TROPICAL PASTURE SEED PRODUCTION, JULY MEETING, 1966

SOME ASPECTS OF PASTURE SEED PRODUCTION

by

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This paper reviews briefly some experiments dealing with pasture seed production carried out by officers of the Queensland Department of Primary Industries and which are being prepared for publication elsewhere.

In the first place we should like to emphasise the importance of proper plant nutrition in increasing seed yields and lowering the cost of production. In fact, we have found that some varieties which have been regarded as shy seeders are capable of very high seed yields when grown under a suitable fertilizer regime. The results of the following three fertilizer experiments illustrate these points:

Molopo buffel grass nitrogen and irrigation experiment

The Molopo variety of buffel grass has been well regarded because of its cold tolerance and vigour, and seed of this line has commanded a premium price. At the Biloela Research Station, Mr. D. G. Cameron and Mr. J. Mullaly laid down an experiment on a stand of Molopo Buffel entering its third year which was grown on a deep alluvial loam. Nitrogenous fertilizer was applied either as a single application at the beginning of September 1965 or an additional application was made at the end of January 1966. The irrigated treatments received waterings commencing at the end of August 1965 but no artificial watering was applied after December. Seed was hand harvested and the data from four main harvesting periods analysed.

TABLE 1.

Yield of Molopo buffel grass seed 1965/66 season (lb/ac).

lb N/ac	early irrigated	non-irrigated
0	4	7
75	23	42
75 + 75	106	150
150	64	141
150 + 150	212	286
300	170	233
300 + 300	339	449

The yields of seed for the whole 1965/66 season is summarised in Table 1, and shows some very striking effects indeed:

(a) Very large responses to nitrogenous fertilizer occurred. It is interesting to observe that the most efficient response occurred with heavy dressings of nitrogen, e.g. for the non-irrigated treatment, 75 lb. N gave an extra 35 lb. of seed/acre, whilst 150 lb. N gave an additional 135 lb. of seed.

(b) Split applications of nitrogenous fertilizer showed to real advantage.

(c) In this particular year early season irrigation was not beneficial under the conditions of the experiment. In the first November harvest period irrigation strikingly increased yield, but following 5 in. of rain in December, irrigation depressed yields at the second harvest very substantially. Possibly irrigation caused the more rapid disappearance of available nitrogen, and where irrigation is used, regular applications of fertilizer are perhaps indicated.

Many people are concerned lest heavy nitrogen applications cause a flush of vegetative growth which will imperil seed production, especially if droughting occurs. Moisture stress was noted before the third harvest and at this time the 150 + 150 lb N treatment outyielded the 300 + 300 lb N treatment. However, at the fourth harvest the reverse situation occurred. It is considered that with perennial grasses whilst heavy nitrogen use can cause some short term depressions below maximum yield, these losses outweigh the subsequent gains when a return to good conditions occurs.

Burnett Makarikari grass nitrogen experiment

In the 1963/64 season Mr. N. W. Doherty laid down a very revealing experiment with Burnett Makarikari grass which was grown in rows on the property of Mr. C. Fryar at Glastonbury near Gympie. This stand was in its third year and acute nitrogen deficiency was evident from the fact that only 9 lb of seed per acre was collected from the unfertilized stands. However, application of 46 lb of nitrogen per acre as sulphate of ammonia increased seed yields from 2 harvests to a total of 201 lb per acre. Both the seed weight per panicle and the number of panicles were increased by fertilizer application; density of seed heads was increased from 410,000 per acre to 800,000 per acre at the first harvest on January 31, 1964, and from 170,000 per acre to 1,050,000 per acre at the second harvest on March 12, 1964.

Burnett Makarikari grass nitrogen and row culture experiment

This experiment was laid down at the Brian Pastures Research Station near Gayndah by the junior author on a shallow fertile chernozem and was continued by Mr. J. K. Teitzel and Mr. R. E. Hendricksen. The grass was established either in swards or in rows 8 feet apart; equal plant numbers per acre were established. Nitrogenous fertilizer was applied at three levels as urea early each summer. Plots were hand harvested weekly in the 1960/61 season, but only three harvests were taken in the 1961/62 season.

The data are summarised in Table 2. Whilst there were some inconsistencies at the 75 lb N per acre level, the results do show a very convincing response both to row culture and to nitrogen application. Nitrogenous fertilizer increased the number of seeds per panicle and the number of panicles produced, but not the individual seed weight. High nitrogen also slightly improved germination percentage. Over the 2 years of the experiment an additional 48 lb of seed per acre was produced by applying 150 lb N per acre.

It will be noted from these three experiments that the response to nitrogenous fertilizer application varied greatly, the range being up to 4 lb. of seed per lb. of N

TABLE 2.
Yield of Burnett Makarikari grass seed (lb/ac).

lb N applied/acre	0	75	150	mean
1960/61 season				
8 ft rows	181	153	233	189
Sward	128	173	177	159
1961/62 season				
8 ft rows	51	66	96	71
Sward	24	77	78	60

applied. However, with current seed prices and with nitrogen ruling at approximately 14 cents per lb, an economic response was achieved in every case.

Further experiments with Makarikari grass

The long period of panicle production, uneven panicle flowering and early drop of ripe seed, all cause problems in the production of Makarikari grass seed. In one experiment at the Brian Pastures Research Station, Mr. J. K. Teitzel attempted to prevent seed abscission by the use of hormone sprays. However, 2,4,5-TP, alpha-napthoxyacetic acid and gibberellic acid applied at various concentrations to shoots varying from the pre-heading to seed ripe stages produced no beneficial effects on seed retention.

A more positive conclusiin resulted from some work carried out by Mr. D. L. Lloyd at the Queensland Wheat Research Institute, Toowoomba. Heads of Pollock Makarikari grass were harvested either at anthesis of the lowest panicle branches or seven days after this occurred. Stems were cut at lengths varying from 6 in. to 24 in. below the head. The cut heads were stored for either 10 or 24 days before being shaken to dislodge the seed. The seeds were then counted and weighed.

Length of stalk made little difference and neither did time of storage. Harvest time on the other hand was most important. Heads cut one week after anthesis of the lowest panicle branches yielded more seed (1.2 g/head) than those cut at anthesis of the lowest branches (0.7 g/head). This was followed by another test in which heads were shaken, not cut, at these same harvest times and at intervals thereafter. The difference in this case was even more marked. Three times as much seed was obtained at the later harvest. This applied to both seed number and seed weight.

It is concluded that maturation of seed on the lower branches of the panicle occurred at a greater rate than seed shatter from the apex. These results show that, for any head of Pollock Makarikari, it is desirable to delay harvesting until a week after anthesis of the lowest panicle branches.

Seed treatments

Low seed viability has caused some plants to be regarded as unsuitable for seed production. Germination is often retarded or prevented by an impermeable seed coat.

