GRASSLAND MEMORIAL TRUST ADDRESS

R. W. BROUGHAM
Grasslands Division, DSIR, Palmerston North

IN September 1964, the New Zealand Grassland Association sponsored the establishment of the Grassland Memorial Trust to commemorate the lives of men who had made outstanding contributions to fostering progress in the science and practice of grassland farming. The men first commemorated in this way were the late Dr Peter D. Sears of New Zealand and the late Sir R. George Stapledon of the United Kingdom.

When established, it was also proposed that every 5 to 7 years there would be a Grassland Memorial Trust address. The first of these was given by Dr W. M. Hamilton, past Director-General of DSIR, at the 34th Grassland Association Conference held at Te Anau in 1972. Dr Hamilton used the occasion to give very adequate and interesting outlines of the achievements of the late Dr Sears and the late Sir R. G. Stapledon and their contributions to grassland farming progress. He also gave a eulogy to the late Alfred Hyde Cockayne, a man whose name was added to the list of those commemorated by the Trust in 1966. These eulogies are published in the *Proceedings* of the Te Anau Conference and require no repetition here.

Since the Te Anau Conference, the Trust Board has added two further names to the list of those commemorated. In August 1973 the name of the late Dr C. P. McMeekan was added because of the tremendous impact he made during his lifetime on many aspects of grassland farming, not only in New Zealand but around the world. During his lifetime he conducted or instigated very fruitful lines of research into the growth of farm livestock, artificial insemination, dairy beef production, facial eczema, and the growth and management of pasture for maximum animal production. A fluent, authoritative, and provocative speaker, the late Dr McMeekan instructed, cajoled and sometimes almost bullied farmers into adopting more efficient techniques. His influence was also wide on his scientific colleagues, and his drive as Director was largely responsible for the growth and worldwide reputation of the Ruakura Agricultural Research Centre. In later years, as agricultural adviser to the World Bank, he was closely concerned with the economic development of pastures for livestock production in many parts of the world.

The fifth name commemorated by the Trust in 1976 was that of the late Dr R. A. Candy, a man who in his lifetime was an outstanding leader in the dairy industry, having been an innovative and highly successful farmer, a pioneer in herd improvement, a factory director, and a prominent member of the industry's administrative and marketing organizations. He was chairman of the Herd Improvement Council for 32 years, chairman of the Dairy Products Marketing Commission, and deputy-chairman of the Dairy Board for four years. His own farms were virtually a training ground for prospective farm owners and managers, many of whom owe their success to his guidance and example.

Each of these men so honoured by the Trust had many features in common. All were extremely intelligent, and, importantly, had the capacity for original and innovative thinking. All had good senses of humour, some of them especially so. None of them could countenance fools, and especially educated fools. And all had tremendous drive which strongly aided their success. I met and associated with four of them, three of them much more closely than the fourth, and can attest to their humour, their drive, their impatience, their abilities, but perhaps most important, their capacity to see the whole, then to model changes for progress and bring these to fruition.

In these terms, Cockayne's and Stapledon's ecological concepts were the foundation of many of the principles adopted during pasture development from bush in New Zealand, and in plant improvement through plant selection and breeding; Sears' concepts of soil fertility build-up in pasture development had a profound impact on the progress of New Zealand's pastoral industries; McMeekan's concepts of balancing feed production from pasture on the farm to feed demand of the dairy herd or sheep flock helped form the basis of present-day concepts in farm management: and Candv's outlook on herd improvement and farmer counselling helped develop herd improvement in the dairv industry, and. as well, was the basis of the formation of the N.Z. Dairy Board consultancy service.

These men developed many other concepts that were equally significant in the development of New Zealand's pastoral industries, and as a consequence their impact on progress was very large. Imnortantlv, they were active at a time when dramatic increases in productivity from our pastoral industries occurred — that is, in the period between 1920 and 1970. Since then progress has been much less dramatic and because of this many of those involved in, or associated with farming, argue that similar progress will not occur again.

