# A REVIEW OF PASTURE SPECIES IN FIJI. I. GRASSES

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## ABSTRACT

*Fijian work on pasture and fodder grasses is reviewed. In the wet zone the best grasses were* Brachiaria mutica, Ischaemum indicum *and* Brachiaria dictyoneura. *Yields up to 32,000 lb dry matter have been recorded in cutting trials. In the dry zone* Dichanthium caricosum *is the principal sown pasture grass.* Panicum maximum *occurs widely in the intermediate zone.* Pennisetum purpureum *and* Tripsacum laxum *are useful fodder grasses.*

## INTRODUCTION

Although introduced grasses such as Para (*Brachiaria mutica*), Batiki blue grass (*Ischaemum indicum*) and Nadi blue grass (*Dichanthium caricosum*) have been widely used in pastures for several decades, there has been little detailed examination of the use and introduction of pasture species in Fiji.

Some papilionate legume species have been recorded since the earliest days of settlement by Europeans, but no serious attempt was made to foster their development. *Leucaena leucocephala* has been common on the main islands but is regarded as a weed. However, this species is now being used as a substitute for lucerne meal in concentrate rations and also as a grazing supplement.

The first serious attempt at classifying the flora of Fiji was that made by Berthold Seeman (1860-73) who travelled to Fiji in 1860-61, and his comprehensive volume "Flora Vitiensis" survives as the most important work on Fiji plants. The following list of grasses and legumes of possible pastoral use contained in this work, although not large, is of interest.

*Legumes*

| Name | Distribution |
|---|---|
| *Clitoria ternatea* | In gardens |
| *Glycine tabacina* | Islands off Macuata coast |
| *Vigna marina* (*V. lutea*) | Seaside locations |
| *Desmodium heterocarpum* | Common throughout the group |
| *Desmodium umbellatum* | Common on sea beaches |
| *Desmodium truxillensis* | Common throughout the group |
| *Lablab vulgaris* (*Dolichos lablab*) | Taveuni and other parts, on beaches; used by author as a vegetable. |
| *Leucaena leucocephala* (*L. glauca*) | Bua and Viti Levu in hedges. |

*Grasses*

| | |
|---|---|
| *Cymbopogon refractus* | Dry, sunny places |
| *Chrysopogon aciculatus* | Dry, sunny places |
| *Imperata arundinacea* | Vanua Levu (U.S. expedition of 1840) |
| *Eleusine indica* | Roadsides, Viti Levu |
| *Cenchrus anomoplexis* | Ovalau, dry places |
| *Digitaria sanguinalis* | Roadsides |
| *Panicum trigonum* | Ovalau and Vanua Levu |
| *Panicum ambiguum* (*Urochloa paspaloides*) | Vanua Levu (U.S. Expedition of 1840) |
| *Paspalum orbiculare* | Ovalau, Viti Levu |
| *Coix lachryma-jobi* | Swamps, Taveuni and other islands |

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It was not until 1920 that an Agricultural Circular was published regularly in the Colony and this later become the Fiji Agricultural Journal. From these sources the information on pastures is sparse, but they indicate that with soldier settlement after World War I a definite need for pasture improvement existed and although this prompted the introduction of considerable numbers of species and varieties of grasses, few have survived the introduction plot stage.

The species detailed in this paper, therefore, do not represent all of those introduced or adapted to agriculture, but are those in common use or considered to be potentially useful in the Colony.

It is noteworthy that apart from references to "Fiji Trefoil" (*Desmodium heterophyllum*), no serious thought was given to the introduction of what are now commonly regarded as pasture and cover crop legumes until 1946 with the introduction of *Calopogonium mucunoides, Centrosema pubescens, Pueraria phaseoloides,* and *Stylosanthes guyanensis*. Thus, although the emphasis has formerly been on grass species, present work is being concentrated on the establishment and maintenance of pasture legumes.

## THE GRASSES

### *Para grass* (Brachiara mutica)

In the wet zone of Viti Levu this is the standard grass on dairy farms possessing alluvial flats and has formed the basis of dairy farm pasturage, especially since the end of World War I. It is believed to have been introduced as seed from Sydney in 1877 (Parham 1956).

Rainey (1920) and McKeown (1921) considered Para grass the only profitable pasture grass but recommended rotational grazing or cutting for stall or yard feeding. Various yield cuts have been taken from time to time, green weights per acre varying between 37 and 41 tons with a crude protein percentage ranging from 5.5% to 15.0% of dry matter.

A cutting trial comparing this species with seven others was initiated in 1954 and completed in 1957 (P. L. Rhodes — personal communication). Table 1 shows the mean yields of each species over the period.

