PRESIDENTIAL ADDRESS

THE ROLE OF CROPS IN ANIMAL PRODUCTION

R.C.Stephen
Ministry of Agriculture and Fisheries
Invermay Agricultural Research Centre
Ministry of Agriculture and Fisheries

INTRODUCTION

My purpose today is to stimulate thought and I have chosen on the role of crops in animal production; the subject it topical and controversial and there is no doubt in **my** mind that, on certain classes of land, crops could play a very much more important role in animal production than they do at this time. There are large areas in this country where permanent pasture will remain the best way of utilising the land for the best economic return. However there are other areas of flat or gently rolling arable land where, by substituting crops for pasture, there is the potential for substantial increases in the DM production/hectare. These higher levels of DM production would permit increases in carrying capacities and there is the possibility of improvement in per animal performance; both these would have a significant effect on this country's income from export earnings. It is because of this that the subject of crop usage for animal production deserves careful appraisal by scientists in all fields of agricultural research.

Consider first the past use of crops for animal production. Palmer (1967) reported that, next to pasture, the brassica crops were the main animal feed crops grown in New Zealand. In recent years, however, the importance of these forage crops in New Zealand appears to have declined as evidenced by the reduction in areas grown in 1971/72 compared with 1960/61. (Table 1)

TABLE 1'; Decline in area of brassica crops grown in New Zealand

	Area (ha)		Decline
Crop	1960/61	1971/72	%
Rape	56,965	18,152	68
Turnips +Rape	107,006	73,769	31
Swedes	74,491	49,259	34
Kale, chou moellier	59,581	31,397	47

With the exception of maize grown for silage or greenfeed these brassica crops are still the only crops grown for animal feeding on a reasonable scale.

This decline in forage crop production must be due partly to the cost of crop production and partly to the improvement in grassland management technology. Ryegrass-white clover dominant pastures produce about 12 -15 000 kg DM/ha/annum on high producing soils but because of the seasonal nature of pasture production it is necessary to conserve pasture in the form of hay or silage to supplement the lower pasture production that occurs in areas (a) where summer drought is prevalent, and (b) in the late autumn and winter. Essentially this procedure is a means of spreading the dry matter produced by pasture more evenly over the year. However, it is recognised that pasture hay and pasture silage are both of lower quality as animal feeds when compared with fresh pasture. Even if it were possible to increase the dry matter produced by pasture, and it is mainly this factor that determines the stock carrying capacity of any land and hence the amount of animal production, there would still be a need to conserve these lower quality feeds as hay or silage. It is as well to remember that hay is the biggest single crop grown in New Zealand and its costs of production have escalated to the point where it might be well to consider whether its value as an animal feed really justifies its cost of production.

In order to increase animal production it would be necessary in the first instance to substantially increase the DM production/ha/annum as this would permit higher stock-carrying capacitites. Most important of all, the systems adopted must be low-cost ones such that the farmer is able to increase his net returns from the land. I suggest that these objectives can only be met by the introduction of crops into the farming system.

In his address to the Agronomy Society in 1974, Dr Mitchell observed that, on an annual basis, the potential production from crops is at least twice that from grazed pasture on the same area of land. On fertile arable soils in Otago and Southland, for example, DM production from crops of 20 - 25 000 kg/ha/annum is not an unrealistic possibility and in other parts of New Zealand the potential production from crops is probably even greater.

Dr Ken Mitchell was the first to suggest a Crops-for-animal-production-system" in what has become known as the "cut-and-carry system". Essentially this consists of growing crops on the land, harvesting them at or near the stage of maximum dry matter production, storing them in the form of silage as in the case of maize or at levels of moisture wetter than hay but drier than silage (Mitchell, 1969). Instead of the stock going out to collect their own feed in the paddock the stock are held centrally and the feed is brought to them (Mitchell, 1963). The system is probably more suited to dairy cows and beef cattle and is less likely to be used for sheep. One must remember, however, the 60 or so million sheep in New Zealand and the contribution they make to the country's economy by way of meat and wool products.

Recently the term "forage farming" has been introduced in discussions on the use of crops for animal production. It is apparent, however, that the term "forage farming" has become synonymous with the "cut and carry" system, or systems that are very similar. To **my** way of thinking, however, forage farming has much wider connotations and merely implies the use of crops as alternatives to pasture for animal production. The term does not specify how the crops are to be utilised neither does it imply that pasture is excluded from the system.