Such pessimism would have been foreign to the outlooks of the men honoured by the Grassland Memorial Trust. I believe their outlooks would have been justified, as since 1970 it is my view that tremendous progress has been made in many aspects of our farming practices, in our knowledge of various elements of the soil-plant-animal complex of pastoral farming, and of ways and means of attaining higher production levels, and some by cheaper methods. Therefore, for the remainder of this address, it is intended to look positively at some of these developments that have occurred over the past 6 or 7 years, that is, over the period spanned by Dr Hamilton's and this address. For obvious reasons remarks will also be confined to those developments that can truly be called pastoral.

PASTURE MANAGEMENT

The results presented in Table 1 illustrate the levels of livestock production that have recently been recorded at research stations in various parts of New Zealand.

The levels of productivity are very high by any standards. In most cases they have been obtained by synthesizing the results of other research, then studying these in whole systems. The studies have assessed the productive potentials of the species in the pasture mixtures evaluated, their tolerances to grazing pres-

TABLE 1: LIVESTOCK PRODUCTION LEVELS OBTAINED AT RESEARCH STATIONS

Farming System	*Carrying Capacity (per ha)*	*Production Level (kg/ha)*	*Source of Data*
Dairy:			
Non-irrigated	4.94	600 (butterfat)	Hutton (1973)
Irrigated	5.56	840 (butterfat)	Hutton (1973)
Sheep:			
Warm temperate	20	360 (lamb meat)	Rumba11 (pers. comm.)
Dryland	16	300 (lamb meat)	Vartha & Fraser (1978)
Dryland — irrigated	27	485 (lamb meat)	Vartha & Fraser (1978)
Cool temperate	19 (170% lambing)	480 (lamb meat)	Harris & Hickey (1977)
Dairy beef:			
Temperate	7.4	1040 (hot carcass meat)	Brougham et *al.* (1975)

sures examined, and their upper levels of productivity better defined.

Within each system many facets of pasture and species growth were manipulated. In the dairy beef study, for instance, long-rotation systems of management were practised over the winter and early spring, the intervals between grazings reduced to about 15 to 20 days in the spring, and then lengthened to roughly 30 days over the summer. Killing of the animals was determined by the onset of the dry weather. Very little hay was made as it was assessed that it was more profitable to eat the growing grass in the late spring/early summer than to conserve and suffer losses of feed in the haymaking process. Also at certain times of the year no effort was made to put weight gain on the animals. This was especially so following the onset of autumn rains for a period of approximately 3 or 4 weeks. Many other variables were assessed and incorporated into the system at different times of the year. The end result in that particular study was a very high carcass yield of meat per hectare that has been sustained over a period of 8 years. Similar approaches were taken in the other studies shown in Table 1.

SOIL FERTILITY

Over the past 5 or 6 years marked progress has been made in our understanding of nutrient cycling and particularly nitrogen cycling in pastoral farming. This has been made possible by the use of the acetylene reduction technique for assessing nitrogen fixation of the legume component of pastures in the field (Moustafa et al., 1969). The results presented in Table 2 are an indication of the type of result presently being obtained using this technique.

Importantly these results show that in developed pastures the amount of atmospheric nitrogen fixed by the legume component of these pastures is in most cases less than half that of previous estimates (Sears, et *al.,* 1953; Walker, 1956). Such information is of high significance when considered in relation to the nitrogen economy of pastures. They also have high relevance in relation to the proposed manufacture of substantial quantities of urea in this country by 1981. Based on results such as those presented in Table 2, together with the large amount of other information that has been obtained over the past few years on other aspects of soil fertility, on response of pastures to fertilizer nitrogen (e.g., Ball and Field, 1979) and on the interactions between

TABLE 2: AVERAGE PASTURE YIELD, CLOVER CONTENT OF HERBAGE, CLOVER NITROGEN FIXATION AND NITROGEN FIXATION PER UNIT CLOVER GROWN FOR THE NINE TRIAL SITES

	Pasture Yield (kg DM/ha)	*Clover Content (%)*	*Nitrogen Fixation (kg N/ha)*	*Fixation/Unit Clover Grown (kg N/tonne clover DM)*
Kaikohe	11500	32	392	106
Manutuke	14 700	14	107	54
Wairakei	7 300	26	141	74
"Ballantrae"	8000	2	17	112
Kairanga	13 700	22	227	75
Palmerston North	12 700	33	208	49
Masterton	10 800	16	166	97
Kirwee				
Dryland	9 900	41	126	31
Irrigated	14 500	33	189	39
Gore	11000	26	280	99

(After Hoglund et *al.,* 1979.)

these and other nutrients applied to pastures, we should be in a very sound position to make rational decisions on the best use of manufactured nitrogen, not only for pastoral farming but also for cropping and horticultural use.

