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IN SEARCH OF CHEAPER PASTURES

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ABSTRACT

There is a potential for large scale pasture improvement in north-eastern Australia, particularly in the sub-tropics within close proximity to Brisbane. The impetus to widescale pasture improvement of this country will not come until we can recommend pastures well within the bounds of financial feasibility. Cheap methods of establishing a legume into native pastures would meet this requirement. A number of types of seedbeds and methods of establishment are reviewed. There is a requirement for agricultural engineers to develop more effective machinery to recover seed and more precise planting machinery to improve pasture establishment.

INTRODUCTION

The Queensland Department of Primary Industries estimates that some five million acres of land are under improved pastures, with an annual growth rate of some 250,000 acres. Whether there is agreement or not on the estimate of Davies and Eyles (1965) of some 150 million acres that are improvable in north-eastern Australia, at the annual rate and provided it is maintained and that no resowings have to be made, it will take an awfully long time to improve the pastures, be it 15 or 150 million acres.

It is patently clear that such an impasse is untenable—and something has to be done about it.

Of the five million acres sown at some time or other to introduced species, more than four million acres of this area had not been sown to legumes, were never fertilized and will, or are, degenerating. We were told at a symposium meeting of the society held in 1969 ("The tropical pasture revolution—fact or fiction?") that this revolution is a fact, but the panel of speakers put forward a number of reasons why the adoption of improved pastures is not proceeding as speedily as might be expected.

Obviously a number of the reasons put forward are quite valid. Many of these could be grouped under one heading—inadequate extension. However, to be fair to extension people, if what you are trying to sell is attractive enough, it is much easier to sell or even sells itself. Shaw W.J.D. (1969) at this symposium meeting pointed to the present weakness in our research. The 100% pastures which scientists are interested in producing are costly and mostly beyond the scope of the average primary producer. He suggested the need for new machinery and techniques to achieve high grade pastures at the lowest possible costs in terms of land preparation, seed, etc. Research and extension workers must look at this aspect of pasture development and be warned against spending more than is necessary to produce a reasonable tropical pasture.

The aim of this paper is to examine some of the possibilities of achieving this goal of cheaper pastures. Obviously, this is a very broad and involved subject which to do it justice would require more time than that at my disposal. I am going to concentrate on the need for and the type of pasture improvement that could have widescale

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application in the sub-tropics and highlight sowing methods and techniques which could help bring this to fruition.

THE VALUE AND POTENTIAL OF IMPROVED PASTURES

It could be argued that we have nothing cheaper than native pasture. That point is not disputed; however we must assume that to achieve a greater efficiency in cattle production we have either to upgrade the native pasture or replace it. Efficiency does not necessarily imply either maximum production per head or per acre, but rather the most profitable use of physical and financial resources.

There are a number of references to indicate the value of improved pastures in at least certain areas of the region of concern. Pasture improvement based on townsville stylo (*Stylosanthes humilis*) is the classic example of what may be done in northern Australia, and even in such undertakings costs must be kept well within possible returns.

Shaw, N. H., and 't Mannetje (1970) found in central coastal Queensland that both the introduction of townsville stylo and the application of molybdenised superphosphate increased beef production from spear grass (*Heteropogon contortus*) dominant native pasture. Single treatments increased weight gain per head and enabled increased stocking rates. The biggest effect on both parameters was when the two treatments were combined. Heavier stocking of untreated native pasture severely reduced weight gain per head, and resulted in severe overgrazing and deleterious changes in botanical composition.

Shaw, W. J. D. (1969) highlighted the feasibility of sowing townsville stylo either aerially or from the ground at a cost as low as $1.30 per acre. This could be done within the 30 in. rainfall belt of central Queensland. This could result in the land eventually improving to 1 beast to 3 acres on the better soils on a property where the carrying capacity is now 1 beast to 9 acres. By using superphosphate carrying capacity could be further increased to 1 beast to 2 acres. Shaw, W. J. D. (1969) pointed out that on a whole property scale this type of development is costly, but the dividends can be as high as 25% on the investment. One of the usual results is a reduction of running costs per animal unit due to greater concentration of effort and stock.

As yet townsville stylo has not shown the same potential in southern Queensland as further north. In the high rainfall (40-70 in.) southern coastal belt a range of legumes have proved their worth, when correctly established and managed. What about the large belt of 30-40 in. rainfall country, including the southern spear grass and some brigalow? Just on the doorstep of Brisbane we have literally millions of acres of unimproved native grasslands. This semi-cleared open forest country includes the Fassifern Valley, the Lockyer and Brisbane Valleys, the country around Kilcoy, and further north, country west of the Mary river.