If we assume that all grass farming is our reference point then clearly the contribution made by crops to the animal feeding system could vary from nil to 100%. It is equally true that feeding animals in a feedlot situation from crops stored in tower silos, as is visualised in the "cut and carry" system, is not the only method of crop utilisation. There is scope for a part-grazed, part-conserved cropping system, or crops could be grazed off **in situ** without the need for any conservation.

There are clearly many alternatives that are possible in a forage farming system and some examples of these are illustrated schematically in Fig. 1. Inspection of this will show that the various alternatives are merely steps in a progressively increasing involvement of crops in the system on an area basis. Initially, as step 1, a small area of the available land might be given over to crop production (e.g. 20%). There is evidence available to indicate that two crops can be grown within a period of one year on this area and these crops could be either conserved or eaten **in situ.**

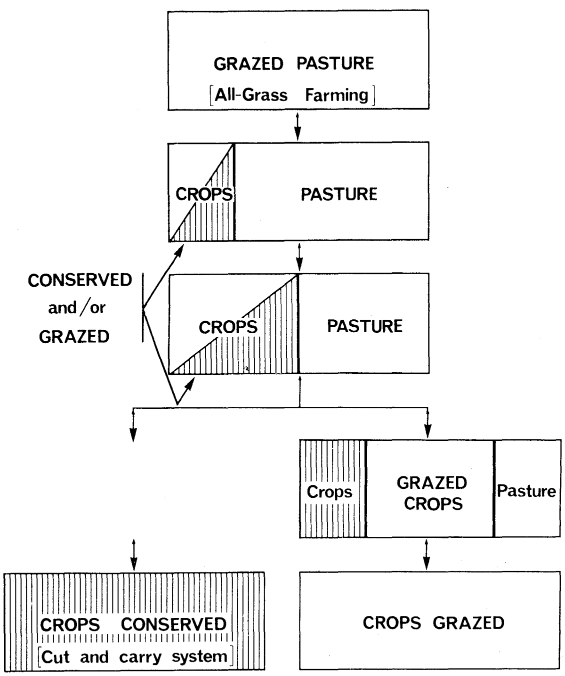

Fig 1 : Increasing involvement of Crops in a farming system

Increasing the proportion of land used for crop growing and conserving all the dry matter produced eventually leads to the "cut and carry" system advocated by Dr Mitchell, as illustrated on the left hand side of my diagram. On the other hand it is possible to increase the area given over to grazing crops **in situ** combined with a simultaneous reduction in the area of crop conserved; the end point of this development entails the elimination of conservation and the whole area devoted to crops would be grazed **in situ**, as shown by the right hand side of my diagram. It might be better, however, to stop short of this last step by retaining a small area of crop for conservation as an insurance or to meet specific production deficiencies that might occur during the year.

It is not possible in the time available to discuss all the steps thay my schematic illustration suggests. There has been much discussion of the Mitchell system and I do not propose to add to it in this talk. However, I should like to explore the potential of the alternative all-grazing crop system.

In Fig. 2 I have outlined one suggestion in a simplified form for an all-grazing cropping system which is appropriate to the Otago/Southland region. The system is based on a limited amount of data and is intended only to illustrate the principles involved and should not be taken to be the best solution. Clearly other crops might be used and there must be other ways of integrating them into a system.

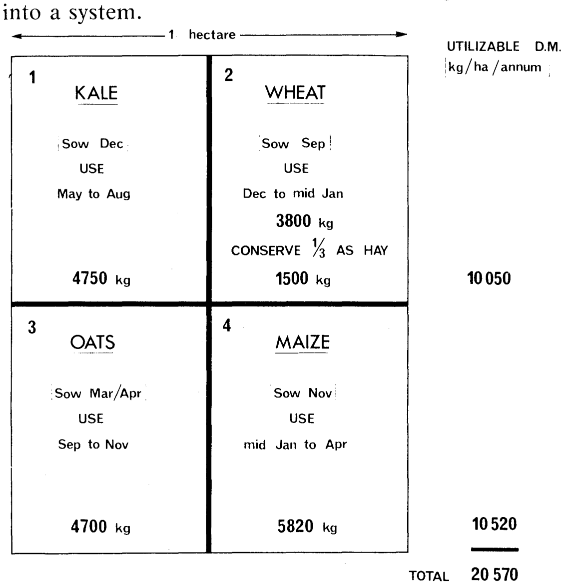

Fig 2 : Example of one All-Crop grazing system

The whole area shown represents 1 hectare of land divided horizontally into 2 half-hectare parts, namely boxes numbered 1 and 2 and boxes 3 and 4. In the upper half hectare, kale and wheat alternate on the same area of land in a period of 12 months and in the lower half oats and maize alternate in the same way. The system protrayed assumes that May is the beginning of the "animal-grazing year" but it is flexible enough, to start the "grazing year" at any time.