During the past few years there have been many other developments in plant nutrition that when applied will have marked effects on the productivity obtained from farms. Some very interesting work on pathways of uptake of nutrients by pasture plants has been carried out (Dunlop and Bowling, 1978). This work has been valuable background information for some current plant breeding programmes aimed at developing legumes, and especially white clover plants, that are more efficient in the use of phosphate. Similarly, the development of sulphur coating of seeds for use in certain areas of New Zealand such as the high country is a very significant development, as is the better appreciation of the role and significance of mycorrhiza (Crush, 1978) in the various pasture types and farming zones of New Zealand. The recent surge in activity around interactions between lime and phosphate in pastoral farming, and especially hill country farming, will also enable farmers to better rationalize fertilizer practices. There are many other developments in this field that are of considerable importance to farming progress but time does not permit elaboration.

PLANT IMPROVEMENT

Since the first Memorial Trust address given at Te Anau by Dr Hamilton in 1972, eight new varieties of pasture plants have been accepted for listing on the New Zealand List of Acceptable Herbage Cultivars. These eight cultivars are shown in Table 3.

TABLE 3: HERBAGE CULTIVARS ADDED TO N.Z. LIST OF ACCEPTABLE CULTIVARS SINCE 1972

'Grasslands Nui' perennial ryegrass.
'Grasslands Pawera' tetraploid red clover.
'Grasslands Maku' lotus.
'Grasslands Matua' prairie grass.
'Grasslands Pitau' white clover.
'G.14' phalaris.
'G.15' paspalum
'G.4710' tall fescue.

Already the growth and performance of a number of these varieties have been considerably researched, although much more information is needed on the performance of all of them in some environments within the country. Nevertheless, all of these species have the capacity to enhance production potentials in different regions of the country.

'Grasslands Nui' perennial ryegrass has certainly illustrated a production potential in many regions of the country beyond those of most other ryegrasses available for use (Armstrong, 1977; Pineiro and Harris, 1978a). Similarly, 'Grasslands Pawera' red clover is being shown to have a large potential for certain farming patterns or endeavours (Anderson, 1973; Hay et al., 1978) . The results presented in Table 4 are an indication of this variety's potential.

Preliminary data being obtained in the Kairanga, near Palmerston North, have indicated that this variety of red clover is very

TABLE 4: PRODUCTION OF PASTURES OF DIFFERENT COMPOSITIONS IN A COOL TEMPERATE REGION OF NEW ZEALAND (kg DM/ha)

Pasture Type	*Spring*	*Summer*	*Autumn*	*Winter*	*Total*
Red clover + annual grass	6000	5000	1500	2000	14 500
Red clover	4500	7100	1200	750	13 550
Perennial ryegrass + white clover	7000	4100	2500	1200	14 800

persistent if sensibly managed. After 4 years in a dairy beef grazing study, the variety is being shown to have a high production potential because its growing period is complementary to ryegrass and white clover (Harris, 1977; Pineiro and Harris, 1978) . The potential of 'Grasslands Maku' Lotus *pedunculatus* (Armstrong, 1974) is being demonstrated through active research by the Agronomy Section at the Invermay Agricultural Research Centre, and the Forest and Range Experimental Station of the N.Z. Forest Service at Rangiora among others. For acid soils this legume is being shown to have no peer and it could be used extensively for revegetation if sufficient seed of the variety was available at reasonable cost. The place of 'Grasslands Matua' prairie grass (Rumball, 1974) is also beginning to be realized and for intensively farmed areas of the country such as most dairyfarming regions this variety will help in raising production levels.

