PASTURE IMPROVEMENT IN THE COOL SUB-TROPICS, WARWICK AREA, S.E. QUEENSLAND
FIELD MEETING—3-4 OCTOBER, 1969

THE WARWICK HINTERLAND AND BORDER REGION

by

S. WALSH, DEPARTMENT OF PRIMARY INDUSTRIES, WARWICK

There are about 2½ million acres of granite and traprock soils in the area south of the Darling Downs and rising to the border of New South Wales. It is essentially a grazing region but includes a small area of fruit growing and small crops. It is mostly hilly to very steep, ranging in elevation from 1500 to 3500 ft. in the east and falling off to about 1000 ft. in the south-west.

CLIMATE

The average annual rainfall ranges from 35-40 in. in the eastern part to about 26 in. in the western part. Approximately 2/3 of this falls during the summer months but there is a fair degree of unreliability in the occurrence of rain. Storms of high intensity are common in summer, the effectiveness of which are greatly reduced by run-off, high temperatures and high evaporation rates.

Frosts are common over the area during the winter. At the Hermitage Research Station more than 100 days with a grass minimum less than 32°F have been recorded.

SOILS

There are two main soil groups, the granite soils of the east and the traprock soils of the west. A small area of soils derived from andesitic basalt is present in the eastern part.

Granite

The granitic sands vary in depth from 6-36 in. They are described (Northcote, 1967)* as sandy acidic mottled soils which become shallow, gritty and more skeletal on the ridges. They are strongly acid (pH 5-6.3), very low in available phosphorus (-5-30 p.p.m.). Plant nutrition work has shown P, Mo, S to be deficient together with Cu in some situations.

Traprock

The traprock soils vary in depth from 4-18 in. They are described by Northcote as uniform medium texture shallow dense loamy soils frequently containing angular rock chips. The pH ranges from 6.1-6.9 but sometimes as low as 5.5. Phosphorus is low at 7-85 p.p.m. on the deeper soils and 5 to 30 p.p.m. on the shallower ones. Plant nutrition studies have shown responses to P, Mo, and S and possibly B in some cases.

Andesite

This is a small area but is an interesting contrast to the other two. The pH lies between 6.3 and 7.0 and phosphorus level at 54-125 p.p.m. The soils are up to 18 in. deep, well drained but often very steep. Mo has also been found to be deficient.

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* Northcote, K. H. (1967)—Atlas of Australian resources, Sheet 3. C.S.I.R.O. and Melbourne University Press: Melbourne.

With most of these soils it has been found necessary to restrict cultivation to a minimum because of the rapid loss of structure, invasion of weeds, loss of infiltration capacity and proneness to erosion.

VEGETATION

The original vegetation forms an open forest on both granite and traprock. On the granite the timber comprises yellow box (*E. melliodora*), rusty gum (*Angophora costata*), rough-barked apple (*A. intermedia*), red and grey gum (*E. tereticornis* and *E. propinqua*), narrow-leaf iron bark (*Eucalyptus crebra*), with stringy bark species on the eastern edges. Black cyprus pine (*Callitris calcarata*) occurs on the rocky fringes. A number of wattles (*Acacia* spp.) invade developed or partly cleared land.

On the traprock narrow-leaf iron bark, white box (*E. moluccana*) occurs on the ridges with yellow box on the lower soils and molly box (*E. pillagaensis*) in the south-west. Rusty gum tends to dominate on the deeper sandy soils and buloke (*Casuarina luehmannii*) and white cypress pine (*Callitris glauca*) on the solodic soils and sandy ridges respectively.

The native grasses of the area are mainly summer growing and include blue grasses (*Dichanthium* and *Bothriochla* spp.), panics (*Panicum* spp.), windmill grasses (*Chloris* spp.), Kangaroo grass (*Themeda australis*). Other genera include *Sporobolus, Stipa, Aristida* and *Eragrostis. Danthonia* spp. are winter growing natives.

The native herbaceous legume flora is very restricted, the most common species being *Glycine tabacina*. However, burr medic (*M. hispida* var. *denticulata*), woolly burr (*M. minima*) and clustered clover (*T. glomeratum*) have become naturalized locally.

LAND USE

Most of the area is given over to pastoral production, the holdings ranging in size from 1800 to 15000 acres, but the average holding would be 3500-4500 acres in the eastern part and 4500-6000 in the western part.

Total Area	2.25 million acres
Number of rural holdings	1434
Area under cultivation	126000 ac
Proportion requiring soil conservation protection measures	75%
Proportion presently protected	12%
Area of lucerne or pasture	28000 ac
Area of annual crops	10000 ac

A small part of the area can be irrigated from the three dams *viz.* Leslie Dam, Pikes Creek Dam and Coolmundra Dam. This is mainly given over to cropping and tobacco growing.

Sheep are the predominant livestock, however in recent years the number of cattle being carried has increased considerably. Only 21% of the sheep are breeding stock which probably reflects the poor nutritional level of the native pastures in their unimproved state. The average lambing percentage is low at 76% and average fleece weight 9.37 lb.

The development of improved pastures is leading not only to the increase in cattle numbers but with sheep to a swing towards a greater proportion of breeders. There is also a considerable improvement in the lambing percentage and wool clip and to the production of fat lambs. The economics of this development will be discussed by Mr. Clark.

PASTURE RESEARCH IN THE GRANITE AND TRAPCOCK AREAS OF SOUTH-EAST QUEENSLAND

by

N. M. CLARKSON, QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, WARWICK.

The area under discussion covers the traprock and granite soils of the Warwick-Stanthorpe-Texas district of south-east Queensland. Each soil will be dealt with separately under headings of plant nutrition, plant introduction and management.

Investigations into pasture improvement in the district began in the 1950's with the Queensland Department of Primary Industries and A.C.F. and Shirleys Fertilizers Ltd. More recently Dr. Andrew of C.S.I.R.O. has been investigating plant nutritional requirements of these soils and a co-operative project is now under way.

GRANITE

The soils generally are shallow, with an A horizon of loamy sand to sandy clay loam, and a bleached A_2 overlaying a yellow clay B horizon. With increasing depth this becomes gritty until parent rock is reached.

Plant Nutrition

Initial work with various fertilizers showed that lucerne responded markedly to superphosphate. Later experimental work using pot and field studies covered a range of nutrients and identified responses to superphosphate, lime (particularly lime pelleting), copper and zinc (the last two applied together), and intermittent responses to molybdenum and boron. Foliar analysis was used to show the copper/zinc effect was due only to copper.