TABLE 1

*Mean yields of seven grasses between December* 1954 *and September* 1957
(Wet zone)

| Species | Dry Matter % | Dry Matter lb/acre | Crude Protein % |
|---|---|---|---|
| *Ischaemum indicum* | 25.0 | 8060 | 8.1 |
| *Brachiara brizantha* | 30.0 | 6940 | 7.6 |
| *Digitaria melangiana* | 26.3 | 5600 | 8.7 |
| *Brachiaria mutica* | 28.5 | 5820 | 8.4 |
| *Panicum maximum* | 30.8 | 6050 | 8.2 |
| *Paspalum dilatatum* | 28.9 | 4700 | 9.9 |
| *Melinis minutiflora* | 32.9 | 4260 | 6.8 |
| *Panicum coloratum* | 31.7 | 3140 | 9.0 |
| S.E. of Mean | | 940 | |

*B. mutica* was utilised in an indoor feeding trial with cattle in 1958, using a forage harvester for cutting. It was found that too high a proportion of stem to leaf was harvested under these conditions. Only 67% of the material cut was eaten. The use of this species as soilage by small-holders and dairymen is common and although

hand cutting may be more selective than forage harvesting, the amount of wastage must still be considerable.

Milk production from Para grass has been found to respond well to nitrogen fertilization (Annual Report 1962) as table 2 shows.

TABLE 2

*Effect of nitrogen applications on productivity of Para grass*

| Rate of nitrogen applied as urea between March & Nov. *lb N* | carrying capacity (beasts/ac.) | Average milk yield/ cow/day *lb* | Total milk per acre/day *lb* |
|---|---|---|---|
| 0 | 1.3 | 8.2 | 10.6 |
| 172 | 1.7 | 11.6 | 19.7 |
| 344 | 2.0 | 13.2 | 26.4 |

What has not been established, is whether nitrogen fertilization of this species is economical under the present dairy price structure. That it is likely to be so is indicated by the considerable amounts of copra meal currently used on farms which do not carry out such fertilization of Para grass pastures. However, reliance on supplementary concentrates on some farms has become such a feature of dairy management that a changeover to a fully grass diet could present intial difficulties.

Combination of Para grass with suitable legumes has not so far become common, though one institutional farm is carrying out a policy of establishing Para grass pastures with *Centrosema pubescens* and is not feeding supplements. The farm is achieving production comparable with farms relying heavily on copra meal.

Para grass is commonly established from runners which are disced or ploughed in and growth is so vigorous that it is difficult to obtain a good strike of legume from seed sown when grass is planted. Also, the weeds sensitive plant (*Mimosa pudica*) and Navua sedge (*Cyperus aromaticus*), particularly the former, generally establish freely under these conditions. Such pastures often contain upwards of 50% of *M. pudica.*

### *Batiki blue grass* (Ischaemum indicum)

This grass, which is a native of tropical Asia and Malaya, was first recorded in Fiji in 1923 but is thought to have been introduced accidentally earlier from India. Batiki is now widespread throughout the wetter areas of Fiji, being vigorous and well adapted to low soil fertility and lax management practices. With Para grass it forms a large proportion of the total dairy pasture acreage, but unlike Para it is largely confined to the hills where its densely stoloniferous habit is an asset in smothering weeds.

As with other grasses in current use its propagation is by means of cuttings, although it can produce reasonable quantities of seed, the viability of which was studied by Parham (1960).

Seed is set in April/May at the onset of the cooler dry season, hence the natural seed dormancy enables seed to be carried over until the onset of the following rains when viability is at its peak (Parham 1960).

The pre-eminence of this species as a producer of dry matter is shown in Table 1. Its very serious defect, however, is its extremely low production during the cooler, dry months. Various other defects have been reported including a tendency to taint milk and that it is detrimental to the productivity of any tree crop grown in association with it. Nevertheless it has been a useful pioneer and its vigour and ready availability will ensure its popularity for some time to come, especially for establishment on unploughable hill country.

Run-down Para grass pastures on alluvial flats in Tailevu, the main dairying district, generally revert to *Axonopus compressus, Paspalum conjugatum,* and *Mimosa pudica,* into which *Ischaemum indicum* from the contiguous hills does not invade to any extent.

The dispute over the relative merits and deficiencies of Batiki blue grass has long continued so that the resolution of various opinions and observations has naturally occupied the staff of the Fiji Department of Agriculture. Current work suggests that it may prove advisable to utilise its advantages and manipulate its shortcomings with agronomic techniques such as incorporation of legumes and maintenance of a Batiki/legume sward, especially for hill grazing for beef cattle and for dry dairy stock.

