

FUTURE PROSPECTS FOR FODDER AND PASTURE PRODUCTION

By

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INTRODUCTION

In the wet tropical environment, there is no distinct seasonal moisture deficiency and the foliage is green throughout the year. The potential production of tropical forage both native and improved species, in terms of protein, metabolisable energy and milk production, has been favourably assessed (Lane and Mustapha, 1983; Luxton, 1983).

The tropical dairy breed, which is basically a *Bos indicus* animal, has a low potential for milk production which is between 500-950 kg/lactation (Samuel, 1974; Sivarajasingam, 1974), whereas the milk production potential of the crossbred (*Bos taurus* x *Bos indicus*) is improved, giving 1,200-1,900 kg/lactation (Sivasupramaniam and Nik Mahmood 1981). Due to the overall feed constraint and environmental stress, purebred dairy cows such as Friesian and Jersey are merely able to produce half of their milking potential (1,150-2,200 kg/lactation) (Wan Hassan *et al.*, 1981; Sivasupramaniam and Nik Mahmood, 1981), compared to those of similar breeds in a drier environment. The expected milk yield is estimated to be 2,700-4,000 kg/lactation for the Friesian and Jersey (Cowan *et al.*, 1975). Hence, the genetic expression of milk production of the dairy cow is confounded by tropical environments.

This paper attempts to present the status, constraints, potential production and management of tropical forages in relation to the feeding of dairy cattle in the tropics.

NUTRITIONAL VALUE OF TROPICAL PASTURES

It is commonly believed that the contribution in milk production due to genetic factors of animal is about 25%. A greater sustainability of production is produced by better feeding. Pasture can be a major source of feed for dairy cows but there are some limitations to its use. Energy and protein supplies are the most essential components in animal nutrition and, in many tropical countries, these components are often the critical limiting factors to animal production.

Most of the tropical grasses (either native or improved pastures) have metabolisable energy values ranging from 7.0 to 11.0 MJ/kg DM when cut between 2-8 weeks (Table 1), and energy concentrations for natural forages were found to be similar (7.1 to 10.1 MJ ME/kg DM). Lane and Mustapha (1983) also reported that broadleaved species and

ferns appeared to have higher metabolisable energy values and their crude protein and crude fibre was superior to natural grasses. Based solely on the metabolisable energy available from the existing forage on offer, Lane and Mustapha (1983) estimated the potential milk production of Friesian-Sahiwal cows in mid-lactation to be 12-16 kg/cow/day depending upon the types of pastures.

Table 1 . Mean chemical composition and estimated ME value of some improved tropical pastures (Wan Hassan, 1987)

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Grass/Cutting Interval (week)	<i>in vitro</i> DMD %	CP S)))))))))	CF g/kg DM	Ash	Estimated ME (MJ/kg DM)*
S)))))))))Q					
Setaria					
2	66.00	189.86	256.69	99.61	9.18
4	60.29	143.17	286.17	98.58	8.42
6	56.09	121.95	314.42	86.38	7.96
8	53.09	104.71	329.27	77.67	7.62
Digitaria					
2	64.24	158.37	273.97	95.77	8.98
4	59.06	139.64	301.79	81.83	8.41
6	55.32	100.89	319.74	79.29	7.92
8	51.90	88.14	334.47	67.80	7.54
Napier					
2	65.60	178.08	256.54	115.55	8.97
4	59.35	124.31	301.65	95.55	8.32
6	54.60	100.00	330.58	91.00	7.71
8	50.92	70.15	343.20	73.33	7.36
Guinea					
2	64.04	172.87	279.34	111.23	8.80
4	57.69	127.27	324.10	88.17	8.16
6	53.88	91.05	350.90	80.63	7.71
8	49.89	62.57	367.36	69.83	7.24
Signal					
2	63.52	154.92	269.66	97.76	8.96
4	57.66	119.29	300.10	81.00	8.22
6	55.03	92.58	325.61	77.86	7.89
8	53.56	76.00	345.73	68.73	7.76
S)))))))))Q					

*ME (MJ/kg DM) = 0.15 (DMD%+2% units)($\frac{100-Ash\%}{100}$)

Protein content varies with age, part of the plant and species. Most of the tropical pastures have crude protein contents ranging from 7 to 12% for grasses and more for legumes like *Leucaena*, which has 25% protein content. Protein content of tropical pastures decreases rapidly as growth progresses.