Because of the obvious incompleteness of the early work and the need to study the lime and trace-elements responses in more detail, a joint C.S.I.R.O./D.P.I. project was begun in 1968. Soil from three sites was used for glasshouse nutrient experiments with lucerne. The trials covered the main elements in factorial combination, a trace element trial and a phosphate rate trial. Responses were recorded to phosphorus, sulphur, molybdenum, copper, calcium, and boron. A calcium/boron interaction was recorded due to lime-induced boron deficiency. The maximum response to phosphorus occurred at a rate equivalent to 2-4 cwt/acre of superphosphate, and this was markedly increased by applying lime at one ton per acre.

In 1969, field experiments based on these results were established. They consist of a phosphorus rate trial, a sulphur rate experiment, and a trial to study lime and trace-elements in various combinations. While no results are yet available, there are indications of field responses to several nutrients and it is hoped that these experiments will put the plant nutrition aspect on a sound footing.

Plant Introduction

A wide range of pasture plants has been tested in the under 30" rainfall area. The plants were grown either in nursery rows or in observation sward plots which were grazed periodically. Adequate non-nitrogenous fertilizer was applied annually.

Legumes

Summer perennial legumes such as Siratro (*Phaseolus atropurpureus*), glycine (*Glycine wightii*) and desmodium (*Desmodium* spp.) failed to persist because of frost. Lucerne (*Medicago sativa*) is the only perennial legume adapted to the area and is

outstanding. White clover (*Trifolium repens*) does not persist satisfactorily below 30" rainfall although plantings in wet years do well at first.

A range of commercial and experimental winter annual legumes has been tested. Quite a few have shown the ability to persist and regenerate each year for some time. These include rose clover (*Trifolium hirtum*), *Trifolium spumosum*, clustered clover (*Trifolium glomeratum*), subterranean clover (*Trifolium subterraneum*) varieties Geraldton and Bacchus Marsh, serradella (*Ornithopus spp.*) and medics (*Medicago spp.*) Most of the winter annuals do not reach their full potential for dry matter production because of slow establishment. While they regenerate during April or May, it is often July before plants are well nodulated. This particularly affects produtions in early winter when it is most needed. In spite of this, during 1969 with only eight inches of rain from April to September, yields in excess of 5,000 lb/acre of oven-dry material were recorded in the best plots, compared with lucerne growth of 1150 lb/acre for the same period.

Grasses

Winter perennial and annual grasses are not very productive and their persistence over dry summers is poor. Those with some promise are ryegrass, phalaris, and fescue. Summer perennials have generally been disappointing. The buffel grasses appear to be killed by frost while Rhodes grass is the most persistent. The Department of Agriculture in New South Wales has grown *Eragrostis curvula* for some years and officers in the Inverell district rate it as the most promising grass for the granite. With unpalatable strains of this grass having some potential as weeds, the release of palatable strains is being considered by the New South Wales Herbage Plant Liaison Committee.

TRAPROCK

Traprock soils are shallow clay loams of uniform texture developed on metamorphosed Paleozoic sediments. They are hard-setting and stony. Some areas near Texas have a tight clay subsoil which is a distinct B horizon.

Plant Nutrition

The early pot and field trial work with lucerne showed a marked deficiency of phosphorus and marginal deficiency of sulphur and molybdenum. Maximum yields were obtained with superphosphate at 4 cwt/acre. On one soil, where analysis showed an available phosphorus level of 80 p.p.m., there was no response to applied phosphorus.

Soil fertility studies by the C.S.I.R.O. and the University of Queensland on traprock soil from three sites covering different types from Tenterfield to Karara were followed by field trials on two of the sites. The results* showed responses to phosphorus, sulphur, molybdenum and calcium, with marginal boron deficiency. There was a calcium-molybdenum, interaction in which it was shown that in the presence of molybdenum, lime was not needed. There was no response to lime pelleting but this would still be recommended to assist *Rhizobium* survival under harsh conditions. The maximum phosphate response occurred at 2-4 cwt/acre of superphosphate. Applying these results to commercial lucerne stands at the Karara site, it was shown that an annual dressing of 1 cwt per acre of superphosphate was adequate to maintain healthy lucerne. The maintenance level of sulphur was found to be approximately 10 lb/acre/year which is adequately supplied in 1 cwt of superphosphate.

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* C. S. Andrew and P. J. Skerman, unpublished manuscripts.

Plant Introduction

Species testing was carried out in the same way as for the granite soils with similar results though greater persistence in the summer perennial grasses. However, their worth as a replacement for native pasture has not been firmly established.

Legumes

Lucerne is the only perennial which persists satisfactorily for more than three years and is productive. Other summer perennial legumes are killed by frost and probably moisture stress too.

The winter annual legumes have shown the ability to persist and set seed every year for the last few years. Their productivity is limited once again by slow establishment and nodulation, although the problem is less severe than on the granite soils. Persistent species include the medics, rose clover, *Trifolium globosum*, *Trifolium spumosum* and Geraldton subterranean clover.

Grasses

Winter annual and perennial grasses are unsatisfactory in growth and persistence, although Wimmera rye grass grows well in the first year of planting after a fallow. All rye grasses were killed in the 1968/69 summer which was dry.

The summer perennial grasses which persist reasonably well are Pioneer Rhodes (*Chloris gayana*) buffel grass (*Cenchrus ciliaris*) varieties Molopo and Biloela, *Panicum coloratum*, *Digitaria smutsii* C.P.I.-16776, and Gatton panic (*Panicum maximum*). Some varieties of Rhodes and buffel have apparently been killed by frosts. There are indications of a high mortality in the Rhodes grass plots during the dry 1968/69 summer.

Management

Grazing trial

In 1962 a grazing experiment was established on a duplex traprock soil near Texas aimed at establishing the animal productivity and optimum stocking rate on native pasture for a wool-growing enterprise. Merino x Corriedale wethers were used to test the effect of supplementary grazing lucerne on wool growth and animal body weight.

Results showed that the maximum safe stocking rate was approximately one sheep to 1½-2 acres on native pastures. Although wool production per acre was higher at a higher stocking rate, the native pasture was severely damaged by this grazing pressure. A large decline in ground cover and dry matter production occurred at the highest stocking rate.

