# proceedings

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*The Tropical Grassland Society of Australia*
*Vol. 14, No. 2, 1980*

# PERSISTENCE OF COMMERCIAL TROPICAL PASTURES IN THE TWEED RIVER VALLEY AREA

## FIELD MEETING, MAY 2, 1980

The first field day meeting for 1980 was held on May 2, 1980 on the property "Lochburn" of Messrs C. K. Roberts and C. S. Coleman, North Tumbulgum. The theme "Persistence of commercial tropical pastures in the Tweed River Valley" was aimed at demonstrating a viable beef cattle enterprise based on tropical pastures in the hill country surrounding the Tweed River Valley, Northern New South Wales. Members and visitors were able to inspect tropical pastures 8 to 12 years of age. Persistence and management of the legume component was emphasised as the key note of the day.

## THE ENVIRONMENT AND PROPERTY

"Lochburn" is a cattle fattening farm of 270 ha with 150 ha sown and 66 ha native pastures. The remaining area is occupied by other enterprises or is uncleared.

The tropical pasture areas were established on newly cleared land during the period 1968-1972 by sowing with varying mixtures of legumes (Siratro, greenleaf desmodium, Miles lotononis, Cooper and Tinaroo Glycine, Archer axillaris and Endeavour stylo) and grasses (molasses, setaria, Gatton and green panic) into a roughly prepared seedbed in spring (September-October) with 400 kg $ha^{-1}$ molybdenised superphosphate. Maintenance fertilizer as superphosphate at 200 kg $ha^{-1}$ was applied every 2 years until 1975 and every second year thereafter. No other fertilizers have been used. Legume seeds were inoculated with appropriate strains of *Rhizobium* to ensure good establishment and growth.

The average annual rainfall is 1800 mm (60% summer, 40% winter) but with a very variable distribution. Temperatures range from 30 to 18°C in summer and from 18 to 6° C in winter. The upper slopes are frost free and elevation is around 200 to 250 metres. The main soil type is a red-yellow podzolic of low fertility derived from sandstones, shales and greywackes of paleozoic origin. The two highest hills are capped by krasnozem soil derived from basalt. Topographically the property is dissected by steep-sided ridges and valleys which force cattle to graze and move to watering points "on the contour".

# GRAZING MANAGEMENT AT "LOCHBURN"

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A system of variable but continuous grazing is used at "Lochburn" which integrates the use of tall tropical pastures with shorter natural pastures. The ratio of tall tropical pastures to natural pasture is about 3 to 1. Their grazing management is different but complimentary.

The normal practice is to increase stocking rate on the sown pastures in spring, when grass growth is rapid and faster than that of the legume, thus keeping the grass in check at about 30 cm. Then from October, when the legume starts active growth, the pasture is grazed at a stocking rate that allows it to attain a height of 60–70 cm and the legume to become the dominant component. This provides a bulk of forage that will permit the cattle to be fattened over the winter period.

The basis of the cattle management strategies used has been for a quick turnover of stock at intervals of approximately six months. This facilitates the introduction of store cattle on to native pastures in winter and then in spring to the higher country with tall tropical pastures to utilize the flush of spring growth from the grass component. This keeps the grass in check and allows the legume component to dominate and provide forage at a time when grazing cattle prefer legume growth to seed heads of maturing grasses. In this way the native pasture is kept short enough to encourage growth of clover in winter and controlled grazing allows tropical legumes to build up a bulk of feed for winter use.

The sown tropical legumes at "Lochburn" include, Siratro, Greenleaf desmodium, Miles lotononis, Archer axillaris, Tinaroo and Cooper glycine and small areas of Safari and white clovers. All species have special roles in this system. The Greenleaf dominant sections, especially on the more fertile basalt cap areas, are used as "finishing" pastures and glycine dominates in cattle camp areas and in the inaccessible gullies. Lotononis is only important on the old low fertility banana areas and Siratro can be found in all areas. The lotononis and axillaris provide early spring forage, whereas Siratro is best during hot humid summer. Glycine and desmodium growth in autumn provides the bulk of the carryover feed for winter. Hay and supplements are not provided at any stage as the above legumes, with green panic and setaria, are able to provide year round feed and so spread production more evenly over the year.