Methods such as acid treatment, hot water treatment, and abrasion of the seed coat have been used to overcome this problem. Previously treatment of legumes has been emphasised, but Dr. B. Grof of the Tropical Agriculture Research Station, South Johnstone, has found acid treatment to be effective in the case of *Brachiaria* species.

In a sample of *Brachiaria ruziziensis* with a caryopsis count of 46%, the germination increased from 17% to 40% after 15 minutes in concentrated sulphuric acid. *Brachiaria decumbens* harvested at South Johnstone in December 1965 showed nil germination in February 1966. Fifteen minutes in concentrated sulphuric increased this to 33%. Sand paper scarification was less effective.

Acid treatment is very effective in dealing with hardseededness in legumes, as is well known, but it is not a method which can be used on a large scale; considerable hazards exist for the operator. Hot water treatments are simpler to use but results are variable. Some authors have shown that seeds become impermeable when their moisture content falls below a certain figure. Therefore if hot water treatments are applied to seed lots with varying moisture contents, those seeds which are already permeable may be damaged by hot water.

Where there is a high proportion of hard seed, hot water treatment can be very effective. For instance, Mr. Fabian Sweeney found that germination of centro seed was materially increased by 30 minutes in hot water, i.e. from 47% to 80%. Twenty-seven per cent of treated seed germinated the day after treatment. This rapidity of germination is an advantage in overcoming weed competition.

A real need exists for increased research into methods of seed production and of harvesting techniques, a need which has become more acute with the rapid growth of the pasture seed industry in northern Australia.

SOME REFLECTIONS ON THE GROWTH OF THE TROPICAL SEEDS INDUSTRY

by

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It was barely six years ago, at a Seeds Industry Conference at Broadbeach, Queensland, that Dr. E. M. Hutton appealed directly to the Australian Seeds' Industry to undertake the task of commercialising the seed of that group of new cultivars that have since become collectively known as "The Tropicals".

On the face of it, the current situation would appear to be thoroughly satisfactory. Science has brought to light a large group of potentially immensely valuable pasture cultivars: it properly directed the attention of the seed industry to the need that existed to place the seed of these cultivars on the market. However, there is one problem;-the price of most of these seeds remains relatively high. As a consequence the suspicion has gained currency in some quarters that seed growers and seed merchants are making unjustifiably high profits from the growing and marketing of the seed of the new plant types.

Not that the odd seed-grower hasn't occasionally, with the odd crop, done very well. But as in most walks of life one hears a good deal more about the occasional windfall gains among seeds' growers, than about the equally frequent near-downfall losses. We ourselves like to reminisce over our beer about the near 1,000 pounds of farm-clean silverleaf desmodium we harvested from one acre of ground on Banora Point 3 years ago, but when the glasses are empty we're quickly sobered by the reflection that that sacred acre hasn't yielded a pound of seed since, thanks to the combined effects of drought and frost. Any of our station managers and co-operating growers and I suspect most of the more experienced growers among the audience today could tell windfall stories, and downfall stories too: but, most would agree that growing tropical seeds is pretty much the same as most other ways of earning a living in farming, with results depending far less upon luck than upon the skill with which crops are selected to suit the characteristics of the individual farm, and upon the willingness of the farmer to work hard and long to achieve even modest success.

Certain it is that individual windfalls no more determine the nationwide level of seed prices, than they do the price of gold, cabbages, or racehorses. The age-old interaction between average production costs, competition, demand, and alternative-resource use determines seed prices as ruthlessly as they determine the prices of every other unsubsidised primary commodity in our economy.

The facts are that some tropical seed-growers have already failed and left the industry; many are still in two minds whether to go out or stay in, hoping against hope for a return to "normal seasons"; a few are doing about as well as they would if they used equal energy, imagination and investment milking cows, or growing beef, maize, beans or tomatoes. There are, to my knowledge anyway, no fortunes being made. What sustains most growers is the sheer interest and challenge of the game, and of course the conviction that if they work hard enough the game might return them a modestly comfortable livelihood for the balance of their days.

As to the seeds' houses; they, in this extremely specialised and difficult sector of seed-production must stand so close to the seed-growers as virtually to share their interests and risks anyway, even where they are not themselves directly producing at least their foundation and mother seed lines. Their position is economically parallel to that of the grower. They have made, or are making, a heavy investment: they hope they will ultimately be able to show their tens of thousands of shareholders a sound return for their faith and enterprise.

Understanding that I'm in no way apologising for seed prices, in fact that I'm relieved and not a little proud that the industry has been able to bring them to their present level so quickly in the face of what is set out below, let me make a few points that I believe may bring a greater understanding of the seed technology side of the exciting tropical pasture picture.

1. To my knowledge, the emergence of so large a group of such completely new cultivars in so short a space of time is certainly unique in the history of world agriculture.
2. The cultivars will bring in their train a land-use revolution; not in northern Australia alone, but, ultimately, throughout the tropical world.
3. The first landholders to feel the full impact of that land-use revolution are those that have set their hand to the seed-production of the cultivars. Such are quite literally the first cultivators to handle large areas of the cultivars as economic crops.
4. Such landholders have been obliged to establish a completely new seeds' industry

with completely strange plants in a climatic zone which has never before been regarded as feasible seeds' cropping terrain. Indeed the climatic characteristics of the districts in which most of the tropicals can alone be successfully induced to set seed, are the very antithesis of those on which the bulk of pasture seeds production has hitherto been based.

5. By contrast with the choices of terrain available to temperate seedgrowers, the areas where tropical seeds' production must apparently be concentrated are extremely limited in area and remote in location. The cost of every service and facility required for production . . . from the mother seed itself (an overlooked but very major cost), to land, fertiliser, fuel, labor and technical services . . . is considerably higher than in historic pasture seed production centres.

6. The bulk of temperate forage plants have been subject to the effects of unconscious and conscious selection for seeding behaviour for many generations: some, like lucerne, for thousands of years. Certainly, over the past few decades all of them have been the subjects of the sophisticated attention of hundreds of workers in scores of research and production centres throughout the world. How profoundly this concentration of effort has modified the natural seeding capacities inherited from the wild progenitors of lucerne, the clovers, and the ryegrasses can readily be imagined.

Apart from the improvement in the genetically determined aspects of the seeding capacity of the temperate forage plants to which this work has undoubtedly led, there has been an enormous fund of information built up on every aspect of temperate seeds' crop establishment, management, harvesting procedures and the post-harvesting handling and processing of the harvested crops. In short the temperate forage species have almost certainly a higher genetic capability as seed crops, and we understand a very great deal about how they should be treated to express that capacity to the best effect.

I don't need to remind the members of this Society that almost all of the exciting materials with which we are dealing were literally wild plants hardly less than a decade ago. As such they are equivalent, at best to the presumed wild originals of the contemporary "temperates". The great tide of work that has developed modern temperate cultivars from their progenitors can hardly be said even to have begun for the tropicals: nor have we a paragraph of accumulated expertise in tropical seed cultivation, to set against the millions of words that are available on the management of the seed-crops of the temperate species.