The other three cultivars shown in Table 3 are less well known, but each will have a place in more selected regions of the country. The phalaris cultivar, for instance, has a likely role to play in dry hill country and the paspalum cultivar is very acceptable in the northern regions of New Zealand.

Other varieties are being developed by both public and private plant breeding institutions. Each should contribute to further increases in productivity, provided their genetic potential is allowed to be realized through good management and husbandry practices. However, we must be aware of what is happening in Europe and take heed of such findings. At a recent International Grasslands Meeting held in Dublin, Van Bogaert (1977) of the R.v.P. Organisation in Belgium produced data to show that yields of recently bred European ryegrasses were no higher than older bred varieties. He also produced data to show that perennial tetraploid varieties did not produce more than perennial diploid ryegrasses. Van Bogaert then posed the question of "whether Odum (1974) is right when he suggests that yield per hectare is physiologically defined and that it is impossible to improve physiological output or the fixation of solar energy into organic material". According to this thesis the improvement in grain yield with cereals is achieved only by decreasing the yield of the straw. Van Bogaert also produced data to support this thesis. A similar phenomenon is occurring with herbage species but at the expense of persistency — *i.e.,* changing the harvest index.

While we are in the phase of developing varieties that are first up within a species, then Van Bogaert's comments are probably not relevant, but they do have marked significance when we begin to assess the possible improvements likely in, for instance, perennial ryegrasses through plant improvement. Van Bogaert's own efforts in Belgium are now being directed towards ensuring that yield is more independent of normal or unfavourable climatic conditions, as well as looking for seasonal spread of production. However, these comments should not. be used to argue that there are little prospects for improvement in pasture productivity through plant breeding efforts. In fact, in my view, they emphasize the reverse.

PASTURE PESTS

Over the last 6 or 7 years there has been a large build-up in resource for research into the control of pasture pests. Already this work is paying dividends, as has been illustrated by the biological control methods used to eradicate army worm. Of equal significance is the development of plants resistant to the attack of some pests, and perhaps more important, the understanding obtained of the chemical pathways involved in this phenomenon (Sutherland, 1975; Russell, 1979). Equally important has been the development of grazing management techniques and husbandry practices that dramatically reduce populations of pasture pests (Kain and Atkinson, 1975). Most of these approaches are being undertaken to look for alternatives to pesticides and ecologically this is very desirable. There was considerable optimism for progress in these fields expressed at a recent Australasian symposium held at Palmerston North.

* * *

The above are but a few examples of progress that has been made in recent years in various areas of pastoral farming and pasture production. Many other examples could have been cited and elaborated on. For example, the demonstration of the potential of various pasture species under irrigation in some of the inland basins of New Zealand that have a semi-continental climate (Scott *et* al., 1975) will have a marked impact on farming in these regions. Similarly, the introduction of the "grass-fence" into farming and especially for hill country farming has been widely acclaimed as progressive. This now means that hill county farmers have a cheap means of fencing to aspect, a' fact that will aid substantially in raising production levels (Suckling, 1975). Parallel to this has been the development of various systerns of "feed budgeting". In my view the concept is the important thing in this development, as it makes people much more conscious of the growth of pasture and the effect changes in management have on pasture production.

Again, if we consider animal breeding, major advances have occurred by selection within the Romney breed, as has been evidenced by developments such as those on the Waihora Lands and Survey Block, near Taupo, and other groups of farmers, of large flocks of sheep with the genetic potential for very high lambing percentages. Similar progress has been made with beef herds within and between breeds. These developments have occurred over a longer period of time but progeny are now becoming available for wider use. Developments in deer farming and in farm forestry have also been dramatic these past 6 or 7 years. In seed production, the developments around the re-export of seed grown from varieties developed in other countries, or the demonstration of techniques required to grow seed crops that ensure better quality seed (Brown, 1977; Clifford, 1974, 1977) are further examples. There have also been many developments in farm mechanization, such as the rotary milking shed and improved methods of direct drilling (Baker, 1976). If fail-safe methods of direct drilling can be developed, there is then widespread scope to incorporate new varieties of pasture plants into existing pastures with the minimum cost and minimum effect on feed supply from the direct drilled paddocks.

