QUANTITY OF PASTURES AND FORAGE CROPS FOR DAIRY PRODUCTION IN THE TROPICAL REGIONS OF AUSTRALIA

2. REVIEW OF FARMING PRACTICE

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INTRODUCTION

Improved pastures, as the source of most roughage and of some quality requirements, have become the backbone of dairying throughout most sub-tropical and tropical dairying districts. The main exceptions are in areas with less than 900 mm (35 in.) rainfall, where there is still great reliance on native pasture and fodder crops. Where irrigation is available improved pastures are of great significance in the lower and/or unreliable rainfall areas.

The feed-year is increasingly being based on improved pastures. Much has already been achieved in selecting pastures with long growing seasons. Where environmental conditions are suitable both temperate and tropical pasture species are grown, either in separate fields or sometimes mixed. Increasingly nitrogenous fertilizer is being used to extend the growing season. Other fertilizers are used to stimulate legumes and to improve the mineral status of both grazed forage and of stand-over pasture.

Despite the advances with improved pastures, forage crops are generally still necessary to complement pastures.

MAJOR LIMITATIONS

In discussing limitations to dairy production CLIMATE, SOIL/SITE, PLANT, ANIMAL, MAN (and his money) interact in pasture development, use and output therefrom. The question arises as to what limitations each of these factors impose at farm level in the region under discussion.

Climate

Obviously important for pasture growth are rainfall, temperature, frost, amount of sunshine, etc. They influence both total annual pasture yield and the duration of the growing season. At times the environment is very well suited to fodder growth, but the greatest environmental drawback is its unreliability. Too often we have extremes of dry and wet, of heat and cold, causing marked variation in growth rates and quality.

Soil/site

The soil factors include physical condition, water-air balance, soil nutrients, pH, salt, and micro-organisms (including rhizobia). Important site factors are the terrain, aspect and slope.

Dairying in the sub-tropics and tropics is carried out on a mosaic of soils ranging from alkaline black earths to extremely acid podzols, latosols and krasnozems. Principally there is a need for nitrogen and phosphorus; depending on the situation, molybdenum, potassium, calcium and sulphur are also of great consequence. Fertilizer price also dictates usage, and priorities have to be determined; for instance whether to further develop the best ground first, such as alluvial flats, or to concentrate on the undeveloped and currently very low producing frost-

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free hillsides. The wide range of topographical situations, apart from their effect on the environment, markedly influence decisions on practicability of cultivation, risk of flood inundation, of soil erosion, choice of species, etc. The farmer must weigh the advice on the requirement for thorough seedbed preparation and the most suitable time for sowing, with the risks associated with adverse weather.

Plant

Species, including variety and grass-legume-weed balance are major considerations. In the region with which we are concerned, there is no single pasture species or mixture available for providing year-round highly nutritious feed. Irrigated pastures come closest to this, but on most dairyfarms only a limited acreage is feasible.

The lack of cold tolerance in tropical species, inability to survive high temperatures with temperate species, and poor drought tolerance and inability to withstand water-logging are major limitations with all species. Summer growing weeds provide intense competition to both temperate and tropical species.

Animal

Frequency, severity and season of defoliation by the grazing animal have profound influence on pasture growth and in some cases persistence. Uneven distribution of dung and urine, and transfer of nutrients from day-grazed paddocks to night-grazed paddocks are other influences. The effects of various animals such as insects, marsupials, hares, etc., are of consequence in many districts.

Man (and his money)

Obviously there is no limitation where the farmer does not desire to improve his welfare, and has no wish to make more money. But generally man with his various goals and his skills and the restrictions placed on him by markets fits very much into the soil-plant-animal system. While socio-economic problems are not the concern of the conference, it does no harm to remind ourselves of man's overriding influence.

The key links between the researcher, the adviser, the farmer and his banker often break down. This may be due to lack of information from the researcher, or the acceptability of the information or relevancy as viewed by adviser or farmer or banker.

