NITROGEN AND PASTORAL PRODUCTION
A SYMPOSIUM HELD AT THE UNIVERSITY OF QUEENSLAND, ST. LUCIA, ON JUNE 26, 1968

CHAIRMAN: E. F. Henzell
PANEL: P. E. Luck, T. R. Evans, D. R. Tait and D. J. Minson

INTRODUCTION

by

E. F. HENZELL, C.S.I.R.O., DIVISION OF TROPICAL PASTURES, BRISBANE.

Before introducing the members of the Panel, I will try to set the stage for this discussion. Why is so much importance attached to nitrogen in pastoral production? I suggest that there are four reasons:

1. Nitrogen is required in large amounts for growth of plants and animals. Of the other essential mineral elements, only potassium is required in as high a concentration as nitrogen for healthy growth.
2. Soil nitrogen is usually released too slowly to satisfy the needs of highly-productive pasture plants. Perhaps the only exception to this is found in fertile soils newly-cleared from forest or after a period of fallow. Many of the brigalow soils have a high natural fertility.
3. Nitrogen is subject to large losses. Some forms are readily leached away, others evaporate into the air. Hence the need to keep adding nitrogen to maintain a high level of production. Compare this with the behaviour of phosphate or the trace elements, where a single application of fertilizer may suffice for several years.
4. In relation to the quantities needed to maintain high production, nitrogen is an expensive fertilizer.

At present pastoral production in Northern Australia depends mainly on soil reserves built up in the past for its supply of nitrogen, and most of the pastures show clear-cut evidence of nitrogen deficiency. However, during the last fifteen or twenty years good progress has been made in the development of improvd pastures based on nodulated legumes that can fix their own nitrogen supply from the air. These legume-based pastures are beginning to make an impact on commercial production along the coast of Queensland and in the North.

More recently, attention has been given to the possibility of using synthetic nitrogen for pasture improvement in this State. Developments now taking place in the manufacture of fertilizer and in the grazing of nitrogen-fertilized grass seem certain to lead to profitable uses for synthetic nitrogen fertilizers on Queensland pastures. Soon there will be two modern plants producing nitrogen at Brisbane.

Strangely enough, development of improved pastures, particularly legume-based pastures, tends to throw even more emphasis on to the role of nitrogen. This happens because of the practice, for which I am sure there are convincing arguments, of fertilizing to correct other deficiencies first. The common practice with a newly-sown pasture is to fertilize with phosphate and trace elements — even potash if it is needed. The result is that nitrogen deficiency becomes the most obvious nutrient deficiency in an improved pasture and sometimes it becomes the only remaining nutrient deficiency.

One of the questions that will demand increasing attention from graziers and scientists in the near future concerns the relative merits of legume-based pastures and nitrogen-fertilized grasses. Here you have two different kinds of pasture,

requiring different managements and differing also in their feeding value for grazing livestock. I hope our discussion will touch on some of the complex issues that are involved.

The members of tonight's Panel will be covering several different aspects of this wide subject of nitrogen in pastoral production. Mr. Luck will speak first on "Legumes and Nitrogen for Wide Bay Dairying".

LEGUMES AND NITROGEN FOR WIDE BAY DAIRYING

by

P. E. LUCK, DEPARTMENT OF PRIMARY INDUSTRIES, COOROY.

The Wide Bay Dairy Region, for the purpose of this discussion, extends from about Landsborough in the south through Maleny, the Mary Valley, Conondale, Kenilworth, and Gympie, to Tiaro, south of Maryborough. On the coastal side we have towns like Nambour, Eumundi, Cooroy, Pomona and Kin Kin. There are approximately 2,000 dairy farmers in this region and it would be the most concentrated dairying region in the State. Unfortunately in the past the area has been rather depressed economic-wise; the dairy economy is based mainly on butterfat prices, which as you all realize aren't very high.

To make a living farmers have to become a lot more efficient. To become efficient you first of all have to increase dairy production. In attempting to boost production the farmers in this area have accepted pasture improvement as the basis on which they can build a better economy. It is rather gratifying that the advice of the Department and other research organisations is being accepted. We have almost half our farmers in the region accepting pasture improvement and taking advantage of the Queensland Government pasture subsidy scheme to the extent that they are planting on an average about 20 acres of improved legume-based pasture each year. That is, on the fifty per cent of farms that are accepting subsidy. And I should add, when I mention legume-based pastures, that about half of this is based on clover and lucerne — it is not all tropical legumes as a lot of people believe.

Now I suggest that nitrogen fertilizer should be used in a complementary or a supplementary role to the legume. I'll postulate a model forage flow for this environment, and in this I suggest that temperate legumes, such as clover and lucerne be planted on the wetter and colder areas such as the flats and where irrigation is available. Tropical legumes should be planted on the drier and warmer hills where the frosts aren't as severe. Nitrogen fertilizer is generally essential on fodder crops, particularly on oats which will help fill the feed gap in winter time, also on supplementary grain crops such as maize. However, at the present price of nitrogen it will also be used increasingly to fill the gaps the legumes leave.

Whether we use this nitrogen on our existing legume-grass pastures with possible deleterious effects on the legume component or whether we use special grass pastures heavily fertilized with nitrogen is a debatable point. It wouldn't make sense for instance to use nitrogen on legume pastures if we are just going to substitute fertilizer nitrogen for the legume's contribution. This contribution can be considerable, of the order of, say, one to two hundred pounds of elemental nitrogen, which is a significant amount. Of course the advent of better grasses and cheaper nitrogen could change the concept. It can be expected that more and more nitrogen fertilizer will be used on pasture, but at the moment about the best grass I know of on which to use nitrogen fertilizer is Kikuyu, particularly for late autumn and winter feed. It is very responsive to nitrogen fertilizer.

However, I must sound a warning against the rather glowing press reports that have been put out recently on the value of nitrogen-fertilized grass for pastures

in the Wide Bay Region. The first thought that came to my mind when nitrogen fertilizer was likened to gold was that they must be referring to the price of it. Certainly some of the claims that have been made are rather extravagant and cannot be substantiated, particularly stocking rates of two or more cows per acre on setaria. Another recent report suggested how much money or profit per acre could be made by heavy stocking of milkers on nitrogen-fertilized setaria. While this is true for part of the year the seasonal growth characteristic of this grass unfortunately precludes such high stocking rates all-year-round. To give them credit I believe these people certainly realize the limitations of our existing sub-tropical grasses and are hoping for better things with more frost-tolerant strains of grass when they are released.

But the fact remains, with our existing grasses and where legumes can be grown, that legume-based pastures should be used to provide the bulk of the cows feed. Grasses alone cannot economically rejuvenate our degraded and often weed-infested hillsides. Mature grass cannot rival mature legume for stand-over winter feed, and I include in this category autumn-saved clover and lucerne and also unfrosted tropical legumes. Both the intake and the digestibility of the legume at this time of the year will surpass mature summer grasses. Certainly white clover has no peer for late winter and spring feed in this environment, both in the quantity and quality of the feed produced at this critical time.

While there are unsolved problems in the growing of legume pastures in the problems may be overcome. The seasonal or warm season yield of nitrogen-stimulated grass is certainly impressive in this environment. However, it is one thing growing feed at a price; a high degree of utilization is required for it to be economic. I have done some work on fertilizing grasses, such as paspalum, trying drier and colder parts of Wide Bay, with sufficient research many of these to smother the mat or carpet grass component of the sward. I certainly grew a lot of grass, but I didn't achieve my desire of smothering out the carpet grass permanently and I certainly didn't make any money out of doing it. All I grew was a lot more grass in the summer which cattle didn't utilize effectively. Now one of the fertilizer companies has shown that you can make money out of fertilizing these grasses providing you do it in the spring and autumn period where it acts firstly as a protein supplement. I believe, as has been shown in the past, that small areas of, say, irrigated clover, will act as protein supplement in much the same way and give production far in excess of what you would expect from such a small acreage.

