, there are hardly any cultivated and/or managed pasture lands in the country. In addition, the quantity and quality of herbage fluctuate with the seasonal rainfall distribution. With the advent of North East and South West monsoons, there is a re-growth of nutritive grasses, but the quantity and quality decline progressively as the season advances into dry periods. Peak forage supplies commonly occur during rainy seasons when they reach a volume of three or four times that which is available during dry seasons. The acute shortage of herbage during dry periods is reflected by poor animal performance and loss of production and body condition. For reasons mentioned above, the excess forage produced during favorable periods is rarely conserved for lean periods making small farmer-based dairying a very low input out put system at large.

The country can be broadly divided into four agro-climatic regions based on elevation, rain fall, temperature, etc. They are up country, mid country, coconut triangle and low country wet zone and low country dry zone. Almost 70 percent of the cattle and buffaloes are in the low country, 25 percent in the coconut triangle and 10 percent in the mid and up country regions. Because of the highly variable climatic conditions and the differences in managerial skills in different regions, diverse animal production systems exist in the country.

Up country

Pure and exotic breeds and their crosses are mainly available in the up country under intensive, stall-fed conditions with very little or no grazing, producing an average daily yield of about 6-8 liters/head. Cattle are kept either in tea estates or in villages. Average herd size is 3-4. The estate labour population is rearing of milch cattle as a subsidiary occupation. Cattle are kept in sheds by the sides of workers' quarters. In village-based systems, cattle are a secondary source of income, in addition to supplying milk and manure. Feed resources are generally pasture on steep terrain above

the tea land and *Gliricidia*, *Erythrina*, etc. from plantations. Even with better- quality forages available, feeding of concentrates, though much restricted due to high cost, is more when compared with other regions of the country.

Mid country

Due to mild climatic conditions in the mid country, pure exotic breeds, their crosses and exotic x zebu crosses are reared mainly under semi-intensive or stall-fed conditions. Mid country has the highest population (25%) of pure breeds giving an average yield of about 4-5 litres/head/day. Stall feeding based mainly on Guinea A or B (*Panicum maximum* spp), *Gliricidia sepium*, wild sunflower (*Tithonia* spp.), etc. is more common with limited grazing situations, tethered on fallow paddy lands or bunds. Feeding of concentrates, mainly rice bran and coconut poonac is practiced to a limited extent.

Coconut triangle and Low country wet zone

Peri-urban dairy systems and integrated coconut-livestock systems are practiced with different intensifications. In this area, crosses of exotic breeds, zebu type animals, indigenous animals and their crosses and buffaloes are reared under tethered or free grazing conditions under coconut plantations or in fallow or inundated paddy lands. Average yield is about 3-3.5 liters/head/day.

Low country dry zone

In the low country dry zone, mainly zebu or indigenous pure and crosses of cattle and buffaloes are reared under extensive free grazing and the average yield is about 1-3.5 litres/ head/day. Cattle and buffalo herds graze on paddy lands, lake bunds, scrub jungles and villus. There is hardly any use of concentrates and little use of crop residues, although buffaloes are fed rice straw. Hay is rarely made by few farmers in small amounts. There is a serious problem in exploiting the genetic potential of improved dairy animals due to lack of good-quality feed year round at the farm level as well as organized breeding programmes.

Feed Resources Available in the Country

In Sri Lanka, dairy production is mostly non-commercial activity. Farm-grown or improved pastures are not available to any great extent among small holders due to constraints such as land limitation. However, there is a considerable trend for improved pasture and fodder utilization in government farms and company based large or medium scale farm holdings. The popular fodder grasses are Hybrid Napier (Var. CO-3 and Bana), common Napier grass, Napier grass-Clone 13, Guinea grass (Variety VRI 435, Hamil, TD 58), etc. Napier varieties produce an average annual dry matter yield of 30,000-60,000 kg/ha under good management conditions. Guinea grasses produce an average dry matter yield of 10,000-15,000 kg/ha/year. Fodder grasses thrive during the dry season as well and produce reasonable yields in many areas of the country. Common pasture grasses used by farmers are Brachiaria spp, Setaria, Kikiyu grass in the up country, etc., which produces a dry matter yield of 8,000-15,000 kg/ha/year under good management conditions. During wet periods, the yields of most grasses are high, but growth is much retarded during dry periods while *Brachiaria* spp. is fairly drought resistant.