Adequately to discuss the present physiological barriers to economic seed production is obviously impossible here. Some of the limitations are quite straightforward; having to do with the unusual mechanical qualities of the tropicals—such as their height, tangled nature, and sheer bulk. Others are more subtle and complex, even and consequently hardly as yet even clearly discerned; frequently having to do, for example, with interactions between the climatic and diurnal determinants for satisfactory floral initiation and seed-set, and the minimum requirements for satisfactory establishment, management and harvesting.

7. Tropical seed problems do not end at the harvester-bin, as Mr. Prodonoff has made clear in his address today. He has drawn attention to the necessity to understand

the post-harvesting physiological development of the diverse stocks of seeds with which we are all confronted.

8. Temperate seed growers produce their wares for a vast, rapidly expanding, settled and sophisticated national and, frequently, international market. Even the rare new cultivars they have to handle can be assured of an immediate and considerable market.

The tropical seed industry faces a very different picture. As well as growing their strange crops, they must market them, at necessarily relatively high prices, in a market that must still largely to be won to the notion of pasture improvement at all, let alone to the potentialities of pasture plants so new that the traditional conservatism of landholders is more than ordinarily difficult to budge.

It's not for the sheer fun of spending money that Terranova originated its seed packs. It's because we knew we had no hope on earth of creating a market for 20 new crops unless we employed every modern marketing and promotion device open to us, and opening markets was just not a matter of academic interest; but of vital and immediate necessity if our attempts to commercialise tropical seeds' production in the manner asked of the industry was not to fail at the outset. Incidentally, to scotch one rumour on the head, it may be of interest to know that our packaging currently costs as much as 3.25 cents per lb. for legumes and a little over 5 cents per lb. for the grasses, not a heavy or unjustifiable cost at this stage of the history of tropical pasture development. Nor was it for fun that we have been forced as an organisation to undertake a direct role in extension and farm and district advisory work. Our field days, schools and seminars covering subjects as widely varying as land-drainage, weed-control, and all aspects of land preparation, and pasture establishment and management, have attracted nearly 10,000 visitors in the past three years.

Again the cost of all this per pound of seed produced and marketed has not been high since we've largely used resources that were necessary for the productive effort anyway. But without that effort very little tropical pasture seed, bearing any brand, would have been, in our experience successfully sold.

Oddly enough the very vigour of our extension effort has sometimes drawn criticism. We are, some have said, overselling. The truth of the matter is that we have sold only the materials that have been produced officially and on the basis of the characteristics claimed for those materials by the originators. We consistently decline to encourage the expansion of use outside the materials' natural use zone. Once having accepted the scientists faith in the new materials we have sought vigorously to expand the production of the materials as science urged us to do. If you produce with vigour, you must, particularly in a completely new market, as vigorously sell: otherwise, quite simply, your enterprise dies.

9. I do not wish to labour this point, but it would distort the picture if it were not mentioned at all. The tropical seeds industry proper, is just 4 years old. Eighty per cent of the gross weight of seed created by that industry has been produced during a protracted two-years' drought that has affected every production area. So far as we can judge from our own and other growers' experience, fully 25 per cent of last years new planting did not bear seed at all in that season: yields of the balance were drastically cut. This year a little over one-third of new planting appear to have produced no seed: and, again, the yields of most established crops have

been generally curtailed. Equally serious, of course, have been the effects of drought on demand. Hundreds of farmers left thousands of intended tropical acres unsown last year.

10. In the face of all these factors, gentlemen, I do not believe that the tropical seeds industry needs to feel in the slightest sense embarrassed by the levels of price that it has managed to establish—in particular, for the coming season.
11. Finally it is of interest to know that, on the average, specialised temperate pasture seeds' producers are earning substantially more per acre than the average tropical seeds' producers to this stage.

THE DETERMINATION AND MAINTENANCE OF SEED QUALITY

by

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The Role of Seed Testing

Most of the 15,000 laboratory seed tests carried out by the Standards Branch, Department of Primary Industries, each year, provide information which can be grouped into two categories. The first result relates to the physical composition of the seed lot, and expresses the percentages by weight of pure seed, other crop seeds, weed seeds, and impurities present in a representative sample. It includes an identification of the particles of admixture. The second refers to the percentage of normal seedlings observed in a replicated germination test of the pure seed component. The percentage of fresh ungerminated seed present at the final count is also reported separately as an indication of the presence of dormancy. Any technique used to promote germination of dormant seeds is also mentioned in the test result.

When grass seed is tested on the understanding that pure seed consist only of those seed units which contain a caryopsis, including free caryopses in the sample, the germination percentage expressed as a fraction, multiplied by the percentage weight of pure seed, yields the PLS or *Pure Live Seed percentage.* The reproducibility of this derived percentage, by overseas laboratories, is a frequent contract requirement when seed is exported. One reason for this is that the PLS is the most useful single figure of a seed test on which to adjust planting rates.

The repoducibility of a routine test result, usually within 95% confidence limits, has both commercial and technical implications. Accurate and consistent results facilitate both local and overseas trade and are the bases on which standards of quality are set and administered by the Government in the country of origin. For example, in Queensland we have "The Agricultural Standards (Seeds) Regulations of 1966". Conversely, an official test is the only immediately authoritative information available to Quarantine officers who release or reject imported consignments of seed.

From the technical viewpoint a reproducible result involves the adoption by official seed testing laboratories throughout the world of standardized methods of sampling, agreement on concepts and definitions, and uniformity in testing procedures. International acceptance of uniform testing methods is condensed in the International Rules for Seed Testing, published by the International Seed Testing Association.

Seed testing laboratories contribute experimental findings to this Association which is composed of a number of Technical Committees. The function of each Committee is to develop Seed Technology by collating and examining data resulting from pure and applied research, and by supervising experimental work on seed exchanged by member countries.

While agreement between Australian States on testing procedures is based on the International Rules, Australia has active representation at the triennial conferences of the Association. Prior to the departure of Australian delegates an Australian Seed Testing Conference is held at which State authorities confer on the Australian point of view to be advanced at this meeting of international authorities. At the same time the Australian authorities formulate seed standards acceptable to all States. The International Association does not undertake to prescribe standards of seed quality.

In recent years the Australian voice has helped to win international recognition of problems associated with the determination and maintenance of the quality of tropical seeds. However, testing methods for many of our important tropical legumes and grasses do not appear in the International Rules of 1966. From our experience in Queensland there is also reason to believe that published definitions of pure seed, and inert matter, derived mainly from knowledge of temperate climate species, require modification in the light of our problems with tropical grass seeds.

Seed Testing Problems

The Queensland view of seed testing is that a test result should attempt to approximate field response. Hence, abnormal seedlings are not included in the final germination count.