In the above some of the developments that have occurred over the last 6 or 7 years around pastoral farming and pasture research have been outlined. The question could be asked, "Has this happened on the farm?" In my view the answer is a definite yes. I know of dairy farmers producing well in excess of 500 kg of butterfat per hectare — in fact, close to 600 kg. These are levels that are very close to research levels outlined in Table 1. Similarly, I know of dairy beef operators who are carrying high levels of stock per unit area and as a consequence obtaining very good economic returns. The same applies to sheep farmers.

This has not happened by farmers adopting practices such as buying out neighbours, or by allowing the other twin to die by taking "easy-care" shepherding to the extreme. Nor has it happened by markedly reducing fertilizer inputs to what some call "economic levels". It has happened, in the large majority of cases, by the application of the sorts of technological developments previously outlined in this paper. In my view it will continue to go on this way. Farmers will be nipping at the heels of the researchers ready to pick up any sensible technological finding available and put it into practice. Some of these developments may occur in the following fields:

PHOTOSYNTHESIS AND INCREASED CROP PRODUCTIVITY

As 95% of the dry weight of plants is the result of photosynthesis, studies on this process should have high priority in efforts to improve plant productivity. The ultimate aim of such work should be to develop new methods for plant breeders that will enable them to identify and incorporate improved photosynthetic efficiency into plants,

NITROGEN FIXATION

It has already been stressed that good supplies of nitrogen are essential for plant and pasture productivity. There is, therefore, a need to understand better the mechanisms that control and regulate the various processes involved in nitrogen fixation. This even includes studies of the genetics of regulation and transfer of nitrogen fixation genes with the possible objective of transferring these to non-nitrogen fixing plants — a pipe-dream at this stage, but perhaps not in 10 years' time. Such studies may seem to this audience far removed from practical farming, but any breakthrough would have a major impact on New Zealand's pastoral industries.

GENETIC ENGINEERING

The objective of these studies will be to determine those plant processes and characteristics that can be used by plant breeders in manipulating plant genotypes for increased productivity. A recent basic research report published by the Agricultural Research Policy Advisory Committee of the U.S.D.A. in 1977 and titled *Basic Research in Agriculture* stated, "Biochemists and plant physiologists must be brought into direct and active team participation with plant breeders and other scientists who work with the genetic and cultural improvement of crops. Studies in this area will utilize pollen cell and tissue culture techniques to accelerate genetic improvement in plants". Seven approaches were then listed. These studies will also be associated with those involved in investigations of recombinant DNA.

CROP GROWTH MODELS

It has already been shown that simulation models can be developed to describe crop response to environmental conditions at different stages of phenological development. Major emphasis is placed on environmental management systems to counteract adverse responses. When these models are appropriately interfaced, crop yield prediction is improved. The value of this work will lie in the user's ability to interrelate large numbers of facts into a model for verification under field conditions.

There are many other areas of research that wili have direct pay-off to farming in the near future. Time does not permit a detailed analysis of these. Suffice to say that they will cover fields such as pest and weed control, the evaluation of alternative technologies for reducing energy used in the production and transport of agricultural products, more detailed assessments of nutrient gains and losses associated with intensive pastoral farming, comprehensive economic forecasting where efforts will be made to upgrade information on the near- and long-term projections, and agricultural outlook aiming at more predictability in farming operations, major developments in long-term weather forecasting and the impact of this on farming operations, and the significance of profitability of farming in relation to the production of products for export and hence survival for all New Zealanders. There are many others.

These advances will be accepted by the better farmers and advisory officers and will be adapted to fit into local conditions and practices, and it will continue to go on in this way in spite of the predictions of the less optimistic. Tn my view there is nothing more certain than that we will carry on increasing productivity by the application of more and better knowledge around the many facets of grassland farming. This was very clearly illustrated to me when I contacted all previous award winners of the Grassland Memorial Trust and asked them, among other things, to outline factors that they saw presently limiting increases in production. Many factors were quoted, but interestingly 85% of those that replied (and nearly all did) stressed the need for more technological information.