Wild Guinea grass has become naturalized all over the country, except in the hill and semi arid areas. It has become a valuable feed for cattle in the mid country, low country wet and dry zone areas of Sri Lanka. Two main varieties are Guinea A (coarse, broad leaved, hairy, stemmy, robust grass, up to 3 meters high), and Guinea B (better quality, finer, narrower leaved, leafy grass, 1-2 meters high). Naturally, it is now spread over roadside verges and railway reservation areas, natural forests, crop plantations, natural grasslands and scrublands at low and mid elevations (Figure 1). Forest Department statistics show that the vegetation under natural Guinea grass in Sri Lanka now covers approximately 35,000 hectares.

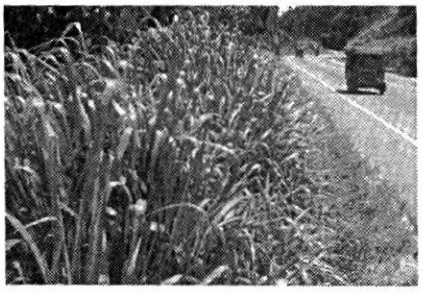

Figure 1. Wild Guinea grass along the road sides

Grazing of weeds between coconut trees by cattle as "sweepers" has been a general practice in Sri Lanka since traditional times and now it has become a novel concept which is referred to as "coconut-cattle integration". According to the statistics of Coconut Development Board, approximately 0.5 million ha of coconut land are available for coconut-cattle integration. The undergrowth of coconut consists of a large number of indigenous pasture species, some of which are quite productive and others are of poor quality. The more promising of these include carpet or mat grass (*Axonopus compressus*), narrow carpet grass (*Axonopus affinis*), buffalo couch grass (*Stenotaphrum secundatum*), Tee grass (*Paspaalam conjugatum*) as well as various legumes such as Alyce clover (*Alycicarpus vaginalis*), *Desmodium ovilifolium*, *Desmodium triflorum*, and sensitive plant (*Mimosa pudica*).Weeds include *Ageratum conizoides*, *Cassia thora*, *Eupatorium odoratum*, *Lantana camara*, etc. Improved shade tolerant grass species such as *Brachiaria miliformis*, *B. dictyoneura*, *Panicum maximum* var. Trichoglume, and legume species such as *Centrosema pubescence*, *Calopogonium muconoides* are available to a limited extent.

Animals in peri-urban dairies are stall-fed with cut grass and expensive concentrates. The soaring prices of coconut poonac, rice bran, etc. has added yet another difficulty to the sub-urban dairy owner.

Approximately 500 ha of inundated paddy lands are available throughout the year for cattle and buffalo grazing in districts such as Matara, Hambantota, Galle and Kalutara. They are not cultivated due to acidification, salinity, etc. Natural rice field weeds such as tikia (*Eleocharis dulcis*), uruwee (*Oryza rufipogen*), bearu (*Seteria glauca*), Layu (*Leersia hexandra*), batadella (*Sachne globosa*), pan varieties (*Cyperus spp*) are being grazed. But they are of poor quality and their nutritive value could only maintain only the existing subsistence level of production.

Mainly, naturally-growing grasses are found on rice field bunds which have a good growth due to use of fertilizer for rice cultivation. Animals are allowed to graze only during the fallow period. The amount of herbage obtained by grazing varies from region to region according to the extent of grazing land and forest areas and their proximity to human habitations.

Harvested material of perimeter fences are used for ruminant feeding in many areas, but quantity of the harvest depends on plant spacing. Farmers can cut and offer leaves and twigs or whole cut branches of fodder plants growing in the fence for animal feeding. Lopped material (leaves and twigs) of fodder trees which are used as live supports for pepper etc., often inter-cultivated with coconuts or as shade trees for tea, coffee, etc. are used as cattle feed.

The other major feed resources are crop residues and by-products of agro-industries. Among the crop residues available, rice straw and sugarcane by-products are of primary importance. Rice straw, in particular, accounts for 90 percent of the crop residues produced. Rice straw has been used as a cattle and buffalo feed for centuries, in dry areas. Although considerable quantities of sugarcane by-products are available in the country, they have not been fully exploited as animal feeds. Green tops are normally burnt while bagasse is used as a source of fuel in the factories. The animal industry could benefit, in particular, from the surplus molasses which has been hitherto used only for alcohol production.