Supplementary lucerne (one sixth of the area for each of the two higher stocking rates) increased wool production per head by an average of one pound per year at one sheep/acre. In the same treatment, body weight increased by about eight pounds/head/year. While these effects were sometimes statistically significant, the results do not argue very strongly in favour of lucerne for wool production. Only in 1967 when a mild wet winter produced unusually good lucerne, did wool production show a large increase of three pounds per head.

Over six years, basal cover of native pasture declined from 15% to 8%, and botanical composition showed a reduction in blue grasses (*Bothriochloa bladhii* and *Dichanthium sericeum*) from 45% to 23% with an increase in small unproductive grasses. While the reduction in ground cover was more severe at higher grazing pressures, stocking rate had little or no effect on botanical composition.

Renovation Trial

In 1966 an experiment was commenced on an area of native pasture with naturalised barrel medic (*Medicago truncatula* var. *truncatula*) and woolly-burr

medic (*Medicago minima*) to sudy the effect of burying the medic pods in spring with a chisel plough to improve regeneration and provide protection from consumption by sheep in summer, and to see whether production of medic could be raised by renovating the native pasture in autumn in order to conserve moisture for seed regeneration. An autumn and spring desiccant (Paraquat) treatment was also included. The treatments thus were nil, spring chisel, spring and autumn chisel, each plus or minus desiccant (Paraquat) applied in autumn to give a wider range of treatments.

Results of the first two years showed that renovation of any kind in the autumn had a highly beneficial effect on the yield of medic. In 1967, yields of medic were increased from 1100 lb/acre of dry matter to 3300 lb/acre and in 1968 from 1700/ acres to 3800 lb/acre. Measurement of plant density in 1967 showed no response to spring chiselling and changes in soil moisture were small. In 1968 more intensive sampling of soil for moisture failed to show differences between treatments. As the area was adequately fertilized, the exact cause of the response to renovation is not known. The results may mean that the mixed pasture tends to have a dynamic equilibrium in which removal of grass is compensated for by more growth of medic which tends to keep soil moisture at the same level as for pure grass swards.

DEVELOPMENT ALTERNATIVES

by

N. T. CLARK, FARM MANAGEMENT CONSULTANT, DALVEEN

This talk discusses the development of the area from the point of view of existing producers. It ignores the influence of taxation concessions and capital gain, which are the two most profitable benefits associated with land development. I propose to separate the district into six six broad land classes, discussing these areas in brief and outlining one area in detail.

LAND CLASSES

1. Arable traprocks
2. Non-arable traprocks
3. Arable granite above 35" rainfall
4. Non-arable granite above 35" rainfall
5. Non-arable granite below 35" rainfall
6. Arable granite below 35" rainfall

Arable Traprocks

Development here is by prepared seed bed with or without cover crops. Lucerne and the medics, particularly Jemalong barrel medic (*Medicago truncatula* var. *truncatula*), are commonly used. Initial fertilizer dressings of 3-4 cwt of superphosphate, 2 cwt of which is applied as Mo-super-12, are usually necessary.

The profitability of development is uncertain but it is probabaly sound on the better areas and the deeper soils. The lack of data on carrying capacity and production limits our knowledge here but the few results that are available are very variable.

On this tour we see two examples of this type of development at Warahgai owned by W. Raff and Risdon owned by K. Leahy.

Non-arable traprocks

The only feasible practise on this country is timber treatment to kill existing timber. The usual method is ringbarking but the increasing cost of labour and the decreasing price of wool has made timber treatment a dubious proposition. The use of chemicals to kill timber has so far proved unsuccessful. These areas run mainly dry sheep with very limited possibilities of breeding sheep or cattle unless technology can find a means of improving nutrition.

Arable granite above 35" *rainfall*

These areas are mostly to the east of the New England Highway, are of coarser granites and higher altitudes (above 2500 ft.). However, there are areas of better class granite interspersed throughout the area. As rainfall increases white clover becomes more successful and lucerne less successful. There is an uncertain area in between where both are unreliable. The main problems are:

a. lack of persistency of legumes
b. higher phosphorus requirement of these soils
c. rabbits

Pastures are based on ladino clover and N.Z. white clover, phalaris, Demeter fescue, Currie cocksfoot and perennial ryegrass. However, the persistency of white clover is not satisfactory and there is a need to examine this critically. Some strains appear better than others. Louisiana white clover is promising and *Trifolium semipilosum* (Kenya white clover) may also be of use.

Clearing costs can be high due to the size of timber and $30 per acre would be common. Development is usually to plough and sow to pasture in one year. Cover crops are not often used but fodder crops, particularly rape and turnips are useful. Fertilizer requirements are higher than on the finer granites and on the traprocks. Probably 8 cwt superphosphate is required to reach a maintenance level.

Non-arable granite above 35" *rainfall*

These areas are similar to the last but because of steepness or stoniness are non-arable. Development here is by timber treatment (mainly ringbarking) and aerial sowing of white clover. The fertilizer requirement is as for the arable areas. However, in both areas there could be boron and potash deficiencies but this is not clear at the moment.

Cattle are the main enterprise in both areas and as development proceeds the trend is towards more breeders and turning progeny off at a younger age.

Non-arable granite below 35"

Development is uncertain as no reliable legume is available for the area. These areas are traditionally dry sheep properties, producing fine to superfine wools. Clustered clover (*Trifolium glomeratum*), rose clover (*Trifolium hirtum*), barrel medic (*Medicago truncatula* var. *truncatula*) and sub clover (*Trifolium subterraneum*) appear promising, but results are uncertain. Other possibilities are lotus (*Lotus cornicalatus*), seradella (*Ornithopus compressus*), cupped clover (*Trifolium cherleri*), snail medic (*Medicago scutellata*) and lucerne (*Medicago sativa*) (aerially sown).

PASTURE IMPROVEMENT ON ARABLE GRANITE BELOW 35" AVERAGE RAINFALL

Existing situation

A typical property would be 4000 acres running 3000 wethers. Timber treatment consists of some ringbarking and sucker control is carried out each year. A few head of dry cattle can be run.