I believe that grass plus heavy nitrogen fertilizer will be the most intensive form of land use. Legume pastures are certainly intensive but I think the management requirements and skills will be far greater with nitrogen-fertilized grass because the cash outlay per acre, the expendable money per acre, is higher and you have to get this back before you make a profit. If the risks go up in proportion to the cash outlay per acre then I think the need for fodder conservation and irrigation is increased, particularly in the marginal areas where drought is more frequent. Most legumes are superior to grasses for making quality hay.

Farmers are generally a fairly shrewd breed with a natural reluctance to take excessive risks. However, they are not averse to progress and when and where it can be proven that nitrogen fertilizers can economically complement or even replace legumes, gradual acceptance will occur. Perhaps the present price of nitrogenous fertilizers and the limitations of our existing grasses are the greatest hurdles. It is pleasing to see in south-eastern Queensland the increasing emphasis, particularly by private enterprise, on nitrogen fertilizer research, but I predict that for the Wide Bay Region legumes are going to remain the most important source both indirect and direct, of dietary nitrogen and energy for many years to come.

SOURCES OF NITROGEN FOR BEEF PRODUCTION IN THE WALLUM

by

T. R. EVANS, C.S.I.R.O., DIVISION OF TROPICAL PASTURES, BRISBANE.

A few years ago a discussion on the topic of legumes versus nitrogen fertilizers would only have been of theoretical interest and of little or no practical significance. Research work on use of nitrogen fertilizer as a source of nitrogen for grass pastures for beef production is still in its infancy. It is therefore difficult to argue in depth on the merits of these sources of nitrogen as alternatives at this point in time, with only limited data on animal production from one of them, viz. nitrogen fertilizer.

I will, however, attempt to summarize the results so far achieved and discuss these in respect to the advantages and limitations of each source of nitrogen as known at present.

As you are aware the Wallum Region has a mean annual rainfall ranging from 40-70in., is fairly densely forested and has infertile sandy soils. The problem has been to convert these soils to sandy loams of higher fertility and to obtain the high levels of animal production needed to offset the high capital input required for development and to give an adequate return on capital invested by the grazier.

A summary of beef production from legume-based pasture is presented in Figure 1. Curves 3-6 are based on data from Hereford steers of 12-14 months of age through to slaughter at 24-26 months. Curve 1 is put in for a comparison of production from spear grass pasture with about 1% of native legume at Charters Towers (25in. rainfall). Live weight gain is about 20lb per acre per year. Curve 2 represents production from an unfertilized pasture of paspalum (*Paspalum dilatatum*), mat grass (*Axonopus affinis*) and 5-9% of white clover, but mat grass dominant, at Meridan Plains near Landsborough. The total production is about 100lb of liveweight gain per acre per year. Curves 3, 4, and 5 are for sown legume-based pastures at Beerwah (65in rainfall), all stocked at the rate of 1 beast per acre.

The first feature to note is the increase in liveweight gain from 250 to 300 to 480lb per acre associated with different percentages of legume in the pasture (% on a dry weight basis). The second important feature is the shortened period of slow rate of gain (or loss) in winter, and the elimination of losses in weight when a high percentage of legume is present in the pasture. The third feature is the higher overall rate of gain throughout the year from pastures with a good legume content. Similar results are being obtained at the Department of Primary Industries Station at Coolum and in our work in the Wallum north of Maryborough.

I think that we can interpret these results in the following way. Chemical analyses of plant material have shown that the nitrogen content of the grass is less than 1% N until there is $> 40\%$ legume in the pasture. This agrees with knowledge of nitrogen transfer to the grass which is generally low ($< 5\%$). At less than $\sim 1.3\%$ N (or 7.5% of crude protein) animal production would be limited by deficiency of protein. In these pastures protein for animal production is provided by the legume *per se*. Because of a higher crude protein and digestible crude protein content in the legume the intake of digestible dry matter is greater for the legume than for the associated grass, particularly in autumn and winter. But because of availability of protein from the legume the animal can also utilise grass of lower nutritive value.

This means that where the legume content of the pasture is low, there will be greater grazing pressure on the legume and this will result in a further decrease in legume content. This is particularly probable under intensive grazing in spring

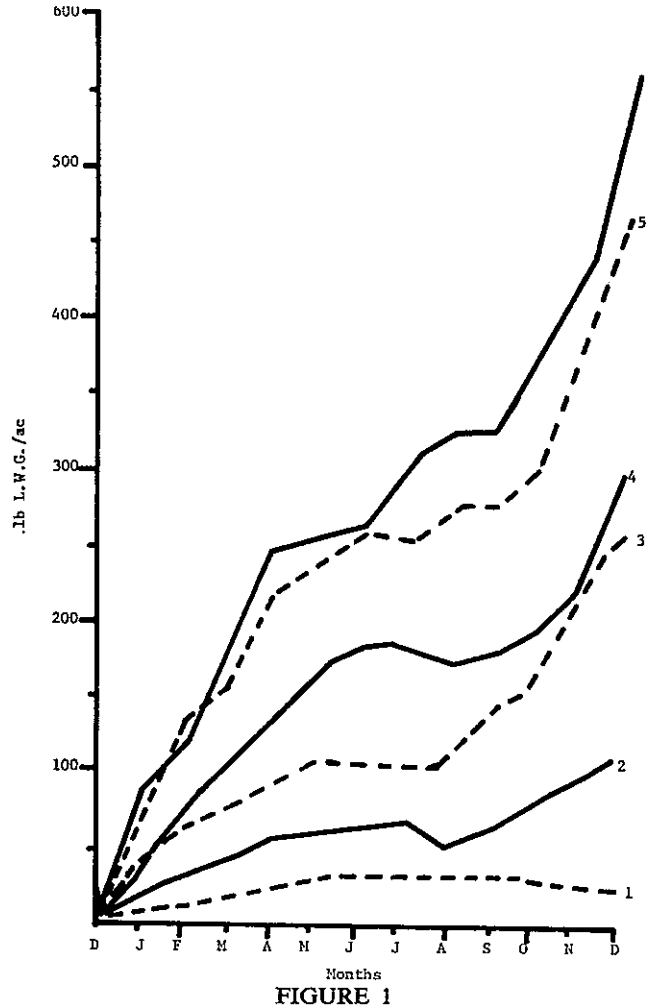

FIGURE 1

Cumulative liveweight gain per acre (L.W.G./ac.) for different pastures.

Legend: 1. Native pasture at Charters Towers containing 1% native legume (Chester, 1952).
2. Unfertilized *Axonopus affinis* dominant — paspalum — white clover pasture at Landsborough with 5-9% legume (Alexander & Chester, 1956).
3. Sown and fertilized pastures containing 13% legume, C.S.I.R.O., Beerwah, at a stocking rate of 1 beast/ac. (Bryan, 1968).
4. ditto but containing 20% legume (Bryan, unpublished).
5. ditto but containing 30-40% legume (Bryan & Evans, unpublished).
6. Pangola grass fertilized with 400lb of nitrogen per acre per year, C.S.I.R.O., Beerwah, at a stocking rate of 2 beasts/ac. (Bryan & Evans, unpublished).

and early summer when the total available dry matter is low and when the legumes are growing slowly.

Minson and Milford (1967) showed that dry matter digestibility was linearly related to legume content when there was more than 10% of legume in the diet.

The higher winter production can be attributed to use of winter-green species, particularly *Lotononis bainesii* and *Desmodium intortum*. Both species retain

their leaves after moderate frosting. Milford (1967) found with *D. uncinatum* that dry matter digestibility did not change in autumn or winter after frosting of this species. This factor may therefore be important in the results obtained.

The problem not yet resolved is how to maintain a high legume content in the sward. Ideally I would suggest a sward of 80% legume and 20% grass and all components winter-green and frost-tolerant. This should not be impossible to achieve.