## PERSISTENCE OF GREENLEAF DESMODIUM IN ESTABLISHED PASTURES

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On a worldwide basis, Greenleaf desmodium has performed best in areas of the elevated tropics or in the subtropics which receive a minimum of 1000–1500 mm annual rainfall, depending on distribution. The essential management requirement, as discussed in Mr. Roberts' contribution, is to avoid overgrazing. However, even in apparently well managed pastures in suitable areas there have been problems with persistence. As a preliminary step towards understanding persistence of Greenleaf, we sampled four good Greenleaf pastures, from 7 to 15 years old in two areas with 1600 mm rainfall, to describe the intensity of stolon rooting and soil seed reserves. The pastures were all sampled in spring (October) 1979, when the intensity of root development would presumably be at a minimum after winter, and following two years of below average rainfall.

Results from the four sites were similar (Table 1), though there were relatively more smaller stolons (1–4 mm diameter) at Beerwah than "Lochburn". Of those roots > 1 mm, most (74–91%) were between 1 and 4 mm and none > 10 mm.

TABLE 1

*Population attributes per square metre of Greenleaf desmodium in old pastures at four sites.*

| Site | Rooted stolons | | Points of rooting | No. of roots > 1 mm | Soil seed numbers |
|---|---|---|---|---|---|
| | length (m) | OD Weight (g) | | | |
| Beerwah-wet | 37 | 151 | 720 | 313 | 4810 |
| Beerwah-dry | 23 | 144 | 670 | 280 | 410 |
| Lochburn sandstone | 19 | 158 | 531 | 296 | 6110 |
| Lochburn basalt | 15 | 95 | 317 | 203 | 1700 |

The main finding was that large (> 10 mm) roots are rare in old pastures. This may have been due to the stoloniferous origin of these roots and to the fact that large roots are frequently damaged by insect larvae. Consequently, with fewer larger and presumably deeper roots than in the early years after sowing, when primary taproots can exceed 2 cm diameter, older pastures may be more susceptible to moisture stress. There were no small taproots similar to those developing in new sowings, suggesting that seedling regeneration was of very little recent consequence. If this is so, good management for persistence involves encouraging a reasonable density of stolons with rooted points.

Reserves of seed, however, were high and with pastures now less dense than usual, there may be opportunity for the weak Greenleaf seedlings to escape smothering, which would be the likely fate in vigorous pastures. Sixty-nine per cent of recovered seed germinated after 21 days, and 95% after scarification of hard seed. After rain in December 1979, there were approximately 30 seedlings $m^{-2}$ in "Lochburn" pastures but none survived to April 1980. Most of this death is attributed to dry conditions.

There is no doubt that Greenleaf desmodium can give very good pasture and animal production. However long term persistence is suspect in many, but not all, apparently suitable areas. Further research on persistence of Greenleaf seedlings, plants and stolons in grazed pasture is required to elucidate more clearly the problems of long term persistence.

## PASTURE LEGUME PERFORMANCE AT DIFFERENT LEVELS OF FERTILITY

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Evidence is accumulating that pasture legumes suited to sub-tropical conditions have different nutrient requirements. Recent research with maintenance fertilizers indicates that nutrient differences between species are sufficiently large to warrant consideration when developing fertlizer programmes for established pastures. They may also influence which legumes dominate in mixed pastures initially sown with a variety of species.

*Phosphorus*

Critical levels of bicarbonate-extractable P have been determined for Siratro, Greenleaf desmodium and white clover components of grass-legume pastures grown under south-eastern Queensland conditions. The values in Table 1 indicate that yield responses are likely to occur at different levels of soil P fertility.

TABLE 1

*Critical levels of bicarbonate-extractable phosphorus for three established pasture legumes growing in association with grasses (0-10cm depth sample).*

| Legume | Critical levels (ppm P) | |
|---|---|---|
| | Response likely | Response unlikely |
| Siratro | $<10$ | $>14$ |
| Greenleaf | $<22$ | $>29$ |
| White clover | $<28$ | $>30$ |

Further, at the upper level of likely response (10, 22 and 28 ppm P for Siratro, Greenleaf and white clover, respectively) legume yields around 70% of maximum can be expected on most soils without topdressed P (provided moisture is adequate and no other nutrients are deficient). Below these critical levels, yields of these species can be expected to vary with changes in fertility, as can the magnitude of responses to various rates of topdressed P (Table 2).