Although a high laboratory germination can be correlated with field establishment under normal seasonal conditions, this correlation does not necessarily hold when the laboratory germination of any crop seed is relatively low. This problem arises from the general procedures for germinating seeds in the laboratory.

Usually 400 seeds are replicated on sterilized cloth, paper or sand and placed in an artificial microclimate in which humidity and temperature regimes are controlled. In low germinating seed, the particles placed out for germination represent varying proportions of viable seeds, weak seeds, and seeds already dead. Moulds developing on these seeds are limited mainly to sparse colonies of saprophytic fungi. The response of weak seeds in the soil cannot be predicted from a routine germination test. Soil tests are not at present included in routine tests because it is difficult to standardize soil to obtain reproducible results, and because a laboratory test is intended to provide a result within the shortest possible time.

The problem of estimating field strike is further complicated by dormant seeds. Germination of freshly harvested grass seed is invariably low, and it is considered worthwhile to carry out duplicate germination tests involving untreated seed, and seed which has been subjected to prechilling, predrying, scarification or chemicals which overcome dormancy to some extent. Both germination results are reported.

Developmental Trends

Future innovations in germination techniques for dormant grass seeds will depend mainly on additional information being made available by research workers investigating the various mechanisms of dormancy (Ballard, 1964). However the problem of dormancy is pressing and cannot be ignored. While every possible method for promoting the germination of dormant seeds is being examined, the Queensland seed testing laboratory is also carrying out investigations directed towards the derivation of acceptable definitions of a unit of pure seed, and the mechanical separation of this unit from the bulk. There is little point in attempting to determine satisfactory germination methods unless these methods are applied to intact pure seeds.

The International Rules (1966) state that pure seed consists of "undersized, shrivelled, immature and germinated seeds, provided they can be definitely identified as the species under consideration".

By using efficient seed blowers of the American General ER type it is possible to separate immature seeds of *Panicum maximum*. These immature seeds cannot be germinated in the laboratory. Samples of Rhodes grass (*Chloris gayana*) seed harvested too early, might appear on visual examination to contain many pure seeds. When these apparent pure seed units are separated from the sample by hand, a detailed examination of a number of particles carried out by removing ensheathing glumes might show no caryopses or caryopses in very early stages of development. Seeds of *Paspalum plicatulum* which appear to be fully formed might not contain caryopses. Apparent pure seed of Nandi setaria (*Setaria sphacelata*) might contain some formed caryopses which are shrivelled and grey coloured, presumably from sweating.

While such detailed examinations on hundreds of samples are difficult to perform, progress has been made in Queensland in the development of seed separation and germination techniques which can be handled by laboratory staff. An example of this is the present method of testing molasses grass (*Melinis minutiflora*) seed.

Recent lines of molasses grass seed have contained many empty seeds which to the eye appear identical with formed seed. In past years when this seed was hand harvested and laboratory equipment was not available to separate the formed seed the pure seed content was determined by hand separation using the Irish method of purity analysis which assumes that an intact seed unit contains a caryopsis. This method is acceptable by seed testing authorities for all but export seed and is still used for Rhodes and buffel grass (*Cenchrus ciliaris*) tests on lines intended for local sale.

Within the last eighteen months many samples of molasses grass seed were examined over transmitted light which aided the laborious hand separation of formed seed from empty seed. It was then possible to calibrate a newly imported seed blower so as to prevent the seeds matting together and to remove only empty seeds.

A comparison of germination techniques on the formed seed showed that by prechilling fresh dormant seed at 8°C for 5 days prior to germination the rate of germination was accelerated and that a significantly higher germination percentage was obtained than by the former pretreatment of drying seed at 40°C for ten days and then moistening the substrata with a 0.2% solution of potassium nitrate.

Test results obtained on four different seed lines after 21 days germination are set out in Table 1.

Progress has also been made in providing information on the hard seed content in pasture legumes. Two germination tests are carried out on each sample. The first test on untreated seed shows the percentage of hard seeds present. The second test result of scarified seed when compared with the first test result gives a clear indication of the viability of these hard seeds.

TABLE 1.

A comparison of methods of seed separation and germination techniques in molasses grass (*Melinis minutiflora*).

Pure Seed %	Germination %		Pure Seed %	Germination %	
(hand)	Untreated	Pretreated (KNO_3)	(air blower)	Untreated	Pretreated
					(Prechill)
93.5	36	22	56.2	49	70 (66% in 4 days)
94.0	30	36	60.6	74	78 (74% in 4 days)
88.0	11	8	30.3	28	43 (37% in 4 days)
92.4	43	39	70.7	64	76 (71% in 4 days)

While admitting that it is desirable to develop mechanical methods applicable to laboratory equipment and seed cleaning machinery which will separate out pure grass seed one could ask whether it is worthwhile to persevere with methods for germinating dormant seeds. The answer to this is perhaps best illustrated in the following table showing germination tests carried out on scrobic (*Paspalum commersonii*) seed. The germination behaviour of this seed over time is fairly typical of our local species of grasses. The pure seed component of scrobic is also easily separated from the sample in the laboratory. The period of the germination test was 28 days.

Sample 1 Harvested December 1964

	Germination %	
Date of test	Untreated seed	Treated seed (KNO_3)
March 65	40	88
May 65	87	90
July 65	83	82

Sample 2 Harvested February 1965

	Germination %	
Date of test	Untreated seed	Treated seed (KNO_3)
March 65	33	84
May 65	91	86
July 65	94	89

In September 1965 the seed producer blended these two lines of seed and obtained the following germination results of a composite sample. Untreated seed 93%, seed treated with potassium nitrate 95%.

The information obtained from these seed tests not only assured the owner that his time of harvesting had been well chosen but also predicted that this dormant seed which responded to a germination pretreatment a few months after harvesting would germinate normally near this percentage in nine months time.

Maintenance of Seed Quality

The maintenance of the quality of seed awaiting sale is an important function of Standards Branch. Regulatory activites involving the sampling of stored seed by Inspectors and the subsequent testing of this seed are designed to keep seed quality at a high level. These activities are further extended with regard to Government certified seed by way of supervision from production to sale.

In recent years it has been pleasing to observe the attention given by seed producers and other commercial enterprises to methods by which seed quality can be maintained. It would be appropriate to mention the great progress made by three of our largest Seedsmen in Australia in the dry conditioning of vegetable seed. Although the quick drying and dehumidification processes used to dry vegetable seed might not be feasible for large bulks of grass seed Standards Branch with the co-operation of Seed companies is examining satisfactory and economical storage conditions for pasture seeds held in unfavourable regions.

While it is important in some instances to maintain the longevity of seed over long periods a more practical approach to storage problems in hot moist areas appears to be adequate storage facilities which ensure that freshly harvested grass seed does not deteriorate during the months while it is maturing.