If we now consider beef production from nitrogen fertilizer, this work has been confined to Pangola grass. Curve 6 (Figure 1) shows an annual production of 560lb liveweight gain per acre at a stocking rate of 2 beasts per acre. There has been a fairly steady rate of gain throughout the year. In another preliminary experiment with Pangola grass we attempted to maximize animal production by applying nitrogen at 400 and 800lb per acre per year, in split applications in quantities that fitted the growth curve.

The mean production for a 2 year period was ∽1200lb liveweight gain per acre per annum from 800lb of nitrogen and 1,140lb from 400lb of nitrogen. The stocking rate was 2 beasts per acre from July to early September and 3 + for the rest of the year. We are currently measuring production under a set stocking rate of 3 beasts per acre with applications of 400lb of nitrogen per acre per year, but applied in different amounts and frequencies of application. In the period September 5 to June 11 we have had a mean production of 1,080lb liveweight gain per acre with slightly higher production from 5-6 applications per year. From these treatments we have recorded ∽320lb liveweight gain per head in 268 days.

The interesting feature is that under rotational grazing of 1 week on and 4 weeks off approximately 4,000lb of dry matter of ∽27% dry matter content and a mean nitrogen content of 1.78% (= > 11% crude protein) have been on offer, i.e. we have been able to control quality.

The likely limitation to production will be rate of growth of grass in winter, which is largely temperature-controlled. Even so, it is quite obvious that where other plant nutritional deficiencies are met, nitrogen is the main limiting factor to production. When this is overcome then high levels of animal production can be attained. The limitations to use of nitrogen on pure grass pasture are largely economic. Firstly in terms of cost of nitrogen, although I think that the levels of production so far attained are economic at present prices. Secondly in terms of the capital expenditure carried in stock at these high stocking rates. It is to be hoped that in the not-too-distant future the price of nitrogen will be reduced but it is unlikely that store cattle prices will follow suit. This poses the question of breeding and fattening cattle in the region which I do not propose to go into, other than to suggest that use of nitrogen fertilizer on pastures with lactating animals will demand a careful examination of other nutrients, e.g. calcium. Certainly in legume-based pastures this element is adequately supplied.

In summary I think is it fair to say that highly productive perennial pastures can be established but that much work still needs to be done in terms of examining systems of management for optimum production. Our aim has to be towards an adequate supply of digestible energy and protein for animal production on a year-round and a continuing basis. In this respect sources of nitrogen from legume and fertilizer will probably be complementary. I do not believe that we have yet achieved from either source the optimum and certainly not the maximum animal production that is capable of being attained in this environment.

REFERENCES

ALEXANDER, G. I. and CHESTER, R. D. (1956) — Growth studies of beef cattle in Queensland. *Queensland Journal of Agricultural Science* **13**: 69-95.

BRYAN, W. W. (1968) — Grazing trials on the Wallum of South-East Queensland. 1. A comparison of four pastures. *Australian Journal of Experimental Agriculture and Animal Husbandry* **8**: (in press).

CHESTER, R. D. (1952) — Some problems of beef production. *Australian Veterinary Journal* **28**: 273-87.

MILFORD, R. (1967) — Nutritive values and chemical composition of seven tropical legumes and lucerne grown in sub-tropical South-Eastern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **7**: 540-45.

MINSON, D. J. and MILFORD, R. (1967) — The voluntary intake and digestibility of diets containing different proportions of legume and mature Pangola grass (*Digitaria decumbens*). *Australian Journal of Experimental Agriculture and Animal Husbandry* **7**: 546-51.

CROPS AND GRAIN FOR LIVESTOCK FEEDING IN THE BRIGALOW

by

D. R. TAIT, "WILGA PARK", BURNCLUITH, VIA CHINCHILLA.

The volume of crops produced in the Brigalow Area is generally only limited by the rainfall, as the soils have native fertility which is quite satisfactory for plant growth.

Soil reaction (pH) which ranges from moderately acid to moderately alkaline is in the range tolerated by most farm crops. Nitrogen is initially high to very high, phosphorus levels are borderline to fair, and potassium is usually very high. The soils have quite good water-holding capacity.

In 1925, prickly pear was at its peak in the Brigalow, and when *Cactoblastis* successfully controlled this pest it left an estimated pear debris of 80 tons* per acre. The brigalow was rung and crops were actually grown in this debris. They gave excellent yields. It was not only the huge amount of surface organic matter from prickly pear and leaf fall from the rung scrub, but there was also a large reserve in the surface few inches of soil from decomposition. Also, brigalow is a legume — thus, when the tree dies, the root nodules release their nitrogen wholly to the soil. The early development of the Brigalow was mainly for dairying and cattle raising. Now times have changed and so have the methods of winning over brigalow to production. Some brigalow is pulled, burnt and cleared for the plough, while other is pulled and burnt to be sown down with pasture. In those areas the pasture grasses Rhodes, buffel and green panic find their place.

When Brigalow is ploughed, crop fattening is usual. The reason for this is quick recoupment of clearing expenses. Because of the soil's high nitrogen status, crops produced are leafy and very dark green in colour. Scouring is a problem on these very lush crops; this is minimized by feeding baled barley straw or other roughage which not only slows down through-put of oats, but also helps balance the high protein of the oats with roughage carbohydrate.

This initial flush of nitrogen loses some of its vitality after two or three good seasons and when cultivation has unearthed the tons of roots and sticks and these have been cleared off the paddock, then grain growing seems to be preferred.

* Presumably this is green weight of pear — Ed.

Winter crop production is mainly oats, barley, wheat and lucerne, while summer crops are of grain sorghum, sorghum-Sudan grass crosses and peas. Oats growing presents a few problems — it is necessary to keep the grazing controlled so that one is not left with a lot of useless trampled and dirty oats stubble. This can be overcome by the planting of varieties with different times to maturity, or by planting only a portion on each planting rain.

Barley is used as a dual purpose crop — feed it off early, then if the season comes good with some rain, grain can be a second string.

Wheat — some wheat is planted for feed, but nearly all is harvested for grain.

Grain sorghum — this crop is harvested for grain, then the stubble is fed before oats is ready, or in conjunction with the oats.

Sorghum almum, sorghum-Sudan grass crosses are used as green fodder.

The legumes, lucerne and peas are used mainly for grazing, but some hay is conserved from the lucerne crops.

The effect of cropping on the productivity of these soils can best be gauged from the following figures for the protein content of wheat.

District	Protein %	Amount of Nitrogen in 30 Bags of Wheat lb.
Guluguba	17.9	51
Chinchilla	15.3	44
Brigalow	15.2	44
Jandowae	14.2	42
Miles	14.2	42
Meandarra	13.4	40
Millmerran	12.1	35
Wallumbilla	10.4	30

The wheat from newly-cultivated land at Guluguba contains 17.9% protein, whereas that from older Wallumbilla soils contains 10.4% protein. It has been estimated that Brigalow soils should be capable of producing twenty good crops of grain before nutritional stress symptoms begin to show. The widespread occurrence of mottled wheat is a reflection of the loss of nitrogen from our wheat growing soils.

The loss of nitrogen is not the only evidence of fertility loss as nitrogen comes mainly from organic matter which is a pre-requisite of good soil structure. With the coupled loss of organic matter this then influences the moisture penetration and we have problems with fine soil structures already.

The only thing that has stopped nitrogen being used before this has been the succession of dry years which has retarded the flow of soil nutrients to plant growth. Years like the last five have yielded rainfall which has given us very intermittent growing seasons with little or no follow-up rains. When moisture is present the plant growth is similar to that following a long fallow.

The only portion of the year when rainfall has been effective is during winter time when evaporation is low. The trend to crop fattening on oats and grain growing of wheat and barley have given the only worthwhile results. The expected pattern of rainfall will bring times of high rainfall and, because farming is opportunist, the time will change to one of better crop production and a higher drain of soil nutrients.

The long term planning for our farming of the Brigalow soils does cause us concern. We have an exploitive system of farming at present which can go on for a limited time. The use of leguminous crops does little for the soil in the environment of the Brigalow region. They must be some help but fall very far short of

the quantity of nitrogen extracted by the other crops. Our present range of pasture legumes cannot survive in pasture mixtures, let alone replace the nitrogen removed by the grass species.

