

# REVIEW OF FORAGE SCREENING AND EVALUATION IN MALAYSIA

*Wong Choi Chee*

## INTRODUCTION

The scenario of Malaysian agriculture comprises two major sectors, namely the estates or plantations and the smallholdings. Over 70% of the agricultural land are under the smallholders. The average farm size of the smallholdings ranges from 0.3- 2 hectares (Table 1).

Table 1. Farm size and animal number in small holdings at different locations in Peninsular Malaysia

Site	Mean farm size (ha)	Range (ha)	Animals per farm (head)	Land/forage Available	Ref.
a) Rice areas in north	1.54	0.08 to 19	1.44	No crops grown for animals	Lai et al. (1973)
b) Banting	0.03	-	6	No land	Mohd Najib and Hassan (1980)
c) MCC (Jasin)	1-2	-	4	a/59% farmers no land b/ 17% have < 1 ha c/ 16% have 1-2 ha	Hassan and Devendra (1982)

A prominent character of the smallholdings is the mixed farming pattern of the crops cultivated. This has evolved because of the need to minimize and spread risks and to ensure that at least some basic food needs of the families are met.

Invariably, some forms of livestock are kept for home consumption and the surplus provides supplementary income to that of the main crops. Such being the situation, many of the integrated crop/livestock farming systems existing in the Malaysian smallholdings are not as economically and agronomically efficient in terms of optimal use of the scarce resources and income generated to farmers

One of the major limitations to efficient ruminant livestock production in the country is the lack of adequate levels of high quality forage for feeding to ruminants. Nonetheless, the wide diversity of farming systems existing in Malaysia offers various potential ecological niches for the forage introduction and evaluation programme to identify adaptive forages and to encourage their adoption and use by the farmers for ruminant production.

## **HISTORY OF PASTURE AND FODDER DEVELOPMENT**

Malaysia lacks natural grasslands. The main vegetation is evergreen equatorial rain forest. Where land is cleared, it is normally cultivated with plantation crops such as rubber, oil palm, cocoa and fruit crops. In any abandoned land, indigenous grasses such as *Axonopus compressus*, *Imperata cylindrica*, *Paspalum conjugatum* and *Ottlochloa nodosa* and some plantation legumes thrive in abundance. The humid tropical climatic conditions favours luxuriant growth of these naturalised grasses and legumes of poor forage quality.

Some ad hoc research on pasture and fodder grasses was initiated in the early twenties by the Department of Agriculture to improve forage quality and quantity (Milsum 1924). Tropical legumes were introduced later as cover crops for the plantations (Hamilton and Pillay 1941, and Watson 1957). It was in the early fifties that a systematic effort was undertaken to improve the cultivation and management of the introduced grasses (ECeeping 1951; Henderson 1955a,b,c and Ure and Jamil 1957). This was followed by forage production studies at Kluang Central Experimental Animal Husbandry Station (Balachandran 1969). Commercial attempts to produce leaf meal from tropical grasses were undertaken by Chemara Reseach Station in Labu, Ngeri Sembilan (Tan et al. 1973).

At the same time, the government was promoting commercial enterprises in the beef and dairy production to increase livestock production to meet increasing meat demand and to raise the standard of living of the farmers through efficient production systems. Commercial farms of varying sizes ranging from 800 to 2000 hectares in various states in Peninsular Malaysia were established with improved tropical pastures.

With the formation of MARDI in 1969, the pasture and fodder research, formerly under the Department of Agriculture was reformulated to fulfil the new overall objective of the national livestock policy. The objective of the pasture and fodder research programme in MARDI was to cater to the needs of pasture and fodder development in the country mainly: -

- (a) the scattered but substantial livestock population that is reared by the small farmers around the padi areas, rubber, oil palm and coconut holdings
- (b) new livestock commercial enterprise as undertaken by Majutemak at that time (Ajit 1972).

In the early 1970s, a joint research programme between MARDI and CSIRO Division of Tropical Crops and Pastures to assist in the development of large scale commercial farms was implemented to cover three main areas of research in the country:

- (a) Plant Introduction and Evaluation
- (b) Plant Nutrition and Soil Fertility studies
- (c) Productivity and Utilization of Promising Pastures.

The failure of the big ranching schemes set up by Majuternak has led to the consideration of exploiting the natural feed resources for livestock production. Today, there are over 1.9 million hectares of rubber and 1.33 million hectares of oil palm plus 0.24 million hectares of coconuts in Peninsular Malaysia. With such a vast indigenous forage resource in these plantation, an estimated 1 million cattle equivalent or 6 million sheep equivalent can be kept (Wan Mohamed, Hutagalung and Chen 1987). Unnecessary spraying of the undergrowth through the use of expensive and toxic chemicals is thus avoided.

The present paper attempts to review the strategy and methodology of introduction and evaluation in the changing roles of Malaysian forage development, and the agronomic performance of the introduced species evaluated over the years under the research programme.

## **THE NEED FOR FORAGE GERMPLASM**

The Malaysian experience with the indigenous and introduced (exotic) forages has been variable. The indigenous species do not produce high dry matter yield and the exotic species are less persistent and prone to pest and disease damage. Poor seeding behaviour of the selected species often prevented commercialization.

Although there is a need for a breeding programme to upgrade the desirable characteristics of the selected species, the present circumstances of forage development strategies in Malaysia do not permit or warrant such a research undertaking. Hence introduction and evaluation of forage germplasm programme has remain as the primary means of obtaining genetic resources for upgrading.

To date only one domestic expedition was undertaken to collect indigenous forage legumes mainly the *Desmodium* and *Pueraria* species. Interest is now on collection of genetic material of high productivity, acid soil tolerance, forage quality, shade tolerance, persistency to defoliation or grazing and tolerance to tropical pests and diseases. Fodder shrubs are being investigated especially in relation to soil acidity tolerance and psyllid resistance in *Leucaena leucocephala*.

## **EVALUATION STRATEGY**

The evaluation process is based on the plants' adaptation to climate, soil, defoliation intensity and to its reproductive fertility and ability to mix with other pasture species particularly legumes.