In this environment native pastures are reasonably productive up to mid-summer, but feed is of either limited quantity or quality at other times of the year. Tropical pastures provide a longer period of quality feed than do native pastures, but the cost and reliability of establishing these make them unattractive to graziers, except for special purposes or for high priced commodities.

With intensive pasture development of such open forest, legume establishment is usually much more reliable and superior to grass establishment. Even in pastures where grass establishment is fair, the lack of soil nitrogen, and the slow release of nitrogen from legumes results in rapid deterioration of these grass stands.

All available evidence suggests that a considerable improvement in productivity may be achieved merely by over-sowing the native pasture with a suitable legume of which *Phaseolus atropurpureus* cv. Siratro could be one.

Work at Narayen on a granitic soil by 't Mannetje (1971) has demonstrated the value of legumes for beef production. These include lucerne (*Medicago sativa*), Siratro and townsville stylo. However on the heavy clay soils of the brigalow lands lucerne is currently the only perennial legume which has proved of practical value (Division of Tropical Pastures Annual Report 1970/71). Of more promise is the report by Russell (1971) of Siratro persisting on solodic soils in areas where it was established up to seven years previously. This is particularly the case where subsoil disturbance enables deep root penetration. Russell estimated there to be some 15 million acres (six million hectares) of solodic soils south of the tropic, much of this interspersed with clay soils of the brigalow lands.

Shaw, N. H., (1970) reported that despite a marked reduction in the density and vigour of Siratro as a result of drought, lighter grazing pressure and better seasons enabled the surviving Siratro plants to regain full vigour. Regeneration from self-sown seed produced a density greater than the original.

Hutton (1971) has recently reported that a group of newly bred lines of *Phaseolus atropurpureus*, some of which have persisted at Narayen, represent a decided advance on Siratro for a number of important characters. These include period of growth, dry matter yield, seed yield and resistance to *Rhizoctonia solani*. Should these characters be confirmed under field conditions in mixed swards, the amplitude of Siratro, already wide, would be considerably extended.

Although Siratro, *Stylosanthes guyanensis* cv. Oxley (fine stem stylo), *Dolichos axillaris* cv. Archer, *Lotononis bainesii* cv. Miles and others have been inadequately tested in low cost situations, early results are highly promising. The challenge is clearly to incorporate suitable legumes into our native pastures as cheaply as possible.

LOW COST PASTURES

In areas below 40 in. average annual rainfall, intensive pasture improvement which requires a well cultivated seedbed, application of fertilizers and sowing of a grass-legume mixture is unrealistic, except in restricted circumstances such as grazing stud cattle or for high price market milk. With commercial beef and butter fat production in the drier areas the increased productivity from improved pasture will not warrant the spending of $30 or more per acre. Unless we reassess our traditional concept of a high cost improved pasture over all land, large areas of potentially improvable land will continue to remain undeveloped.

The New South Wales Department of Agriculture research group based at Grafton has given a lead on the aspects of low cost legume introduction. This includes the development of special sowing machinery such as the roto-seeder to more effectively sow legumes such as Siratro and Miles lotononis. While there are climatic, soil and species differences which may preclude direct application of this group's findings to southern Queensland, nevertheless the principles are the same.

In the Brisbane Valley the prospects for upgrading the native pastures by means of legume oversowing and fertilization could be economically more attractive than coastal lowland development. If cheap methods of oversowing legumes are proved feasible costs could be kept at a relatively low level compared with the coast where the replacement of timber vegetation is costly.

CHEAPER PASTURES

While my remarks have tended to concentrate on areas with 30-40 in. average annual rainfall where intensive pasture improvement is generally unacceptable, there is still much scope for reducing pasture costs in the high rainfall areas. For instance coastal areas supporting good stands of grass, particularly better grasses such as kikuyu, may be improved by oversowing legumes. Ostrowski (personal communication) has reported that many farmers in steep elevated areas close to Brisbane have improved the carrying capacity and milk production of their run-down kikuyu (*Pennisetum clandestinum*), paspalum (*Paspalum dilatatum*), mat grass (*Axonopus* *affinis*) and white clover (*Trifolium repens*) pastures by the aerial application of heavy rates of Mo superphosphate and in many instances also seeding with while clover, plus annual maintenance dressings of straight superphosphate. Methods cheaper than a cultivated seedbed may be available on the coast, such as sowing pasture species at the stick-raking stage, early grazing and later treatment of timber regrowth with chemicals. Economies in the use of fertilizer and particularly seed apply in any situation. The productive life of a pasture markedly influences the cost of a pasture. Thus maintenance can be just as critical as establishment. Management to get the best out of pastures is obviously important in all situations.

