NIGHT MEETING OF THE TROPICAL GRASSLAND SOCIETY HELD AT THE CUNNINGHAM LABORATORY, ST. LUCIA, BRISBANE ON JULY 18th, 1973

SOME PROBLEMS OF ESTABLISHMENT AND MANAGEMENT OF LEGUME-BASED TROPICAL PASTURES

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INTRODUCTION

In some tropical countries where population pressure is high and labour is cheap, pastures tend towards highly intensive systems such as heavily fertilized elephant grass (*Pennisetum purpureum*) which is cut and carried to the animals. These systems undoubtedly have a place where land is at a premium and a market exists for relatively high priced animal products, in Hong Kong for example.

On the other hand there are vast areas in the tropics, such as the llanos of Colombia and Venezuela, which are suited to extensive systems using legume based pastures. I believe that it is to these areas we must look for any substantial increase in world beef production at a reasonable price. My remarks will therefore be confined to the problems of establishing and managing *legume based* pastures in the tropics.

ESTABLISHMENT

No cultivation

Under favourable circumstances it is possible to establish tropical legumes and grasses by broadcasting seed and fertilizer into open grass swards after burning. This has been done successfully in northern N.S.W. in blady grass (*Imperata cylindrica*) and kangaroo grass (*Themeda australis*). It can also be done in mission grass (*Pennisetum polystachon*) in Fiji.

Clearing

In general, large bulldozers are more economical than small ones, provided the area to be cleared is large enough to justify the cost of transporting large machines. Two or three smaller machines working in unison are particularly effective in steep country. Smaller units are more maneouverable in tight corners and if one gets stuck the others can help to extricate it.

The same argument applies to dam building. Large machines are usually more economical but two smaller machines are safer in wet situations. To minimise the risk of siltation, dam construction is best left until after the pasture is well established. If possible, the by-wash should be constructed first and given time to completely grass over before the wall is built.

Minimum cultivation

Sod seeding and other partial cultivation techniques can be used successfully in open grass swards with some legume species such as siratro and centro. These methods are not recommended in grasses such as carpet grass (*Axonopus affinis*) which form tight swards.

Full cultivation

In steep country cultivation should aim at: (a) elimination of all species which will compete with the sown pasture and (b) breaking up the surface sufficiently to facilitate entry of seed and moisture. Erosion will be minimised if the surface is left as rough as possible. This also allows surface sown seed to be washed down into

crevices where the soil is damp and the germinating seed will be protected from direct sunlight. Heavy tandem disc harrows can be operated in quite steep country. This can be done by starting down a gully as close as possible to the creek bed, turning around the toe of the ridge and coming up the edge of the creek bed on the other side. By repeating this, each ridge can be cut out with the tractor working on firm ground all the time.

Chisel plowing should be done on the contour as far as possible but on country which is too steep for discs the only alternative is to rip straight down the slope. If this must be done it should be done early in the season and sown immediately to try and obtain a good cover before the heavy rains commence. If erosion does occur the viney legumes such as Siratro (*Macroptilium atropurpureum*) and desmodium (*Desmodium intortum*) do an excellent job of repairing the damage.

WEEDS

The viney tropical legumes will smother most weeds if they are allowed to. The main exceptions are woody species such as wild tobacco, lantana and eucalyptus suckers. These usually have to be butt sprayed or cut and swabbed with hormone. To enable legumes to control weeds they must be given time to climb up the weeds, weigh them down and grow over them. Trampling by cattle or rolling will assist. If cattle are used, grazing must be carefully controlled to ensure that the legumes are not eaten back too far, otherwise they will be slow to recover and the weeds may get away again. The legume can only win so long as it is allowed to cut off light to the weeds.

SEEDING

It is frequently recommended that sowing of tropical pastures should be delayed until good follow up rains are assured and that seed should then be drilled into a moist, well prepared seed bed. For the past eight years we have been doing just the opposite, with good results. The seed bed is left as rough as possible, consistent with eliminating competing species. As soon as plowing is finished pelleted seed is aerially sown, or broadcast with ground equipment, on to the dry seedbed. It is important to do this before heavy rain falls, otherwise a surface crust may form and the seed cannot be washed in. The pelleting material helps to maintain good contact between the soil and any seed which remains on the surface. Operations are timed to complete sowing during October for preference, but no later than November. Spring storms germinate the seed and a good ground cover is usually established by the end of December.