The main objective of forage plant evaluation is to identify forages which, under defined management can increase animal productivity when introduced into existing forage/cropping. systems. The purpose and situation for when the forage is to be used are clearly defined when deciding on the strategy to be used in the evaluation programme.

This is to ensure that the research technology is economically justifiable and applicable at the small farm levels. Generally, the superior species/cultivars must be well accepted by farmers, easy to propagate either by seed or by cuttings and the seed must be cheap and easy to produce.

The selection attributes expected from the forage plants are:

- S** adaptation to local environment
- S** persistence to defoliation/ grazing
- S** tolerance to pests and diseases

- S tolerance to drought
- S effective nodulation in the legumes
- S competitive ability over weed species
- S good compatibility of grasses with legumes
- S good nutrient concentrations
- S palatability/acceptability
- S leafiness and high seed yield
- S high digestibility of dry matter
- S relatively free from toxins and restrictive factors

## **EVALUATION PROCEDURES**

To achieve efficient utilization of forages, a systematic critical appraisal of the forages and their potential for development into a permanent source of fodder is imperative. The series of stages in the evaluation process is illustrated in Figure 1.

### **Screening of forages**

The screening of germplasm is critical to the whole programme of plant introduction and evaluation. The selection of germplasm should be related to the soils and climatic conditions of the place of assessment. Review of past publications and experiences of researchers should be sought prior to the introduction of adaptive forage species. This is to ensure that the limited-range of species closely related to the target area of evaluation are introduced and evaluated. Wastage of scarce germplasm and financial resources are avoided. At this stage, an assessment of feed resources, feeding systems and problems concerning smallholders at a particular region could be undertaken as reported by Hassan and Devendra (1982). Such a survey will provide a basis for the selection and introduction of appropriate forage species.

In Malaysia, acquisition of tropical genetic material is mainly from international institutions such as CSIRO-ADAB Pasture Seed Project, CIAT in Colombia, Department of Agriculture USA, Universities of Florida, Hawaii and Philippines in Los Banos, the International Board for Plant Genetic Resources and collection expeditions.

### **Nursery evaluation**

In Malaysia, new introductions or accessions are continually being introduced, screened and evaluated at MARDI Research Station, Serdang. Plant observations often commence as soon as the seedlings emerge and continue at weekly or monthly intervals for two to three years. A numerical rating system in which plant attributes are scored from poor to good is simple and effective.

Since 1972, over 700 introductions of grasses and tropical legumes have gone through the process of evaluation. The grass introductions are mainly from the following genera: *Brachiaria*, *Cynodon*, *Digitaria*, *Panicum*, *Paspalum*, *Pennisetum* and *Setaria* while the legumes are from *Stylosanthes*, *Centrosema*, *Desmodium*, *Calopogonium*, *Cajanus*, *Pueraria*, *Cassia*, *Desrnanthus*, *Leucaena*, *Vigna* and *Zornia*.

The first phase of forage selection and evaluation was completed a couple of years ago. Results of the species performance have been reported (Wong et al. 1980). *Brachiaria decumbens*, *Cynodon plectostachyus*, *Digitaria setivalva*, *Panicum maximum*, *Pennisetum purpureum*, *Paspalum plicatulum*,