PRESENT PROGRESS IN PROVIDING YEAR-ROUND FEED

Alternative feed sources

Given reasonable environmental conditions and with the careful choice of adapted species, together with adequate fertilizer, it is possible to produce a large bulk of paddock feed. However the main problem is seasonality of production rather than total annual production. If we accept the premise that maturation of pasture or crop goes hand in hand with lower nutritive value, then it becomes necessary to establish whether we can satisfy the herd's nutritional requirements by the year-round availability of highly nutritious pasture and crops. The cost of providing such feed is paramount, and due consideration should be given to alternative methods of providing feed, whether it be from grazing young or mature pasture, or crop, or from conserved feed or concentrate. In areas where we have learnt to rely on tropical grasses and legumes for warm season feed, it has become increasingly difficult to justify the use of summer fodder crops. Their use by farmers is rapidly and justifiably diminishing, except where they are used as a pre-crop or cleaning crop prior to establishment of improved permanent pasture. Sometimes these species, particularly *Dolichos lab lab* cv. Rongai, are lightly sown in improved pastures to provide early high quality grazing.

In the tropical and sub-tropical environment, despite the inherent unreliability of climate, there is a degree of predictability which has enabled some farmers to use feed-year systems that work reasonably well in most years. The cautious have learnt not to place all their reliance on a restricted suite of species so that their systems have an in-built degree of flexibility. Obviously fodder conservation and the use of concentrates increase this flexibility, and these practices, where they are felt to be economic, are being increasingly employed by the better managers.

Although it has sometimes been claimed that we are experiencing a tropical pasture revolution, there has also been an accelerating use of cool season species. In all fairness these have always been popular for reasons of feed availability at critical periods, and because of high nutritive value for milk production.

Oats (*Avena* spp.) is the most widely grown winter fodder crop, both in northern N.S.W. and in Queensland. With oats greater use is being made of nitrogen fertilizer and some farmers plant as much as 0.2 ha (0.5 ac) per milking cow. Oats is also frequently used as a cover crop when sowing clover pasture. Some farmers and agriculturalists reason that oats is too expensive. As an alternative ryegrass is increasingly grown, particularly where the nitrogen status of the soil is satisfactory. Annual species such as Italian rye (*Lolium multiflorum*), including in the future the tetraploid Tama, and sub clovers (*Trifolium subterraneum*) are sometimes recommended and used. Vetch (*Vicia sativa*) still has some advocates in northern N.S.W. for providing spring feed, despite the incidence of disease. A more disease resistant strain has shown promise in trials.

Fodder conservation is of increasing importance in some dairying districts. Especially in the drier areas, conserved feed, particularly lucerne and pasture hay is of consequence. In the wetter coastal areas hay making is a hazardous operation due to the risk of spoilage. A limited number of farmers ensile pasture and forage crops, but generally most coastal dairymen prefer to rely on paddock grazing or to purchase hay or grain.

At the farm level many alternatives have been considered and attempted but little comparative information was obtained therefrom, especially on the economics of milk production. Since advancement in dairying involves a gradual and simultaneous acceptance and adoption of proven practices on a number of fronts, it becomes increasingly difficult to isolate individual factors.

Complementary usage

In an endeavour to put the situation in perspective Luck (1970) reviewed the role of improved pastures in the near north coast region of south-east Queensland. The complementary use of temperate legumes, tropical legumes and grasses, and nitrogen fertilized grasses was advocated. Rainfall, incidence of frost, soil type, drainage and size of farm are determinants in the choice of pasture and/or crop. No broad generalisations can be made and every situation has to be treated on its merits. Nevertheless, there are many situations where complementary use is both possible and desirable.

An ideal but still quite common situation is to grow white clover on alluvial flats and lucerne and fodder crops on better drained sites, with or without irrigation. The steep and warm hillsides are suited to tropical legume-grass pasture, and the lower slopes where frost is of some consequence can support sub-tropical grasses supplemented with nitrogen. Temperate pastures provide some late autumn and winter feed with a peak in the spring. Tropical legume-grass pastures can provide the main summer and autumn feed and in frost-free situations they may be autumn-saved for winter. Oats provides winter and early spring feed, and nitrogen applied to pure grass is more beneficial for use in autumn, early winter and, moisture permitting, spring. The principle is to exploit a wide range of species grown where they are best suited. To suit each individual requirement numerous variations are possible. In the long run results achieved by resourceful farmers have already led and will increasingly lead to important modifications of existing recommendations.