As a general guide, 10% crude protein on a dry matter basis is adequate for fattening cattle but about 15% crude protein or more is required for high producing milking cows. The critical level of crude protein required in the pasture before intake is reduced by a protein deficiency has been estimated at between 6.0 and 8.5% (Milford and Minson, 1966; Minson, 1967). The deficiency of crude protein in pasture can be corrected by the use of tropical legumes or nitrogen fertiliser on pure grass pastures.

The digestibility of cultivated tropical grasses lies between 50 and 65%, whereas temperate grasses range from 65 to 80% (De Gues, 1977). Thus it is necessary to utilise immature herbage in order to obtain a high metabolisable energy intake. Milford and Minson (1966) showed that the decline in digestibility with age was more rapid in tropical grasses compared with tropical legumes, which retained relatively high digestibilities at maturity. Values recorded for a number of different tropical grasses indicate that there is a decrease of 0.1 to 0.2 digestibility units/day with increasing maturity (Minson, 1971). This explains why tropical legumes are particularly valuable for animals in the dry season.

PASTURE SPECIES SELECTION AND PRODUCTION

Species Performance and Adaptation

Selection of pasture species should take into account the nutritional requirements of different classes of livestock, as well as the suitability of the plant for different animal production systems such as large scale or smallholder production.

Lately, improved species which had gone through the screening process in the wet tropics are the following genera:

Grass: *Brachiaria*, *Digitaria*, *Panicum*, *Setaria* and *Pennisetum*

Legume: *Centrosema pubescens*, *Desmodium ovalifolium*, *Pueraria phaseoloides* and *Leucaena leucocephala* (Wong et al., 1982).

The performance of the above mentioned species evaluated under different soil types are listed in Table 2. In general, on sedentary soil and peat soil, dry matter production ranged from 15.0 to 30.0 ton/ha/yr, whereas the same species grown on coastal marine sand dropped to almost a third or a half of their normal yields.

Table 2. Dry matter yield (ton/ha) of grasses and legumes under cutting in three regions in Malaysia

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Species	Sedentary soil	Peat soil	Sandy soil
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Grasses:			
<i>Brachiaria decumbens</i>	24.7	26.3	16.5
<i>Brachiaria brizantha</i>	19.4	24.5	11.8
<i>Digitaria setivalva</i>	20.5	25.4	3.8
<i>Digitaria pentzii</i> (Slenderstem)	18.2	23.1	11.8
<i>Panicum maximum</i> (Coloniao)	17.0	20.2	3.1
<i>Panicum maximum</i> (Typica)	26.1	-	-
<i>Setaria sphacelata</i> (Kazungula)	20.6	15.8	6.7
<i>Setaria sphacelata</i> (Splendida)	18.6	16.6	-
<i>Pennisetum purpuruem</i>	30.0	16.3	3.4
Legumes:			
<i>Centrosema pubescens</i>	6.0-10.0	5.0- 8.0	3.0
<i>Desmodium ovalifolium</i>	5.0- 7.0	7.0- 9.0	3.0
<i>Stylosanthes guianensis</i> (Schofield)	7.0-15.0	5.0- 7.0	7.0-10.0
<i>Leucaena leucocephala</i>	8.0-20.0	10.0-15.0	5.0- 6.0

S))Q
Adapted from Wong *et al.*, (1982).

Fertiliser applied at 300-400 kg N/ha/yr; cutting interval of 4-6 weekly.

