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Presidential Address

HILL COUNTRY: A MAJOR AGRICULTURAL RESOURCE AND ITS CAPACITY FOR INCREASED PRODUCTION

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In this address I would like to focus attention on hill country and the need for a redeployment of technical, capital and other resources in order to develop its potential for increased productivity.

There are about 4 500 000 ha of hill-country (predominantly non-ploughable) land, excluding the South Island high country, in New Zealand. The distribution of this land resource is indicated in Figs 1 and 2. In Fig. 2 the demarcation between High and Hill South Island land areas is not possible except to note that of this area 2 700 000 ha is classed as high country. At present the hill-country land supports about 32 million ewe equivalents or 42% of New Zealand's total stock units. It is responsible for earning more than $600 million a year in foreign exchange and, if allowance is made for the relatively low import content of hill-country sheep and beef farming, the net foreign exchange earned is about 50% greater than the value of receipts from "manufactured exports". There are about 8000 hill country farms which have a total capital value approaching $2000 million. These farms provide direct employment for more than 15 000 people as well as markedly affecting employment opportunities in other sectors. In addition, the hill country has a vital role as a reservoir of breeding ewes, wether lambs and cattle for lowland farms. Thus, in terms of land area, number of livestock carried and the volume and export value of meat and wool produced, hill-country farming is a major enterprise and a key aspect of the New Zealand economy.

Hill country is highly variable in physical features as well as stage of development to pasture. This variability has been a key factor in the reluctance of scientists to undertake research in hill country, and will continue to pose problems in applying research results from low land to hill country or in defining productive potential.

Recorded pasture production levels have varied from about 1 400 to 9 000 kg DM/ha on dry hill faces, 11 000 to 13 000 kg DM on wet hill faces and up to 22 000 kg DM/ha on stock camps. In the North Island, pasture composition varies from browntop dominance with some sweet vernal, Yorkshire fog, dogstail, danthonia, suckling and white clover, and *Lotus* spp. to danthonia dominance with ratstail and other minor species. Paspalum is usually present in northern regions. The extent to which these pastures can be manipulated on a farm basis towards pastures with a higher legume content and better producing grasses is very substantial but as yet poorly defined. Nevertheless, the experience of farmers and limited trial data show that it is possible to grow pastures with very much higher production over large areas of hill land.

The average carrying capacity on hill-country farms is about 7 stock units (s.u.)/ha, with 2.5 s.u./ha being supported on South Island hill country and about 10 s.u./ha on the easier and wetter land in the North Island. For this type of country the highest carrying capacities have been about 18 to 20 s.u./ha under sheep farming. However, the physical limits of productive

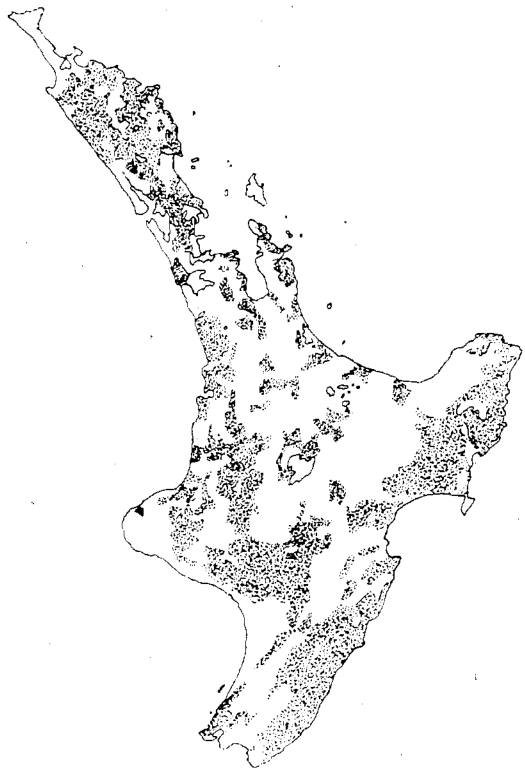

FIG. 1: *North Island hill farming areas.*

capacity on hill country with intensively farmed, genetically superior livestock have not been tested experimentally.

At present, hill country is grossly under-farmed, with little more than half the potential being realized in many cases. The level of utilization of pasture by grazing animals and its conversion to salable products are capable of substantial improvement, as are the production, composition and feed value of the pasture. It is my contention that the productive potential of hill country can be increased by 50% on a national basis, with the wetter and higher fertility areas being capable of achieving increases of over 100% per unit land area.