Results in practice

The feasibility of dairying in the sub-tropics and tropics is well established. However it is difficult to apportion the pre-requisite factors for success. One thing is certain. A primary requirement is adequate fertilization of pastures and crops. Economic responses have even resulted from fertilizing the sometimes despised naturalized grasses such as paspalum (*Paspalum dilatatum*) and mat grass or narrow leaf carpet grass (*Axonopus affinis*). However for very large improvements high inputs are generally required, both in terms of fertilizer and better species. An example of using a combination of tropical and temperate pasture species, oats, some molasses particularly for dry stock, together with a grain supplement (approx. 1.4 kg (3.0 lb)/head/day) for approximately the first six months of the cows' lactation is illustrated in Table 1.

TABLE 1

Property–Location: *Eerwahvale, via Eumundi*
Farm size: 86 *ha* (216 *ac*)
Dairy cattle†: 90 *milkers* + *a limited number replacement calves and heifers*

Year	Pastures				Grazed Fodder Crops				Total	
	Temperate*		Tropical		Summer		Winter		Butter Fat	
	ha	(*ac*)	*ha*	(*ac*)	*ha*	(*ac*)	*ha*	(*ac*)	*kg*	(*lb*)
1963/64	0	(0)	0	(0)	0	(0)	12	(30)	2,180	(4,796)
1964/65	12	(30)	0	(0)	16	(40)	4	(10)	3,940	(8,668)
1965/66	23	(57)	5	(12)	5	(12)	2	(5)	5,830	(12,826)
1966/67	23	(57)	14	(35)	2	(5)	3	(7)	7,500	(16,500)
1967/68	23	(57)	31	(77)	0	(0)	8**	(20)	8,640	(19,008)
1968/69	18	(44)	36	(89)	0	(0)	8**	(20)	9,410	(20,702)
1969/70	18	(44)	52	(128)	0	(0)	16**	(40)	12,570	(27,654)

*Temperate pastures consist of white clover, Kangaroo valley ryegrass (*Lolium perenne*) and paspalum. Some of this pasture may be spray irrigated at times.

**The practice over the last three years has been not to sow oats in a separate paddock but renovate some temperate pasture lightly and oversow with oats, clover and ryegrass.

†Dairy cow numbers have nearly double since the development programme commenced.

With fertility improvement and night paddocking the remainder of the farm is now almost exclusively under kikuyu (*Pennisetum clandestinum*) where mat grass previously dominated.

Using tropical legume-grass pastures only, it is reasonably easy to achieve a production of approximately 91 kg (200 lb) of butterfat per cow where about 0.8 ha (2 ac) of improved tropical legume-grass pasture per milking cow are provided. In southern Queensland we have an example where 1.2 ha (3 ac) of pasture with *Glycine wightii* cv. Tinaroo were provided per cow, and the production rose to 136 kg (300 lb) of butterfat per cow. Admittedly this feed is grown on hillsides almost free of frost, and while vast quantities of dry matter were produced during the summer, the extra benefit was probably due to the increased availability of stand-over glycine in the winter and spring. This is possibly a wasteful means of providing highly nutritious feed at a critical time of the year, especially on small farms. However there are many large dairyfarms which have ample land for tropical legume-grass pastures.

Experience has indicated that on small farms very intensive pasture use is necessary and tropical legume based pastures may not support the high stocking rates required. This is where greater emphasis is being placed on the heavy use of fertilizer nitrogen on grasses such as kikuyu, pangola (*Digitaria decumbens*) and *Setaria sphacelata* cvs. Nandi, Kazungula and the recently released Narok. While there is no evidence that the use of nitrogen will improve production per cow above the levels achieved with tropical legume-grass pastures, a greater than two-fold increase in stocking rate is usually feasible, particularly with species possessing a considerable cool season growth habit (kikuyu and Narok setaria).

WHERE IMPROVEMENTS MAY BE MADE

In December 1970 dairymen of the Maleny plateau in south-east Queensland issued a report on management strategies. They suggested that for their average situation (80% of gross income on Maleny plateau is derived from milk and its products) the following are profitable strategies—

1) Better winter-spring feed
2) Better year-round feed and more milking cows
3) Correct fertilizer program
4) More thought about stock sales
5) A balance between the physical program and the farmer's physical capacities.

Most Maleny dairyfarmers are agreed that the first three are equally important, and have precedence over others, but none should be left out of consideration. In other words, it is a simultaneous advance on many fronts that is required, rather than a move first in one direction and then in another.