There are also other feed resources of minor importance, available in specific regions of the country. They are tea refuse, cocoa husk, coffee pulp and fruit processing wastes such as pineapple peels. These new feed resources could fit into location specific animal feeding systems.

Natural Grassland Systems in Sri Lanka

Sri Lankan natural grasslands provide a potential source of feed for livestock. Natural grasslands in the country can be divided into the following general categories: Patna (dry and wet), Savanna (lowland and upland), Villu (lowland), Damana and Talawa. Patna grasslands of wet (Hortan plain, Elk plain, Moon plain, Bopaththalawa) and dry (Uva basin) humid zones and are important sources for livestock feeding. Dominant forages in wet patna grasslands are Kikiyu grass (*Pennisetum clandestinum*), *Chrysopogen zeylanicum*, etc. The dominant grass species in dry patna grasslands are *Arundinella* spp, *Polliania* spp, *Andropogen* spp., etc. Lowland (Bibile, Monaragala) and upland (Wellawaya, Pethyagoda) Savenna grasslands have a high potential for livestock feeding and the available pastures are Guinea grass (*Panicum* spp.), *Themada tremula*, *Desmodium* spp., etc. Lowland Villu grasslands, particularly of Polonnaruwa, Manampitiya, Thamankaduwa and Maduruoya are found in the flood plains of the rivers in the dry zone. Succulent grasses such as *Brachiaria mutica* (water grass), *Cynodon dactylon*, *Stenotaprum secundatum*, *Bothriochloa glabra* are dominant species. Damana grasslands (Ampara, Inginiyagala) originated as a result of forest cleaning, followed by repeated fire and are dominated by *Imperata cylindrica* (coarse low quality aggressive weed). Talawa grasslands available in Kalutara, Galle and Matara districts arose as a result of forest felling and chena cultivation are dominant with *Cynadon dactylon* grass.

Main characteristics of feeds offered by natural grasslands are high seasonal variability in quantity as well as in quality. Generally, free grazing is practiced by moving the animals towards forages. They are allowed to graze from morning to evening in the same location and housed only at night. Generally, the levels of livestock production from these extensive systems of grazing management are low. However, semi-intensive systems do exist, resulting in higher levels of production, particularly in wet patna areas.

Scrub jungles in the low country dry zone, on the other hand, represent a valuable forage resource for goats in a very socio-economically viable manner. They are being grazed by cattle as well, to a limited extent.

Available feed resources and their utilization

Grasses and grasslands for grazing are the main issues discussed for decades, when considering feeding of cattle. In addition to scarcity of land, cultivation and management of forage crops by small farmers appear impractical in view of low returns in dairying. This is quite evident considering the lack of or under utilization of even already available natural grassland in certain areas of the country. Forage production is seasonal due to bimodal pattern of rainfall resulting in a dry periods of varying durations from about three months in intermediate rainfall areas to eight months in the driest areas. During dry spells, forages are in short supply, often leading to soil erosion due to overgrazing, particularly under extensive systems of management. Not only the milk production, but also the fertility and calving intervals are adversely affected with dire economic consequences. Therefore, it is essential to adopt suitable feeding strategies to overcome the seasonal availability and the quality of forage crops.

Even during periods of ample forage availability, animal performance is not very attractive. That can be due to rapid growth, early maturity, high flowering, etc. of the available natural forages. Result being a high fiber together with a low crude protein content of the forage, reducing the quality. In upcountry areas, high moisture together with low energy contents in Kikiyu grass during cloudy and rainy seasons result in considerable shortages in the intake of required energy.

There are number of possible methods that can be used by farmers to ensure adequate year-round quality feed supplies for livestock. Basically, the excess production during wet periods can be conserved as hay or silage. Cheap trench or pit silos covered with a "kadjan" roof can be used for ensiling of forages. Sun drying to make hay during rainy periods with excess forage is not always practical. It is more feasible with the initiation of the dry spell when there is excess forage due to remaining moisture content of the soil and abundant sun light. These practices are well recognized and recommended, but it is not difficult to understand as to why they are hardly practiced under our small farmer situations. In fact, we have to accept that the farmer is right, considering the present status of dairying in the country.