Harrington (1959) has suggested three important considerations for seed storage which apply to our agricultural seeds:

1. A rule of thumb for safe storage is that percentage relative humidity plus degrees Fahrenheit should not exceed 100.
2. The time seed may be stored without a significant decline in germination doubles for each one percent fall in seed moisture and for each 10°F drop in temperature.
3. For longest storage without loss of germination and vigour the seed should be kept as dry and as cold as possible.

Although store rooms for seed can be built in which relative humidity is kept at a low level it is believed that it might be more economical for producers in damp areas if suitable impermeable packages were available to store seed which has been dried after harvest. The rate of deterioration of Hamil grass (*Panicum maximum*) seed produced and stored in North Queensland is at present being investigated. Standards Branch has also requested Government co-operation of an overseas country to investigate the behaviour of seed packaged in various ways and transported by ship.

Germination tests for grass seed

The following summary, contained in Table 2, sets out germination temperatures, moistening agents, light response, and days to final count, for grass seed tests, carried out in cabinet germinators in Queensland. The abbreviation "IR" means International Rules for Seed Testing. Light requirements are intended to mean natural or artificial light between 750 and 1,250 lux. Temperatures joined by a hyphen refer to daily alternating temperatures with the highest temperature operating for eight hours. The exception is 8-20°C for green panic seed.

This table shows that Queensland methods agree closely with the International Rules. There are however, some exceptions which include seeds of prairie grass, buffel grass, molasses grass, *Panicum maximum* and Sudan grass. When the glumes of prairie grass seed can be removed without damaging the seed it has been found that

TABLE 2.

Germination characteristics of various seeds and their assessment with criteria set out by the International Rules (IR) of seed testing.

Species	Temp. and Moistening Agents	Light beneficial	Final count (Days)	Remarks
Axonopus sp.	20-35°, KNO_3	+	21	IR—same as Qld.
Brachiaria ruziziensis	20-35°C, H_2O	—	21	Qld.—Acid 10 minutes IR—Not listed.
Bromus uniloides	20°C, H_2O	+	21	Qld.—Remove glumes after two days. IR—20-30°, 10-30° Light. Final count 28 days. Predry fresh seed. Test 15° in soil.
Cenchrus ciliaris	20-35°C, H_2O 32°C, KNO_3	+	14	Qld.—Predry fresh seed. IR—Prechill in soil. Deglume, prechill 5°C for 7 days. At count on 28 days scratch firm seed and test 7 more days.
Cenchrus setigerus	20-35°C, H_2O 32°C, KNO_3	+	14	IR—not listed.
Chloris gayana	20-30°C, H_2O 32°C, KNO_3	—	14	IR—20-30°, 20-35° 32°C KNO_3.
Cynodon dactylon	20-30°C, KNO_3	+	21	IR—20°-30°, 20-35°, KNO_3, Prechill fresh seed, test at 20-35°C.
Dactylis glomerata	20-30°C, H_2O	+	21	IR—15-25°, 20-30° Light KNO_3. Prechill fresh seed.
Dichanthium aristatum	20-30°C, H_2O 32°C, KNO_3	+	21	IR—not listed.
Ehrharta calcycina	20°C, H_2O	+	21	IR—20° 10-30° Light.
Lolium spp.	20°C, H_2O	+	14	IR—15-25°, 20-30°, 20-25°, 20°C. Prechill fresh seed. Test at 10-30°C, KNO_3.
Melinis minutiflora	20-30°C, H_2O	+	21	Qld.—prechill fresh seed. IR—same as Qld. except pre-chilling not listed IR also advocates use of KNO_3.
Panicum antidotale	20°-30°C, H_2O	+	28	IR—same as Qld.
Panicum coloratum	20-35°C, H_2O	—	21	Abrase seed. IR—Not listed.
Panicum maximum	20-35°C, H_2O 8-20°C, H_2O	—	21	IR—20-30°, 15-35°C Light, KNO_3.
Paspalum commersonii	20-35°C, KNO_3	+	21	IR—Not listed.
Paspalum dilatatum	20-35°C, KNO_3	+	21	IR—Same as Qld. Predry fresh seed.
Paspalum notatum	20-35°C, KNO_3	+	28	IR—Same as Qld.
Paspalum plicatulum	20-35°C, KNO_3	+	21	IR—Not listed.

TABLE 2.—*Continued.*

Species	Temp. and Moistening Agents	Light beneficial	Final count (Days)	Remarks
Phalaris arundinacea	20-30°C, KNO_3	+	21	IR—15-25°, 20-30° Light. Prechill fresh seed KNO_3.
Phalaris tuberosa	20-30°C, H_2O	—	21	IR—20-30°, 10-30°, 20° Light. Prechill fresh seed KNO_3.
Setaria sphacelata	20-35°C, H_2O	—	21	IR—Not listed.
Sorghum almum	20-35°C, H_2O	—	21	IR—20-35°, 15-35°, 32°C. Prechill. On 10th day clip or pierce distal end of ungerminated seeds.
Sorghum sundanense Common sudan	32°C, H_2O	+	10	IR—20-30°, 20-35°. Prechill fresh seed.
Sweet sudan	20-35°C, H_2O	+	10	
Urochloa mosambicensis	20-30°C, KNO_3	—	21	IR—Not listed.
Urochloa panicoides	20°, KNO_3	—	21	Qld.—Predry fresh seed. IR—Not listed.

their removal two days after the seed has been placed out for germination will reduce the germination period to approximately ten days. The method for germinating buffel grass seed in the International Rules is assumed to refer to caryopses removed from the fascicle. A laboratory could not cope with this method when testing many samples of this seed. Although a test of caryopses usually results in a higher germination percentage than for that of intact fascicles it is believed that a test of the fascicle is sound practice. The germination of molasses grass seed has already been mentioned and the superior effect of prechilling over the use of potassium nitrate shown. Seeds of *Panicum maximum* provide almost a classical example of dormancy which awaits a solution by research workers. Fresh Guinea grass seed exhibits less inhibition to germination than recently harvested green panic seed. Although light and potassium nitrate are recommended in the International Rules the beneficial effect of these two agents have not been noted when *Panicum maximum* seed is germinated in cabinets. An unusual alternating temperature of 8°C for 8 hours daily followed by 20°C for sixteen hours has frequently resulted in the highest germination percentage obtainable when lines of fresh green panic seed are tested. Common Sudan grass will germinate easily at 32°C constant but sweet Sudan grass must be tested in an alternating temperature of 20-35°C.

While comparing Queensland and International methods one should consider that many conditions in the International Rules may have been verified experimentally by members who have Copenhagen tanks. Stabilization of a temperature within thirty minutes inside a cabinet is considered satisfactory. By using modified apparatus on the Copenhagen tank principle it is possible to lower a germination temperature 15°C in fifteen minutes.

Although it is probable that optimum germination temperatures for many species occur within a range of temperatures, an important current project of the Germination

Committee of the International Seed Testing Association is to ascertain those temperatures which provide the most uniform results. This work will eliminate alternative germination temperatures from the Rules.