Recently Barnes (personal communication) indicated that wherever cultivation is possible on the Atherton Tableland good pastures can be established. It is similarly possible to establish improved pastures in the higher rainfall areas of south-east Queensland and northern N.S.W. The problem is pasture maintenance while achieving economic utilisation.

The two major weaknesses in our pasture plants are

(a) Length of growth period, and
(b) Species persistence.

Points which come to mind in tackling these problems are outlined below:—

Length of growth period

As a consequence of our stop-start climate all species have a restricted growing period and a very irregular rate of growth. Points which come to mind in tackling these problems are—

Species selection and breeding

Of importance is to find and exploit species which are physiologically better adapted to our particular environment. It is encouraging that in north Queensland Grof and Harding (1970) have selected tropical species which exhibit superior cool season performance. These include selections of *Centrosema pubescens, Stylosanthes guyanesis* and *Panicum maximum*. At least on the tropical coast the goal of year-round high production from pasture is in sight. However, these species may have restricted use in the sub-tropics. Narok setaria could have wider application. At Cooroy the author found that *Setaria sphacelata* C.P.I. 33452 (from which Narok was selected) outyielded Nandi throughout the year and that it is much more cold tolerant. At Gatton Research Station, Lowe (personal communication) found that *Panicum maximum* cv. Gatton ceased growth in winter whereas C.P.I. 32930 setaria, a close relative of Narok, continued slow growth and, despite extremely cold winters, never completely frosted.

Pangola grass possesses excellent beef and milk producing characteristics when heavily fertilized with nitrogen. Evans and Pulsford (personal communication) have found that under irrigation at Parada, pangola will produce year-round feed. When fertilized with more than 450 kg nitrogen/ha (400 lb/ac) yields during the winter are generally in the order of 2240 kg of dry matter/ha/month (2000 lb/ac) on which steers grazed at 7½ beasts/ha (3 beasts/ac) continue to fatten. At Coolum in southern Queensland where frosts are quite severe Tierney (personal communication) found that pangola when fertilized with 560 kg nitrogen/ha (500 lb/ac) and grazed at 7½ beasts/ha (3 beasts/ac) produced ample dry matter during late summer and autumn with an average monthly presentation yield of approximately 4480 kg dry matter/ha (4000 lb/ac) from February to the end of June 1970. By October-November after a severely dry and cold winter there was little more than 350 kg of dry matter/ha (312 lb/ac) present and severe weight losses were recorded. Under severe winter conditions at Coolum, Wright (personal communication) found the frost tolerant C.P.I. 32930 setaria able to maintain liveweight. For winter and early spring production oats and clover sod-seeded into pangola have given handsome liveweight gains. There may be potential for selecting and breeding suitable cool season species for over-sowing.

Legumes with better cool season growth, particularly under relatively dry conditions, are urgently needed. For a number of years *Trifolium semipilosum* has been recorded as promising but its potential value is still uncertain. In many situations dry weather is the major limitation. Siratro (*Phaseolus atropurpureus*) is generally the most productive tropical legume in drier areas (750-900 mm (29-35 in.) annual rainfall) but considerable improvement towards a longer growing period is required. Lucerne breeding and selection also offers scope for improvement.

Choosing mixtures with better seasonal growth distribution

Brougham (1968) indicated that, except for irrigation, there are no economical and practical ways to either increase or decrease inputs of the major climatic factors into pastoral systems. There are however ways of maximising them or altering them; or even modifying interactions between them and the growth of plants in pastures. He indicated that in order to maximise the major climatic factors research efforts should be aimed at blending species with particular seasonal characteristics into mixtures for sustained annual exploitation of the environment.

Where a particular legume is well suited and much superior to anything else there is certainly no value in a mixture of legumes. Opponents of mixtures maintain that growing species singly enables them to express more fully their growth potential. Unfortunately the growth potential of any one species all too often falls far short of the farmers' requirements. In many cases mixtures of legumes have provided a degree of insurance. Where the commercial desmodiums (*Desmodium intortum* cv. Greenleaf and *Desmodium uncinatum* cv. Silver leaf) failed in the dry, siratro or *Lotononis bainesii* cv. Miles helped maintain productivity. In some instances pastures which were previously desmodium dominant became lotononis dominant. With a return to wetter years desmodium in many instances has again reappeared and proved superior for long season growth. The appearance after several years of unsown white clover in stands of tropical legume-grass pastures suggests that if we deliberately sow mixtures of temperates and tropicals the above desirable result could be hastened. A criticism to the mixture approach is that it complicates management. This is granted, but management is also complicated if there are a number of different species, each requiring special and different management, being grown in separate paddocks.