The budget would show the following:

Receipts	Wool 3000 wethers cutting 9 lb. is 27000 lb wool at 48 cents nett.		= $13000
Costs	Operating costs	$6700	
	Stock depreciation (60c)	1800	
	Owner's labour	2,500	
	Total cost	$11000	$11000
True nett profit			$2000
Capital	Land 4000 ac. at $21	$84000	
	Stock 3000 sheep at $4	12000	
	Machinery value	4000	
Total value		$100000	

Return to Capital 2%

A few points from this exercise:

1. Dry sheep restrict versatility and income.
2. A very low cash surplus is available for development.
3. This is particularly so if interest and repayment commitments exist.
4. A subsistence level of existence only prevails.
5. Owner has either to increase area (at 2% return) or develop his country.

Development History

Early attempts about 1952 to sow temperate species, such as white and sub clover, perennial ryegrass and phalaris were not entirely successful. Usually the legume inoculum was inviable, no molybdenum was used and only 1 cwt of super was applied. Results were usually good for 1-2 years and then complete loss of pasture ensued.

Recent developments using lucerne and higher rates of superphosphate initially have completely changed this picture. Fodder crops and cash crops can also be successfully grown with the result that carrying capacity can be increased and more profitable enterprises can be run.

The development alternatives are

a. *Aerial sowing*: This is not a proposition yet because we do not have species that can be aerially sown successfully.

b. *Sod seeding*: This is a cheaper means of establishing pasture and can cover a big area in one year. It is a higher risk type of establishment and the lucerne will propably not last as long as in a prepared seed bed.

c. *Pasture in year 1 without a cover crop*: This is fairly common but I prefer to use a cover crop.

d. *Sow pasture in year 1 with a cover crop*: This is a common method of establishing pasture, the crop usually being oats.

e. *One year's fodder crop then pasture and cover crop in year 2*: This method appears the best as it allows some cash return immediately to offset development costs. It provides a better initial kill of the native grasses and a better seedbed can be achieved.

A variation of this is to use a summer cash crop such as soybean and sunflower between the two autumn sowings while the cover crop can be varied either for grazing or for seed.

Pasture species used and methods

Hunter River lucerne has the ability to respond to our rainfall pattern and will respond and grow at any time of the year.

It is usually sown with a mixture as follows:

4 lb. Lucerne—45c lb	$1.80
1 lb. Cluster clover—35c lb	0.35
1 lb. Wimmera Ryegrass—10c lb	0.10
½ lb. Marrar Sub clover—26c lb	0.13
½ lb. Kondinon Rose clover—35c lb	0.18
½ lb. N.Z. white clover—50c lb	0.25
	$2.81

This mixture would be sown between the middle of March and the end of June, usually drilled in with 2 cwt Mo-superphosphate. Generally 5-6 cwt is applied in the first 3 years.

Legumes

Hunter River lucerne has been already discussed. African and Hairy Peruvian lucernes may have a place but the lack of persistency of these is a disadvantage.

White clover does not persist in these drier areas with the possible exception of Louisiana.

Sub clovers of some use but production is not as high as in the true sub clover belt. Marrar looks best but its persistency has not yet been proved. Some years are good sub clover years, other poor. Sub clover is possibly of more use as a minor part of the pasture and to give some feed after lucerne dies out.

Rose clovers: These look extremely promising and are being use more and more, particularly in the drier and lighter soils. Which variety will prove best is as yet uncertain. It appears that it could be aerially sown.

Cluster clover: This is a small companion legume, useful in mixtures and to give cover after lucerne dies out.

Barrel medics: These are promising on the granite but more so on the heavier soils and traprock soils. Hanaford and Jemalong are used but their relative values are as yet uncertain.

Oher legumes: serradella, Louisiana white, snail medic, cupped clovers, *Trifolium semipilosum* and *Lotus corniculatus* could be of use and are under trial.

Tropical legumes: They have not shown themselves to be of any value. Siratro persists moderately but is not grown.

Grasses

Phalaris, Currie cocksfoot, Demeter fescue, tall fescue and Wimmera ryegrass are the main species used. These are all of value on heavier soils and flats but not on lighter, drier soils. Wimmera rye is best on lighter soils due to its annual habit and regeneration; the others tend to die out. Lucerne is very competitive in drier areas, is too tough in dry times and tends to kill out existing plants. Rhodes grass, buffel grass, and green panic are of little value.

Results of development

A lucerne pasture on this particular area will carry four dry sheep or 2.7 breeding ewes per acre averaged over the full 12 months. This is for 5 years and it then starts to deteriorate.

Year	*Description*	Carrying Capacity	
		Wethers/ac	or Ewes/ac
Year 0	Native pasture	0.75	0.5
1	Fodder crop	4	2.7
2	Lucerne pasture	4	2.7
3	,, ,,	4	2.7
4	,, ,,	4	2.7
5	,, ,,	4	2.7
6	,, ,,	4	2.7
7	thinning out lucerne pasture	3	2.0

Economics of development

Additional carrying capacity is 3.6 dry sheep per acre or an extra 2.6 breeding cross-bred ewes averaged for the 7 years. If we assume 100 ac is to be developed then:

Additional production and receipts:	
260 additional cross-bred ewes carried	
Wool 8 lb per head 2080 lb at 35c	$728
Lambs 80% sold 208 at $5.50	$1144
cfa ewes 50 @ $3	150
Total receipts:	$2022
Additional costs:	
1 cwt super per year maintenance at 1.70	$170
Drench, shearing etc 260 ewes $1/head	260
Ram cost per ewe per year @ $40 each	32
Purchase 54 ewes @ $8	432
Additional labour @ $1/ewe	260
	$1154

Additional Profit $868

Cost of development (100 *acres*)

Clearing $10/ac	$1000
Fencing, say	200
Water, 1 dam	150

Seed pasture $2.71/ac	271
„ oats $1.50	150
Fertilizer 5 cwt over 3 yrs @ $1.70/cwt	850
Sowing costs $3/ac (fuel, oil, depreciation, labour)	300
Stock purchase 260 ewes @ $8	2080
	$5001

Return to Additional Capital

$868 on $5001 = 17%

Thus if pasture can carry an extra 2.6 breeding ewes per acre (3.6 dry sheep) the return to additional capital is approximately 17%. The return if lambs average $7 would be 23%.

The return is adequate, but only just, and the use of cash crops can be considered. A sowing sequence of winter fodder crop, soybean, pasture with cover crop should show a 30% return to development spending. The effect of the development on the overall farm position is to raise the return to capital from 2% to 7-10%.