Since 1965 a trial to compare this grass and a more recently introduced one which has become popular (*Brachiaria dictyoneura*), has been in progress (Table 3). No legumes were involved in the comparison, the nitrogen being provided by regular dressings of urea. This was applied at 224 lb N per acre twice a year in April and September. Each treatment was subdivided to allow a grazing rotation of 4 days grazing to 24 days rest. Results have been variable and changes in stocking rate have had to be made, mainly due to weed invasion and the type of stock available. The cattle for the first two years were young Friesian heifers.

TABLE 3

*Daily live weight gains of cattle grazing fertilised* B. dictyoneura *and* I. indicum (*Wet zone*)

| Stocking rates, beasts per acre | 1966/67 | | | | 1967/68 | | | |
|---|---|---|---|---|---|---|---|---|
| | Koronivia | | Batiki | | Koronivia | | Batiki | |
| | per head (lb) | per acre (lb) | per head (lb) | per acre (lb) | per head (lb) | per acre (lb) | per head (lb) | per acre (lb) |
| 2.5 | 1.00 | 2.50 | 0.65 | 1.66 | — | — | — | — |
| 3.0 | 1.01 | 3.00 | 0.70 | 2.12 | 0.33 | 1.5 | 0.41 | 1.00 |
| 6.0 | — | — | — | — | 0.35 | 2.10 | 0.36 | 2.20 |

Observations during the grazing year indicate that Batiki retains its palatability if kept short and the resting period provided allows this. On the other hand during winter and subsequent to seed-set the sward opens up at the stocking rates used and incursion of tar weed (*Cuphea carthagenensis*) and sensitive plant (*Mimosa pudica*) follows. In 1967 a plague of army worm (*Spodoptera mauritia*) induced conditions suitable for weed invasion similar to those of over-grazing. *B. dictyoneura* was not as severely affected.

Work carried out by Wildin (Annual Report, 1962) with different rates of nitrogen fertiliser on Batiki, indicated that under similar conditions this grass showed up poorly when compared with Pangola and Para grasses (Table 4).

On the other hand, crude protein content of this grass on offer in the spring of 1967 in the trial quoted in Table 3 had a mean value of 10.3, while the value for Koronivia grass was 8.75.

### *Koronivia grass* (Brachiaria dictyoneura)

The species was first introduced in 1957 and also known as *Drachiana dictyoneura.* It is the third of the most widely used species in the wetter areas of Fiji. Although it does not yet cover large areas, small nursery plots at least exist in most districts including the drier coconut producing islands to the east.

Intensely stoloniferous, once established this grass covers well, but requires higher fertility than Batiki. Stems tend to be slightly woody, hence conditions become favourable for a dense mat layer beneath a grazing level which becomes progressively

TABLE 4

*Crude protein percentage under three rates of nitrogen fertilisation (Wet zone)*

| Grass | Season | Amount of nitrogen applied (as urea) between March and November | | | |
|---|---|---|---|---|---|
| | | Nil | 86 lb N | 172 lb N | 344 lb N |
| Pangola | Spring | 9.3 | 10.7 | 12.9 | 14.3 |
| Para | | 10.5 | — | 11.6 | 12.1 |
| Batiki | | 3.8 | 3.9 | 4.4 | 6.4 |
| Pangola | Summer | 5.9 | 8.5 | 8.6 | 9.6 |
| Para | | 8.6 | — | 10.3 | 10.8 |
| Batiki | | 7.1 | 7.5 | 7.7 | 8.1 |
| Pangola | Autumn | 6.0 | 6.6 | 8.5 | 9.8 |
| Para | | 6.6 | — | 8.6 | 10.7 |
| Batiki | | 4.9 | 4.9 | 8.9 | 9.1 |
| Pangola | Winter | 6.0 | 6.7 | 7.4 | 10.4 |
| Para | | 6.6 | — | 10.7 | 12.4 |
| Batiki | | 4.9 | 5.6 | 6.8 | 7.4 |

higher under the type of grazing management favourable to Para grass. On the other hand, such density of growth does prevent weed invasion.

Establishment is usually vegetative, small bundles of stolons being planted at spacing of 3 ft-6 ft centres. *B. dictyoneura* is a shy seeder and this factor alone contributes to its slow spread. With labour costs inevitably rising species producing harvestable quantities of viable seed should naturally be preferred.