The grass species Napier, and to certain extent Guinea, are mostly used for cutting while the rest are meant for grazing. In view of the grass-legume combining ability, it is proposed that the grasses with erect and clumpy characteristics such as *Panicum maximum*, *Setaria sphacelata* can combine well with all the promising tropical legumes, especially *Desmodium ovalifolium* and *Centrosema pubescens*, which need a shady canopy. Sometimes, legume species which are not that palatable, such as *Calopogonium caerulum*, *C. mucunoides* and *S. scabra*, may have to be included in the pasture system so as to serve specific objectives such as preservation of feed for drought and nitrogen fixation for soil improvement. Care is required with aggressive grasses with prostrate rhizomes which form a thick mat on the ground surface which may impede the legume. Selection of shrubby legumes for this system could be probably the best way out, for instance, the *L. leucocephala* and *B. decumbens* pastures.

Cutting and grazing

It is important to note that for most grasses and legumes, forage yield increases as cutting frequency decreases while forage quality declines. The digestibility of both grasses and legumes decreases with

maturity, implying that forage should be fed at a younger stage for maximum energy digestibility. A wide range of digestibility occurs both between and within pasture species. One has to compromise between maximising forage yield and quality and try to improve the latter by using better species for milk production.

In general, defoliation affects the both above ground growth and the underground rooting system. In the case of legumes, it affects also nodulation and nitrogenase activity. When sufficient fertilizer and moisture are available, a 6 to 10 weeks regrowth interval should be the practice to obtain optimal yield and quality of forage, except in the dry season, when the cutting interval may inevitably be prolonged.

In the case of grazed pastures with defoliation by dairy cows, either by continuous or rotational grazing, the optimal leaf to stem ratio should be maintained at close to 1, giving forage availability of about 2500 kg/ha of dry matter at any time (Cowan *et al.*, 1977)

Response to Fertiliser

In tropical regions, where light and moisture are non-limiting, soil nutrients are the major factors affecting the production of forage. Due to highly weathered soil conditions, deficiencies of macro- and micro-nutrients in ultisol, oxisol, peat and marine sand were reported (Coulter 1972; Chew *et al.*, 1981; Tham and Kerridge 1979, 1982). Nutrient deficiencies may lead to the non-persistence of the species, especially with legumes which are sensitive to molybdenum, copper, magnesium, boron and calcium. They may eventually affect animal production, e.g. cobalt deficiency both in soil and pasture (Mannetje *et al.*, 1976b). There is a response of pasture growth and animal performance to the application of phosphorus fertilizer (Eng *et al.*, 1978).

A high rate of nitrogen fertilizer is necessary to maintain high productivity of fodder grasses. The dry matter yields of some of the improved and native species in response to nitrogen fertilizer are documented (Ng, 1972, Vincente-Chandler *et al.*, 1959. Dry matter yield responses have been recorded up to as high as 1,600 kg N/ha/yr (Tham, 1980). Even though high rates of nitrogen increase dry matter yield, the efficiency of use of nitrogen was found to decrease with increase rates of nitrogen applied. The nitrogen efficiency drops from 23.0 to 20.1 to 17.6 to 16.8 kg DM/kg N as nitrogen rate increases from 200 to 400 to 600 to 800 kg N/ha/yr respectively. Whereas at the same rate of application, the nitrogen recoveries were 30.3, 38.4, 41.9 and 42.7% (Chadhokar, 1978).