DISCUSSION

Does lucerne production suddenly decline towards the end of about 5 years or does it gradually go over the five year period?

Mr. Clark: In general it seems to go rather quickly towards the end of five years. There is not much lucerne that is seven years old in this district.

Comment: It has been found in the Inglewood/Texas area that crown borer is responsible for quite a lot of damage. Recently some unthrifty lucerne appeared to be afflicted by rugose leaf-curl also.

Hairy Peruvian lucerne has been mentioned as having some promise here. What sort of persistence does it give?

Mr. Clarkson: Certainly it has been about 10% more productive in trials. However, it loses this advantage in its lower persistence than Hunter River and in this environment persistence is definitely more important than production as a first consideration.

What about the use of nitrogen fertilizers on pasture? It seems to me that there is adequate rainfall for results to be worthwhile.

Mr. Walsh: This can certainly be done but I think it will be uneconomic for the following reasons. Firstly the price probably precludes it, particularly where one thinks in terms of two hundred to four hundred acres. Secondly, the only grass that could be used in such a system would be perennial rye grass which will persist for about two years. It would seem more practical to plant oats, barley or turnips instead. Thirdly, it is a difficult climate for, although the long-term monthly rainfall average looks adequate, April-May and August-September are rather dry months. Thus it is too much of a stop-start sort of environment to make nitrogen fertilizer use really efficient.

You said that rose clover has a specific nodulation requirement. Assuming that the specific inoculant has been used why doesn't it nodulate? Is the inoculant fully effective?

Mr. Clark: We have been using the right specific rhizobium and we don't have any trouble initially. It is in the subsequent regenerations that we encounter nodulation failure.

Would it be possible to cut back the superphosphate maintenance dressings after a number of years?

Mr. Clark: This is somewhat up to the individual to find out for himself by trial and error. However, I would say that on the traprock you won't be able to go much below 1 cwt per acre per year because of the sulphur requirement which is about 10 lb per acre per year.

What comments do you have about re-establishing lucerne after it cuts out from an area or do you have any alternatives?

Mr. Clarkson: As yet we don't have much to offer. It seems that one or two years of cropping are necessary between successive lucerne pastures. Barrel medic is showing more promise each year as a useful substitute for lucerne. Being annuals however, the medics must rely on seed for regeneration so that one is at the mercy of the environment more than with a perennial such as lucerne. In the higher and drier areas there is a greater disease problem with lucerne than on the wetter deeper soils so that on the traprock lucerne has a shorter life than on the granites. I think there are three possible reasons for the non persistence of lucerne. One is disease, the other is grazing management and the third is nutritional. With only one application of Mo at sowing there may be increasing deficiency of it. There may also be marginal boron deficiency.

FARM VISITS

"PALGROVE"—PROPERTY OF MR. P. BONDFIELD, DALVEEN

The Property of 4600 acres lies in the 25 in. rainfall zone. The topography is gently undulating with stone outcrops, the soil being a fine granitic sand about 12 in. deep. The pH is about 6.0 and the natural phosphorous status 10 p.p.m.

At the time we started development here it was said that oats and lucerne were not suitable for this country. Tallarook sub clover was one of the few alternatives but we found that in many summers there would be 4 or 5 germinations on the scattered rains so that the natural seed reserves could easily be exhausted. The inoculum was unreliable then too and it was not until the advent of peat inoculum that it could be relied upon.

Tree clearing costs have now dropped to about $30 per acre which is about half the former price. The usual procedure now adopted is to plant oats at 30 lb per acre with 2 cwt superphosphate. In the second year 14-15 lbs oats is seeded with 4 lb lucerne per acre. The total cost of establishing lucerne is therefore $20-22 per acre including two winters of grazing oats. Fat cattle would yield about $20 per acre by the time the lucerne was properly established.

As the lucerne paddocks run out after 4-5 years clustered clover and rose clover can be established. Therefore, up till now we have found it more profitable to develop new country. However, with the present cost-price squeeze we are turning back to the old run-out pastures.

Carrying Capacity

Originally the property carried mainly wethers with a few cattle which were run on native pasture. The build up in stock carrying capacity associated with the development, is shown below.

Note the doubling of carrying capacity and the switch from wethers to breeding stock.

	1958-59		1967-68	
	Number	D.S.E.*	Number	D.S.E.
Ewes	600	900	2200	3300
Wethers	2000	2000	180	180
Hoggets	400	400	900	900
Rams	0	0	600	900
Cows	90	810	264	3168
Yearlings	60	480	330	2640
less agisted				1500
TOTAL D.S.E.		4590		9588
D.S.E. per acre		1		2.1

*Dry sheep equivalents

Pasture type and carrying capacity

Pasture Type	Acres	D.S.E./acre	Total Carrying D.S.E.
Old improved pastures	1000	2	2000
Winter crop	400	4	1600
Lucerne pastures	1000	4	4000
Native pasture	2200	0.9	2000
TOTAL	4600		9600

Development Costs

Clearing and Ploughing	$10.00
Seed and Super	$10.00
Fencing and Water	$2.00
Total Development Costs	$22.00

Thus it costs approximately $22 to increase carrying capacity from a little under one dry sheep per acre to four dry sheep per acre. This is an increase of three D.S.E./ acre for a cost of$22.00.Thus each additional sheep area is developed for about $7.00 compared to $20.00 to purchase a sheep area.

DISCUSSION

In these native grass pastures how deep do you chisel plough and how deep is the seed sown?

Mr. Bondfield: It was chisel ploughed to a depth of about 1½ in. using the 2 in. chisels and the seed was dropped behind the chisels. It was a very rough job and we had trouble seeing where we were going. Fertilizer was applied from the air.

Are you happy that the phosphorous intake of your animals is adequate on improved pastures receiving superphosphate?

Mr. Bondfield: I'm not sure. We are not putting it out in licks but then the animals don't show signs of requiring more.

How important do you consider cattle are in preparing pastures for sheep?

Mr. Bondfield: They are very important. In the higher rainfall areas pastures can become very rank and unpalatable to sheep and it is just not possible to handle this country well without cattle.

Having had the chance to compare sod-seeing with aerial seeding, which do you. consider to be the more desirable?

Mr. Bondfield: I would sod-seed as much as possible and only use aerial seeding for the rough country. Species seeded aerially do not seem to persist as well.

Would you sow improved grasses at the same time?