Let us examine some of the choices we have which ultimately affect our expenditure on and return from improved pasture.

(a) *Adapted Species*

We should choose pasture grasses and legumes which are adapted to the situation and method of use for which they are intended. With care species can persist for many years, but we know only too well how a radical change in environmental conditions e.g. drought or flood) or a sudden change in grazing management (e.g. a markedly increased grazing pressure) can result in rapid pasture deterioration. We need to get to know our pasture species better to be in a much better position to extract the most value from them. Species which spread readily from seed or by stolons may, if managed to take advantage of these attributes, fit well into a system of cheaper pasture establishment and maintenance.

If we are to rely on seeding for thickening up or spread, the plant must be able to seed before winter. Moreover the species must be hardy and preferably still seed under open grazing and exhibit an ability to successfully extract moisture and ideally nutrients where these may be in short supply.

(b) *Reliability, Efficiency and Cheapness of Establishment*

Wastage of seed, fertilizer, time and effort in pasture sowing must be minimised. Establishment success reflects the soil moisture, soil temperature and competition both between sown species and from other vegetation. Plant nutrition, seeding rates and predators all have a bearing on establishment.

Because of higher rainfall at more frequent intervals, pasture establishment is generally more reliable on the coast.

(i) *Some Alternative Methods of Establishment*

Under high rainfall competition from existing vegetation may be high. But even so cultivated seedbeds are not always essential, at least for some species, as illustrated by the following two examples from experiments I have conducted.

TABLE 1

Comparison of Siratro and Tinaroo under three methods of establishment
Oven dried yield (lb/ac.)—Total of 3 harvests

	Prepared seedbed			*Grass partly killed with 5 lb dalapon			Alternate strips rotavated and sown		
	Legume	Grass	Weed	Legume	Grass	Weed	Legume	Grass	Weed
Siratro	3246	4868	1589	2996	8309	1066	2374	11398	845
Tinaroo	5342	2969	2036	3149	7726	645	769	7143	519
L.S.D. P = 0.05	1529	3304	1541						
P = 0.01	2114	4568	2131						

* Grass was mainly mat grass (*Axonopus affinis*) and *Paspalum dilatatum*.

In an experiment planted at Cooran (55 in. annual rainfall), south-east Queensland, in February, 1963 in a typical coastal latosolic soil derived from phyllite, Siratro and *Glycine wightii* cv. Tinaroo were compared under three different seedbed conditions. Total yields for three cuts are summarized in Table 1.

Tinaroo significantly outyielded Siratro under prepared seedbed conditions and the reverse occurred with the rotavated strip. In contrast to Tinaroo, Siratro was insensitive to establishment conditions. Grasses were mainly inferior naturalized varieties and their yield tended to be inversely proportional to legume yield.

Counts in April of the establishment year indicated that legume density on a prepared seedbed was higher than that with dalapon which was higher than the rotavated treatment. Despite a seeding rate of 2 lb/acre for Siratro and 3 lb for Tinaroo, Siratro establishment was superior to Tinaroo. This was not evident under prepared seedbed conditions where there was no significant difference between the legumes.

Dense sward forming grasses such as kikuyu provide intense competition to an introduced legume. In February, 1966 on a krasnozem soil at Maleny (80 in. annual rainfall) four legumes were planted by drill sowing into a cultivated seedbed, and by drill sowing into a kikuyu pasture sprayed with 8 lb dalapon/acre. Total yields for the duration of the experiment are shown in Table 2.

TABLE 2

Comparison of four legumes under two methods of establishment
Oven dried yield (lb/ac.)—Total of 5 harvests 1966-1968

	Legume	Kikuyu	Legume and Kikuyu	Weed
Desmodium uncinatum cv. Greenleaf (2 lb/ac)				
(cultivated seedbed)	4654	7079	11733	896
(dalapon prepared seedbed)	5217	6788	12006	1631
Desmodium intortum cv. Silverleaf (1 lb/ac)				
(cultivated seedbed)	7165	5732	12897	1236
(dalapon prepared seedbed)	5458	5965	11423	1848
Glycine wightii cv. Clarence (4 lb/ac)				
(cultivated seedbed)	3618	6269	9887	582
(dalapon prepared seedbed)	3078	7452	10531	2051
Glycine wightii cv. Tinaroo (4 lb/ac)				
(cultivated seedbed)	4142	6794	10936	616
(dalapon prepared seedbed)	3029	6622	9651	1643
L.S.D. P = 0.05	1848	2641	2453	879
P = 0.01	2516	3596	3339	1197