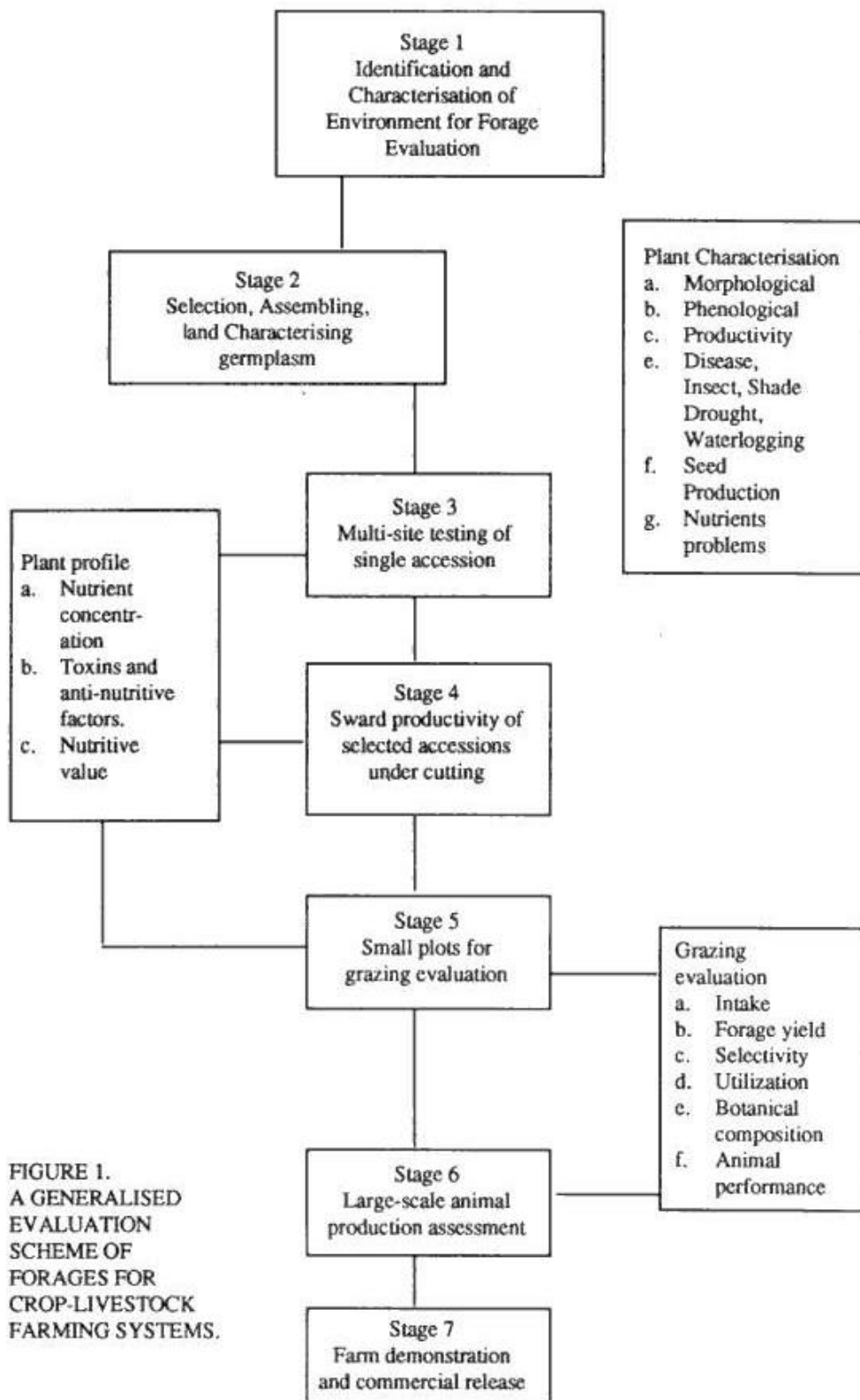


FIGURE 1.  
A GENERALISED  
EVALUATION  
SCHEME OF  
FORAGES FOR  
CROP-LIVESTOCK  
FARMING SYSTEMS.

*Setaria sphacelata* cv. Kazungula were potentially promising for forage and fodder plants. The legume introductions suffered badly from insect pests and disease infestations resulting in poor growth and regeneration. *Stylosanthes guianensis* accessions were productive and persistent. *Centrosema pubescens* and *Desmodium ovalifolium* were suitable for pasture legumes and *Leucaena leucocephala* as a promising fodder legume.

In the second phase of the introduction programme beginning from 1979 onwards until the present time, suitable species or cultivars from the identified genera: *Digitaria*, *Brachiaria*, *Centrosema*, *Desmodium*, *Leucaena*, *Cajanus* and *Zornia* were added to the germplasm collection. Over 300 accessions from the above genera were brought in from Beltsville, Maryland, Georgia, USA; ICRISAT, India; CIAT, Colombia; Cunningham Laboratory, Australia.

From ICRISAT, six accessions of *Cajanus cajan* were introduced in July 1979. From Beltsville, USA, a total of 96 miscellaneous tropical legumes from the genera, *Aeschynomene*, *Centrosema*, *Clitoria*, *Desmanthus*, *Desmodium* and *Leucaena* were introduced. Of these only 63 introductions survived in the first year. In 1981, 76 miscellaneous accessions of legumes from CIAT, Colombia, mainly *Aeschynomene*, *Centrosema*, *Stylosanthes*, *Zornia*, and *Galactia*, and *Andropogon gyanus*. In 1982, a local collection of *Desmodium* and *Pueraria* with two international scientists from CIAT and Thailand was made. In 1982, another 54 new introductions from Florida, USA comprising mainly of *Digitaria* hybrids and *Pennisetum* hybrids were introduced from University of Florida, USA. Also in that year, a total of 172 accessions of indigenous legumes belonging to the genera *Desmodium* and *Pueraria* were collected.

In 1983, six *Leucaena* species were introduced at MARDI Station, Serdang. Later, 72 *Centrosema macrocarpum* accessions from CIAT were added to the germplasm collection for assessment. In 1986, *Arachis pintoii*, CIAT 17434, *Setaria* synthetic cv splendida, *Arachis pintoii* CSIRO 58113, *Setaria* (hybrid) cv splendida, *Codariocalyx gyroides*, *Cassia pilosa*, *Cassia rotundifolia* CPI 49713, *Cassia rotundifolia* cv Wynn. Again in 1986, 19 new introductions were added to the present collection. In 1987, a collection of recommended fodder shrubs was assessed.

Performance of the promising introductions is illustrated by their dry matter production (Table 2).

Table 2: Dry matter productivity of some of the forage introductions in the 2nd phase

Species/ cultivars	Mean dry matter production (kg/ha/ann)*
<i>Aeschynomene histrix</i> CIAT 9690	6228
<i>Centrosema pubescens</i> CIAT 5126	3035
<i>Centrosema brasilianum</i> CIAT 5247	1352
<i>Centrosema macrocarpum</i> CAT 5065	4377
<i>Centrosema brasilium</i> CIAT 5234	1130
<i>Centrosema pubescens</i> CIAT 438	1905
<i>Centrosema</i> sp. CIAT5112	2841
<i>Centrosema</i> CIAT	1520
<i>Galactia striata</i> CIAT 964	1771
<i>Stylosanthes capitata</i> CIAT 1019	3663
<i>Stylosanthes capitata</i> CIAT 1315	2556
<i>Stylosanthes capitata</i> CIAT 2013	4285
<i>Stylosanthes capitata</i> CIAT 1078	3152
<i>Stylosanthes capitata</i> CIAT 1693	4679
<i>Stylosanthes capitata</i> CIAT2310	4285
<i>Stylosanthes capitata</i> CIAT 1798	2271
<i>Stylosanthes capitata</i> CIAT 1405	2433
<i>Stylosanthes guianensis</i> CIAT 1200	5693
<i>Stylosanthes guianensis</i> Ciat 21	5111
<i>Stylosanthes guianensis</i> CIAT 136	6597
<i>Stylosanthes hamata</i> CIAT 147	5593
<i>Stylosanthes humilis</i> CIAT 1304	3138
<i>Stylosanthes leiocarpa</i> CIAT 1087	3988
<i>Stylosanthes macrocephala</i> CIAT 1582	3358
<i>Stylosanthes sympodialis</i> CIAT 1044	3536
<i>Stylosanthes guianensis</i> cv Graham	4443
<i>Zornia</i> sp. CIAT 9648	3238
<i>Zornia latyolis</i> CIAT 728	3181
<i>Zornia latifolia</i> CIAT 9260	3033
<i>Zornia latifolia</i> CIAT9199	2664
<i>Zornia</i> sp. CIAT	1400
Grasses	
<i>Andropogon gayanus</i> CIAT621	3240
<i>Cenchrus ciliaris</i> cv Buffel	3985
<i>Cenchrus ciliaris</i> cv Bioloela	3275
<i>Melinis</i>	7745
<i>Setaria sphacelata</i> cv Kazangula	7207
<i>Setaria sphacelata</i> cv Narok	6064
<i>Setaria sphacelata</i> cv Nandi	6363

\* Mean over 3 years

Table3. Mean annual dry matter yield (tons/ha/year) of some promising grasses defoliated at 6weekly intervals in three regions and their performance under grazing.