Later sowings may have seedlings burnt off by very hot weather in December/January, suffer from erosion during the wet months of February/March, or be insufficiently established when cold weather checks growth in May. Although the spring rains are unreliable, the risks associated with early sowing are not as great as may be thought. One area sown in the above manner in early October 1968 received no germinating rain until early December. This was followed by an exceptionally dry summer and no really soaking rain was received until April. The first grazing was deferred until August 1969 to allow the legumes to seed but during the following summer it built up into an excellent pasture.

Costs of aerial sowing range from about $2.20 to $3.30 per hectare.

Drill sowing ranges from about $7.15 to $13.20 per hectare.

SEED MIXTURES

There is still a great difference of opinion as to the relative merits of simple or complex pasture mixtures. Generally N.S.W. recommendations favour one grass plus one legume while Queensland seems to favour more complex mixtures.

Most of the coastal areas of Australia which are suited to tropical legumes are characterised by frequent changes in soil type, especially in respect to soil texture,

depth and moisture holding capacity. Legumes are more sensitive to such changes than most grasses. Hardy types such as Siratro (*M. atropurpureum*) and stylo (*Stylosanthes guyanensis*) do well on the hard, dry ridges, greenleaf desmodium (*D. intortum*) on the hillsides and glycine (*Glycine wightii*) is best along the creeks and in the more fertile soils formed on basalt. For this reason I usually include several legumes in a mixture. In time they tend to sort themselves out into colonies, with each species dominating in that part of the paddock which suits it best. A second reason for using several legumes is to try and spread the growing season over as long a period as possible to provide a continuity of high quality feed.

On the contrary, I prefer to use only one grass species usually a setaria (*Setaria anceps*) or one of the guinea grass family (*Panicum maximum*). Molasses grass (*Melinis minutiflora*) is often included as a pioneer species. It grows well on infertile soils, controls weeds without unduly suppressing the legumes, and can be eliminated by the better grass species as fertility builds up and stocking rates are increased.

Kazungula setaria has been used extensively in northern N.S.W. because of its ease of establishment but it is not really compatible with legumes. Nandi and Narok setaria are much better than Kazungula in this respect but I believe that for ease of management, persistence of the associated legume and long term productivity Gatton panic and green panic are the best grasses available at present.

I do not see any merit in including temperate legumes in tropical pasture mixtures as I believe that tropical and temperate pasture legumes require completely different management techniques. As far as possible I keep tropicals above and temperates below the frost line.

SEEDING RATES

When discussing seeding rates at a Field Meeting of the Tropical Grassland Society, held at Mudgeeraba in April 1968, I gave the following reasons for decreasing the amount of grass seed and increasing the legume seed in pasture mixtures: "Firstly, legume dominance has been aimed at in the early stages of development to try and build up soil nitrogen and organic matter as quickly as possible; secondly, the grasses thicken up quickly from their own seed, so costs can be reduced by keeping initial seeding rates at a low level; thirdly, the legumes suffer less competition from the grasses and are able to establish more quickly." (Roberts 1968).

TABLE 1

Seeding rates used with two successful sowings.

Species	"Lochburn" North Tumbulgum	"Oakwood" Upper Kandanga
	Kg/ha	Kg/ha
Siratro	1.1	.55
Greenleaf Desmodium	1.1	.28
Tinaroo Glycine	3.3	1.1
Cooper Glycine	3.3	1.1
Endeavour Stylo	1.1	
Louisiana Clover		.28
Ladino Clover		.28
Molasses Grass	1.1	
Green Panic	2.2	3.3
Gatton Panic		.55
Nandi Setaria		.2
Total Legume Seed	9	3.59
Total Grass Seed	3	4.13
Cost of Seed:	$27.67	$15.57
+ Aerial Sowing:	3.38	
	$31.05 per ha.	

Table 1 shows the rates of seed used recently at "Lochburn" near Murwillumbah, N.S.W. compared with a mixture used at "Oakwood", Upper Kandanga (Tropical Grassland Newsletter, June 1973). The amount of grass seed in each is approximately the same but at "Lochburn" about three times more legume seed was used than at "Oakwood". This almost doubled the cost of seed per hectare but this still only represents about 14% of the total development cost of approximately $200 per hectare.

FERTILIZATION

We are extremely fortunate that fertilizer requirements for establishment and maintenance of legume based pastures are well known and the principal materials, single superphosphate and molybdenum, are readily available at reasonable prices.

Despite conclusive evidence that application of nitrogen fertilizer is harmful to legume-based tropical pastures (Jones 1970 & 1971) some people are still advocating this practice. Nitrogen fertilizer is obviously necessary for pure grass pastures but if it is going to be used on legume-based pastures there does not seem to be much point in including a legume in the first place.