At present, the volume of production is high, but we all realize this will deteriorate. This trend will be slowed up by using legumes but eventually fertilizer nitrogen will have to be used for production. This will enable us to produce crops in sufficient volume so that we can earn a reasonable return on capital.

ANIMAL NUTRITION

by

D. J. MINSON, C.S.I.R.O., DIVISION OF TROPICAL PASTURES, LAWES.

What I would like to do, this evening, is to refresh your memory on the principles of animal nutrition and then summarise some of our current ideas on the relative feeding values of legumes and grasses and where nitrogen fertilizer might fit into the picture. For maintenance and production four factors are required: energy, protein, minerals and vitamins. Under most conditions the main factor which is limiting animal production is the daily intake of energy. In other words, the more the animal eats per day the greater will be the daily production. Grasses are not completely digestible, in fact they are only about 70% digestible when they start to grow, that's when they are a couple of days old, but as they mature their digestibility falls. By comparison oats are far more digestible, having a digestibility of 80% when young.

Mr. Luck has already mentioned that for maximum animal production pastures should be grazed when young and highly digestible. However, the thing that really matters is not just the digestibility, but the total quantity of digestible nutrients eaten per day. Having a lot of grass around is no good unless it is eaten! In general it has been found that the quantity of grass cattle will eat is related to its digestibility. If you have a grass with a digestibility of 80% the intake will be high, but for grass with a digestibilty of 60% the ntake will be low since each 100 units of feed contains twice as much indigestible material to fill the digestive tract. Naturally enough, the animal can't handle all this indigestible fibre and cuts back its intake. Hence as the grass gets older both intake and digestibility fall.

The legumes, both tropical and temperate, have the same digestibility as the grasses, but a much higher intake. This is a most important factor and explains why we usually find much higher liveweight gains where legumes are present in the pasture. This higher intake does not appear to be caused by the higher nitrogen content of legumes since increasing the nitrogen content of Kikuku grass from 2.4 to 3.6% nitrogen by applying urea has no effect on intake; evidently nitrogen is not the limiting factor. With young grass the only thing that will be achieved by putting on fertilizer nitrogen is an increase in the quantity of food available and therefore a higher potential carrying capacity. There will be no increase in the feeding value of the grass. From this point of view, provided the pasture is being grazed at a very young stage of growth, no increase in production per animal can be expected.

With mature grasses and even quite young Pangola grass the crude protein content may fall below the critical value of 7% and the intake is then restricted by a lack of protein. As an illustration of this several years ago we grew Pangola grass at Beerwah — a couple of weeks before harvesting urea was applied to increase the crude protein content from 4% to 8%. This overcame the crude protein deficiency and the intake increased by 50%.

This rise in intake can also be obtained by incorporating a legume in the pasture. If we take Pangola grass with 4% crude protein the intake might be 600g for sheep. By adding 10% of legume to the ration the intake immediately rises to 900g due to the supplementary action of the nitrogen in the legume. The same sort of result can be achieved with mixtures of molasses and urea.

GENERAL DISCUSSION

Is it true that urea should be ploughed in and not left exposed on the surface?

Dr. Henzell: You can reduce the loss of nitrogen by putting urea into the soil but this practice is not applicable to permanent pasture.

What happens if you apply nitrogen to a legume-grass pasture?

Mr. Evans: I can quote some results obtained at Samford by Mr. Jones*. A Siratro grass pasture was fertilized with urea. The addition of 67lb. of nitrogen reduced Siratro yield by 16% and 200lb of nitrogen reduced it by 33%. Total pasture yield was increased but the legume component was reduced.

The thing that may be important is the time of growth of the legume in spring or early summer. Mr. Jones found in this particular experiment that below a minimum temperature of 57°F. the growth of Siratro was very slow. When the temperature went above this level there was an almost linear rate of growth from mid-December to mid-March. Dry matter production from Siratro reached a maximum rate of 79lb per acre per day in February-March. Most of our grasses start growth rather earlier than the tropical or sub-tropical legumes in early summer, and the addition of nitrogen could have an effect on the legume content of the pasture.

Dr. Henzell: Nitrogen put on in winter will affect the growth of grass in spring. Do you think this will reduce the yield of legume?

Mr. Evans: I think it will for a time, but the result will depend on grazing management, in utilizing the early summer grass production.

If the nitrogen were used up by grass growth in winter, would this affect the legume?

Mr. Evans: I think not, if the increased growth of grass is used so that it doesn't have a competitive advantage over the legume. The question assumes a grass that will grow through the winter, such as a frost-tolerant species.

Mr. Luck: Whilst on this subject, getting away from tropicals, there is some published evidence by Mr. Jones, Dr. Griffiths-Davies, and others**, on irrigated clover at Samford where, in fact, 100lb of nitrogen didn't deleteriously affect the clover component and the recovery of nitrogen was high, but when they used up to 300lb the white clover was suppressed in the early years and the nitrogen recovery was low. In autumn and winter, 100lb of nitrogen appeared to stimulate the regenerating white clover. I think the point is, if you are going to use nitrogen you must utilize it effectively. Some southern workers at the recent Australian Agrostology Conference were quite emphatic that providing the extra growth was fully utilized you wouldn't and shouldn't deleteriously affect the clover component of the pasture.

Mr. Evans: If I might add to that, a Pangola grass pasture receiving 800lb of nitrogen per acre per annum had some white clover in it in the early stages of

---

* JONES, R. J. (1967) — Effect of close cutting and nitrogen fertilizer on the growth of a Siratro (*Phaseolus atropurpureus*) pasture at Samford, South-Eastern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **7**: 157-61.

** JONES, R. J., DAVIES, GRIFFITHS, J., WAITE, R. B. and FERGUS, I. F. (1968) — The production and persistence of some grazed irrigated pasture mixtures in South Eastern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **8**: 177-89.

the experiment. This white clover was maintained in the pastures for a period of about three months. However, it wasn't effectively nodulated, as far as we could find out. I think the point is that by manipulating grazing pressure, and maintaining very high grazing pressure, then a legume such as white clover can be maintained in the pasture for a short period with heavy applications of nitrogen.

Mr. Lemon: Professor Geddes at Badgery's Creek increased clover growth in winter time by using high rates of sulphate of ammonia applied in the late autumn. Would this happen up here?

Dr. Hutton: Sulphur may be involved in this response.

Mr. Roe: In answer to Mr. Lemon, at Gympie, we've had some experience with pastures of setaria and other grasses, with white clover in them. For the last three summers we have given these pastures 400lb. of nitrogen over the summer period; this is nitrogen without any sulphur, calcium-ammonium-nitrate. Except for last spring, which as you recall was a very dry one, we have had so much white clover there in the late winter and spring that we couldn't induce the farmer to graze it for fear of bloat.

To Dr. Minson: Referring to urea and molasses drought licks, under what conditions will they increase intake?

Dr. Minson: The principle of the use of urea is well-recognized. The nitrogen deficiency in the grass is overcome by the urea and certainly in the Charters Towers area they are apparently getting extremely good results and there is a boom in the sale of rotary drums. These are apparently a very safe method of feeding the molasses-urea mixtures.

With regard to Pangola grass, why don't you use Kikuyu grass in the Wallum? It has much better winter growth than Pangola.

Mr. Evans: Well, the straight answer to that is that Kikuyu grass demands high fertility. Pangola grass will grow on these poor infertile soils and when nutrient deficiences have been corrected it is our best grass for achieving high levels of animal production. Under conditions of high fertility and on relatively well-drained areas then Kikuyu undoubtedly is a good grass. In the Wallum in most areas we have a fluctuating water table that could cause problems.

I think you said, if you used high nitrogen on the Pangola you got better weight gains by your cattle in winter.