Grasses		Serdang	Jalan kebun	Sg. Baging		
(a) Cutting						
<i>Brachiaria decumbens</i>		24.7	26.3	16.5		
<i>Cynodon plectostachyus</i>		6.1	26.3	5.2		
Tanganyika guinea		27.7	30.0	-		
Sigor guinea		13.0	19.2	-		
Common guinea		26.1	-	8.7		
Coloniao guinea		17.0	20.2	3.1		
Hamil guinea		15.5	19.6	2.8		
MARDI digit		20.5	25.4	3.8		
Slenderstem digit		18.2	23.1	11.8		
<i>Paspalum plicatulum</i>		21.1	24.1	8.5		
Local napier		30.0	16.3	3.4		
Uganda napier		21.0	12.7	2.7		
<i>Splendida setaria</i>		18.6	16.6	0.5		
<i>Kazangula setaria</i>		20.6	15.8	6.7		
<i>Tripsacum laxam</i>		23.0	21.0	2.0		
<hr/>						
(b)	Grazing	Stocking rate	DM Yield tons/ha	Grass (%)	Legume (%)	Weed (%)
1.	Legume-Guinea	4 K.K.	5.0	69.3	24.3	6.3
2.	Mixtures (Legume-Guinea)	2-3.3 drought-master	4.4	67.1	6.8	20.4
	(Legume-Transvala Digit)		3.8	36.9	3.3	43.6
	(Legume-Native pasture)	2.8	80.0	2.9	5.4	
3.	N-fertilised MARDI digit	6.7 K.K.	2.6	55.0	35.0	10.0
4.	N-fertilised Guinea	6 K.K.	4.1	85.5	7.3	7.2
5.	N-fertilised Signal grass	8 K.K.	3.9	81.2	9.5	9.3

adapted from Wan Mohamed et al. (1987)

The aim of sward trials is to measure seasonal forage yield under conditions not very different from those in the grazing paddock. The trials are carried out for three years. Once again a range of sites within the farming systems are selected to cover the range of climatic and soil variation within the country.

Forages are established in small plots (5m X 5m). The experimental layout and design is simple, with treatments being as pure swards or grass/legume mixtures replicated three times, and arranged in randomised blocks (Wong 1982; Wong and Eng 1983). Economical fertilizer rates are applied to ensure adequate nutrients. Here, good seeds should be used. Legume seed must be inoculated with an appropriate *Rhizobium* strain. Pure grass swards would receive nitrogen fertilizer at the rate of 200kg N /ha/year, split into 4 applications.

Harvest is taken between 4 to 6 weekly intervals during the growing season but may be delayed to 12 weeks during unfavourable conditions.

Cutting height and frequency will vary with the forage species. Forage samples are oven-dried for dry matter yield determination and proximate analysis.

Plants are usually rated 6 weeks after sowing and at the beginning of each growing season. This information provides an estimate of initial establishment, survival of adult plants and seedling replacement in the developed forage phase.

Observations are made on the flowering and seeding behaviour. Crude observation of animal acceptance of the forage may be made by allowing cattle or sheep to graze the plants following sampling or harvest. After the forages have been grazed for two to three days, the residual forage is cut uniformly to promote regeneration.

From such trials, grass yields of dry matter ranging from 18-30 tons/ha/year cut at 6-weekly intervals were obtained on inland soils. Production on peat was quite similar to that on inland soils, while on sandy soils, dry matter yield declined to 9 tons/ha/year (Table 3). In the smallholdings, the mean forage productivity of promising grasses was 15 - 19 tons/ha/ year (Izham and Hassan 1983). In a commercial farm, forage productivity of 14-29tons/ha/year (Darabif 1982)and 11 tons/ha/year in plantation holdings (Tan et al. 1973). Promising legumes such as Pueru and Stylo yielded 5-15 tons/ha/year. Productivity of dry matter from *Leucaena leucocephala* accessions ranged from 6-20 tons/ha/year (Izham et al. 1983; Wong et al. 1983). Two selections i.e. ML1 and ML2 from the *Leucaena leucocephala* evaluation were released in 1983 to farmers for the cut-and-carry system of livestock feeding under pilot project evaluation.

Table 4. Dry matter production of six *Cajanus cajan* accessions from Icrisat, India (kg/ha/yr)

Icrisat No.	Pedigree	Cutting interval in Weeks			
		6	8	12	16
Cutting height 50 cm					
7118	C11	1720	1260	3249	3717
1	-	2525	1661	6465	8365
7221	Gwalior-3	1343	2702	6639	7424
6344	T-7	2334	1289	6053	6430
1641	T-17	1935	3824	8044	4791
6469	S-29	2776	1896	5000	7449
Cutting Height 90 cm					
7118	C11	2127	3038	6641	7421
1	-	5301	5024	10521	10084
7221	Gwalior-3	4361	7383	10521	14727
1641	T-17	4219	5476	9239	15368
6969	S-29	4862	6013	9720	14122

Some of the sward results of the 2nd phase introduction programme are illustrated. The *Cajanus cajan* trial which was aimed at assessing the productivity of dry matter at 6, 8, 12 and 16 weekly cutting intervals was completed in February 1981 (Table 4).

Many plants of the 6 accession died by the end of the trial in the first year. Major causes were due to termite damage of roots and stems. Increased cutting intervals and cutting height enhanced dry matter productivity by 57%. In vitro dry matter digestibility decreased from 57% to 41% with increased cutting interval. Nitrogen content ranged from 3.5 to 2.2% .

Similarly, the promising *Stylosanthes* accessions were evaluated in sward trial under three cutting frequencies. Results are shown in Table 5.