Under any system of grazing most tropical legumes are at a competitive disadvantage compared with the grasses. This is mainly due to their slower growth rate and the fact that grasses tolerate defoliation much better than the legumes.

To achieve a stable balance between grass and legume, management practices should be designed to favour the legume wherever possible. Any practice, such as nitrogen fertilization, which increases the competitive advantage of the grass must reduce the legume component and thereby reduce the long term productivity of the pasture.

MANAGEMENT

At the Mudgeeraba Field Meeting in 1968, referred to earlier, I outlined the stocking policy on "Tallai" as follows:—

"The project was originally planned on the assumption that the improved areas would carry a beast to two acres (.8 ha.) Present carrying capacity, *on a year round basis,* is estimated at about a beast to an acre and a half (.6 ha) or a little better. It is important to realise that full production from these pastures cannot be expected in the first year or two and anybody who stocks them too heavily, too soon, may do irreparable damage."

During the discussion on pasture management which followed, Mr. John Redrup, who was at that time developing a property nearby, stated: "If you manage to get your pastures in by mid-January you have to be stocking at the rate of up to a beast to 1½ acres (.6 ha) in January, February, March and you can carry through the winter on that early pasture quite well at about that rate. Come mid-November you should be putting your cattle on particular country very much more heavily, particularly the lower country which gets away very rapidly."

This wide divergence of views on how and when to graze tropical-based pastures still exists and very little factual evidence is available on which to base management decisions. Studies by Jones (1971) and Bryan and Evans (1973) have shown a reduction in the tropical legume component of pastures grazed at high stocking rates.

Most of the development with which I have been associated has been done in hill country where it would be extremely difficult to reintroduce the legume component of the pasture if it was eliminated. For this reason seeding rates are selected which will give legume dominance early in the life of the pasture and stocking rates are adjusted to try and maintain this indefinitely.

At "Lochburn" near Murwillumbah a policy of continuous stocking has been in effect ever since development commenced five years ago. Stocking rates have been about one beast per hectare in the establishment year of a pasture, increasing to about one beast to .6 ha in the third year.

Although total cattle numbers do not vary greatly throughout the year, the number of animals in any one paddock may change from time to time (mainly for purposes of cattle management rather than pasture management) but as far as possible some animals are kept in every paddock throughout the growing season.

Under this system it is found that while the grass is growing actively cattle clip the tops off it, promoting new palatable grass growth and allowing the legumes to build up a bulk of feed for later use.

MAINTAINING THE BALANCE

Legume dominance can be maintained quite easily if the pasture is never grazed too short but this is not always possible, particularly towards the end of winter and early spring. When growth recommences the grass grows more quickly than the legume and delays its recovery.

I believe that the quickest way to restore the balance is to leave some stock on the pasture instead of removing them altogether. Whilst the grass is young and growing quickly it appears to be more palatable than the legume. The cattle graze it preferentially and allow the legume to recover with the minimum of competition from the grass. The aim is to adjust stocking rates so that most of the grass but very little legume is eaten.

If the pasture has been correctly managed during the winter the ground should be covered with uneaten legume runners. This gives the maximum number of growing points and enables the legume to recover much more quickly than it would if eaten right back to the crowns of the plants.

CONTINUOUS V ROTATIONAL GRAZING

No doubt the argument regarding the relative merits of continuous and rotational grazing systems will go on for a long time to come.

Jones (1971) found that "the variable of cutting interval had the most dominating influence on total legume and total pasture yield". He later states: "It is reasonable to conclude that rapid rotational grazing would result in lower legume yields than a slow rotational system in which the recovery time was eight weeks or longer. Shorter

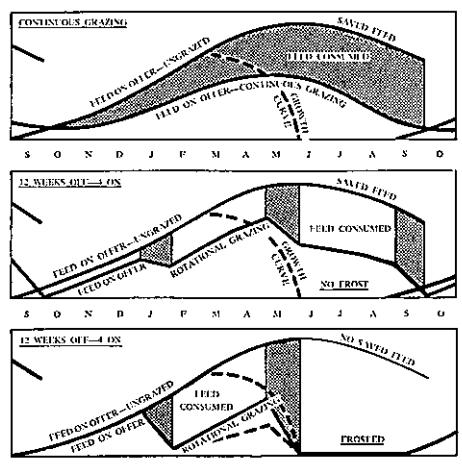

FIGURE 1

A diagrammatic representation of the effects of continuous and rotational grazing upon the utilisation of tropical pasture.

rotations would result in higher stocking pressures, associated with lower yields, and hence a further adverse influence on the tropical legume. The use of continuous grazing, provided the stocking rate was not too high, would enable the legume to increase in summer when stocking pressure was low and under these conditions the legume would not receive the sudden and drastic reduction in leaf area and in numbers of growing points experienced under cutting or close rotational grazing". This is illustrated in Figure 1.