Another strategy is to reduce the variability in seasonal forage production by utilizing a range of fodder species rather than limiting to a few. For example, farmers can be encouraged to grow fodder grasses such as Napier, Guinea, etc. and legume tree fodders such as Ipil-ipil and Gliricidia to prolong the availability of higher-quality feed into the dry season. Since fodder grasses and tree fodders are deep rooted and of higher nutritive value, they could supply better forage.

Possibility of seasonal livestock breeding programs should be exploited so that the total demand for feed achieves a peak approximately the same time as forage growth is maximal.

Another possibility is to use alternative feeds in a systematic manner in addition to normal feeding regimes. Many crops are available in wet and dry seasons with high overall yields and many of them do not require annual planting. Unutilized naturally-grown Guinea A grass covered in large areas in certain parts of the country can be harvested every four weeks to avoid rapid loss of quality with further maturity and used to supplement the normal forages. In fact, at present, vast amounts of agro-industrial by-products, including the waste material generated from crop and animal production as well as the residues resulting from the processing of food are under-utilised. They include banana (reject fruit, leaves and pseudostem), cassava leaves, peelings and tubers, sweet potato vines, maize stalks, stems of stover, wastes of jak and bread fruit waste, fruit cannery waste such as pineapple peels, poultry waste, palm oil mill effluent, palm kernel cake, rice bran, sugarcane tops, molasses,

bagasse, etc. As most of these potential feeds are available in many parts of the country, livestock owners should be made aware of their feeding potential, particularly during dry periods when conventional forages are in short supply. The rising costs of conventional feeds and reduced grazing areas, have made it required that the above-mentioned by-products of agro-industries and other sources are utilized to feed cattle and buffaloes. However, there is a general lack of awareness of the possible uses of crop residues and other agro-industrial by-products for animal feeding due to many reasons. These include, lack of information on composition or nutritive value together with possible variations in available quantities and quality, non-availability and or costly handling and processing facilities, inability to collect material in a dry state for storage due to rain, localized availability and the need for costly transport, inadequate or lack of storage facilities for bulky seasonal agricultural by-products such as rice straw, and logistic problems in availability and seasonality of supply.

Rice straw

Every year several thousand tonnes of straw are left or burnt in paddy field after harvesting the crop. Rice straw has been fed, particularly to buffaloes and cart bulls, for many years and is also used together with conventional forages. However, it is low in nutritive value, being low in crude protein (2-4%) and other essential nutrients together with a low digestibility due to lignifications and high silica content. Thus, rice straw alone is insufficient even to maintain the live weight of cattle. Its quality should be improved through supplementation of nutrients with more nutritive feed ingredients and or processed to improve its digestibility and therefore the intake. However, its quality also depends on the stage of harvesting. It is higher with early harvesting when the plant is less mature. Thus, harvesting at an optimum time for the grain when the plant is yet green, before the grains become too mature, provides better-quality straw with a higher digestibility and a protein content as well. In fact, most of the aspects in the utilization of rice straw as a feedstuff for cattle and buffaloes apply to most of the fibrous agricultural by-products. Thus, from the field through collection, transport, storage and feeding itself pose difficulties. Nevertheless, appropriate strategies could overcome all, if not, most of those difficulties. Collection of straw in a dry state, pressing into bundles to facilitate the chain of events from loading through transport, storage and feeding are required for this.