Mr. Evans: Yes. This initial small-scale experiment was the one in which we tried to maximise production from Pangola. Nitrogen applications were split according to the growth curve for the grass; therefore, we applied our maximum amount of nitrogen in the summer. At this time Pangola grows at the rate of 100lb of dry matter per acre per day, but in the winter period only at about 2lb of dry matter per acre per day. At the 800lb rate of nitrogen, the crude protein content of the grass during winter was 11-12% and at the 400lb level of application the crude protein was approximately 8%. I think that the difference in animal production over winter was due to this difference in pasture quality.

Mr. Luck: I think Mr. Kyneur hit a touchy point with Pangola grass. He is obviously looking for more winter growth. Only 30 miles away from Beerwah at Coolum we are also running a nitrogen grazing trial on Pangola. Obviously Coolum must be a bit colder than Beerwah, this winter we have already had five frosts and they have been bad enough to frost nearly all the Pangola and completely stop grass growth. I don't know yet what it is going to do to the cattle. In the southern Wallum, anyway, in at least part of it, it seems that we have only an eight-month growing period with Pangola and I don't think you

can base a production system on eight months, unless you can buy stores at the right time and the right price. This is just one of the possible limiting factors to the use of Pangola grass by itself. There are other promising grasses, by the way, and some have more frost tolerance.

Dr. Henzell: To Mr. Luck. Wouldn't it be fair to say that these new grasses — frost tolerant or not — require a good deal of testing to make sure they give the same kind of animal production as Pangola grass does?

Mr. Luck: Well, unfortunately I can't see that any of our frost-tolerant grasses are going to have the same sort of production potential as Pangola, when it is really growing. I just can't see it, but the other thing that tends to happen, from observation at Coolum this winter, is that plots that have had high nitrogen are more sensitive to frosting. We definitely need some other grass or cold-tolerant pasture plant to back up Pangola grass in areas that are frosted in winter.

Mr. Harrison: To Mr. Luck. You mentioned lucerne for cold and wetter areas. What do you think it does in the way of production of nitrogen other than for itself, and do you think that nitrogen can be used economically on lucerne pastures, taking into consideration that one can put on a cwt. of nitrogen fertilizer for the price of 3 cwt. of super? If phosphate is not particularly deficient in the area, could this be an economic proposition?

Mr. Luck: Yes, well, I won't put lucerne into the wet category, I'll put it into the cold category. I was speaking of the wet category for clovers. I don't think it is so important that lucerne doesn't contribute much to an associated grass. I think the highest nitrogen yield will be obtained if you plant pure stands of lucerne. Perhaps Mr. Leslie might be able to confirm this for the Downs. This gets back to having the 80% of legume Mr. Evans was talking about. Unfortunately, I don't think our legumes are going to be very good at transferring nitrogen to the associated grass in that particular pasture. I think they might be fairly good in transference of nitrogen over the farm by judicious management, e.g. if you rotate night paddocks and thus have some control over the recycling of nitrogen from the legumes to other paddocks. I think the use of nitrogen on lucerne has been proved and will give you say an extra hay cut a year. Whether this is economic or not I wouldn't know. It has certainly been adopted by a number of farmers.

Concerning the reliability of fertilizer nitrogen or legume nitrogen, I think Mr. Luck suggested that fertilizer nitrogen could be risky in the Wide Bay Area. I'd like to suggest that in certain instances fertilizer nitrogen is more reliable than legumes. Could the Panel try to characterise situations where legumes are reliable? Our experience points to the fact that legumes are more reliable on low-nitrogen soils.

Mr. Luck: Yes, I'd agree that the first place we'd put legumes would be in the worst, lowest-fertility paddocks, the ones that don't carry good grasses at the moment. I think Kikuyu is one grass you have in mind and it is very doubtful how much contribution you are going to get by trying to introduce some of our legumes into it. It can be done, but it requires a fair bit of trouble to do it. Certainly I think these strong-grass areas on the property are the ones you might tend to leave in strong grass, such as Kikuyu, and try to manipulate the feed supply by judicious use of fertilizer nitrogen.

We have one farmer who is trying to do this at Maleny. Mr. Gartner has done it in the Atherton Tablelands. Fortunately there are many farmers up there on a warm milk quota and the price for that product is higher. I think that the practice would probably be economic in, say, the late autumn, winter, and possibly spring period, if there is moisture available. Moisture is a key factor — at Maleny this year a farmer is using 100lb of nitrogen over 30 acres and he was going to put on more, but there has been hardly any rain since he put the first dressing on. I think

this is the catch. It could be economic if you get the moisture and even in a high-rainfall area like Maleny our rainfall can be unreliable. It may be a lot of money to outlay if you don't get the right weather to get the benefits from it.

Mr. Tait: The only reliable results for brigalow soils have been obtained with lucerne. The best results have been obtained by cropping on soils with good nitrogen status, and probably these lucerne crops have been limited only by the moisture supply. The nitrogen production from lucerne on poor land would be low since the crop is only mediocre on this class of land.

Mr. Addison: We've got ample evidence to suggest that one of the main effects of nitrogen on grass is to increase dry matter production, and some of these sub-tropical grasses are about the most efficient dry-matter producers in the world. Dr. Minson has already pointed out that, although these grasses do produce a large quantity of protein per acre, it is the percentage of protein which is of particular interest for cattle. Now, in view of this, can we make our tropical grasses into efficient nitrogen producers? I doubt it very much, particularly in view of the alternate source of protein that we have at our disposal.

The second part of my question is directed to Mr. Evans. Isn't the use of nitrogen likely to be very profitable on the Wallum, where the clearing costs and the initial development costs for sown pasture are pretty high, say from about 60 to 80 dollars per acre, and where you have to wait a considerable time for the legumes to build up sufficient nitrogen to get the pasture going?

Dr. Henzell: Taking the first part of the question. When you say, can we make these grasses into efficient nitrogen producers, do you mean can we make them so their protein content doesn't fall below a minimum value when they run short of nitrogen?

Mr. Addison: Yes, to meet Dr. Minson's requirements for digestion and intake.

Dr. Minson: Theoretically we could select tropical grasses with a higher minimum crude protein content. However, these grasses would be less vigorous than the ones we have at the moment and they would be unable to compete.

Mr. Evans: With Pangola grass you certainly get a large increase in dry matter production from additional nitrogen fertilizer, but nevertheless, by manipulation of the time and rate of application of nitrogen a pasture of high quality can be maintained. This is shown by the fact that we can treble our production using three times the stocking rate; the per head production is in fact much the same as we get in the grass-legume pasture. Through use of nitrogen fertilizer we are producing a higher total amount of dry matter and maintaining a higher protein content. I cannot fully agree with Mr. Addison's comment on the time taken for the legume to build up in the pasture in comparison with production from nitrogen-fertilized grass. For instance, we have seen in our own work and also on commercial developments on the Wallum, in the 60-65in. rainfall area, that legumes such as *Lotononis bainesii* have established very rapidly and can reach legume dominance (up to 80%) in the first year of the pasture. These pastures can be stocked within 12 weeks of sowing, at a rate of about a beast to 2.5 or 3 acres. The legumes in fact grow away fairly rapidly and we can stock the pastures early. It is also true that by use of nitrogen fertilizer we can probably stock pure pasture at a heavier rate, but the rate of growth of the pasture, from establishment, may not be very much quicker than from the grass-legume pastures we are using at present. It depends very much upon the species and their rate of establishment. Pangola grass is stoloniferous and establishes fairly rapidly. Species such as setaria or plicatulum may take much longer to produce a highly-productive pasture, or to achieve the same grazing pressure in the first year as a grass-legume pasture.

Dr. Hutton: To Mr. Tait. Why are you so pessimistic about getting a legume that will put back the nitrogen that's taken out by a crop? I think there are legumes that will do this very thing. Have you tried Dolichos lablab?