Similar results on napier and signal grass were recorded at rates of 42.0, 34.2 and 25.2% nitrogen recovery as the nitrogen application rate increases from 200-400, 400-800 and 800-1600 kg N/ha/yr (Tham,

1980; Aminah *et al.*, 1989). It implies that the most efficient nitrogen fertilizer rate should be around the level of 200-400 kg N/ha/yr. This further confirmed an earlier finding that nitrogen concentration in the forage had a limited effect on increasing the nutritional value (Minson 1973) and that nitrogen fertilizer at 250 kg N/ha/yr was sufficient for the attainment of crude protein for optimum digestion by the animal in the wet tropics (Mustapha *et al.*, 1987). Furthermore, excessive crude protein in tropical grasses following heavy application of fertilizer nitrogen may also adversely affect intake. Milford (1960) recorded a depression of 33% in the intake of *Chloris gayana* when crude protein content increased from 8 to 13.5% due to high nitrogen fertilizer application. A similar case was reported that the intake of young, heavily fertilised pasture with 20% crude protein was 28% less than the intake for the same pasture after growing for a further 28 days when the crude protein had fallen to 11%.

There are interaction of N, P and K fertilizers on forage production. With application of N, P and K fertilizer at the rates of 421, 196 and 1004 kg/ha/yr respectively, the yield of fresh napier grass increased by 74.5% over the yield of unfertilised grass. It is recommended for a broad range of soils in the humid tropics that fertilizer rates of 300-600 kg N, 100 kg P and 50 kg K/ha/yr should be sufficient for forage production under cut and carry system (Robbins, 1986). Based on research work and experience on grazed pastures, Gilbert (1984) has attempted to recommend fertilizer for different soils derived from granitic, metamorphic, basaltic and marine sand (Table 3).

Table 3. The fertilizer rates for grazed pastures on different soil types (Gilbert, 1984).

Fertilizer	Granitic soil	Metamorphic soil	Basaltic salts	Marine sand
Superphosphate	300 kg/2yrs	300 kg/2yrs	300 kg/yr	150 kg/yr
Muriate of Potash	100 kg/4-5yr	100 kg/4-5yr	-	50 kg/yr
Copper sulphate	8 kg/4yr	-	-	8 kg/4yr
Zinc sulphate	8 kg/4yr	-	-	8 kg/4yr
Sodium molybdate	0.5 kg/4yr	0.5 kg/4yr	0.5 kg/2yr	0.5 kg/4yr
Lime	-	500 kg/ha	-	-

On a pure grass sward grazed by dairy cattle, it is advisable to split the amount of 300 kg N/ha/yr of nitrogen fertilizer into five equal applications. The economic aspects of fertilizer use has to be assessed in relation to the increased dry matter yield and its subsequent effect on animal carrying capacity.

Legume in the Pasture

To maintain high productivity and forage quality for dairy cows, it may be better to include leguminous species in the pasture production system rather than rely on nitrogen fertilizer. The advantages of legumes in the system are:

- (i) improvement of soil conditions due to nitrogen built up in the soil from accumulation of organic matter,
- (ii) fixation of nitrogen by the legume through *Rhizobium* symbiosis, and
- (iii) increased animal production due to the higher nutritive value of legumes and shorter digestive passage time in the gut that enhance voluntary intake.

Usually, the crude protein content of legumes (at about 25%) is higher than that of grasses at similar ages and stages of growth and shows little fluctuation during the growing process. Apart from higher nitrogen content, tropical legumes generally maintain higher sulphur (0.07-0.21%) and calcium (1.13-1.93%) in the plant tops (Andrew and Robbins, 1969) as compared to that of grasses (0.09-0.15% and 0.17-0.41%, respectively). Similarly, the values of phosphorus in legumes are expected to be higher than grasses despite great variability between species and plant age. The additional role of legumes in increasing the mineral content of pastures has an additive effect on animal nutrition and production.

Legume viability and persistence on acidic soil are always problematic. The inclusion of local legumes or well-adapted species as one of the leguminous components in the pasture is highly recommended. Because of specific requirements for certain elements for nitrogen fixation, the legume may be more sensitive to some minerals such as phosphorus, sulphur, calcium, magnesium, molybdenum and cobalt.