Table 5. Dry matter production (kg/ha/ann) of nine *Stylosanthes* accessions at Serdang as affected by cutting frequencies

Cultivar	6Wk	8Wk	12Wk	Mean
Q8442	9133	9221	11375	9910
Schofield	9736	8734	12899	10456
Scrabra	8687	7352	14341	10127
CPI23706B	10810	10999	14684	12164
CPI40294	11204	9781	10495	10493
CPI33432	9293	13416	11038	11249
CPI47396	13765	14493	15846	14701
CPI33978	13097	9030	13377	11835

In addition, shade tolerance of grasses and legumes were undertaken to screen these species for adaptation in shade environment of plantation crops ( Figs 2 and 3). These shade studies have been reported (Wong, Rahim and Mohd. Sharudin 1985a; Wong, Mohd. Sharudin and Rahim 1985b).

The potential of fodder shrubs and tree leaves is also being evaluated. The species evaluated were *Gliricidia sepium*, *Leucaena leucocephala* and *Manihot esculenta* at 4, 8 and 12 weekly intervals (Wong and Mohd. Sharudin 1986).

In addition, the obnoxious plantation weed, *Asystasia intrusa* has been evaluated for suitability in forage production. Dry matter yield of 3 - 10 ton /ha /yr could be obtained. Forage quality of the weed is as good as that of any other tropical legumes.

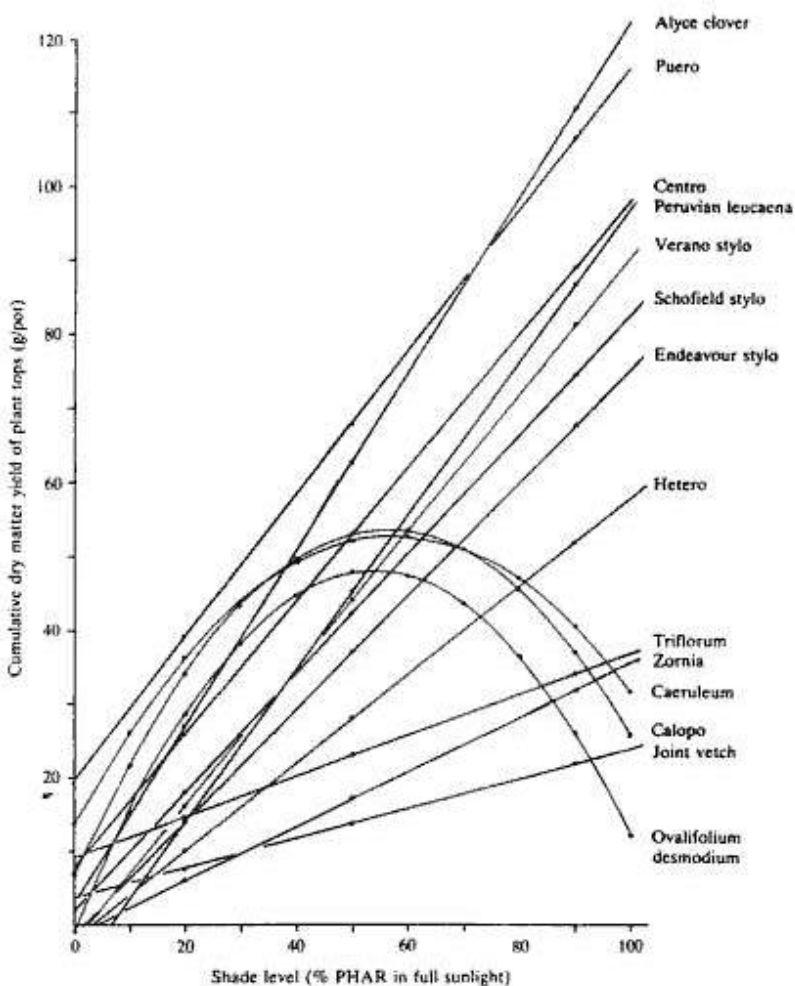


Figure 2: Dry matter yield responses by 14 tropical legumes in soil pot culture to shading

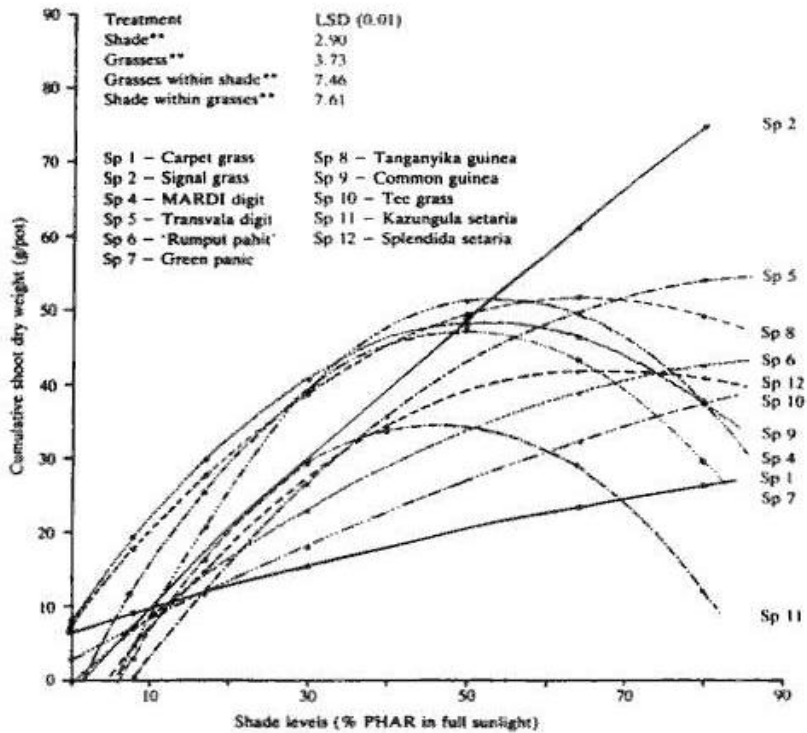


Figure 3. Regression curves of the effect of shading on the cumulative dry matter yield of the top growth in 11 tropical grasses grown under greenhouse conditions. Species 3 (Congo gras) was omitted

The potential of *Leucaena leucocephala* on acid soil environment is thus illustrated below:

Table 6. Mean annual DM production (kg/ha/ann) of *Leucaena leucocephala* at three cutting heights and three cutting frequencies

Cultivar/ Accession	Cutting height (cm)	2 months	3 months	4 months	Mean
Cunningham	10	4435	4910	5577	4971a
	50	6228	7507	7922	7217b
	100	5295	6857	6287	6146b
	Mean	5319a	6425b	6595c	
ML2	10	5463	8383	10182	8009
	50	9975	11861	18365	13400b
	100	10353	13068	14083	12501b
	Mean	8597a	11104b	14210c	

Means with different letters are significantly different (P<0.05)

Leucaena mixed with pasture was also evaluated in Serdang for productivity and forage quality. The results are shown (Table 7).