Herbage yields can be substantially increased by the application of phosphatic fertilizer, trace elements and legume introduction. To utilize this pasture more effectively demands that feed be rationed to grazing animals in a way which more closely

FIG. 2: *South Island hill and high country farming areas.*

equates with their quantitative feed requirements and which also enables manipulation of the frequency and severity of grazing for optimum pasture growth. Better control of the intensity and frequency of grazing, achieved by rotational grazing and manipulation of stock through closer subdivision with electric fences, will be an important factor in enabling this potential to be realized. With better grazing control, improvements in the fertility cycle, legume content and therefore soil nitrogen levels, as well as pasture quality, can be expected. High and even grazing intensity is a key to more efficient hill-country farming. What is not available is an adequate technology to guide the intensification of pasture and animal management on hill country. The fertilizer requirements, pasture responses to varying frequency and intensity of grazing, the quantitative relationships between levels of pasture allowance and animal response, the effect of method of grazing on pasture variability, and many other facets are largely unknown. This knowledge is essential before optimum farming systems can be defined and evaluated.

While estimates of potential production are imprecise owing to the lack of research, the indications are that stocking rates could be increased by 20 to 30% above present levels by subdivision and better planned feeding of stock. It appears, for example, quite feasible to increase the amount of feed grown from 8 000 to 11 000 kg·DM/ha, or to improve the level (and evenness) of pasture utilization from 60 to 80%, both of which could increase the number of stock units carried by about 30%. Over much of the North Island hill country now carrying 9 to 12 s.u./ha, stocking rates could then be increased to 12 to 17 s.u./ha with intensification of grazing and animal management. A 3.5% annual compound increase in stock numbers on hill country as a whole would mean a 50% increase in about 12 years, representing at least 15 million extra stock units. This appears a realistic target.

There are many other valuable ways by which further increases in the volume and efficiency of production can be achieved from hill country. It is not proposed to detail these here, but merely to emphasize that the definition of phosphate requirements for development and maintenance, control of diseases such as facial eczema, improved pasture production through the introduction of new species, higher legume contents, the growing of high-yielding forage crops such as maize and even cash crops on the better class cultivatable land within hill-country farms, introduction of improved strains of *Mycorrhiza*, strategic use of nitrogen fertilizer, improved water conservation, insect and weed control and fencing, not to mention improved nutrition of young and mature stock leading to higher fertility levels, lower mortality, improved wool production and many other facets, offer enormous potential for increased production from hill country. Multi-discipline research on many aspects of soil, plant and animal production has high relevance to hill-country farming, yet very limited research has been undertaken in hill-country environments.

There is also a large potential for more processing of the agricultural products from hill country; that is, to add more value to indigenous resources before these are exported. Examples of this are the scouring, spinning or further processing of wool, the tanning of pelts, and other developments of "manufacturing" industries based on raw materials produced from hill country.

THE PERFORMANCE OF HILL-COUNTRY SHEEP

As the limited cultivatable areas are progressively devoted to more intensive production, an increasing proportion of the total sheep and cattle in New Zealand will be bred and finished for slaughter on hill country. As a result, the relative importance of this land to meat and wool production will increase, as will the need for breeding stock to be generated in this environment.

There are many thousands of structually unsound, genetically low-producing sheep on farms in New Zealand. In hill-country sheep, low growth rates from weaning, poor pre-tupping ewe liveweights, reflected in low conception (57%), in lamb rates and multiple birth rates, with up to 25% lamb mortality to weaning, are often characteristics of several breeds and crosses. A wide variability in productive traits between animals is evident. While the definition of the factors influencing the level of performance of these component traits undoubtedly requires further research, much has been achieved towards providing solutions to these problems. It is now clear that dramatic improvements can be achieved in the capacity of animals to respond to improved feeding and management through selective breeding.

While the evaluation and utilization of breed resources deserves further attention because genetic diversity can be quickly utilized for more efficient animal production and changing objectives, in general, breed characterization and crossbreeding are relatively short-range techniques to maximize the commercial usefulness of existing purebreds or to develop new breeds. Continuing genetic improvement depends upon the effectiveness of multi-trait selection within the more useful breeds. Sheep and beef cattle breeding technology has reached the stage where a major effort should be made to facilitate its widespread adoption by the farming community.

In hill-country sheep, this within-breed improvement needs to include:

(1) An extension of within-flock objective recording of performance traits particularly in the the Romney, Coopworth, and Perendale breeds.

(2) The identification of those animals within large populations which are of sufficient merit to justify recording and data processing costs and the transfer of these into nucleus flocks of private breeders and group breeding schemes. If a high proportion of the 300 000-odd rams needed annually by industry are to be of high genetic merit, then larger numbers of ewes and sires, themselves of above average merit, need to be identified and exploited. Because of the genetic, social and economic advantages, there should in my view be a greater commitment to the establishment of further large-scale group breeding schemes to supplement the effective selective breeding and higher culling needed in the smaller "closed" ram-breeding flocks.