The high potential productivity of this species has been cited by Wildin (unpublished data) who indicated that a linear response was obtained to increasing amounts of nitrogen per acre, achieving 30105 lb dry matter from 400 lb N per acre. Without nitrogen it yielded only 9684 lb dry matter in the same trial.

Progress results showing live weight production from Koronivia and Batiki pastures under identical fertiliser treatment and at various stocking rates are shown in Table 3. Unfortunately the results show trends only, as all the *I. indicum* fields were grouped together and the animals (Friesian heifers) used in the first two runs were not completely satisfactory as test animals. Nevertheless these trends do indicate a certain superiority in favour of *B. dictyoneura.* This is more than likely due to the greater production of dry matter of this species especially during the dry cooler

TABLE 5

*Mean yields of dry matter of 8 grasses cut every 8 weeks over a period of 11 months at Koronivia (Wet zone)*

| Species | Yield (lb) |
|---|---|
| *Brachiaria decumbens* | 30200 |
| *Brachiaria brizantha* | 26200 |
| *Setaria sphacelata* C.P.I. 13249 | 24000 |
| *Brachiaria dictyoneura* | 23700 |
| *Panicum maximum* var. *trichoglume* | 23700 |
| *Paspalum plicatulum* | 22800 |
| *Ischaemum indicum* | 18600 |
| *Setaria sphacelata* C.P.I. 28709 | 17200 |
| S.E. of mean | 2460 |

months of the year. Flowering does not normally commence until November. Cattle in these tests were not run during the dry periods and at the high stocking rates during the summer *B. dictyoneura* was under-utilised. *I. indicum* pastures tend to become more readily invaded by weeds.

A study of dry matter production of *B. dictyoneura* in comparison with *I. indicum* and other species under cutting at 8 week intervals gave mean yields of dry matter per acre as shown in Table 5.

Due to the rapid accumulation of dense vegetative cover, the establishment of legumes with this species remains a problem. At the same time *B. dictyoneura* transplanted into a field establishes rather slowly, so that if a legume is seeded before grass planting the grass becomes smothered under such species as Siratro (*Phaseolus atropurpureus*), *Vigna marina* or greenleaf desmodium (*D. intortum*). If legume sowing is delayed until the time of planting of the grass, weed competition from such species as *M. pudica* and later *Cyperus aromaticus* becomes a problem.

Some success has been achieved by sod seeding Siratro and centro (*Centrosema pubescens*) into established *B. dictyoneura* which had been closely mowed with a rotary mower. Again, however, some incursion of *M. pudica* became evident after eight months.

### *Nadi blue grass* (Dichanthium caricosum)

There are three main varieties of *Dichanthium* in Fiji, all of which thrive in the drier parts of the islands where the annual rainfall varies from 80 in. to 100 in. and the year is marked by a distinct and often prolonged dry season lasting usually from May to November.

Nadi blue was introduced in 1906, (Parham 1946) its origin being tropical Asia. Although it is the most important grazing species in the dry areas at the present time, it cannot be considered an ideal pasture species because of its low productivity. However, with mission grass (*Pennisetum polystachyon*) and kangaroo grass (*Themeda quadrivalvis*) it does form a useful basis upon which to effect some improvement. As with Batiki blue in the wetter areas, Nadi blue is a vigorous competitor with less desirable species on unamended hill soils in the dry areas. The available soil moisture during the winter is rapidly depleted by the intense evaporation occasioned by the prolonged strong S.E. trade winds during such periods. Further, low winter productivity follows seed set which occurs in April-May, which period often marks the onset of low rainfall conditions.

No critical examination of this grass under grazing has been made.

### *Pangola grass* (Digitaria decumbens)

Widespread throughout developing tropical countries, Pangola was introduced to Fiji in 1957, initially showing great promise.

In 1962, however, Pangola became infected with a suspected virus disease which drastically retarded its growth rate and yield of dry matter. Isolated plantings of this species have persisted however, and though the rosetting condition persists, the grass is still, in one case at least, providing useful feed. Wet season conditions appear to provide a degree of recovery.

Of other *Digitaria* species introduced in 1962, *Digitaria pentzii* has persisted and spread at Ba and Yaqara in the Dry Zone (rainfall 80-100 in. and a distinct dry season of four to five months) and a cutting trial is currently comparing this with other species likely to be suited to conditions in that area.