Mr. Tait: I haven't tried dolichos myself. There are areas in the immediate vicinity that have tried dolichos with quite good results, but the trouble is still to try to fit this all into the cropping programme. First of all, you put a crop of dolichos in, using up some of the moisture to build up nitrogen, then you plant another crop to make use of that nitrogen. It doesn't always follow that it is going to rain, in the meantime. However, if it does and you do get successful crops, you are maintaining that balance well; I'm not sure it will replace everything that has been taken out by the succeeding crop, but you say it will overcome your insufficiency.

Dr. Hutton: With crops after *Dolichos lablab* there is certainly no evidence of nitrogen deficiency.

Mr. Tait: No, that's right, but when you try to fit it all in and you graze off dolichos, some of the nitrogen has gone. If you could afford to plough in dolichos then you might win the race.

Mr. Harrison: I have noticed on soils that are probably far more depleted than those Mr. Tait is talking about, soils that have been depleted by a number of years of annual cultivation, that pre-cropping with dolichos does give a marked improvement in pasture establishment.

Mr. Leslie: Cowpea and dolichos plants are no respecters of mineral nitrogen in soil and do in fact use it. Another point is that, even if you plough them in as a green manure crop the amount of nitrogen released for succeeding crops is relatively small.

In a 10-year rotation experiment on the Darling Downs with 1-4 years of lucerne followed by wheat, Mr. J. W. Littler found that the lucerne appeared to be adding about 80lb of nitrogen per acre per annum. The bulk of this change occurred in the first 18 months of the life of the stand. An economic analysis of the results indicated the following gross margins: continuous wheat $23 per acre; wheat and lucerne running 5 sheep per acre, $27 per acre; fertilizer nitrogen on continuous wheat, about $33 per acre. This is the point that Mr. Tait is making. Until the pasture part of a rotation is economically viable in its own right there's not going to be a lot of emphasis on crop rotation.

Could I ask Dr. Minson what happens if you do feed animals plum pudding for four days and sawdust for ten days — is this worse than feeding them the relative proportions of plum pudding and sawdust daily? The question arises from the observation that with animals grazing a pasture like green panic and lucerne the first thing they do is to go around and eat the lucerne and clean this up in 4 days and eat grass for the next 10. I'd like to ask, as a point of interest, whether the animal has some means of buffering itself against this.

Dr. Minson: If one has high and low nitrogen feeds where the high nitrogen feed is capable of acting as a supplement to the low nitrogen feed then obviously the best results can be expected when the two are fed at the same time. However, the excess nitrogen in the high nitrogen fed will not all be excreted within a day and some supplementing action would probably occur where high and low nitrogen feeds were fed on alternate days.

The example you gave of lucerne and green panic was one of preference where supplementing effects are unlikely. In this situation I think the cattle would grow fast for the four days they were eating lucerne and slowly for the remaining ten days while on grass.

It seems there's an inference from what the Panel has said that nitrogen fertilization accompanies the more intensive levels of stocking. I think this might be important in relation to the high cost of land development. Could I get an opinion from the Panel as to what in the Wide Bay Region and Wallum Region is the maximum stocking rate under which you would expect to maintain tropical legumes. In other words, at what level of intensity do you go from legume-based pastures to nitrogen-fertilized grass?

Mr. Evans: That is a difficult question and I can only answer from the facts that are available. These are that with grass-legume pastures, at a stocking rate of a beast to two acres you can maintain a high legume content, but as the stocking rate is increased there is a general tendency for the percentage of legume in the pasture to drop. There are also other interactions in terms of different species of legumes reacting with stocking rate. In terms of production, at a beast to an acre, even at 20% legume content in the pasture we've produced 300lb liveweight gain per acre per annum. (One thing I haven't mentioned is that we are talking about animals of 12 months of age coming on to the pasture and being fattened in a 12-month period.) Now in terms of use of nitrogen fertilizer, we can treble this rate of production per acre. A comparison between the two systems in practical terms has to take into consideration the capital required for development and the investment in stock needed for very intensive production with heavy rates of nitrogen fertilizer. Use of nitrogen will enable pasture to carry a high stocking rate, and produce a lot of meat per acre. But this involves purchase of 2-3 times as many stock. The other factors are the short supply of store animals and the progressive increase in price of these animals. I think that the situation at the present time is in fact in favour of the legume, if one considers the cost of development and stocking and the returns obtainable therefrom.

Mr. Cassidy: Good grazing legumes like lotononis and white clover will stand pretty high grazing pressure but our suite of tropical legumes tends to be a bit weak in this regard.

Mr. Evans: Lotononis is a sub-tropical legume and will take a grazing pressure of a beast to an acre. Under the system of evaluation that we're using, which is continuous grazing, *Desmodium intortum* will not stand a grazing pressure of a beast to an acre but it will a beast to two acres; it wil be reduced in content at a beast to 1.5 acres.This, however, is under a particular system of evaluation, viz., set stocking or continuous grazing, and it may be possible that, under different systems of evaluation, e.g. rotational grazing, we may be able to keep a higher percentage of legume in the pasture.

Mr. Luck: At the Perth Conference, Dr. Greenwood summed up on nitrogen and he did suggest on Mr. Evans' evidence that even at 1,100lb of liveweight gain per acre, the economics are still marginal. The advantage of the more intensive system with nitrogen will increase as the price of land increases because you increase the capital investment and the need to get a decent return out of it goes up. I think Mr. Cassidy might suggest it would be more economic sometimes to clear a lesser area of Wallum, fertilize it heavily with nitrogen and get into production very quickly without too great a capital investment, but I would sugest that your clearing costs go down as the acreage cleared becomes greater. There is a suggestion here, in fact, that you might be better off being a bit more extensive fairly early in the piece and getting the benefits of cheaper cleared land.

Mr. Evans: The cost of clearing at the present time is about $20 to $35 per acre for moderately-timbered Wallum and I doubt if this in fact will come very much lower, due to the type of machinery required to do this job and the fairly high depreciation and maintenance rates on such machinery.

What Wallum land are you quoting at $20-$35 per acre?

Mr. Evans: This is moderately-timbered Wallum and includes chaining, windrowing and burning; the very densely-timbered Wallum is being cleared for anything up to $60 per acre and this is where a blade is involved for pushing and windrowing.

Dr. Donaldson: Tonight we have heard animal production defined repeatedly as growth rate per acre. In itself I think this can be a dangerous term because cattlemen are also interested in whether the pasture is finishing the beast. Also many people here are interested in milk production. Mr. Luck and Mr. Evans touched on very important points when they suggested one of the difficulties associated with pastures is obtaining stores at the right price and at the right time. The fact is that obtaining stores is becoming almost impossible and many cattlemen have to breed and before you can fatten a steer you must breed it. So I am very interested in the effect on cattle fertility of nitrogen fertilizer and of legumes. On the Wallum I've read you need an 80% fertility to survive in relation to capital investment. We have overseas experience where high lush fertilized mixed pastures produce white muscle disease and in southern Australian we have legume pastures that produce fertility problems due to pasture oestrogens. In Queensland there is increasing evidence that certain pastures produce infertility. We have not established whether this is due to the legume, grass or weed component. However, whichever it is has a big bearing on the type of grazing. *I wonder if the Panel knows whether it is the nitrogen fertilizer which causes the white muscle problem and whether they could hazard a guess or have any knowledge of the problems that might be encountered with deleterious factors in pastures in Queensland.*

Dr. Minson: I would like to see evidence that there is an infertility problem that cannot be explained by disease or poor body condition.

Dr. Donaldson: I know of one particular pasture on which for three years in a row practically no cattle calved, and they have all been in fat condition. They have had lesions in the genital tract suggestive of something in the pasture causing the problem. There is sufficient evidence in other parts of the world that as intensive pasture production increases there are associated problems too. My question was as much directed at people with world-wide experience, so they could throw some light on these problems.