There are many factors affecting legume component in the tropical pastures. The most important but controllable factors are the defoliation, grazing management and fertilizer. Very little is known about the optimum level of legume content in the tropical pasture. Results from grazing pangola-legume pasture have shown that the live weight gain of beef cattle was linearly related to legume content of the pasture (Evans, 1970).

PASTURE MANAGEMENT AND MILK PRODUCTION

Average production per cow from tropical pastures is in the range of 10 to 12 kg/day for Friesian cows, 7 to 9 kg/day for Jersey and 6 to 10 kg/day for crossbred cattle. The potential of these pastures for milk production was suggested to be 4,000 kg/lactation for Friesian and 2,700 kg for Jersey (Cowan *et al.*, 1974). Production per hectare varies from 2,600 to 8,300 kg/ha/yr. Grass and legume systems have produced up to 8,000 kg/ha/yr, but these stocking rates caused degradation of the pasture due to loss of legume (Cowan *et al.*, 1975). A production level of 5,000 kg/ha/yr is the potential of stable grass and legume mixed pastures. (c)

Continuous Grazing

Cows grazing tropical pastures require about 10 to 12 hours a day of grazing to satisfy their nutritional needs (Cowan, 1975). Often they are reluctant to do a lot of grazing during the day as the temperature are high. In Northern Queensland during summer, about 80% of grazing are done during the night. Obviously, night grazing or feeding in the tropical environment, must be encouraged.

There is linear increase in milk output per hectare with increase in stocking rates but milk production per cow also decreases linearly (Cowan, 1984). There are a wide range of stocking rates tested for milking cows on different types of pastures (Table 4). The optimal stocking rate for Friesian milking cows on Guinea-Glycine mixed pasture was 1.6 cows/ha to produce 5,351 kg/ha/yr (or 3,345 kg/cow/yr) of milk, whereas on nitrogen fertilised Guinea was 3.5 cows/ha to produce 8,880 kg/ha/yr milk yield. Both stocking rates were able to maintain stable pasture of about 2,500 kg DM/ha on offer, the amount of forage considered to be minimum for dairy production.

For practical purposes, when advising a farmer on the basis of experimental results, it is best to be conservative at 20-30% lower stocking rates than those used in the research.

Rotational Grazing

On reviewing over 16 grazing experiments, Mannelje *et al.*, (1976a) concluded that there is no definite advantage of rotational grazing over continuous grazing system. However, in the hot humid tropics where even rainfall is available, the rotational grazing system has a 25% higher in beef production than that of the continuous (Chen and Othman, 1986). This is attributed to a higher amount of forage on offer rather than forage quality in the rotational grazing system. The practice of rotational grazing (or strip grazing) may help to ease the forage problem, particularly during a prolonged dry spell.

Table 5. Milk production from N-fertilised and legume-based tropical pastures without supplementary feed

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Pasture	Stocking Rate	Breed	Milk yield kg/cow /day	kg/ha/yr	References
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Unfertilised pastures

<i>P. maximum/ M. minutiflora</i>	1.1	Jersey	6.8	2667	Toledo 1968
<i>D. decumbens</i>	1.5	Friesian/Zebu	6.9	3760*	Serpa et al., 1973

Nitrogen fertilized pastures

<i>D. decumbens</i>	2.5	Jersey	6.8	6014	Toledo 1973
<i>D. decumbens</i> (irrigated)	8.9	Jersey	6.5	22466	Thurbon et al., 1973
<i>P. maximum</i>	2.5	Holstein	11.3	8488	Vincente-Chandler et al., 1974

Grass-legume pastures

<i>B. decumbens/ Leucaena</i>	5.0	Sahiwal-Friesian	5.7	8580	Wong et al., 1987
<i>P. maximum/ Glycine</i>	2.5	Friesian	12.7	8221	Cowan et al., 1975

S))Q

*Calculated yield

Cut and Carry System

The "cut and carry" (or zero grazing) system means that the fodder is cut and removed for stall-feeding to animals. This system has been widely adopted by smallholders in dairy farming. The reasons for this practice are the shortage of land, small scale of farm size (0.3 -2.0 ha), abundance of cheap labour, limited forage resources and strict control of animals.