Table 7. Effect of cutting intervals and Leucaena spacing on the productivity of dry mauer (kg/ ha/yr) of four Leucaena/pasture grass mixtures

Cutting interval	Grass	2 M	3 M	4M	Mean
6 Wk	MARDI digit	22317	14659	12754	16577
	Common guinea	20888	17819	15982	18229
	Signal grass	20089	13870	15583	16514
	Napier	20299	20869	11407	17525
8 WK	MARDI digit	15193	12384	9928	12502
	Common guinea	14258	14866	14115	14413
	Signal grass	15449	12683	10812	12198
	Napier	16784	12693	10598	13358
12 Wk	MARDI digit	19177	16974	15049	17066
	Common Guinea	30816	27509	23410	27245
	Signal grass	35895	17391	11988	21758
	Napier	35127	25543	24299	28323

### Regional evaluation

Promising material is further evaluated in Research Stations at Sg. Baging on Bris soils, Kluang on Rengam Soil Series, Pontian on peat and Kuala Linggi on acid sulphate soil (Wong et al. 1980).

Regional evaluation aims to examine the performance of new forages on a range of soil types and climates within the farming systems for forage management and production. The simplest method is to establish plant nurseries at several sites covering the range of soils and climates to be encountered in the region. Mineral deficiencies in the forages should be overcome through separate pot and field fertility trials. Amelioration of soil mineral deficiencies are undertaken to enable continuation of the evaluation process.

The correction of soil nutrient deficiencies has been the most important factor for successful establishment of forage legumes and grasses. Total N content in soils is low (0.05-0.1%) and this is aggravated by the low pH values (pH 4-5). There is a universal deficiency in phosphorus in soils (Kerridge and Tham 1974). Deficiencies in potassium, molybdenum, copper and calcium have been reported (Them and Kerridge 1979; 1982).

### Acceptability trials

The proximate composition data are inadequate to assess the nutritive quality of the forages but serve as an approximate indication of the actual potential nutritional value for comparative evaluation purposes.

In feeding trials, the forages are fed in their raw forms at various levels or as supplementation in standard ration to test their acceptability levels. The acceptability trials will thus help to determine

their practical levels of forages for rejection based on parameters such as growth performance, feed intake, feed conversion efficiency and mortality.

Information related to toxic effects could be obtained from blood sample analysis and through autopsies during or after the trial. From such studies, the feeding value of the forage will eventually become apparent. Any restrictive or anti-nutritional factors that limit their use should be detected and overcome for improved utilization. This is best demonstrated with the utilization of *Leucaena leucocephala* as a high protein source. Wong and Devendra (1982) reported a 50% intake limitation in indigenous goats. Beyond this level, toxicity symptoms of mimosine from *Leucaena leucocephala* were detected.

Currently, the problems of photosensitivity caused by *Brachiaria decumbens* on small ruminants are being studied. Related *Brachiaria* species such as *B. humidicola* and *B. dictyoneura* are screened for such a toxicity. No symptoms of toxicity from these two *Brachiaria* species were detected.

Only well adapted accessions with proven agronomic superiority to current species/cultivars need to proceed to feeding/grazing experiment to assess animal acceptability and plant responses to grazing management.

## **ACHIEVEMENTS IN FORAGE SCREENING AND EVALUATION**

From these past two decades or so of pasture and fodder research and development in Peninsular Malaysia, the dry matter productivity of the promising forage and fodder has been generally high due to favourable climate, adequate use of fertilisers and overcoming soil deficiency elements. Guinea, rapier, signal and kazungula setaria and MARDI digit are by far the best pasture and forage grasses identified, two of which (guinea and rapier) have been classed as traditional fodders. The forage legumes are *Stylosanthes guianensis*, *Aeschynomene histrix*, Puerto, *Centrosema* and *Leucaena*. These species can be cultivated in any inland soils without much problems provided they are properly managed and fertilised.

On peat soil, MARDI digit and paragrass are being recommended. On Bris soil, *Digitaria pentrii* cv Slenderstem *Digitaria decumbens*, *Brachiaria humidicola*, *B. dictyoneura*, *Zornia diphylla* and *Stylosanthes guianensis* are promising. Both, *B. humidicola* and *B. dictyoneura* do not cause any photosensitivity problems in goats and sheep in the grazing trials. However the acceptability of the two grasses is low although they are high dry matter productivity. For the plantation grasses, the shade tolerant species namely *Paspalum conjugatum*, *Axonopus compressus*, *Centrosema pubescens* and *Desmodium ovalifolium* appear best for low light level (<50% sunlight). In moderate shade, guinea and *B. decumbens* are suitable with dry matter yield of 5-7 t/yr.

With adequate fertilizer application (200kgN/ha/yr) the DM yield is 15-20 tons/ha/yr but with grass/legume mixtures the DM productivity is 10-15 tons/ha/yr on a long term basis. *Leucaena leucocephala* ML1 and ML 2 have been selected as suitable fodder crops for protein supplementation in the small holdings.

## **DEVELOPMENTAL CONSTRAINTS**

- (a) The strategy of forage screening and evaluation is a long term programme requiring many years of continuous research and development before package technologies could be developed. In a

fast developing country, like Malaysia, the livestock industry cannot afford to wait for such technologies to be implemented. A short and more versatile research programme for fodder and forage evaluation is thus needed not only to reduce the time span but also to cope with the ever-changing agricultural science and governmental policies in livestock production.