The above-mentioned grasses at present constitute those on which reliance is placed, but more recent introductions, which from observation and preliminary trials merit further investigation, are:—

*Brachiaria decumbens* and *B. brizantha*
*Setaria sphacelata*
*Panicum maximum* var. *trichoglume*
*Panicum coloratum* cv. Kabulabula
*Panicum maximum* cv. Coloniao
*Panicum maximum* cv. Embu

## FODDER GRASSES

Elephant grass (*Pennisetum purpureum*), Guatemala grass (*Tripsacum laxum*), Kavirondo Sorghum (*Sorghum verticelliflorum* cv. Kenya) have been investigated. Of these the last named is now nowhere in evidence, but Elephant and Guatemala grasses find favour with a few dairy farmers for the form of soilage known as "chop-chop" which is usually fed in the dairy at milking time.

Cutting trials were carried out at Sigatoka in the Intermediate Zone between 1949 and 1953 on these grasses (Payne *et al.*, 1955) (Table 6). These trials were not followed up, possibly due to the greater importance attached to establishment and maintenance of more permanent and less labour-consuming forms of pasture. Nevertheless, Sigatoka is subject to long drought periods from time to time and further investigations on zero grazing are probably warranted.

TABLE 6

*Mean annual yield per acre of wet material from four fodder species at Sigatoka (Intermediate zone)*

| Fodder | Leaf ('000 lb) | Total ('000 lb) | % leaf |
|---|---|---|---|
| Elephant Grass | 64 | 85 | 75.3 |
| Kavirondo Sorghum | 21 | 36 | 58.3 |
| Guatemala Grass | 26 | 26 | 100.0 |
| Urban Cane (*Saccharum sinense*) | 31 | 33 | 93.9 |

## LEY GRASSES

Grasses considered suitable for short or medium term leys were studied at Sigatoka (Payne *et al.*, 1955). Again comparisons were made under cutting only, but a wide range of local and introduced grasses were studied. Tables 7 and 8 summarise these studies.

TABLE 7

*Yield of grasses from introduction plots* 1950-52 *(Intermediate zone)*

| Species | Green matter yield ('000 lb) 1950 | 1951 | 1952 |
|---|---|---|---|
| Woolly Finger (*Digitaria melangiana*) | 93 | 91 | 98 |
| Molasses (*Melinis minutiflora*) | 57 | 59 | 79 |
| Nadi Blue (*Dichanthium carisosum*) | 72 | 69 | 100 |
| African Foxtail (*Cenchrus ciliaris*) | 45 | 33 | 62 |
| Batiki blue (*Ischaemum indicum*) | 42 | 50 | 62 |
| Dallis (*Paspalum dilatatum*) | 58 | 35 | 43 |
| Rhodes (*Chloris gayana*) | 107 | 85 | 39 |

Guinea grass does not figure prominently in these studies but considerable areas of a naturally adapted variety exist in the region. The effect of fertilisation, particularly with nitrogen, was hardly considered during these tests, so that the

survival of grasses grown in a hill situation reflect an ability to survive under unamended soil conditions and without the benefit of a companion legume.

TABLE 8

*Average annual yields of grasses in a pasture yield trial (Intermediate zone)*

| Species | Green matter yield/ac./year ('000 lb.) |
|---|---|
| Woolly Finger (*D. melangiana*) | 34 |
| Para (*B. mutica*) | 23 |
| Nadi Blue (*D. caricosum*) | 20 |
| Little Para (*Urochloa mosambicensis*) | 16 |
| Guinea (*Panicum maximum*) | 13 |
| Dallis (*Paspalum dilatatum*) | 9 |

Of the 23 species sown in October 1950, five had disappeared, four lived but did not thrive, five grew well, and nine were vigorous by January of the following year. Those showing vigour were *D. caricosum, P. maximum, I. indicum, Pennisetum polystachyon, Chloris gayana, Cynodon dactylon, Eleusine indica, Themeda quadrivalvis,* and *Echinochloa colona.* Later, guinea was considered to be one of the most useful general-purpose grass species for the Intermediate and Wet climatic zones of the islands. The area under conscious cultivation and management, however, remains small, possibly due to the difficulty of obtaining sufficient viable seed and storing it adequately before use.

## CONCLUSION

Of the main grasses discussed, vegetative planting is the usual means of establishment and the stoloniferous nature of Para grass, Koronivia grass and Batiki blue grass has a strong appeal to farmers with few items of cultivation and planting equipment. Establishment by hand on unploughable hill country is also made easier by the use of such species. This emphasis on vegetative propagation is also a factor contributing to the paucity of information obtained on the more common tropical grasses of bunch habit and commonly propagated by seed.

From the results quoted it is apparent that potentially there is considerable room for improvement of Fijian pastures, not only by the testing and spreading of more vigorous species, but also by either the judicious use of applied nitrogen, or particularly in rugged country, the successful establishment and maintenance of legumes to assist in supplying this element.

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