Experience at "Lochburn" over the past five years supports this conclusion. Some of the factors which influence the stability of a grass/legume mixture are:

(a) Relative growth rates of grass and legume
(b) Maximum height of grass
(c) Shade tolerance of the legume
(d) Relative palatability of grass and legume
(e) Seedling regeneration
(f) Ability to withstand trampling.

I believe that continuous grazing helps the legume to compete with the grass under each of these headings better than it could under a rotational grazing system.

GRAZING HEIGHT AND TRAMPLING

Under continuous stocking at one beast to .6 ha there is a big body of feed on the paddocks during late summer and autumn but losses from trampling are not as great as might be expected. The cattle establish tracks across the face of the slope at intervals of about 1.5 m. This enables them to graze the pasture between the tracks without trampling it down. This gives rise to a characteristic "lumpy" look.

A few cattle are usually left in a paddock to keep the tracks open. If at any time a paddock has to be locked-up, e.g. to allow the legume to set seed, it is advisable to let a few cattle in first to re-establish the tracks. If a large mob is admitted to a paddock of very tall feed they will waste a lot by trampling. This frequently leads to disappointment at the amount of feed which cattle obtain from a paddock of autumn-saved tropical pasture.

RENOVATION

Renovation is a practice which, as far as I know, has not been widely recommended or adopted for tropical pastures. I believe that if grass is becoming dominant the balance may be restored by allowing the legumes to set seed and then renovating the pasture in spring, after fertilizing. This should bring up a good crop of new seedlings. Management should then be as for a newly sown pasture, with the aim being to restore legume dominance as quickly as possible.

PURE STAND OF LEGUMES

The value of a pure stand of a high producing grass, well fertilized with nitrogen, for filling in gaps in the "feed-year" is well recognized. I think that on many farms there are areas of frost-free country which could be used for pure stands of legumes to provide a protein rich supplement in winter. Steep areas which are at present underutilized would be quite suitable for this purpose if aerial spreading of super is available.

WEED CONTROL

Weeds can be a problem in old cultivation paddocks or in areas which have been consistently overgrazed and/or burnt for many years. The methods of weed control usually recommended are either spraying with hormone chemicals or mowing. Neither of these methods is likely to harm the grass component of a grass/legume pasture but care must be taken or permanent damage may be done to the legume component.

If chemical methods are employed, spot spraying or "cutting-and-swabbing" with 2,4-D or 2,4,5-T do very little damage to most pasture legumes once they are well established, especially stylo and desmodium. Siratro is most susceptible to hormone damage. Blanket sprays of hormones, particularly Tordon, will eliminate most legumes from the pasture.

It is frequently recommended that pastures should be slashed after grazing at about nine inches to a foot above ground level. Unfortunately rotary slashers do not work well at this height, with the result that the operator usually lowers the slasher and in so doing damages the legumes. Slashing should only be done at the end of winter, when the pasture is short and before spring regrowth has commenced. At other times good control of most weeds can be obtained by managing the pasture in such a way as to allow the legumes to smother the weeds, as described earlier in the section on establishment.

INFORMATION NEEDED ON WHICH TO BASE MANAGEMENT DECISIONS

The management methods which I have described, and some of the establishment methods also, have been evolved by trial and error because in most cases there is very little research data on which decisions can be based. I am referring particularly to research into aspects such as compatability of various combinations of grasses and legumes and the yield and persistence of these mixtures under various systems of management.

For such research to have the greatest possible practical application it is essential that the results should be expressed in a form which enables the nett cash return per hectare to be readily calculated. For instance, liveweight gains per hectare can obviously be most misleading unless some indication of carcase quality is also given. Liveweight gains per head help in this respect but the majority of people who want to make use of this information need a more direct indication of quality than this.

In emphasising the need for economic assessment of results I would suggest that we are not simply dealing with a soil-plant-animal system. There is a fourth element required to complete the cycle—the banker. To make the system work he must be convinced that there will be a reasonable return on capital invested.

Research into pasture management systems is a slow and costly business. Before it is undertaken it should be quite certain that: firstly the lessons learnt from it can be passed on to the grazier in a form which he understands, and secondly, that he will accept the findings as valid and adopt them in practice.

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