Feeding unprocessed straw as it is, together with other low-quality feedstuff such as over-matured grass is of limited use in dairying, although it may play a role in less nutritionally demanding situations as with maintenance of mature bulls. In dairy production, the quality of straw has to be improved. Small farmer situations where both inputs and output are low, requires practically feasible, simple, low-cost supplementation. In addition, processing of straw, to improve its quality also required to improve nutrition of dairy cattle. Benefits of such a supplementation program have been clearly demonstrated in a continuous six-year study, simulating small farmer milk production with locally-available cattle and other resources. Feeding rice straw with rice bran, urea, molasses and minerals (*Gava–Triposha*) to supplement critical nutrients resulted in a significant increase in the performance of indigenous cows (growth, milk yield and reproduction parameters) grazed natural herbage under coconut plantation in Hakmana. Milk production level of 1L/day of indigenous cows has been increased to 4L/day with the above-mentioned simple inputs including grazing of weeds under coconut instead of cultivated grasses. Urea was fed by mixing at the rate of 100 kg straw with 2 kg urea dissolved in about 50-100 L water (depending on the wetness of straw and mixing experience). Molasses could also be dissolved in the same water. Mixed straw should not be kept for more than two days the most, since N is lost as NH_3 (ammonia). A later study at Mirissa showed that tree legume fodder as an additional supplement to rice straw and *Gava-Triposha* could enhance the growth, age at first heat, conception rate of tethered cross–bred heifers grazed natural herbage under coconut. Above findings confirmed the benefits of supplementation of animal feed with unprocessed rice straw. In fact, edible fractions of tree legume fodder under our farming situations represent a key essential supplement for straw during lean periods of pasture growth. These tree legume fodders have the advantage of having much higher nutritive value than even well-managed grass, in addition to their availability during dry spells. Supplements such as urea, molasses, rice bran and minerals could be also offered as block-licks or using the roller drum method.

The supplementation of unprocessed straw for feeding small farmers' low-producing (1 to 2 L/cow/day) animals, particularly during dry spells, can be helpful, as an initial step, for improved and sustainable dairying. Such a feeding regime would increase the production up to about 4 to 5 L/cow/day. Findings of a survey done with cattle and buffalo farmers in down stream Nilwala villages confirmed that milk production potential of dairy cows grazed forages grown in inundated paddy fields were further limited due to non-availability of *ad libitum* drinking water and minerals. In addition, if feeding of edible tree legume forage could be gradually increased to about 5 kg/cow/day, unprocessed straw-based feeding system could increase the production further up to about 7 L/cow/day. Therefore, greater the amount of tree fodder added, greater will be the milk production.

For higher levels of milk production, straw has to be processed in addition to supplementation, depending on the specific production level. Processing involves physical, chemical, biological or combinations of those methods. Physical processing involves chopping, grinding or high pressure steam treatment. Additional cost of labour or on chopping or grinding equipment or steam generation, together with the abrasive nature of rice straw due to high silica do not justify any of the procedures under local conditions. Chemical treatment procedures use acids, alkalis, detergents or a combination of them. Often chemical processing is preceded by physical processing for the treatment to be more effective. Because of its more effectiveness. alkali treatment has been more investigated than other treatment methods, Sodium hydroxide, being a strong alkali, has been the most effective treatment. But, its use is prohibitive due to high cost, limited availability and dangers in handling, compared to much cheaper, freely available and safer-to-handle urea, as an ammonia source, and lime (Figure 2).

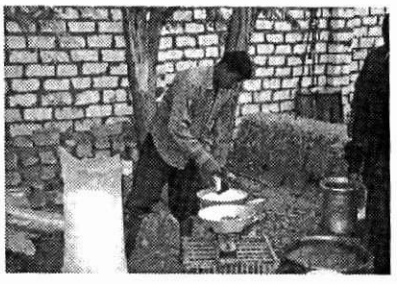

Figure 2. Treating rice straw with urea

There is consensus among all researchers in this field with an experience with small farmers in Sri Lanka, that out of all available methods, urea/ammonia treatment of straw as the method of choice due to many advantages. It involves making straw silage by *mixing urea at the rate*

of 4 kg dissolved in about 50-100 L water (depending on wetness of straw and mixing experience) with 100 kg straw and ensiling for about one week before feeding.

Conclusion

Grasslands for grazing have remained only a talking point for decades and would certainly remain so in practical terms, particularly under the prevailing economics of milk production against many other options available to farmers. Use of common Guinea grass, rice field weeds, herbage under coconut plantations, agricultural by-products or wastes such as rice straw and alternative feeds in combination with commonly-available multipurpose tree fodders such as *Gliricidia*, *Erythrina*, etc. offer great alternatives to grass-based milk production. Milk production level of 1L/day of indigenous cows can be increased significantly by supplement feeding of animals with rice straw together with rice bran, fertilizer-grade urea, molasses and a mineral mixture while providing *ad libitum* drinking water.

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