Queensland is playing a leading part in this work by participating in the activities of a special germination working group concerned with tropical and subtropical seeds.

REFERENCES

BALLARD, L. A. T. (1964).—Germination. *In* "Grasses and Grasslands" Ed. C. Barnard. (Macmillan: London.)

International Seed Testing Association Proceedings **31** (1) International Rules for Seed Testing 1966.

HARRINGTON, J. P. (1959).—Drying Storing and Packaging Seeds to Maintain Germination and Vigour. Mississippi Short Course for Seedsmen Proceedings 89-107.

TROPICAL PASTURES IN THE RICHMOND-TWEED REGION OF N.S.W.—RECENT EXPERIENCES AND FUTURE DEVELOPMENT

by

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INTRODUCTION

The Richmond-Tweed region is an intensive dairy and pig producing area, with beef production assuming increasing importance in the drier western section. The welfare of the region's population of 95,000 is largely dependent on the dairy industry. Some 4,100 dairy farms contribute 40% of the State's butter and cheese production. The value of allied dairy products is about 18½ million dollars a year. Compared with Southern Australia and New Zealand dairy areas average productivity is low—only 160 lb B.F. per cow and 33 lb B.F. per acre. The naturalised grass pastures are nitrogen deficient and are unable to match the energy and protein requirements of the lactating dairy cow.

The climate is a humid, subtropical coastal type equivalent to Kôppens cfa, modified with appreciable winter rainfall, and has been described in an earlier proceedings of this Society (Anon, 1964).

The environment is well suited to intensive pasture development with both summer and winter growing species. In contrast with other parts of the world, where productive pastures are generally located where forest has been replaced by grassland, in this region permanently productive grass pastures have not been maintained following the clearing of rain forest. Now, improved legumes and grasses, fertilizer application and good farm management can be used to raise levels of animal production.

During the last five years experience has been gained in the use of tropical species in this environment. This talk has been prepared to review briefly recent research and commercial developments, including problems which have arisen. Potential future development will also be discussed.

SPECIES TESTING

Legumes

It appears that there is an adequate range of tropical legumes adapted to the area. Plot studies and commercial sowing have shown that the species *Glycine javanica* (Clarence, Tinaroo, Cooper), silverleaf and greenleaf desmodiums (*Desmodium uncinatum* and *D. intortum*), Siratro (*Phaseolus atropurpureus*), *Lotononis bainesii* and *Dolichos lablab* can be grown successfully on various soils throughout the region.

The results of a five year research study showed that 30-150 lb N per acre per year could be recovered in the herbage of effective, established legumes depending on the soil type. Annual D.M. yield of legumes have ranged from 1,500-4,500 lb per acre in favourable season. The clover root weevil, *Amnemus quadrituberculatus* has caused serious reduction of legume yields in desmodium and glycine pastures but lotononis has been unaffected by the pest. Siratro appeared to be fairly resistant (Mears and Murtagh unpublished).

The dry summers of 1964/65 and 1965/66 have highlighted the drought hardy qualities of Siratro, which is probably the most versatile legume of the species tested. For this reason Siratro is being included in simple mixtures with other legumes. Varietal differences in glycine have been most marked on red basaltic soils, where Clarence nodulated earlier and out-produces Tinaroo or Cooper. This difference has not been tested on other soils.

Grasses

The naturalised grasses of the region are *Paspalum dilatatum*, Kikuyu (*Pennisetum clandestinum*), carpet grass (*Axonopus affinis*) and blady grass (*Imperata cylindrica*). Without applied nitrogen the species produce about 1,000-3,000 lb D.M. per acre per year.

Research with grasses has been aimed at determining species adaptability on various soil types, at potential dry matter production when heavily fertilized with N and at testing compatability of grass/legume mixtures. Kikuyu, Pangola (*Digitaria decumbens*) and *Setaria sphacelata* (cv. Kazungula) have been the most productive grasses under cutting and heavy N dressings. Annual D.M. production has ranged from 17,000 to 27,000 lb per acre (Colman pers. comm.). The results of sward trials with various grasses and legumes have been generally inconclusive. There is some evidence that stoloniferous grasses combine more satisfactorily with tropical legumes than bunch-type grasses.

A few *Setaria sphacelata* accessions from high altitudes in Kenya supplied by Mr. R. Jones of the C.S.I.R.O. Division of Tropical Pastures, have been tested at Wollongbar Agricultural Research Station. Several cultivars (notably C.P.I. Nos. 33452, 33453) remained green throughout winter despite heavy frosts.

TROPICAL PASTURE DEVELOPMENT IN THE REGION

The dominant factor hindering pasture development has been two consecutive dry summer and autumn seasons in 1964-65 and 1965-66. This is well illustrated by rainfall figures for Kyogle and Murwillumbah in Table 1.

Inspection of rainfall figures at Kyogle showed that when the critical January to March period is considered, 590 points were received in 1965. Over the 81 year period

TABLE 1.

Summer and Autumn Rainfall at Kyogle and Murwillumbah—November, 1964—May, 1966.

		Nov.	Dec.	Jan.	Feb.	March	April	May
Kyogle	1964/65	529	334	414	143	38	242	87
	1965/66	343	972	86	879	233	314	53
	Average (81 yrs.)	371	497	646	658	628	374	308
Murwillumbah	1964/65	390	321	693	251	72	266	295
	1965/66	176	1029	76	669	150	335	174
	Average (81 yrs.)	455	580	839	950	1031	595	554

1884-1966, one other year (1915) recorded a January-March rainfall below 6 inches compared with the average of 19 inches. In many cases 6 inches of rain was insufficient to establish satisfactory, sown pastures.

It has been estimated from sales that enough seed has been purchased to sow the following areas, using conservative seeding rates (Table 2).

TABLE 2.

Estimated areas sown to tropical pasture.

Region	1965-55 (acres)	Total Area Sown Over Past 3 Years (acres)
Richmond district	2,500	6,000
Tweed district	3,175	6,720
Kyogle and Bonalbo districts	100	800
Totals	5,775	13,520

Owing to climatic conditions and other factors such as poor seedbed preparation, the figures should not be taken as effectively established areas. A survey conducted in 1965, by the North Coast Agricultural Research Council showed that establishment failures were as high as 60% in some areas. On heavy alluvial soils where *Paspalum dilatatum* is dominant, it has been difficult both to replace the species with other grasses such as setaria and to introduce perennial legumes. In certain cases, failures, and poor growth coupled with high seed prices, have resulted in a sense of caution or even disappointment in the performance of tropical species among farmers in the region.

The problem of the clover root weevil (Amnemus quadrituberculatus) in tropical pastures

Root damage on tropical legumes caused by the larvae of the Amnemus Weevil is an important problem confronting research workers and farmers in the region and is shown in Figure 1(a).