Extending the effective utilisation period with legume dominant pastures

There is ample research and practical evidence that legumes can provide effective stand-over feed for much longer periods than grasses. They do not decline nearly as rapidly in nutritive value and intake. Very mature legume, provided it has retained a reasonable amount of leaf can still have good feeding value. There have been advocates of pure legume stands but these are botanically unstable. As legumes build up nitrogen levels a grass is required otherwise weeds will ingress. However, with careful choice of species, it is possible to achieve legume dominance, particularly in young pastures with high legume and low grass seeding rates. Legumes which stand-over well include Tinaroo glycine and *Dolichos axillaris* cv. Archer. Both species are ideally suited to stand-over winter and early spring grazing where frost is minimal. *Dolichos axillaris* may also be reserved for use in dry periods.

Extending the growing period with nitrogenous fertilizer

There is general agreement on this, but the main argument is whether the nitrogen should be applied to pure grass or grass-legume pastures. If anything complicates management it is the use of nitrogen on grass-legume pastures. Nitrogen on grass only is preferred except in those cases where the legume content is no longer of significance or where a suitable pure grass pasture is not available. Experience with tropical legume-grass pastures is that the use of nitrogen for an extended period will adversely affect the legume persistence and result in substitution of fertilizer nitrogen for symbiotic nitrogen. Limited quantities of nitrogen, up to 112 kg nitrogen/ha (100 lb/ac), have been used with some benefit on clover-grass pastures.

Greenwood (1968) made a plea for defining the strategic role of nitrogen fertilizer in pastures while seeking ways to improve the yield of symbiotic nitrogen. He suggested that for an economic application the first requirement is that it must increase the growth rate of plants and the yield of digestible nutrients. The second requirement is that the extra nutrients must be utilized and this may need a higher stocking rate.

Extending the growing period with irrigation

Irrigation has not been dealt with at length, but obviously it is a useful tool for extending growth into dry periods. Work by Lowe (personal communication) at Gatton Research Station, together with the previously quoted work by Evans and Pulsford have indicated the potential for irrigating sub-tropical and tropical species. Lowe compared tropical and temperate species and found that tropical grasses fertilized with nitrogen are the most efficient users of water. Cold tolerant grasses such as Narok offer distinct possibilities for efficient use of irrigation water.

Species persistence

In designing feed year systems it is necessary to anticipate the expected period of sown pasture persistence. Experience indicates problems here. Pasture improvement is expanding rapidly, particularly in the higher rainfall coastal dairying and beef districts. Some pastures are persisting well and are still most productive after nine or ten years. However there is a need to know why others are declining in productivity. The variability in pasture production from year to year is quite often due to lack of persistence, although in many cases it also reflects climatic variability. Some points that need clarification in this regard are—

Economic life of a pasture

Before looking at reasons and remedies for lack of persistence information is required on how long pastures must last to provide an economic return. Some farmers feel that highly productive but rather short term pastures are a good proposition. Thus several years from a white clover pasture is considered satisfactory. Many expect or require a longer life from tropical legume based pastures. This attitude has been fostered by the much higher seed costs and in most cases more difficult and more expensive land preparation. Now that seed is much cheaper a change of attitude is timely. A review of methods of establishment is necessary. In particular low cost methods which may have application over extensive areas need evaluation.

Reasons for lack of persistence

Overgrazing is obviously one of the main worries with many legumes but sometimes inadequate grazing or too infrequent grazing, which allows the grass to become rank and unpalatable, is the problem. At times of the year grazing some pastures at weekly intervals may be necessary to attain both legume persistence and high nutritive value, and a set rotation of grazing tropical grass-legume pastures every six weeks is open to challenge.

On the other hand some legumes persist longer under a rotational system and should be grown preferably with grasses which stand-over well. Some *Panicum maximum* cultivars are better in this regard than the cultivars of the setaria group. *Dolichos axillaris* is an example of a legume which will not withstand frequent defoliation. Its main attribute is that it will grow on very poor hard hillsides which may be too dry and infertile for other legumes and it persists well if saved to provide stand-over feed.