To have feed available in May, kale is sown in December, as shown in box 1, and eaten off from May to August. Thereafter this same area would grow feed wheat (box 2) sown in September; two-thirds of the wheat area would be grazed off from December to mid January and the remaining one third would be conserved as hay as an insurance.

On the other half hectare (boxes 3 and 4), oats would be sown in March/April for grazing from September to November followed by greenfeed maize sown in November for use from mid January to April. The maize crop represents the end of the first "animal-grazing year".

The amounts of utilizable DM available for grazing are shown in each of the boxes and these are based on experimental data obtained at the Invermay Research Centre. By summation, a total utilizable yield of 20 570 kg DM is obtained on the hectare of land in a 12 month period. No account has been taken of the possible yields derived from the regrowth of both the wheat and oats on early grazed areas, but this would further contribute to the DM production.

This system or one similar would be suitable for dairy cows or beef cattle. The stock-carrying capacities have been calculated to be about 4 1/2 dairy cows/ha, (1.8/ac) for factory supply and 8/ha (3.2/ac) for a 12-month beef weaner fattening system giving liveweight gains of 225 kg. Both these carrying capacities are almost double the present stocking rates achievable in Otago and Southland. No doubt still higher carrying capacities might be possible in the North Island where the climatic conditions favour the use of other crops and much higher DM production.

With some modification a similar system would theoretically carry 37 ewes/ha (15/ac) in a Romney fat lamb situation with 110% lambing. This compares with a stocking rate of 20 ewes/ha (8/ac) currently achieved by only the best farmers in Otago/Southland. Using these stocking rates as a guide it is possible to calculate the increases in sheep numbers that might be attained from allocating increasing proportions of the area available to

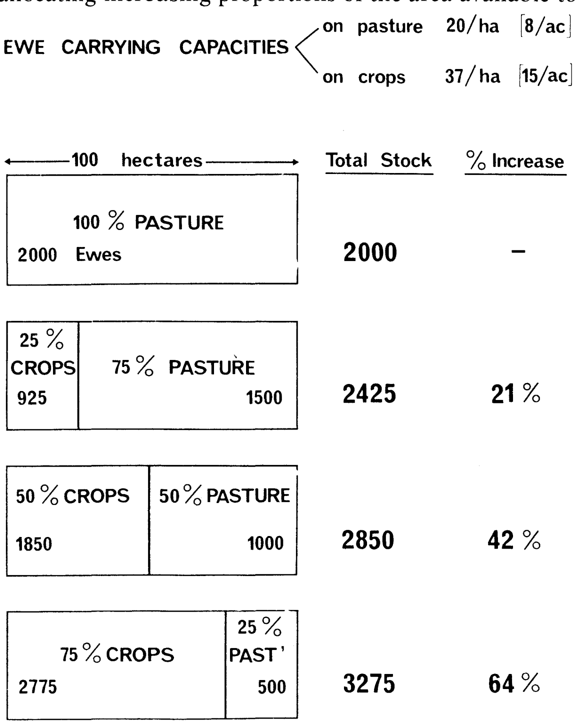

Fig 3 : Effect of increases in cropping area on Ewe carrying capacities

an all-grazing crop system in the south of the South Island. Fig. 3 shows the results of this exercise for a 100 hectare area. For every 25% of the area available that is changed over to the all-grazing cropping system the sheep carrying capacity is increased by 21%. Where 75% of the area available is used for crops and 25% for pasture the ewe carrying capacity is increased by 64%.

At this point I wish to make it clear that much research remains to be done before any such system as I have portrayed can be put into practice. The estimates of dry matter production that I have used are from only 1 or 2 years' data and it is not known just how long these yields from a 2 crop per year system can be maintained. More importantly, perhaps, is the lack of knowledge concerning animal management and performance on such production could use existing equipment and hence would have a low initial capital input. Variations of the system could apply to sheep, beef or dairy animals.