Dr. Minson: Overseas experience does not indicate that heavily-fertilized improved pastures cause infertility. Dutch experiments on 20 farms receiving heavy applications of fertilizer showed no adverse effects on reproduction. A smaller experiment at the Grassland Research Institute with 30cwt of nitrogen fertilizer applied per year also showed no adverse effect on any aspect of cattle or sheep production. Improved tropical pastures are now being used in the dairy industry in both northern New South Wales and Queensland, but there appears to be no drop in fertility.

Mr. Evans: Commercial developments on the Wallum are carrying breeding stock at the present time and obtaining a 75 to 80% calving. At Beerwah we carry heifers from 14-26 months of age and they are then returned to Samford for mating. There has not been any infertility trouble with these heifers that have been grazing grass-legume pastures on the Wallum, and calving percentages of 95-100% have been obtained.

Could I hark back to question 1 on losses of ammonia from urea. We hear a lot of different answers to this question. I think urea costs about 7.6 cents or something like that, per unit of nitrogen, and sulphate of ammonia about 12 cents. Thus, urea could possibly lose some nitrogen and still be very economical. Perhaps some people in the audience could comment further.

Dr. Henzell: There are wide differences in the amounts you can lose in different places and under different circumstances. For instance, it is known that clay soils hold ammonia better than very sandy ones, and that the acidity or alkalinity of the surface of the soil is an important factor. Ammonia is lost by evaporation, so the rate of evaporation is important too. I think the problem is to get this information into a form where everyone can interpret it for themselves and get the right answer.

Mr. Merke: Applying nitrogen fertilizer to the surface of the soil introduces a lot of variations and everyone that has investigated losses comes up with a different answer. There has been some work reported in the literature where as much as 80% of the nitrogen was lost from ammonium sulphate applied at the surface.

Dr. Henzell: It is a fair point that all forms of nitrogen are subject to some loss.

Dr. Hutton: Coming back to fertility, when I was in Western Australia recently I was told that sub-clover pastures that were giving infertility in sheep were not giving infertility in cattle.

Dr. Donaldson: There was a report in the last issue of the Australia Veterinary Journal of infertility in cattle on sub-clover.

To Dr. Minson. Would you care to describe for us your view of a model tropical pasture plant?

Dr. Minson: Well, a perfect pasture plant would be one with a 100% digestibility so that there is no fibre to block up the system. It must also have protein — with 100% digestibility 14% crude protein would be necessary — and a nice balance of minerals and vitamins. That's what we would like. What we have got in our present grasses is too much fibre, which is blocking up the system and limiting intake and hence production.

Mr. Christian: The early discussion relating to the comparison of a grass receiving nitrogen from a bag and a legume receiving it from *Rhizobium* seems to be based on the proposition that you can supply more nitrogen more quickly to a grass from a bag than the *Rhizobium* can supply it to the legume.

Can the situation be manipulated to increase the rate at which the legume receives nitrogen from Rhizobium, or alternatively can one produce legumes which will respond to applied nitrogen just as well as grasses and perhaps produce a better product from the digestibility point of view?

Mr. Luck: I've got one suggestion on this — obviously the legume is nodulated, is growing and fixing nitrogen, but we have seasonal effects because of the growth rhythm of the legumes. I suggest that a mixture of legumes with different growth rhythms is one way of partly overcoming the problem. I feel that some of our tropicals, such as *Desmodium intortum*, have a pretty long growth period, and this legume does actively fix nitrogen for a fairly long period. Some others like siratro with more of a peak of growth probably don't fix nitrogen for such a long period. Siratro fixes at a faster rate in that short period, but the total is probably no greater.

Mr. Evans: Legumes will fix approximately 150lb of nitrogen per acre, and under ideal conditions in Hawaii more than 360lb of nitrogen were fixed by *Desmodium intortum*. There is little doubt that these legumes can fix a lot of nitrogen. When they are grazed other factors may be important, such as the effect of the grazing animal on nodule production, the number of nodules, the growth of nodules, and the weight of nodules produced by the plant.

Dr. Henzell: The legume produces enough nitrogen for its own purposes if it is grown with good mineral nutrition and the right strain of *Rhizobium*. The point is, does it produce enough for the grass. However, if one could get nearer to Mr. Evans' 80% of legume, the needs of the grass would be cut back to a

point where the efficiency of transfer becomes much less of a problem than it is when one is hoping for a relatively small amount of legume to supply nitrogen for a large amount of grass. In other words, if legumes were dominant they might supply the pasture's nitrogen needs quite effectively.

The answer to the question about use of nitrogen on legumes may depend on how fast they can be made to grow with an unlimited nitrogen supply. There is evidence that tropical pasture grasses have an inherently faster growth rate than tropical legumes, or temperate legumes, or temperate pasture grasses. If this difference proves to be general, it may be impossible to make the legumes grow as fast as the tropical pasture grasses.

You're speaking in terms of dry matter, not in terms of Dr. Minson's digestible nutrients?

Dr. Henzell: Yes, but there may be a limitation on digestible nutrients too because legumes won't grow as fast as grasses.

Mr. Leslie: I am wondering about the possibility of growing tropical grasses with annual winter legumes. In the U.S.A., with Coastal Bermuda grass and crimson clover, they fertilizer the Bermuda grass during the summer and grow crimson clover during the winter. In Israel they do this with Rhodes grass and berseem. *Has someone looked into the situation here? It might be a good thing to have grasses which have a relatively well defined summer growth period and are relatively dormant in winter, and grow them with a winter annual.*

Mr. Redrup: We have been trying for some years to oversow temperate pasture species — grains, oats and barley right through to the small seeds — into tropical pastures at the theoretical time when frosts have stopped the growth of the tropicals. This has shown a lot of promise but seasonal conditions impose the chief limitation. This year, for example, we had early, heavy tropical material in our pastures, and we have better results from oversowing than ever before. Frequently, however, temperatures do not drop sufficiently to eliminate competitive growth of the sub-tropicals by the time the temperate species have to be sown. Perhaps some of the desiccant chemicals might help in these seasons.

Dr. Russell: The idea is good but the limitation is winter rainfall. If we had a little more winter rainfall, we'd be right. It would be an ideal system. The fact is we haven't. It works in some years but we can't rely on it every year.

Mr. Redrup: In our own case we tried to limit this work to swampy areas, which tend naturally to have a good deal of moisture in an otherwise dry situation. Elsewhere it is even more difficult to forecast results.

Mr. Bryan: I'd like to challenge Mr. Leslie's statement. In the deep south of the United States from 1956 to 1966 the acreage of crimson clover dropped to 1/7th of what it had been in 1956. So obviously it is not working over there, though I can't speak for Israel.

I'd like to bring up the question of soil structure. Isn't there a place in the long-term picture in pastoral production for the legume as a physical soil builder as compared with nitrogen from the bag? Is there any evidence as to what happens to soil structure under a nitrogen fertilizer regime as compared with the legume as a nitrogen provider?

Mr. Tait: By putting fertilizer on from the bag I feel you are only trying to replace what is missing in the soil and the build-up, if any, in soil structure would be very small.

Mr. Evans: In the Wallum it's too soon to draw any conclusions from the work with nitrogen because this has been applied to permanent pasture and we are only just commencing heavy rates of nitrogen on newly-sown pastures. The

build-up of organic matter under a legume-based pasture is an extremely important feature of the system. There is a rapid build-up of organic matter and a change in soil structure to that of a sandy loam in this very sandy soil, which in its native state consists of about 92% sand in the top 6in. of the profile. This is most important in terms of improving structure and increasing fertility and has been increasing gradually through the years.

Do you think you can get the same effect with nitrogen-fertilized Pangola as you can with the legume?

Mr. Evans: I don't know if we can get it as rapidly. I doubt that it would be as rapid a build-up as from legumes such as desmodium, lotononis, or siratro which produce a very rapid build-up of leaf duff layer at the soil surface.

Dr. Ebersohn: Can we get any lead as to whether we may use nitrogen on our grasses and legumes for seed production?