(3) Ram-breeding populations that are large enough to avoid inbreeding and to take advantage of the economies of scale of operation and of the limited specialized skills available.

(4) An organization which can effectively help to implement selection programmes, not only in ram-breeding flocks but also in commercial flocks, to ensure sires are selectively bred to best advantage.

(5) A team of scientists able to develop further the technical basis of Sheeplan and the integration of appropriate technology, together with an increased number of trained advisers.

Consideration should also be given to the establishment of national nucleus flocks, at least of the Romney, Coopworth and Perendale breeds, under the independent control of a National Sheep Improvement Council (representative of Sheeplan users), with the objective of generating sires for use in contributing flocks and other sire-generating units. Direct industry control with support from a permanent technical advisory committee is suggested.

The developments in Sheeplan and the establishment of large-scale breeding schemes are deserving of more support. The total costs of recording and testing in the sire-breeding sector, although high for the sire breeder on a per animal basis, are relatively small in comparison with the cumulative benefits that accrue from such improvement programmes. These costs can be reduced, and the numbers of high merit rams that are needed can be generated more quickly through screening and the establishment of group breeding schemes than if reliance is placed on selection within many smaller flocks now of average merit. In the Lands and Survey (Waihora) Sheep Breeding Scheme, for example, estimates of the cumulative net discounted return are about $8 million over 15 generations of selection, or an annual return on investment of about 40%. We have in New Zealand the livestock, land, technology and practical skills to revolutionize the breeding of sheep on a far greater scale than at present and thereby to increase output per animal by at least 30%. In my opinion a well-organized sheep-improvement programme deserves to receive the full commitment of the sheep industry.

BEEF CATTLE IMPROVEMENT

The key to selective breeding in commercial beef herds is the genetic merit of the bull-breeding herds, as about 80% of the potential rate of improvements results from the sires used. There is still an important need in the beef industry for a rejuvenated, co-ordinated, genetic improvement programme which both identifies and exploits superior genetic merit.

This exploitation of genetic merit is not being achieved either by systematic crossbreeding or by progressive selective breeding within straightbred beef animals on a national basis. Much has recently been achieved towards this objective by the definition of the comparative performance of different breeds and crossbreeds, the development of some large-scale integrated breeding schemes, Beefplan, and progeny testing, and valuable experience has been gained in the use of techniques such as embryo transfer, synchronization of oestrus, and artificial insemination (A.I.), which have some application in sire-breeding units. Nevertheless, most beef sires are still generated in many small herds rather than in larger, more economically efficient units, and there is lack of a defined national policy and real commitment of resources to the genetic improvement of beef cattle in New Zealand.

The following are some of the aspects needing attention:

(1) Under the umbrella of a National Beef Improvement Council (elected by the users of Beefplan), there should be a rapid development and extension of on-farm recording (Beefplan) in sire-breeding herds to provide comparative performance records on which to base selection decisions. Unfortunately, this on-farm performance testing in the many small herds now generating bulls has limitations. First, the groups of bull offspring being compared are small in size, so the efficiency of selection is reduced. Secondly, most of the bulls being compared will be the offspring of one or two sires, which itself will markedly reduce the rate of improvement compared with selection among the sons of a large group of bulls. Thirdly, to avoid inbreeding, sires of unknown relative genetic merit from outside herds tend to be used, and, fourthly, the cost of establishing and maintaining recording programmes is high in small compared with larger units.

The further technical development of Beefplan, better supported by animal breeding scientists and specialist advisers working closely with farmers, is essential for more rapid acceptance of performance recording.

There are many aspects requiring research to support this improvement, including research on selection indices, feed efficiency, factors influencing earlier calving, carryover effects of maternal environment on performance, oestrous synchronization combined with A.I., indirect methods of assessing fatness, carcass merit, quantitative feed requirements, etc.

(2) Privately operated, large-scale integrated cattle-breeding schemes in which selection in larger (500 plus) nucleus units is based on maternal and growth traits should be actively encouraged. The Lands and Survey (Waihora) Angus Breeding Scheme is sufficiently well known to indicate the potential of this approach to breed improvement and does not require further elaboration.

(3) National nucleus herds, at least of the Angus and Hereford breeds and possibly other breeds, should be established under the control of a National Beef Improvement Council with the objective of generating sires for use in other key sire-breeding herds. These could be established on Crown land.

(4) Progeny testing programmes for maternal, growth, carcass and other traits of economic importance in selection need to be pursued through the use of large herds specially used for progeny testing and A.I. reference-sire programmes.