Usually, when cut forage is given, the nutritive value of forage is inferior to that received by grazing animals. The protein content of napier grass by cattle was 17.1%, while that of the same forage being fed to stall kept animal was 7.4% (Vincente-Chandler *et al.*, 1964). Grazing animals are able to choose their own forages. Grazing cows tend to produce more milk and obtain better reproductive performance than stall-fed cows. Milk production in the stall-feeding system was 8,577 kg/ha/lactation while rotational grazing without supplements yielded 9,180 kg/ha (Wong *et al.*, 1987). A similar finding was obtained with 20% higher milk production for grazed cows (10,203 kg/ha/yr) than that of stall-fed cows (8,134 kg/kg/yr) (Soetrismo *et al.*, 1985). This may explain the low milk yield of the smallholders.

Like grazing animals, stall-fed milking cows need night feeding. In order to have a near-balanced diet, some broadleaved weeds such as (*Asystasia intrusa* and others) or leguminous shrubs (such as *Leucaena* and *Glyricidia* species) in place of a high protein supplement, should be included. Protein is an expensive supplement at smallholder level.

Frequent defoliation of herbage is a threat to the persistence of sward and it may result in the need to replant the pasture. If it is a machine-cut, the mortality of forage plants will be higher than hand-cut materials. Experience shows that Napier grass cut by forage harvester has to be replanted every three years. The severity of forage die-back may be reduced if a reciprocal cutting machine is used.

Replenishment of soil fertility is essential with the cut and carry system. It was estimated that to be able to produce 150 t/ha/yr of fresh Napier/Guinea fodder, a fertilizer programme of 880 kg N, 252 kg P and 756 kg K/ha/yr (or 6.3 ton of 14:14:12 compound fertilizer) is needed. On the highly-leached acidic soils of the tropics, "soil exhaustion" may be experienced, despite the frequent application of N, P, K fertilizers. The consequence is the rapid die-back or retarded growth of forage sward. It may be due to the following factors:

- (i) high hydrogen ion concentration (urea source),
- (ii) toxic level of aluminium and manganese, or
- (iii) induced deficiency of molybdenum.

Correction of such a problem probably requires the incorporation of organic matter or animal waste into the soil, as well as the application of recommended fertilizers. Organic matter which is the source of much nitrogen, and to a certain extent phosphorus and sulphur, improves soil condition. Organic matter improves also the inorganic particles (the clay colloids) which are the main reservoir of cationic nutrients such as K, Ca, mg, Fe, Zn, Mn and Co.

Some micro-elements which are not essential to plant growth such as sodium and cobalt are critical to animal performance. Even the

major nutrients such as phosphorus, potassium, calcium and nitrogen if they are low in fodder plants, will affect milk production. Supplementation of minerals to animal to correct the immediate need must be given.

Forage-based Supplementary Feeding

In areas where dairy cattle are kept near a pineapple factory, palm oil mill, sugar-cane plantation or in any major agriculture operation from which crop by-products are plentiful, a complete year round feeding system involving these by-products could be established. By-products do not provide a balanced feed on their own, being either excessive or deficient in certain minerals, but they are good roughage with high metabolisable energy. They may be available or harvested only in a certain period of the year, mostly approaching the dry season when shortage of green forage is experienced.

Besides the agriculture by-products, the conservation of feed in the form of silage or hay may be another alternative to ease the situation of feed shortage on the farm. Due to low leaf:stem ratio or high fibre content, tropical pasture may not be that good for silage and hay making, but with some additional mixing with leguminous shrubs, good quality feed can still be maintained. Hence, using forage as a basic diet, supplementary feeding of formulated by-products in the ration, may possibly be able to maintain full milk production throughout the year.

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