TABLE 2

*Expected yields† of three established legumes at three rates of topdressed P and three levels of bicarbonate-extractable P.*

| P rate (kg $ha^{-1}$) | Species | Soil bicarbonate-extractable P status (ppm P in 0-10 cm depth samples) | | |
|---|---|---|---|---|
| | | 5 | 15 | 25 |
| | | Expected yield (% of maximum) | | |
| Nil | Siratro | 50 | 80 | max. |
| | Greenleaf desmodium | 20 | 60 | 75 |
| | White clover | 5 | 50 | 70 |
| 10 | Siratro | 75 | 85 | max. |
| | Greenleaf desmodium | 60 | 70 | 80 |
| | White clover | 40 | 65 | 75 |
| 20 | Siratro | 80 | 90 | max. |
| | Greenleaf desmodium | 70 | 75 | 80 |
| | White clover | 60 | 75 | 85 |

† for south-east Queensland conditions.

Bicarbonate extractable P at 4 sites at "Lochburn" indicated that only one of four sites tested was likely to respond to further applications of phosphorus.

*Other nutrients*

When P is adequately supplied (naturally or through fertilizer applications) other nutrients are likely to influence legume performance. At "Lochburn", Mo supply probably warrants greatest attention.

While there is no convenient test to directly estimate Mo availability, it is known that glycine and Greenleaf are more likely to be adversely affected by Mo deficiency than are Siratro and lotononis. Consequently, if Siratro or lotononis achieve a position of dominance in a pasture at the expense of glycine or Greenleaf (and P is well supplied), Mo deficiency could be responsible. If so, this trend could be reversed by more frequent and/or higher rates of Mo application.

## NEED FOR INOCULATION OF LEGUMES AT "LOCHBURN"

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Experiments established at the same time as "Lochburn" pastures in 1970 were aimed at evaluating the response of the legumes, used in the "Lochburn" programme, to inoculation with selected strains of *Rhizobium*.

Siratro, axillaris and glycine did not respond to inoculation. Yields of dry matter from inoculated and uninoculated plots of pure legume were not significantly different, and fewer than 3% of nodules were due to the inoculum strain. For Greenleaf desmodium, most nodules were formed by the inoculum strain in the establishment year. Uninoculated controls were nodulated but growth was negligible compared to that obtained from the inoculated treatment. However, by the end of the third season dry matter yield from the uninoculated plots equalled that for the inoculated. This improvement is the result of an increase in number of effective nitrogen fixing strains of *Rhizobium* from the native strain population, that were too few in number in the establishment year to make a measurable contribution. In the inoculated treatments these indigenous strains of *Rhizobium* competed with the inoculum strain for nodule forming sites on the hosts' roots, so that by the end of the third year the inoculum strain accounted for only 31% of nodules and had declined to only 5% after five years.

Miles lotononis and Safari clover responded markedly to inoculation. For these legumes there are no native *Rhizobium* present and inoculation with suitable *Rhizobium* inoculant is essential. These strains accounted for all nodules formed even after five years.

Despite the lack of response to inoculation with some species it is recommended that all legume seed be inoculated with appropriate strains of *Rhizobium* at sowing to ensure a good early establishment of legume seedlings. Cost is small and it ensures against failure if indigenous rhizobia are sparse or absent.

## IMPROVING FEED QUALITY WITH LEGUMES

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The humid subtropics of northern New South Wales is characterised by high summer-autumn rainfall, a potential for abundant feed production from improved pasture, and scope for intensive cattle production. However, without improvement, progressive decline in soil fertility from early settlement has been accompanied by invasion of 90 per cent of the grazing land with degenerate carpet grass pasture which is characterised by a short growing season, low production, and poor animal performance. Degenerate pasture supports only store weaner production or steer fattening enterprises. Typical commercial production figures are a breeder area of 2 to 2.5 hectares, 60–70 per cent weaning rate, and live weight gain of less than 100 kg per hectare per year. Naturally fertile (or partially improved) country typically supports a breeder area of 1 to 1.5 hectares, 85 per cent weaning, and a live weight gain of up to 150 kg per hectare per year. The major limitations to greater productivity are low nutritive quality of degenerate pasture, and paucity of winter/spring feed.