Although sown at only 1 lb/acre *Desmodium intortum* cv. Greenleaf was the outstanding legume, particularly under cultivated seedbed conditions. However among the dalapon seedbeds the larger seeded *Desmodium uncinatum* cv. Silverleaf was equal to it in yield. Overall both legume and kikuyu yields were unaffected by seedbed treatment, although weed yield was significantly increased by dalapon treatment.

Preparing a seedbed in kikuyu is expensive and under present prices the dalapon seedbed is likely to be cheaper.

There are other methods of reducing the time and cost of sowing pastures. A practice in some areas is to undersow crops with pastures, although the so-called cover crop can often be a strongly competitive crop to pasture establishment. Sowing pasture into the litter left behind by a grazed or harvested crop is another alternative.

(ii) *Broadcast Oversowing*

Field evidence in the higher rainfall areas (50 in. or more) is that some legumes can be successfully oversown into blady grass (*Imperata cylindrica*), molasses grass (*Melinis minutiflora*) and native grasses. Prior treatment of the sward includes burning, heavy grazing or a combination of these. With this method success has been achieved with Siratro, *Stylosanthes guyanenis* cv. Schofield and Archer, and *Glycine wightii*. Prior chemical desiccation or partial killing of the sward provides extra cover which conserves soil surface moisture longer for germination and early root development. This technique has been successfully used with southern grasslands but no specific examples can be cited of this technique being put to commercial use for broadcast establishment in Queensland.

Grasses need to be somewhat weak, the cover discontinuous and the plants nitrogen deficient for successful establishment from broadcast legume seed.

(iii) *Reliability with Minimal Cultivation*

Under drier conditions (30-40 in. annual rainfall) in southern Queensland the reliability of establishment without some mechanical soil disturbance appears to be low. Chances are improved by using legumes with superior establishment vigour where seedbed preparation is minimal. Siratro is such a legume. At several sites in the Brisbane Valley, Filet (unpublished data) has demonstrated that by heavy grazing followed by lightly ripping the native pasture and sowing Siratro seed, together with phosphate fertilizer, successful establishment can be achieved.

Further promising results over three seasons were provided by Tothill (1970) in pilot experiments at Narayen on a sandy soil derived from granite. Treatments involved killing of trees with picloram. Legumes were then sod-seeded and the fertilizer applied. The tree vegetation was dominated by narrow-leaved ironbark (*Eucalyptus crebra*) and the herbaceous vegetation by spear grass.

Surface seeding, drilling (disc coulter machine), and drill sowing plus ring rolling were used. In the first season (1967-68) moisture conditions were favourable following planting at the end of December, and all methods gave satisfactory establishment. The Siratro stand was slightly thinner in the surface seeded plot. In 1968-69 very dry conditions prior to sowing at the end of March produced marked differences between treatments. Drilling and rolling gave the best establishment followed by drilling alone, surface seeding being the least satisfactory. Hunter River lucerne and Siratro were more sensitive to degree of seedbed preparation than townsville stylo or snail medic (*Medicago scutellata*) and *Medicago truncatula* var. *trucatula* cv. Jemmalong. The 1969 plot of Oxley fine stem stylo was established entirely by drilling and rolling and this was obviously the most effective treatment.

Time of sowing is often critical and more effort could be directed towards predicting the safest periods for sowing. However, it is in the method of sowing that we could make our greatest advance.

O'Brien (personal communication) found the efficiency of the sowing machinery to be the most significant factor in legume establishment into short grass pastures. Various methods of ground preparation such as nil preparation, hard grazing, burning, chisel ripping (twice), and rotary hoeing (once) had little effect on ultimate establishment. Adjustment of seeding rate was not as critical as the use of sound sowing techniques. Methods of sowing compared were broadcasting, roller-drilling, sod-seeding, broadcut sod-seeding and roto-seeding. There was little difference in percentage establishment means of Siratro and Miles lotononis between different ground preparations, but mechanical preparation caused a substantial rise in costs. Significant differences occurred between the establishment means of the sowing methods. Yet the cost of using the most precise sowing implement was cheaper than minimal cultivation. O'Brien found roto-seeding combined with burning was the most efficient method of establishment of both the medium-sized seed Siratro and very small seed Miles. In the case of Siratro, it was 55% more efficient than roller-drilling-burning, the next best method. The roto-seeder prepares a narrow band of seedbed with precision placement of seed and fertilizer; row spacings are adjustable between 30 and 60 inches.