Mr. Bondfield: No. Initially there are a lot of natural grasses which, although not very good, do provide some feed. Until such time as they have been eaten back they would compete strongly with sown grasses.

Do you burn before seeding?

Mr. Bondfield: This is a controversial point. I have never burnt before seeding and I feel there is little need. In the rough paddocks which have been aerially seeded the stock are getting the rough grasses down. My reason for refraining from burning, and I have often been tempted, is that burning exposes the raw granitic surface and I feel some litter and ground cover is necessary for seed establishment.

How do you manage to control bloat?

Mr. Bondfield: This is the problem that frightens us most of all. In the 10 years we have been growing lucerne we have averaged less than 1% loss. With the unusually early growth this year we have exceeded this. Our method of combating bloat, which appears to be fairly successful, is if a paddock is rather lush and we suspect bloat we put in a large mob of sheep for a while before putting in the cattle. Consequently the cattle do not take in as much fresh lucerne and they walk around much more.

What is your grazing management for this type of country?

Mr. Bondfield: It depends on the time of the year and the amount of growth there is. Most of the paddocks are set-stocked during the winter months. In the spring with rapid growth we tend to use a rotational system in order to better handle the feed. The length of time they stay on any one paddock depends on the size of this paddock and the amount of feed available. Normally we can expect quite good winter growth so that we can reckon on set-stocking at close on 3 sheep per acre for the winter months.

With respect to the fertilizer requirements of this country do you think you might require more sulphur than is contained in your superphosphate dressings?

Mr. Bondfield: No. I think this might be applicable to the basalt country. Sulphur has not been found deficient in any of the fertilizer trials here. Molybdenum, however, has definitely been found to be beneficial and we have been applying Mo-superphosphate for the last four years. It looks as if we will have to apply Mo about every 5-7 years. Each year we apply superphosphate to as much of the property as we can afford. Priority is given to the better and newer pastures although we find that even the run-out pastures do carry a lot more stock if they are regularly fertilized.

I would like to ask how both summer and winter fodder crops could fit into the system?

Mr. Bondfield: Winter grazing oats are very necessary for our winter bulk grazing. I don't think we can afford to be without oats. The summer crops can suffer from dry periods in summer however, soy beans and *Dolichos lablab* are new crops with some promise. The only problem with summer forage crops is that it makes one a little late in commencing seed-bed preparation for the lucerne which we like to have planted before June.

Work at Trangi in the west part of N.S.W. indicates that the life of the lucerne stand is directly related to the amount of regeneration from seedlings. It seems that no one has done any work like this here and that present management appears to be aimed at preventing the lucerne from becoming too mature. Can we have a discussion of this important issue?

Comment: I have heard it said that rotationally grazing lucerne with cattle, where the rotation is 6 weeks or longer, allows a stand to thicken up by the re-seeding which takes place.

Mr. Clark: In this area six weeks is a minimum time to get good seed set but even then we don't have any evidence indicating that the stands will thicken up by natural regeneration here. The work that was referred to at Trangie was based on a fairly light seeding rate (2-2½ lb/ac). Thus the stand was thinner than ours but there was little else but lucerne. We are talking of sward lucerne where there is competition for light and moisture by grass whether it is sown or not. This is obviously a less suitable situation for seedling re-establishment. Even where we have tried renovating by sod seeding more seed into thinning stands we have not succeeded. Finally, satisfactory inoculation has been a problem on these acid soils and it has been found necessary to lime pellet for successful inoculation. Thus, it is likely that natural re-seeding could be at a disadvantage through the seedlings not nodulating properly.

What effect does a sequence of wet seasons have on the lucerne stands?

Mr. Bondfield: We have some trouble with rushes coming into new lucerne paddocks after establishment: wet years do not have much effect on stands of lucerne established 2 years or more. With the mixtures we now sow with lucerne I think we would see lucerne establishing on the rises and the clovers and other species in the hollows.

With the problem of getting lucerne re-established on old lucerne areas, what do you intend doing with these areas in the meantime and for how long do you have to wait?

Mr. Bondfield: We're not really sure as we do not have much area at this stage yet. However, I think we would crop the area for oats, leading to oats and lucerne the second year. Failing that, we now have some clovers which are new to us but which look very promising (rose clover) and we can think in terms of clover-based pastures for the intervening time.

Mr. Clark: From my experience it seems that three years is a minimum time needed to spell lucerne areas. It is possible that soil moisture has something to do with this and that recharge of the sub-soil takes some time. During the drought a number of good stands in the district dried out through lack of water, presumably sub-soil water. It is also interesting that lucerne stands which have reverted to natural grass are still very productive and will carry 2-3 sheep per acre for the first 2 years.

Does a higher rate of seeding of lucerne than the normal 4 lb per acre affect the survival of the stand?

Mr. Bondfield: It does seem that higher rates than 4 lb per acre affect the survival and the stand runs out more quickly. It is obviously necessary to effect a compromise here between production and longevity and 4 lb per acre appears to be the best compromise.

"WARAHGAI" — PROPERTY OF MR. W. RAFF, KARARA

The property of 4000 acres lies in the 25 in. rainfall zone. The topography is steep to undulating traprock in the Herries Range at 1600 ft. elevation. The soil is a stony traprock of pH 6.3 and phosphorous level of 9 p.p.m.

Experimental work by C.S.I.R.O. and D.P.I. has shown that an initial application of 3-4 cwt Mo-superphosphate is necessary for establishing legume based pastures and a maintenance rate of 1 cwt superphosphate is necessary in subsequent years.

Lucerne has been established on 400 acres of the property. Initially the property carried a stocking rate of 1800 dry sheep equivalents (D.S.E.) which has been raised to 3000 D.S.E. by the use of lucerne and timber treatment. The property now carries 1000 breeding ewes with a lambing percentage of 85-90. 25% of the ewes are culled each year. The ewes are lambed onto the lucerne paddocks while the wehers are run on the rougher country. The wool clip is as follows: wethers, 9 lb; ewes, 11 lb; lambs (8 months), 7 lb. Replacement sheep are now bred on the property and about 500 surplus lambs sold annually. Prior to the use of lucerne it was necessary to buy in the replacement wethers, the transport cost of which amounted to $1 per head to be added to the purchase price of the sheep.

DISCUSSION

What cultivation practise and what depth do you work this traprock country before you plant?