Grazing management techniques have still to be determined but these should not be very different from the current pasture grazing methods. I envisage larger-sized paddocks, rectangular in shape, in which the crops are strip-grazed along the length of the paddock with back fencing to restrict animal movement. Such **in situ** strip grazing has certain advantages:

1. Regrowth can occur with certain crops (e.g. wheat and oats etc.) and an area fed off once can be spelled for a time and grazed over again later — perhaps more than once thereby making a significant contribution to dry matter production.
2. It is possible that treading effects might be less pronounced.
3. Returns of dung and urine to the land are likely to be much more uniform.
4. With the increased stock numbers there will be greater returns of dung and urine to enhance soil fertility — the extent of which has still to be assessed. This may have important implications on the need for artificial fertiliser application.

It is pertinent at this juncture to ask what sort of experimental evidence is available which would support the case for the use of crops in the way I have described. For example, yields of over 15 000 kg DM/ha have been frequently recorded from maize, kale and autumn-sown oats and 12 - 14 000 DM/ha from spring-sown wheat and oats. Spring-sown wheat and oats attain near maximum dry matter production in 120 days, maize in 150 days and October-sown kale takes about 180 days; Autumn-sown crops take longer but there is clearly sufficient time available to grow 2 crops in one year. At Invermay, yields of 20 - 25 000 kg DM/ha have been achieved from combinations of wheat and kale and maize and oats in a 12 month period. Matthews (1973) at Ruakura has obtained 24 000 kg DM/ha in one year made up by combining a yield of 16 000 kg/ha from a silage maize crop and 8 000 kg/ha from ryegrass-white clover pasture for the remainder of the year.

Generally speaking, however, in recording the crop yields scientists have not taken into account the cropping history of the land and to what extent this affects production. The only longer-term work employing a double-crop system that I am aware of has been documented by McCormick (pers. comm.) who combined a silage maize crop with Tama ryegrass. For the first 3 years of a 5 year trial the total DM production averaged 22 100 kg/ha. In the fourth very dry year the yield dropped to just under 14 000 kg/ha but rose again to 21 000 in the fifth year.

No doubt there may be other examples but these three suggest that, compared with pasture, much higher yields of dry matter can be obtained using a double crop system. More work of this nature is required and should be directed towards examining the effects of longer-term cropping systems on dry matter production. If crops are to be grazed, then assessments of production must be made during growth. Growth curves can be constructed from such data and used for feed budgetting purposes. The yield data presented earlier in Fig. 2 (i.e. the example of an all-crop grazing system) were derived from such information.

So far I have said nothing about the potential DM production that might be possible under irrigation and this aspect needs examination as does the requirement for nutrient application. Another requirement of any system is the need to replace one crop with another in as short a time as possible and the no-tillage direct-drilling technique may be of considerable importance particularly in view of its lower labour and fuel inputs compared with traditional cultivation. There is a great deal to be done in respect of the effects of these crops on animal performance, but it should be remembered that many of the crops, which might be used in a cropping system, have been fed to stock in the past.

It is clear that the successful development and implementation of cropping systems for animal production will need the collaboration of research workers in many fields. There is a place for the plant breeder to select and to develop the most useful cultivars or varieties of crops capable of higher dry matter production. Agronomists should produce production cruves for potentially-useful crops sown at different times of year and averaged over a number of years; due account must be taken of the influence of previous cropping history on yield. Such data taken in conjunction with an animal nutritionist's assessment of the crop in terms of its value for a particular kind of animal and for a particular purpose would enable a systems analyst to determind the more useful cropping systems. Animal husbandry experts would be required to assess the effects of crops on animal performance and to determine the best methods of management. Lastly there is the very important contribution to be made by the economist with his cost analysis of different systems.

It is well known that New Zealand leads the field in grassland technology but by the substitution of crops for pasture we have the means to produce twice the dry matter on the same piece of land. Let us make use of this untapped potential and show the world its possibilities.

REFERENCES

Matthews, P.N.P. 1973. Re-establishing pasture after a maize crop. Ruakura Animal Research Station Annual Report 1972-73, Ministry of Agriculture and Fisheries, 39.

Mitchell, K.J. 1963. Production potential of New Zealand pasture land. New Zealand Institute of Agricultural Science Proceedings **9**: 80-94.

Mitchell, K.J. 1969. Nitrogen and Storage farming. New Zealand Agricultural Science **4**, (3): 9-14.

Mitchell, K.J. 1974. Presidential address. Proceedings Agronomy Society of New Zealand **4**: 1-3.

Palmer, T.P. 1967. Brassica forage crops. New Zealand Agricultural Science **1**, (4): 14-16.