I sincerely hope that what has been presented in this address honours sufficiently the five men commemorated by the Grassland Memorial Trust. I hope that, by looking ahead, especially at the possibilities and probable developments in pastoral agriculture, the attitudes of these men have been illustrated. They all looked ahead, they all had good concepts of the factors needed to advance the cause of pastoral farming, and they all endeavoured to do this as well as they were able during their lifetimes. It is a spirit worth fostering, especially at the present time.

REFERENCES

Anderson, L. B., 1973. N.Z. *Jl agric.* Res., 16: 395-S.
Armstrong, *C.* S., 1974. N.Z. *Jl exp. Agric.,* 2: 333-6.
——— 1977. *Ibid., 5:* 381-4.
Baker, C. J., 1976. Ph.D. thesis, Massey University.
Ball, P. R.; Field, T. R. O., 1979. In Lynch, P. B. (Ed.), *Fertiliser Nitrogen Use in N.Z. Farming.* N.Z. Inst. Agric. Sci., Wellington (in press).
Brougham, R. W.; Causley, D. C.: Madgwick, L. E., 1975. *Proc. Ruakura Frms' Conf.:* 165-8.
Brown, K. R., 1977. N.Z. *Jl exp. Agric., 5:* 143-6.
Clifford, P. T. P., 1974. N.Z. *Jl exp. Agric., 2:* 261-3.
——— 1977. *Ibid., 5: 147-9.*
Crush, J. R., 1978. *Massey Dairyfmg A.: 53-5.*
Dunlop, J.; Bowlng, D. J. F., 1978. *J. exp. Bot., 29: 1139-46.*
Hamilton, W. M., 1972. *Proc. N.Z. Grassld Ass., 34:* 8-16.
Harris, A. J.; Hickey, M. J., 1977. *Proc. 13th int. Grassld Congr.:* in press.
Harris, W., 1977. *Proc. 13th int. Grassld* Congr., Leipzig.
Hay, R. J. M.; Kelly, R. W.; Ryan, D. L., *1978. Proc. N.Z. Grassld Ass.,* 38 (2) : 246-52.
Hoglund, J. H.; Crush, J. R.; Brock, J. L.; Ball, Roger; Carran, R. A., 1979. *N.Z. Jl exp. Agric.. 7: 45-51.*
Hutton, J. B., 1973. *Proc. Ruakura Fmrs' Conf.: 220-32.*
Kain, W. M.; Atkinson, D. J., *1975. Proc. N.Z. Grassld Ass., 37: 132-7.*
Moustafa, E.; Ball, P. R.; Field, T. R. O., 1969. N.Z. *Jl agric. Res., 12:* 691-6.
Odum, E. P., 1974. Fundamentals of Ecology (Abstr.). *Jaaroverzicht 1974 van de uctiviteiten van de Belgische Boerenbord,* Leuwen.
Pineiro, J.; Harris, W., 1978a. *N.Z. Jl agric. Res., 21: 83-92.*
———; ——— 1978b. *Ibid., 21: 665-73.*
Rumball, W., 1974. *N.Z. Jl exp. Agric., 2:* 1-5.
Russell, *G.* B., *1979. Proc. Australas.* Symp. on *Invert. Ecol.* (in press).
Scott, D.; Clifford, P. T. P.; Maunsell, L. A.; Archie, W. J., 1975. *Tussock Grassld Mount. Land Inst. Rev., 31: 49-52.*
Sears, P. D., *et al.,* 1953. *N.Z. Jl Sci. Technol., 35A. Suppl. 1:* l-77.
Suckling, F. E. T., 1975. *N.Z. Jl exp. Agric., 3: 351-436.*
Sutherland, *0.* R. W., *1975. Proc. N.Z. Grassld Ass., 37,:* 126-31.
Van Bogaert, *G., 1977. Proc. int. Meet. Anim. Prod. from Temp. Grassld,* Dublin: 29-35.
Vartha, E. W.; Fraser, T. J., 1978. *N.Z. Jl exp. Agric., 16:* 195-200.
Walker; T. W., *1956. J. Sci. Fd. Agric., 7: 66-72.*