Mr. Raff: We have been giving it three workings; a shallow one in the early summer more or less to conserve the moisture, a second thorough cultivation to 4 or 5 in. and a final working when we sow at the same time. The aim is to have a rather rough seed bed into which the seed is dropped without further covering. While we may get a better and more even germination on a fined seedbed, I think the most important thing is to conserve as much moisture as possible. This country can shed up to about 70% of the precipitation as run-off. With a rough seed bed this is drastically reduced or eliminated.

Do you apply the fertilizer at planting or before the deep working cultivation?

Mr. Raff: We apply it when we can before sowing. At sowing we are too busy getting the seed into the ground because of the short time that conditions for establishment are suitable. Applying fertilizer at the time of sowing causes too much delay. However, we were, on one occasion, forced to apply it 6 weeks after planting without apparent ill-effects.

You mentioned that once this country has been cleared and cultivated the rainfall run-off is very much reduced. For how long does this effect last?

Mr. Raff: The effect lasts for some time but some periodic light cultivations, such as one would do for pasture renovation, I think is sufficient to prevent the ground packing down. While the lucerne stand is good the plants themselves intercept rainfall and prevent much run-off.

In its original condition much of this country is quite densely timbered with small trees of eucalyptus and acacia and although the ground is very hard-packed there is a fair cover of native grasses seasonally.

How long do you expect your lucerne stands to last?

Mr. Raff: We really don't know yet but we hope to get five years of useful life. The lucerne doesn't disappear suddenly here, it is a gradual process. Even with only 10 or 15% of lucerne we still have a valuable pasture. Now we are also sowing 1 lb/ac of barrel medic with our lucerne in the hope that it will take over as the

lucerne disappears, and there is one paddock in which this is happening. I think management has a lot to do with the life of the stand. Grazing is always harder on the rises than in between although the soil is also shallower there.

You do not sow any grasses in your pastures. Is this because you have no suitable ones?

Mr. Raff: Yes, it is really. The Department of Primary Industries have been experimenting with different grasses but no permanent pasture grasses are yet available. Some rye grass is used but it does not last. The main concern is for a winter legume and the grasses are just those that volunteer. However, as time goes by we do seem to be getting better types of native grasses coming in with the increase in fertility.

Elsewhere we find lucerne often established under a cover crop such as oats. Could you comment on this?

Mr. Raff: I think it depends on soil fertility. Since we are starting with soils of rather low fertility we aim to establish the lucerne and medics as quickly and effectively as possible. Cover crops are essentially a compromise and we're not prepared to take the risk. Where regrowth is a problem cover crops can induce more cropping of the regenerating shoots at a sensitive stage of growth but I do not consider it significant enough for us to use a cover crop.

What sort of management problems do you have with paddocks in which only a part has been cleared and put down to lucerne?

Mr. Raff: It is a distinct management advantage providing considerable savings in labour and time particularly in mustering and supervision for fly strike.

What has been the value of the lucerne pastures to your level of animal production?

Mr. Raff: It is almost impossible to estimate as it is now so much a part of our overall management. By developing about one quarter of these areas to lucerne we find we can roughly double the carrying capacity of the whole area. Our ewe flock is divided into three lambing groups for ease of management with a little more than 300 in each. The first lot lamb in June, the second in July and the third in August. These groups go onto lucerne about 2 weeks before lambing which is about the critical time for pregnancy toxaemia to develop. As a result we are no longer troubled with this condition. Our lambing percentage has increased dramatically to 91% this year. We are aiming to develop 100-150 acres each year. It is being done within the present pool of labour which includes myself, my son and 1 man.

Is there a place for conserving feed as hay in order to supplement the stock at critical times of the year?

Mr. Raff: Yes, definitely. This is the only way you can safely go into a programme of consistent heavy stocking. On our other property nearby we make a large amount of hay and I'm not happy to face the ensuing season without our storage capacity being full.

Could you comment on the use of cattle along with sheep in this enterprise?

Mr. Raff: We are definitely going to be carrying more cattle as development progresses. It is much easier to manage lucerne with cattle than with sheep. The cattle adjust themselves to lucerne in a larger area of native pasture. They will spend ¾ of the time grazing the rough country and only ¼ of the time on lucerne while the sheep tend to eat all the lucerne first and then forage out from there.

Since you seem to be able to establish barrel medic quite well do you see any hope of aerial seeding it into the rougher country where you haven't established lucerne?

Mr. Raff: No, I don't think it would work successfully because it is necessary to control the level of grazing rather closely to establish these pastures and in these larger, rougher areas this is not possible.

Is galvanized burr (Bassia burchii) a problem in pastures in this area?

Mr. McDowall: While it has been a considerable problem in the past, galvanized burr does not seem to be compatible with barrel medic and can now be successfully controlled by the establishment of a vigorous stand of barrel medic.

Many of the farmers who don't believe in lucerne say that in dry spells much of the leaf drops and then mainly stems are left.

Mr. Raff: On grazing lucerne this is not a problem because it is usually eaten back by then anyway. The stocking rate can always be increased to ensure that it is if this is occurring. Besides that, sheep will pick up fallen leaves from the ground. It is amazing how the lucerne will keep producing shoots even in prolonged dry spells.

"RISDON" — PROPERTY OF MR. K. LEAHY, RISDON PASTORAL CO.

The property of 13500 acres is situated 11 miles south of Warwick with an annual average rainfall of about 27 in. The topography is steep to undulating, ranging between 1500 ft to 3000 ft above sea level. The soils are of two types, one derived from andesitic basalt, the other granite, but only the basalt soils are being considered here. At present about 2000 acres of usable country remains in timber which is narrow leafed ironbark (*Eucalyptus crebra*) yellow and grey box (*E. melliodora* and *E. conica*) and wattle (*Acacia* spp.)

The property was purchased by the present owner in 1961 and since then 1900 acres have been developed to improved pastures. This development has been associated with closer sub-division of the paddocks, the largest of which is 1300 ac but many are 500 ac; this latter size presently being divided into 3 by use of suspension fences. Sheep, cattle and thoroughbred horses are run on the property and the most satisfactory fence has been found to be an 8-wire plain high-tensile suspension fence. Initially the property was carrying 11000 wethers. At the present time it is carrying: 2500 cattle, 2200 wethers, 1100 lambs, 800 ewes and 150 horses.