- (b) The lack of a forage breeding programme for forage development and improvement in the country is a major constraint. Forage genetic resources are introduced from different regions of the world. Often the selected introductions provided, are not well adapted to the Malaysian soils and climate. The large majority of the species w accessions failed in the preliminary assessment. For the few selected species, many of them do not have all the desirable characters listed earlier.
- (c) In Malaysia, the promising grasses and legumes evaluated are usually poor seeders. They have to be vegetatively propagated and thus are not suitable for commercialisation because of the high establishment costs. Examples are rapiar, Splendida setaria and MARDI digit which do not produce viable seed.
- (d) The humid tropical climate also does not favour forage seed production because of the lack of large differences in daylength, temperature and drought seasonality. As such, the forage species tend to remain vegetative, giving high dry matter production e.g. *Brachiaria decumbens*, and the tropical legumes like *Pueraria phaseoloides* are poor in blooming and seed set.
- (e) The latent pest development could be an obstacle to forage development. A good example is the Leucaena project. After years of research and development in the identification and management of potential varieties, the outbreak of psyllid in July 1976 has hindered its developmental programme for the smallholders.
- (f) Development in the utilization of the promising forages into the overall feeding system of the farmers' situation is lacking in the programme, resulting in non adoption of the forage materials developed. This is also a consequence of the lack of close rapport between researchers and extension agencies.
- (g) There is always the land constraint for fodder/forage crop cultivation as farmers prefer to use their land for high value crops rather than growing fodder. Hence, the technology developed may not fulfil the needs of the farmers.
- (h) The high cost of fodder/forage establishment involving high seed and fertiliser costs is a major constraint in the development of forage cultivation by the smallholders especially when there is an abundance of natural green feeds available at most time in the plantations and vacant lands. The only problem is the distance to collect the forages. Nevertheless, there is a need to evaluate the role of improved species in the overall low-input production system of the livestock rearers.
- (i) The lack of commercial (pioneer) enterprises with successful demonstration of profitability on forage/fodder-based farm to stimulate the private sector into further expansion of the industry. Hence, the scope of the programme would be limited. There is a need to utilise efficiently fodder/forage in conjunction with available byproducts to reduce production cost.
- (j) Finally, suitable breeds to express the better nutritive value of tropical improved forage over the indigenous species are lacking. Consequently, there are no advantages in improved forage cultivation and utilization.

## CONCLUSIONS AND FUTURE DIRECTIONS

The relevance of forage production and utilization in farming systems research rests primarily in its applicability and potential to service the needs and aspirations of the integrated small-scale livestock farmers. Forage as a feed resource base will continue to play a greater role in the future development of ruminant industry particularly the goat and sheep subsectors. Although integration of forages into plantation crops will provide the greatest potential for the further expansion and development of the small ruminant industry, selection and evaluation of genetic resources are needed to attain more productive and adaptive forage species for use in different farming systems to maximise agricultural land use.

A systematic critical appraisal of the available germplasm is probably the most relevant strategy in the promotion for increased development and utilization of forages and the realization of achievable levels of economically viable production systems of ruminants amongst the smallholders.

Current projects on forage introduction and evaluation are primarily aimed at getting genetic materials that are high yielding, persistent to defoliation under low inputs, tolerant to shade, drought and soil acidity as well as pests and diseases. Browse plants and tree leaves with good quality forage potential and short-term annual forage legumes that can thrive as off-season crops after rice or other food crops, will definitely be of interest. Similarly, shade tolerant forage species that can contribute significantly towards improving feed supplies both qualitatively and quantitatively in the perennial plantations are being studied.

## REFERENCES

- Ajit, S.S. (1972). Fodder and pasture development policy of MARDI. *Quart. J. Inst. Techn. MARA*. 4:56-61.
- Balachandran, N. (1969). Fodder production in Malaysia with special reference to napier (*Pennisetum purpureum*). *Kajian Vet.* 2: 83-88.
- Burt, R.L. (1983). Observation, classification and description. In: McIvor J.C. and Bray R.A., ed. *Genetic Resources of Forage Plants*. CSIRO, Melbourne, Aust., pp.169-181.
- Chen, C.P. (1985). The research and development of pastures in Peninsular Malaysia. *Trop. Agric. Res. Series No. 18*. TARC, Ministry of Agriculture, Forestry and Fisheries, Japan.
- Chen C.P. and Abdullah Hashim, M. (1984). The productivity, plant component, plant mineral composition and persistence of six tropical grasses under cutting on Bris. *MARDI Res. Bull.*
- Chen, C.P., Ajit, S.S. and Evans, T.R. (1981). Beef production from three nitrogen fertilized grasses in Peninsular Malaysia. *MARDI Res. Bull.* 9:207-224.
- Chin, F.Y., Raghavan, V. and Md.Nor. Hashim (1974). The yield, moisture end chemical composition of some grasses grown in Malaysia. *Kajian Vet.* 6: 81-88.
- Clements, R.J. and Bry, R.A. (1980). Information storage and retrieval. In: Clements R.J. and Cameron D.G. ed., *Collecting and Testing Forage Plants*. CSIRO, Melbourne, Aust., pp. 52-70.
- Duabif (1982). *Darabif Fourth Annual Report 1982* p. 3.
- Devendra, C. (1979). *Malaydan Feeding stuffs*. pp. 33-127. Pub: MARDI.
- Eng, P.K., Kerridge P.C. and Mannelje L.'t (1978a). Effects of phosphorus and stocking rate on pasture and animal production from a guinea grus-legume pasture in hore, Malaysia. I. Dry matter yields, botanical and chemical composition. *Trop. Grasslds.* 12:188-197.
- Eng, P.K., Mannelje, L.'t and Chen, C.P. (1978b). Effect of phosphorus end stocking rate on pasture end animal production in Johore, Malaysia. II. Animal liveweight changes. *Trop. Grasslds.* 12: 198-207.