The importance of the insect as a serious pest on White Clover and Sub Clover was recognised in 1956 (Braithwaite, Jane and Swain 1958) and more recently on tropical legumes (Annual reports Wollongbar Agricultural Research Station). The life cycle and damage to legumes caused by the insect is well known to research workers in New South Wales, but may not be so well known amongst Queensland workers.

The life cycle of the Clover Root Weevil is shown in Figure 1(b).

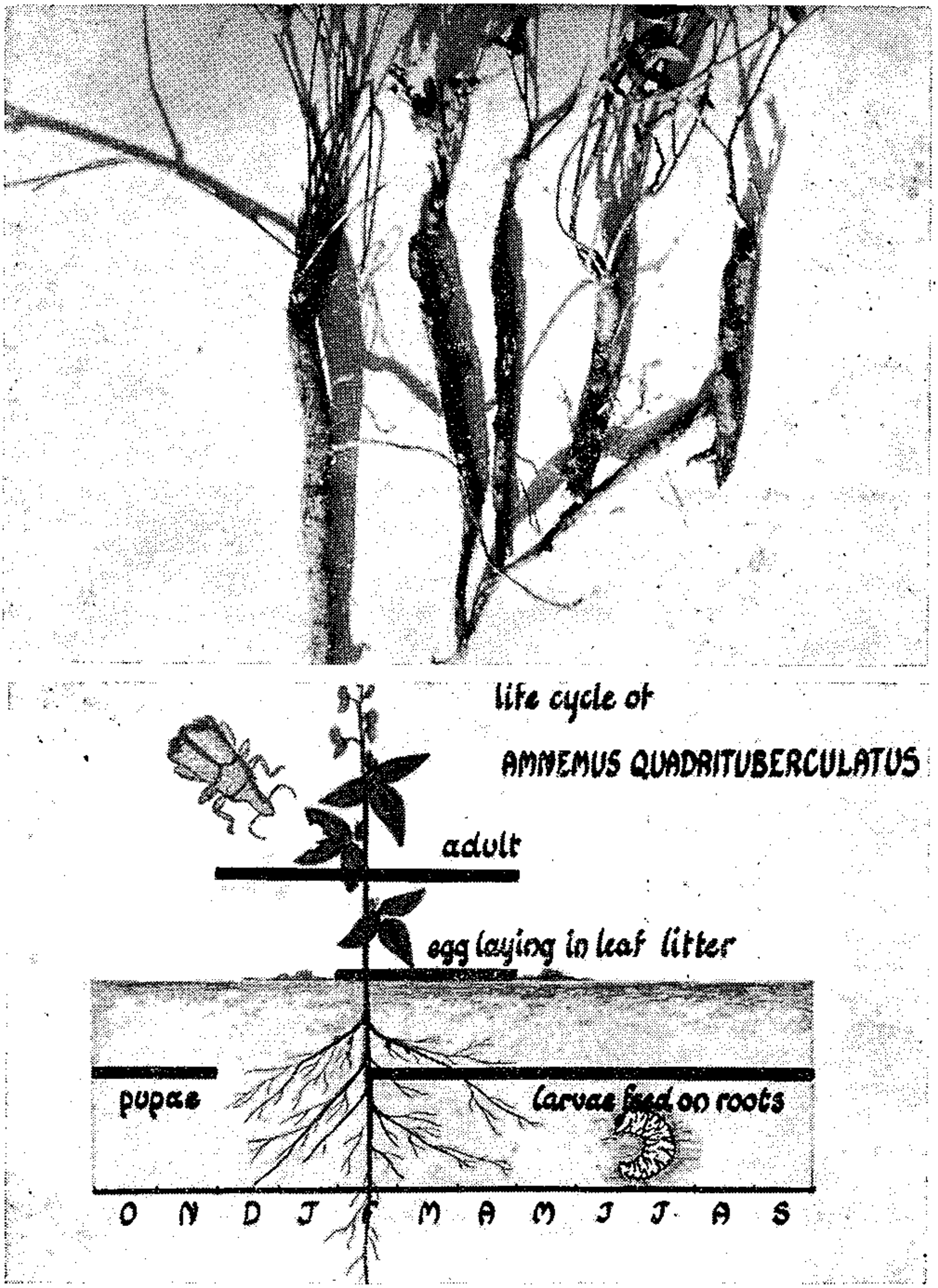

FIGURE 1.

(a) Root damage on *Desmodium intortum* caused by *Amnemus.*
(b) Life cycle of *Amnemus quadrituberculatus* (Boh).

Larvae feeding in winter damage roots and the effect is severe when this coincides with dry weather.

The known distribution of the insect is from Moruya on the New South Wales South Coast to Gympie in south east Queensland. It has also been reported to occur on the Atherton Tableland. The ecology of the insect requires further study.

Effective methods of control have been formulated which involve the application of Dieldrin R at the rate of 1 lb active ingredient per acre in January. Owing to the danger of residues being taken up by animals and deposited in milk and body fat, the New South Wales Department of Agriculture has withdrawn the recommendation involving surface application of Dieldrin and related compounds. The current recommendation for the use of Dieldrin specifies sub surface application or application to the soil before sowing but further work is needed to determine the longevity of the effect produced by Dieldrin used at sowing. Currently, a range of legumes is being screened for possible resistance to attack by the pest.

District potential for development with tropical species

A prediction on the future trends of land use is fraught with many assumptions which may change, e.g. economic factors, social factors influencing adoption of improved techniques, availability of credit and market trends. However a purely physical assessment of pasture development is worthwhile in that it sets a goal, even if this may prove ultimately to be unattainable. The following figures in Table 3 have been calculated from the total area of the different soil types based on the survey of McGarity (1956). The crude assumptions have been that up to 40% of a particular

TABLE 3.

Potential development of tropical legumes in the Richmond Tweed region

Soil type	total area (sq. miles)	% of total area	species and seed rate	potential acreage (acres)	Seed requirement (tons)
Red Soil	483	13.4	Clarence glycine (4 lb.)	61,800	123
Chocolate Soil	613	17.1	*Glycine* spp. (2 lb.)	78,500	78
			Siratro (2 lb.)		78
Alluvial Sandy and Meadow Soils	1,031	28.7	Silverleaf desmodium (2 lb.) Greenleaf desmodium (1 lb.)	132,000	131
Sandy Podsolic	1,187	33.0	Siratro (4 lb.) (Possibly mixed with *L. bainesii*)	151,900	303
Red and Yellow Earth—Tweed Soils	277	7.8	*Glycine* spp. (2 lb.)	35,400	35
			Siratro (2 lb.)		35
			Desmodium spp. (1 lb.)		14
Totals	3,591	100.0		459,600	

soil type could be improved with machinery currently available and of this fraction, 50% might be developed with tropical species over a period of years.

Utilization of tropical pastures on the Richmond-Tweed

Although tropical grass/legume pastures are perennial in most cases and can produce more nitrogen and dry matter than the replaced pasture base, winter and spring growth of the tropical species is unlikely to meet the sustained, nutrient requirement of spring calved, dairy cows in the district.