Drought is a major cause of lack of persistence but this is covered in species selection.

There has been little work on disease prevention and control and this warrants further attention. If a plant fails because of disease how long should replanting be deferred? Should alternative crops or crop-pasture rotations be introduced?

Much more effort has been directed towards insect pests. Controls have been obtained for various pests but the implementation of effective control is clouded by the problem of residues. It seems strange that N.S.W. farmers are recommended to incorporate heptachlor into the soil with the establishment fertilizer when sowing desmodium whereas this practice is banned in Queensland. More evidence is required of its effectiveness in control of Amnemus weevil (*Amnemus* spp.) plus a guarantee of minimal residue problems. A similar problem occurs with the control of *Leptopius corrugatus* (rough brown weevil) in north Queensland.

Nodulation problems and failures need more intensive investigation and further clarification is required on seed pelleting. There is little point in recommending farmers and seedsmen to use rockphosphate to pellet seed of tropical legumes unless suitable grade material is commercially available.

CONCLUSIONS

While not underestimating the major limitations imposed by CLIMATE, SOIL/SITE, PLANT, ANIMAL and MAN there are a number of pasture and crop species that can successfully fill in the feed-year. The wide range of available species tends to complicate matters. Is there a need for fewer species with wide adaptation or a large number of species suited to particular ecological niches to exploit the environment more fully? The difficulty in getting farmers to manage pastures properly is an argument advanced for concentrating on legumes which fit in with the farmers' present management. While overall productivity will be lower, greater adoption by farmers will result. Perhaps this is a rather negative attitude, as well as an indictment of the research worker for his neglect of pasture management. A new generation of pasture and livestock manipulators may readily accept and adopt refined management.

With the wide range of pasture species and crops, together with the various means of manipulating the feed supply throughout the year in most dairying districts of northern N.S.W. and Queensland, it is feasible to provide economically year-round feed of reasonable and at times high quality. Increasingly the base feed is being provided by improved pasture. However, in most situations no one pasture alone adequately meets this need, and for adequate year-round feed complementary use of pasture and forage crop is generally necessary.

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DISCUSSION

Definition of quantity limitations

Quantity limitations are mainly related to the seasonal distribution of pasture growth rather than to annual total yields; limitations need to be defined in terms of the time of the year and the actual animal requirements.

Limitations of pasture species

Major weaknesses of existing pasture species for the tropics and subtropics were considered to be a relatively short period of active growth, a lack of persistence of legumes under grazing and poor frost tolerance. Suggestions for improvements to species were mainly related to seasonal growth pattern and reliability.

Two opinions were expressed as to the ideal seasonal growth pattern for the basic perennial pasture. Firstly, it was suggested that the base pasture should grow for as much of the year as possible. Secondly, there was a suggestion that warm climate species with a much shorter period of growth would provide less competition for temperate species either included as a permanent part of the mixture or oversown in the autumn. Within a farm system, both types of base would be useful but the general opinion was that most emphasis should be given to species with wide seasonal adaption.

Better seasonal spread of production may result from mixtures of species. It was suggested that consideration be given to competition studies which aim at determining the factors that influence production and persistence of temperate and tropical species in mixtures. Naturalised pasture species should be evaluated more fully to determine their deficiencies and to determine the best technique for their improvement.

Rainfall and temperature limitations to pasture production

It was doubted if major advances could be made to overcome rainfall limitations on pasture yield by concentrating on species alone. Because of the frequently unpredictable nature of the moisture limitation there was a need for some flexible practice such as conservation, supplementary feeding or stock transfers. One possible research approach would be in the selection or breeding of plants which are more efficient in using available moisture.

Temperature limitations particularly related to warm climate species can be partially overcome by selection of species with greater frost tolerance. This was considered to be an important criterion for future species selection.

The spring feed gap

The spring is frequently the period of greatest feed shortage for dairy cows in the tropics and several proposals were offered as to how this gap could be filled:—

a) annual forage crops with potential for spring growth and ability to exploit sub-soil moisture.

b) the possible use of fallow stored moisture for the early growth of warm climate crops.

c) carry-over of autumn sown pasture where a reasonable quantity can be maintained, e.g. tropical legumes in frost free areas.

d) nitrogen fertilizer application in spring.

e) feeding of concentrates, conservation of crops or pasture as silage and hay, and irrigation.