Mr. Luck: We haven't got much evidence on the legumes, but I would suggest that it could be a good thing if we applied a little bit of nitrogen to get the legume going quickly before it starts to receive its *Rhizobium* nitrogen. I think there is some evidence, particularly in North Queensland, that they have got siratro and desmodium into active seed production in the first year by giving a nitrogen starter. From then on I think these legumes should be able to produce enough nitrogen for adequate seed production. The grass is a different story, of course, and I think quite a lot of nitrogen fertilizer must be used to get high seed production out of all our tropical and sub-tropical grasses. When I say nitrogen levels I mean something in the order of at least 100lb of nitrogen for grasses like setaria. If irrigation is available it could be boosted to a couple of hundred pounds of nitrogen for each seed crop, and double that if there are two seed crops in a year. There is some evidence that some of our newest setarias might require even higher levels of nitrogen than the existing Nandi and Kazungula. I think you will often get straight line responses to application of nitrogen for grass seed production.

Mr. Evans: Nitrogen is obviously required for grass seed production, and up to 150lb of nitrogen are used for seed production of grasses such as plicatulum, scrobic and setaria. In a small experiment a linear increase in seed yield was obtained up to 300lb of nitrogen per acre.

Mr. Redrup: In our early days we screened the legumes with which we were working for their response to nitrogen. We very quickly established that 50lb of nitrogen seemed to be extremely useful, particularly in the rapid establishment of seedlings and the capacity of seedlings to establish successfully against competition. However, at levels above 50lb we very quickly found a depression in yield. We, of course, dropped the attempt to increase seed yields by this means. In the grasses there is, it is true, a linear response to quite high levels of nitrogen, in fact, up to 300lb over a season. This works on a small scale but on a large scale it can work against you. Depending on the incidence of the rainfall, and the interaction between rainfall, temperature and wind you can find yourself with a gross bulky crop which exceeds the capacity of the equipment available to the seed grower.

What would be the phosphate requirements for those high nitrogen pastures?

Mr. Evans: We've been applying a high rate of phosphate, i.e. twice the normal maintenance dressing applied to a grass-legume pasture. In other words we have been applying 4cwt of superphosphate and 2cwt of potash per acre per annum. This was done deliberately so that neither of the elements would be limiting for pasture production. The levels of both phosphate and potassium in the grass were above the critical values required for optimum growth.

CONCLUSION

by

J. S. PULSFORD, A.C.F. AND SHIRLEYS FERTILIZERS LTD., BRISBANE.

Nitrogen is important for the future economy of Queensland, not only from the farmer's viewpoint, but from that of manufacturers and the Federal Treasurer who this year will subsidise nitrogen use to the extent of about $14 million. Opinions vary on the usefulness of nitrogen fertilizers for animal production — our Panel presented both optimistic and pessimistic views. Such views are to be expected when considering dairying and beef cattle raising, 20 inch and 60 inch rainfall country, small farms and large.

Mr. Luck examined the situation in the Wide Bay area of Southern Queensland, where 60 years of dairying have resulted in a high proportion of depressed farmers with depressed incomes. This is largely attributable to infertile soils and degraded pastures. The answer to this problem, for most farmers, must be to use legume-based pastures. Some use of nitrogen is essential, if oats, maize or other fodder or grain crops are grown.

Autumn and/or spring nitrogen on high yielding grasses such as Kikuyu might have a place. The use of high rates of nitrogen on Kikuyu, is being investigated at Wollongbar in New South Wales (400lb butterfat per acre from 300lb of nitrogen). The nitrogen fertilizer plus legume combination might have promise for particular situations; especially where the legume is not completely eliminated by nitrogen and where it returns if nitrogen fertilizer application is discontinued. Generally however, legumes and nitrogen are not additive, despite the fondest hopes by some that they might be, and if not, that they would be partly complementary and not mutually exclusive.

Whether or not higher managerial skills are required to use nitrogen than legumes was discussed. Some argued that it is simpler to manage a grass than to maintain legumes in a grass-legume mixture, particularly if the legume is not well adapted to seasonal variations in grazing pressure, grass competition, nutrient availability, temperature, etc. Irrigation or high and assured rainfall, and fodder conservation might not be inherently necessary for effective use of nitrogen, though high productivity may be allied to these.

If the use of nitrogen on grasses involves putting more money **into** the system, and getting more **out** of it than is the case with legumes, one would expect higher skills to be employed in the process of turning over more cash. Mr. Evans' evidence suggests that with legume-grass pastures generally, the emphasis should be on the legume, since the more legume there is in the pasture, the higher the liveweight gain per acre. But the legume places a ceiling of about 500lb liveweight gain per acre — if higher production than this is required, nitrogen fertilizer might provide an answer. Three things are needed; a nitrogen-responsive grass such as Pangola, lots of nitrogen (and other nutrients), and high stocking rates. Not only is the price of nitrogen critical, so also are the buying and selling prices of cattle for fattening.

Having decided on the nitrogen route to prosperity, its realisation depends on when and how much nitrogen to apply, i.e. the manipulation of the pasture to suit the requirements of the stock, and to a lesser extent, vice versa. Doing this has resulted in 3lb liveweight gain per pound of applied nitrogen, which is a gross return of over 30c for less than 10c worth of nitrogen. However a greater investment in other nutrients and cattle is also involved.

In the drier areas referred to by Mr. Tait, the amount of land available tends to set the pattern for development. If there is plenty of (cheap) land, pastures are important. As pressure for land increases, more emphasis must be put on cropping, both for cash from grain, and for stock fattening from forage crops and

grain stubbles. Soil fertility in the brigalow region was undoubtedly high initially — brigalow and prickly pear saw to that. Thirty years of cropping has significantly reduced nitrogen status, and use of nitrogen fertilizers might be necessary in the future. Legume fodder crops such as *Dolichos lablab,* or lucerne, were not considered likely to be important in the long term nitrogen status — maintenance — improvement problem. Reliability of crop performance might ultimately depend on using fertilizer; whether a start should be made before the drop in crop yields or quality is evident, poses a dilemma. Will fertilizer be relatively dearer or cheaper in the future?

The general questions and answers posed by Dr. Minson on forage and pasture quality or feeding value need continual ventilation. Too many farmers and graziers cannot or will not concede that for an animal to gain weight, it must eat, and the more it eats, the more it is likely to gain. The difficulty arises when fibre content is high; the feed cannot then pack enough energy and protein into its structure for high intake and high animal response. One problem inherent in many tropical grasses is their high fibre content, and since this is not markedly affected by nitrogen fertilizers, and since the legumes generally have a lower fibre content than the grasses, it is not surprising that animals do better on legumes.

The wide variety of questions and comments indicated the interest in this subject. The hardy perennials such as possible losses of nitrogen from some forms of fertilizers, were all raised and answered — not necessarily to everybody's satisfaction. Depending on whose side you were on, or how misguided you were, you could be happy or unhappy. Time did not permit everybody to be satisfied.

Several years ago, a symposium on nitrogen was held in Brisbane.* Some of the contributions were excellent reviews of the role of nitrogen and of pasture legumes, and most of the views expressed had to be based on overseas information. Now we have our own opinions — some tentative, but many being actively researched or tried by farmers and graziers. Many people **want** something to happen — primary producers, pasture seedsmen and fertilizer manufacturers.

Whether we use nitrogen or legumes depends on many things. Obviously the most economical method of production should be employed, but as we know, Government decree, financial policy, balance of payments requirements and the votes of people who pressure for dairy pasture subsidies, feed year assistance schemes, nitrogen bounties, tariff protection, etc. often decide the issue instead. Let us hope that sanity prevails.

Good research will provide leads for farmers and graziers to follow. Manufacturers can continue to produce and sell nitrogen only if the users (farmers) make a profit from its use — they will not produce it for kicks. Let us not pretend that the manufacturer is hoodwinking the farmers — few are caught once, none twice by chicanery.

* A review of nitrogen in the Tropics with particular reference to pastures — A Symposium — Ed. C.S.I.R.O. Division of Tropical Pastures, Australia. C.A.B. Bulletin No. 46. 1962.