This fact coupled with the inherently lower feeding value of tropical compared with temperate species, has led the Wollongbar group to grow winter species when the tropical plants are dominant. The systems under test attempt to provide feed, not only when the dairy cow most needs it, i.e. early in lactation but also to continue at a high level throughout lactation. The system is known locally as the "Feed Year". Several production trials are being conducted on the station. In addition eight farmers are co-operating to evaluate the "Feed Year" principle under commercial conditions. The experience gained from these studies, where development is ahead of the district, has greatly assisted extension recommendations. Increases in butter fat production and the economics of pasture development are being assessed over the development and subsequent periods.

A number of systems aimed at providing uninterrupted grazing from various combinations of tropical and temperate species, are being studied at Wollongbar Agricultural Research Station. Two general principles are being followed:—

(i) providing better quality temperate pastures for spring calved cows.
(ii) changing the calving time to summer to take advantage of grazing on improved tropical pasture.

The following is a summary of the current grazing trials on the station.

I *Systems involving legumes*

A. Spring calving

(1) Unimproved grass rotationally grazed—"*Control Farm*"
(2) 100% development with glycine and Kikuyu pasture, supplemented with vetch

B. Summer calving

(3) 100% development with glycine and Kikuyu
(4) 100% development with glycine/Kikuyu pasture supplemented with vetch

(5) 100% development with glycine/Kikuyu pasture, concentrate ± supplement

II *Systems involving applied nitrogen only or nitrogen on mixed grass/legume pastures*

A. Spring calving

(6) 300 lb N/ac/annum applied on predominantly Kikuyu pasture grazed at three stocking rates:
0.75 acres/cow
1.0 acres/cow
1.5 acres/cow

B. Summer calving

(7) 100% development with glycine/desmodium/Kikuyu pastures + oats + applied N on a portion of the glycine/Kikuyu pasture

(8) 100% development with glycine/desmodium/Kikuyu pasture + oats + applied N on a portion of the glycine/Kikuyu pasture.

Encouraging increases in butterfat production per acre are being obtained from the various systems currently under study (Colman, Holder and Swain 1966). At current prices, costs for improvement are much lower than returns obtained from increased production. It is emphasised however that a measure of insect control and lessening of the risk at time of establishment of tropical legume/grass pasture must be achieved, if the new technology is to be adopted wholeheartedly by the local farming community.

ACKNOWLEDGEMENTS

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REFERENCES

ANON. (1964).—Notes on the environment of the region. *The Tropical Grassland Society of Australia—Proceedings No.* 1 February, 1964. (old series for limited distribution only).

BRAITHWAITE, B. M., JANE, ANNETTE and SWAIN, F. G. (1958.)—Amnemus quadrituberculatus (Boh). A Weevil pest of clover pastures on the North Coast. *Journal of Australian Institute of Agricultural Science* **24**: 146-54.

COLMAN, R. L., HOLDER, J. M. and SWAIN, F. G. (1966).—Production of dairy cattle from an improved pasture system in a subtropical environment. *Proceedings of the 10th International Grassland Congress*, Helsinki Section 2 p. 149-53.

MCGARITY, J. W. (1956).—The soils of the Richmond-Tweed Region—a study of their distribution and genesis. M.Sc. Agr. Thesis University of Sydney.

DISCUSSION

Would the use of sulphate of ammonia give rise to acidity problems?

Dr. Humphreys: Yes, especially on acid soils. This may be corrected with lime on acid soils.

Does a high nitrogen status in the soil favour vegetative growth rather than seed production?

Dr. Humphreys: Proportionally a high nitrogen level gives bigger plants with a reduced proportion of leaf, providing water is not limiting.

How and where should you place nitrogen?

Dr. Humphreys: A considerably larger proportion of the nitrogen applied is taken up from sub-surface application than when it is placed on the surface. In practice nitrogen placement is largely an economic problem.

Is there any advantage in cutting off irrigation at a specific time to give the plant a brief stress period? This system has been used to increase seed yield in some temperate regions.

Dr. Humphreys: With *Stylosanthes gracilis*, drying off before harvest is beneficial, but this is to facilitate harvesting rather than to give a physiologically based increase in yield. I do not know of critical studies on the effect of a brief stress period on seed production. With perennial grasses any temporary depression of seed yield after high N application (due to moisture stress) is probably more than compensated for when conditions improve.

What would you consider to be a safe moisture percentage for seed storage?

Mr. Peel: This is very much related to the conditions under which the seed is to be stored. The rule of thumb methods of Harrington (Davis, California) which I outlined are generally applicable. In Queensland 12% moisture may be considered an absolute maximum.

Is mechanical scarification or acid treatment of grass seed beneficial?

Mr. Jones: Germination of seed of *Panicum coloratum* is very much improved by scarification, but odd results have been obtained where seed is treated with acid. This might have been related to moisture content.

How do these laboratory germination tests relate to performance in the soil?

Mr. Jones: Comparable results were obtained when the treated seed samples were planted in the soil. There is some doubt whether scarification of seed of *P. coloratum* should be recommended, as storage of scarified seed may be unsatisfactory.

Has the effect of scarification been assessed on seed of other grass species?

Mr. Jones: Yes, in a number of species. In some cases there was a beneficial effect on germination, but the most pronounced response was obtained from *P. coloratum* seed.

Dr. Humphreys: Scarification should perhaps be restricted to seed for planting in areas with a good and reliable rainfall, which would ensure germination. In drier areas there is a danger of loss of seed after planting.

Mr. Peel: Then gave a short appraisal of "The Agricultural Standards (Seeds) regulations of 1966", commenting particularly on the problem of admissible proportions of seed of weed species, many of which are particularly small. The new regulations were generally fairly well accepted. One cannot afford to have too high a standard, as this would result in unreasonably high apprices. Thus both with respect to germination and purity, one has to seek a compromise.

When you were predicting the potential use of seed of different species in the Northern Rivers area, why do you predict that less Desmodium intortum seed will be used than seed of D. uncinatum?

Mr. Mears: This is simply due to the recommended seeding rates of the two species.

Why does white clover play such a limited role?

Mr. Mears: White clover does not persist well in this area. One can only expect a longevity of 2-3 years. This is at least in part due to its susceptibility to Amnemus weevil and nemotode attack. Nutritional requirements of white clover are being investigated on various soils.

How effective is Glycine javanica as a legume in the Richmond area?

Mr. Mears: Glycine does very well on the red soils. It produces about 100-150 lb of nitrogen. Clarence *Glycine* nodulates better than Tinaroo on these soils.

How does Dolichos behave with respect to nitrogen fixation?

Mr. Mears: Few studies have been made. *Dolichos* behaves as an annual here. *Rhizobium* cultures approved by the University of Sydney's Department of Agriculture Liaison Service (U.D.A.L.S.) are now available which have overcome nodulation problems and give good grazing crops.