(c) *Cheaper Seed*

It is well known that successful stands can be achieved with any sowing method simply by increasing the seeding rate. This is rather an expensive way of compensating for poor establishment techniques, especially with expensive seed.

In high cost and high output situations it is very desirable to achieve a thick stand of pasture as quickly as possible and hence higher seeding rates coupled with the best sowing techniques are necessary. It usually resolved into a question of costs; whether to devote more attention to seeding rates, or sowing methods. The alternative, where there is no urgency to develop a thick stand, is to allow the stand to thicken up naturally; this is commendable. Grazing management must be adjusted towards this end. Strategic band sowing, preferably on the contour, of those species which spread naturally (e.g. townsville stylo and fine stem stylo) is a cheap means of slowly but surely establishing pasture. Much larger acreages can eventually be established in this way.

Immaterial of the method of establishment cheaper seed is always desirable. This highlights the need for much more research on seed production. In saying this, I am conscious of increasing attention throughout Queensland to pasture seed production research.

While it is acknowledged that the actual price of seed is governed by the law of supply and demand, the costs of production can be reduced by increasing the yield of retrieved seed per acre. One important facet of seed production with some species is not the lack of seeding ability but rather inability to recover most of the seed set. For instance Hopkinson and Loch (personal communication) logged seed production in a two year old stand of Siratro from which six seed crops had already been taken. Following four inches of rain in early August 1970 two flushes of seed production were recorded. At the peak of each (in late September and late October, the crop carried 200 and 480 lb/acre (fresh weight) of standing seed respectively. At the same times 760 and 940 lb/acre were recovered from the ground.

The problems of retrieval are of two kinds; that of poor synchronization of seed ripening, and that of poor retention of ripe seed. These factors, together with the numerous mechanical problems of harvesting pasture seeds, lead to large and wasteful losses of viable seed. Apart from people working on the agronomy and plant physiology, why have we no agricultural engineers working on adaptation or novel design of harvesting machinery? Surely we cannot continue to rely on enterprising farmers to tackle all the mechanical problems, or decry the fact that manufacturers of machinery will not lend a sympathetic hand.

CONCLUSION

Time did not allow for a complete coverage of all the avenues which could be explored in the search for cheaper pastures. Cheaper and more reliable methods of pasture establishment were singled out as rewarding areas.

A number of field problems occur and others will occur in the future. Nodulation difficulties, seedling pathogens and insect predators are among these. Plant nutrition was glossed over, yet here is a source of major expenditure where economies should be made. Much more research is needed on the possible economies to be achieved by positive placement of fertilizer in the vicinity of the root zone of the seedling. Band placement and seed pelleting of nutrients are important leads.

Similarly, no attempt was made to cover pasture maintenance with all its ramifications of fertilizer requirements and stocking rate for long term pasture productivity.

The search for more adapted species which will establish with minimal effort must continue, but in the meantime we should make much greater use of some of the useful species that we have. Essentially, we have millions of acres of potentially improvable country within close proximity to Brisbane. The impetus to widescale pasture improvement of this country will be disappointing unless and until we can recommend pastures within the bounds of financial feasibility. A cheap method of establishing a legume into native pastures is one avenue that would meet this requirement.

It is acknowledged that there are a number of situations where the low cost approach is not applicable. I am referring to situations where the most advisable strategy is to get more intensive on smaller areas. In terms of greater profitability this may be the most rewarding. This would be particularly the case where land is restricted and highly priced and with intensive development capable of very greatly increased productivity. However this is not the most likely situation for most of the area of concern.

It is important to stress that the mere sowing of improved pasture or cheaply introducing legumes into extensive areas of native pasture is only the start and will not guarantee success. Overall property management must be improved. Improved animal management must go hand in hand with improved pasture management and adequate fertilization. For continued productivity stocking rate should be adjusted taking into account the stage of development of the various pastures.

Within our scientific and extension ranks we have a number of persons with the necessary skills to tackle many of the problems. The one exception would appear to be the agricultural engineer. However there appears to be a need to reassess our thinking towards improved pastures. It may be necessary to depart from some our traditional ideas and adopt a fresh approach. Fortunately I know that there are a number of pasture workers who are at present doing just this, and it can be taken for granted that the grazing community will continue to lend their support to the search for cheaper pastures.

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