Improved pastures are planted in late May or June following a short period of seedbed preparation. This timing has been found to be quite critical. The steeper hillsides are chisel ploughed whereas the flatter areas are more thoroughly worked, but generally the seed beds are left fairly rough.

The initial fertilizer application is of 1 cwt Mo-superphosphate-24 and 1 cwt superphosphate, followed by 2 cwt superphosphate in the second year and 1 cwt superphosphate thereafter.

A complex seed mixture is used for establishing pasture and this includes up to 11 species but with lucerne common to all mixtures.

Legumes: lucerne (*Medicago sativa*), Ladino and N.Z. white clover (*Trifolium repens*), clustered clover (*T. glomeratum*), rose clover (*T. hirtum*), Marrar subterranean clover (*T. subterraneum*), Jemalong barrel medic (*M. truncatula*), snail medic (*M. scutellata*).

Grasses: fescue (*Festuca arundinacea*), *Phalaris tuberosa*, Kangaroo valley and Clunes rye grass (*Lolium perenne*), wimmera rye grass (*L. rigidum*) and cocksfoot (*Dactylis glomerata*).

DISCUSSION

After viewing these pastures of Mr. Leahy and the excellence of his lucerne, annual legumes and winter oats, I wonder why he is also attempting to establish winter

perennial grasses with the lucerne when they appear to be rather poor? It is known that these grasses are vulnerable to competition from summer-growing native species. What will these grasses give him in winter that the lucerne won't?

Mr. Leahy: The winter is our problem here. I am aiming at a more balanced pasture than lucerne or annual medics alone, because I find in sowing lucerne in pure stands the weedy summer annuals such as *Urochloa* spp. come in and then the lucerne goes out quite rapidly. I think a balanced pasture is more stable and certain to provide feed at the time of the year when it is needed most.

Mr. Clark: Because this country is more naturally fertile I think the lucerne/grass problem is somewhat different than it is on the granite or traprock. There is more chance for winter-growing perennial grasses to survive. Even so I think lucerne is of more value in winter than perennial grasses and I would stick with lucerne. There is some lucerne blight here which is a problem so perhaps there is some reason to think of planting grass.

Dr. Norris: Mr. Leahy's lucerne problems are not for lack of good root nodulation which have been the best of any of the areas we have seen on this trip. He is obviously doing the job properly by having his seed inoculated by professionals and thus taking no risks. However, he has things more in his favour than in other areas. Just looking at the three zones which we have been through during the last two days, I would say that the probability of nodulation troubles is in decreasing order from these andesitic basalts, to traprock, to the granitic sands. There are several reasons for this. Firstly there is a significant pH difference. On the andesites the pH's run from 6-6.5 or perhaps even higher which is a very favourable environment for nodulation. On the traprocks the pH's are down to 5-5.5 while on the granitic sands they may be as low as 4.5 which is very unfavourable for nodulation of temperate legumes. Secondly there is a difference between these soils in clay colloid content. This is high on the andesitic soils, medium on the traprocks and very low on the granitic sands. It is well known from work in Western Australia that the survival of bacteria in the soil is a function of the clay colloid content.

The need for inoculation: In the development of these new areas it is obviously vitally important that legumes should be inoculated with the specific inoculant for those particular legumes and this should be carefully checked beforehand. At Mr. Raff's place we heard of some unfortunate incidents where inoculation was not originally carried out and the trouble to which he had to go in order to achieve satisfactory nodulation. It is a simple and cheap undertaking before sowing and in many cases seed is now commercially available pre-inoculated.

Lime pelleting may or may not be necessary for successful nodulation and this depends on the type of legume and its type of *Rhizobium*, the pH of the soil and whether the seed is to be sown together with or separately from the fertilizers. A new process known as the 3-step, triple coat process is quite an unnecessary sophistication of pelleting technique. The very large numbers of bacteria that are claimed to be put on in broth form in this process are found to be of little consequence in the field nodulation of the seedling. The most effective nodulation comes from peat cultures which are well stuck on to the seed coat by an effective "sticker". The application of a lime coat in addition to this is not always necessary. With lucerne, which is a very lime-demanding species, lime pelleting must be carried out if the pH is 5.5 or less. For the clovers and others medics the limit could possibly be set at pH 5. However, if inoculated seed is to be mixed with superphosphate before sowing it is absolutely necessary to pellet the seed.

I should like to make it quite clear what a seed pellet is. It is not a mere dusting of lime on the seed coat which has previously had the inoculant stuck on with sugar or some such material. It is a considerable quantity of lime stuck on with a very good

adhesive such as 40% gum arabic or 3-4% Methaphas.* This latter material has given us good results and is considerably cheaper.

Seradella has been mentioned a number of times as a legume of some promise for the area. This is a legume which takes a specific *Rhizobium* of the tropical legume cow pea type and is quite different from the temperate legumes we have been talking about. From work done in Western Australia it is quite clear that it responds negatively to lime pelleting or lime. Thus the bacteria should simply be stuck on the seed without lime pelleting or, if it is necessary to pellet for mixing with superphosphate, rock phosphate dust should be used.

At Bowenfels, the higher rainfall property on granite of Mr. Bondfield, there were quite a number of clover plants not nodulated even though everything had been inoculated and pelleted at sowing. Could Dr. Norris comment on this?

Dr. Norris: Western Australian work has shown nodulation failure in subterranean clover due to bacteria being unable to survive over the dry period in sandy soils. This has been found to be related to the low clay colloid content of the soil and it may be partly a comparable case here. I would think that as the organic matter content of these soils builds up the situation may progressively improve.

Is it possible to supply the molybdenum requirement of these soils through the lime pellet?

Dr. Norris: Some work has been done on this. It has been found that the sodium salt of of molybdenum is toxic to the *Rhizobium* but molybdenum trioxide is quite safe and harmless.

How well do you think your program of pasture improvement is paying off Mr Leahy?

Mr. Leahy: That is hard to say at present because we haven't gone far enough to come out of the red! I have also to think about the horse stud which gets the cream of all the pastures. I am quite sure we are at a distinct advantage with our improved pasture because we've just come through a severe drought, and although we sent the cattle away for grazing elsewhere, we still carried a lot of stock through. I think the secret lies in the superphosphate almost more than anything else. The way things grow when 5 cwt/ac of superphosphate has been applied compared with what grows without fertilizer is so astounding as to convince me that pasture improvement must pay off.

* Trade name of an I.C.I. product.