Pasture improvement based on legumes offers the greatest scope for overcoming these limitations to enable diversification into profitable fattening enterprises.

Pasture grasses differ from pasture legumes in morphology, chemical composition, and fine structure. These differences confer differences in nutritive quality, rate of digestion, intake, and feeding value. Legumes are higher in nitrogen, certain minerals and organic acids, but lower in sugars and soluble carbohydrates. Total cell wall constituent is less in legumes, as is hemi-celloluse, and the lignin content of legumes is greater yet less diffused. The composition of legume leaf remains constant with advancing maturity while leaves remain green and actively growing. By contrast, cell wall constituent of grass leaf increases with maturity with a corresponding reduction in digestibility and intake. Energy in legume regrowth is utilized with similar efficiency as primary regrowth, in contrast to grasses in which regrowth is utilized with reduced efficiency.

Degenerate carpet grass pasture (and unimproved native or naturalized pasture) is at most times deficient in protein. The critical protein level in pasture for beef production is 6.0 to 8.5 per cent crude protein yet degenerate pasture frequently falls below 4.0 per cent crude protein. With inclusion of a suitable legume, the diet of grazing cattle improves in protein and mineral status to overcome deficiencies and to stimulate appetite for increased cattle growth and performance.

# THE ECONOMICS OF DEVELOPING TALL TROPICAL LEGUME BASED PASTURES FOR BEEF CATTLE

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An examination of the economics of tall tropical legume based pasture indicates that these pastures can generate a much improved level of income over the native pastures. It also indicates the rather massive amounts of expenditure and finance required for their development.

It has been estimated that "Lochburn", in its original state, would be capable of earning a gross margin of $3,600 per annum from beef at current market conditions. The gross margin for the fully developed farm under current stocking policy and market conditions is estimated to be approximately $38,000 per annum.

Table 1 summarises the cost, at present prices, of establishing and maintaining the pasture development programme that occurred at "Lochburn". It includes the cost of buying, running and selling cattle under the current stocking policy, but does not include any overhead costs, living expenses for the farm operator, costs and returns for enterprises other than beef, principal and interest payments and personal income taxation payments.

TABLE 1

*Ten year cash flow for development of farm with tall tropical legume based pastures.*

| Year | Development and maintenance costs | Stock purchases | Total costs | Returns from stock sales | Annual deficit or surplus | Cumulative deficit or surplus |
|---|---|---|---|---|---|---|
| 1 | 19111 | 5950 | 25061 | — | —25061 | — 25061 |
| 2 | 37315 | 35000 | 72315 | 20901 | —51414 | — 76475 |
| 3 | 30763 | 85400 | 116163 | 70899 | —45264 | —121739 |
| 4 | 21524 | 136500 | 158024 | 132781 | —25243 | —146982 |
| 5 | 20117 | 182700 | 202817 | 184009 | —18808 | —165790 |
| 6 | 8142 | 231700 | 239842 | 248760 | + 8918 | —156872 |
| 7 | 8142 | 252000 | 260142 | 283185 | +23043 | —133829 |
| 8 | 8821 | 270200 | 279021 | 305726 | +26705 | —107124 |
| 9 | 8142 | 270200 | 278342 | 316382 | +38040 | — 69084 |
| 10 | 8142 | 270200 | 278342 | 316382 | +38040 | — 31044* |

* In addition, there are 386 head of stock which, valued at cost, are worth $135,100.

What the table does show is the high initial debt of establishing the pastures. The debt level then remains high for another four years while stock numbers build up on the new pastures. This happens even under the short-term steer fattening programme followed at "Lochburn", as each lot of steers is sold a larger number is bought to restock until the pastures become fully developed.

Developments such as those at "Lochburn" would seem to be restricted to farm owners who already have a substantial income which can be used to finance at least some of the programme. The costs of development give substantial reductions to personal income tax and thereby reduce the effective cost of the development.

Smaller scale development of such pastures shows the same financial characteristic. The high initial debt associated with pasture establishment remains high for three to four years while stock numbers are built up.

Financing the pasture establishment and the subsequent gradual increase in stock numbers is the key to the economic development of tall tropical legume based pastures.