- Hamilton, R.A. and Pillay, K.S. (1941). The manuring of *Centrosema pubescens*. J. Rubb. Res. Inst. Malay. 4: 85-95.
- Hassan, A.W. and Devendra, C. (1982). Assessment of feed resources, feeding systems and problems concerning smallholder dairy cattle production in the milk collection centre, Jasin, Malacca. MARDI Report No.77.
- Henderson, R. (1955a). The cultivation of fodder grasses in Malaya. 1. Introduction. Malay. Agric. J. 38: 71-77.
- Henderson, R. (1955b). The cultivation of fodder grasses in Malaya. 2. The application of artificial fertilizers. Malay. Agric. J. 38: 141-150.
- Henderson, R. (1955c). The cultivation of fodder grasses in Malaya. 3. Time and frequency of application of fertilizer. Malay. Agric. J. 38: 250-255.
- Izham, A. and Hassan, A.W. (1983). Agronomic evaluation of promising grasses and legume in small holdings. In: Devendra C., Sivarajasingam S, Kassim Hamid and Vidyedaran M.K. ed., Proceedings of the 7th Annual Society of Animal Production. MSAP, Serdang Malaysia pp. 188-198.
- Izham, A. Evans, T.R. and Ajit, S.S. (1981). A comparison of planting techniques for legume establishment in native pasture under coconut on bris soils. MARDI Res. Bull. 10:409-419.
- Ivory, D.A. (1985). Performance of genoplasm in new environments. ACIR Proc. No. 12 on Forages in southeast Asian and South Pacific Agriculture, Cisarua, Indonesia 1985. pp. 61-68.
- Keeping, J.S. (1951). A review of fodder investigations, 1947-1950. Malay. Agric. J. 34: 65-75.
- Kenidge, P.C. and Tham, K.C. (1974). Nutrient requirements for establishment of legume-grass pastures on inland soils of Peninsular Malaysia. Paper presented at the Symposium on Classification and Management of Malaysian Soils, Sabah, Malaysia November 1974.
- Lai, K.C., Devendra, C., Hashim, M.Y., Djafar, M.J. and Jegathesan, S. (1973). Preliminary findings of a study on buffalo and cattle rearing in the Muda area MARDI Report No.3.
- Mohamad Najib, M.A. and Hassan, A.W. (1980). Tinjauan projek pengumpulan susu di Daerah Kuala Langat Aspek pemakanan lembu tenusu. Teknologi Pertanian 1:80-88.
- Mohd. Najib, M.A. and Hassan, A.W. (1985). Effects of farmyard manure and inorganic fertilizers on dry matter production of two grasses. MARDI Res. Bull. 13: 323-332.
- Tan, H.T., Yeow, K.H. and Pillai, K.R. (1973). Potential pasture production and development. In: Proc. of the Symposium on National Utilisation of Land Resources in Malaysia. Serdang, 1973. p. 23.
- Tham, K.C. and Kenidge, P.C. (1979). Nutrient responses by *Stylosanthes guianensis* on coastal marine sands (bric) of Peninsular Malaysia MARDI Res. Bull. 7:43-54.
- Tham, K.C. and Kenidge, P.C. (1982). Responses to lime, K, Mo and Cu by grass-legume pasture on some Udisols and Oxisols of Peninsular Malaysia. MARDI Res. Bull. 10:350-369.
- Ure, J.S. and Mohd. Jamil (1957). Fodder grass cultivation - A manurial and variety trial at Federal Experimental Station, Serdang, Malay. Agric. J. 40: 209-216.
- Wan Hassan, W.E. (1987). Annual dry matter yield and nutritive value of improved grasses for dairy production in Malaysia. MARDI Res. Bull. IS: 115-128.
- Wan Mohamed, W.E., Hutagalung, R.I. and Chen, C.P. (1987). Feed availability, utilization and constraints in plantation-based livestock production system. In: Hutagalung, R.I., Chen, C.P., Wan Mohamed, W.E., Law, A. T. and Sivarajasingam, S. ed., Proc. of 10th Annual Conf. of MSAP on Advances in Animal Feeds and Feeding in the Tropics. Genting Highlands, Pahang, Malaysia. pp.81-100.
- Watson, C.A. (1957). Cover plants in rubber cultivation. J. Rubb. Res. Inst. Malay. 18: 123-308.
- Williams, W.T. (1983). Analysis of plant evaluation data. In: McIvor J.G. and Bray R.A. ed., Genetic Resources of Forage Plants. CSIRO, Melbourne, Aust., pp. 293-298.
- Wong, C.C. (1982). Evaluation of ten pasture legumes grown in mixture with three grasses in the humid tropical environment. MARDI Res. Bull. 10: 299-308.
- Wong, C.C. and Devendra C. (1982) Research on *Leucaena* forage production in Malaysia In: Proc. *Leucaena* Research in the Asian-Pacific Development Research Centre. NIFTAL and IDRC. pp. 55-63.
- Wong, C.C. and Eng, P.K. (1983). Small sward comparison of *Stylosanthes* and *Desmodium* species grown in association with Guinea. MARDI Res. Bull. 11: 146- 165.
- Wong, C.C., Chen, C.P. and Ajit, S.S. (1982). A report on pasture and fodder introduction in MARDI. MARDI Report No.76.
- Wong, C.C., Izham, A., Chen, C.P. Hasssn, A.W., Aminsh, A. and Eng, P.K. (1983). Studies on forage potential of *Leucaena leucocephala* in Malaysia. In: Devendra, C., Sivarajasingham, S, Kassim Hamid and Vidyedaran, M. ed., Proc. 7th Annual Conf. MSAP. Port Dickson, Malaysia. pp. 115-12

- Wong, C.C. and Mohd. Sharudin, M.A. (1986). Forage productivity of three fodder shrubs in Malaysia. MARDI Res. Bull 14:178-188.
- Wong, C.A., Mohd. Sharuddin, M.A. and Rahim, H. (1985). Shade tolerance of some tropical forages for integration with plantations. 2. Legumes. MARDI Res. Bull. 13: 249-269.
- Wong, C.C., Rahim, H. and Mohd. Sharudin, MA. (1985). Shade tolerance potential some tropical forages for integration with plantations. 1. Grasses. MARDI Res. Bull. 13: 225-247.

## **ACKNOWLEDGEMENTS**

The authors wish to thank Dato Dr Hj. Mohd Yusof b. Hashim, Director-General of Malaysian Agricultural Research and Development Institute for permission to present this paper. Thanks are also due to En. Ahmad Tajuddin b. Zainuddin, Director of Livestock Research Division, MARDI for suggestions and assistance in the preparation of the paper.