(5) The potential of the dairy industry to supply dairy cross-bred steers for meat production needs to be vigorously exploited. My personal view is that this would be best achieved through the development of more large units rearing calves on forward contract arrangements to beef farmers, both on hill country and on finishing farms. Such units could also undertake the rearing of female replacement stock for beef breeders. These developments would supplement the efforts of farmers generally rearing small numbers of stock as at present.

All these aspects of beef improvement will require technical inputs. This technical support is currently beyond the time that the small number of scientists with expert and practical knowledge of the industry have available. While more effective integration of existing technical and advisory resources can no doubt be achieved, further trained beef specialists are needed to service these applied research and development projects. It has been estimated that the extra genetic returns per generation of selection in beef herds could approach $7.5 million, and even when discounted by 30% the development of applied cattle breeding is clearly of major importance.

RESEARCH INPUTS AND PRIORITIES

The NRAC Hill Country Research Working Party recently examined the allocation of research inputs to hill country. Using the current level of production as a yardstick and adjusting production downwards because of lower current outputs per animal, it was estimated that hill country contributes about 30% of total gross farm income. Using information available from NRAC, it was estimated that 22% of DSIR and 24% of MAF research inputs are directed towards hill country. However, only 3% of DSIR and 6% of MAF scientist and technician man-years were actually spent working in the hill-country environment. The difference between this and the respective 22 and 24% estimates by NRAC is largely due to the proportion of research undertaken at non-hill country stations that is *assumed* to be directly relevant to hill country. For example, if a project involves sheep reproduction and 40% of sheep are grazed on hill country, then

40% of the man-years in that project may be assumed to be relevant to hill country, whether or not the project has high relevance to the key hill-country problem in reproduction. Nevertheless, these figures show there is a very limited allocation of research resources specifically for hill-country research relative to other agricultural sectors and few of the total scientists are working in a hill-country environment. New resources are needed to ensure that hill country is receiving a better balance of technological inputs. In the present static budget situation and rising cost of research inputs there is limited opportunity to redirect existing scientific staff to hill country. Many of those able to contribute are already committed on other high priority work. An extension of hill-country research will thus require the appointment of new staff and the development of new research resources.

The effective exploitation of hill country and the development of appropriate technology to support this is fragmented in New Zealand. Forestry, soil conservation, agricultural, wildlife and recreational interests are not well co-ordinated. We need to develop more detailed regional guideline plans for hill-country land in order to provide for the planned inputs of capital, technical and other resources needed for balanced development.

SOCIO-ECONOMIC ASPECTS

The development of hill country is also being frustrated by the shift of manpower and capital to other sectors. This movement of people and their skills away from the hill-country sector should be of major concern. These skills and resources will be difficult to replace in the short term, as our attitudes to education, training and social factors are all operating against the maintenance of hill-country communities. As a consequence of these population and resource shifts, fewer "leaders" now responsible for allocating resources have experience of hill-country farming. They do not have a close understanding of its unique problems and potential, and therefore they lack confidence in what increased production can be achieved from this sector. A large proportion of time and effort is being focused away from the relevant issues which could assist in maintaining the viability of hill-country farming. This is of direct relevance to our Society, for hill country offers one of few opportunities to increase production in the magnitude needed to sustain our standard of living.

The social and financial factors constraining the development of hill-country farms and of essential servicing industries have not been well defined. Relatively poor roading, mail and other services, inadequate social amenities consequent on a decreasing population, difficulties in slaughtering livestock, limited opportunities for a second income, inadequate or costly educational facilities, the type and hours of physical work, and the lack of net short-term cash profitability are all aspects of importance. These problems are not insurmountable.

These trends need to be arrested before a quasi-peasant type of farming develops on hill country. With decreasing profit margins, farmers may not be prepared to meet the rising cost of essential subdivision, fertilizer, weed control, labour and other items in order to obtain increased production. The primary motivating factor in increasing production is, in my opinion, net cash profitability after tax. Because of the uncertainties of and rising cost of inputs, farmers are rightly not convinced that by simply increasing output their financial position in terms of net cash income will be improved. The absolute level of net cash incomes, and not just stability of prices, must be improved on farms. Small wonder, then, that less emphasis is placed on maximizing gross profit with its increased vulnerability, and that a defensive position aimed at reducing input costs is adopted. Short-term subsidies, applicable in general to farms to maintain short-term viability, are unlikely to fully and efficiently exploit the potential available on a long-term basis on particular farms. The primary producers need steady financial incentives in the form of net cash profits to be able to organize those production variables to best advantage on their own farms as they see fit.

No apology is made for emphasizing the importance of these aspects to a technically orientated conference, for without an understanding of them much of the potential impact of new technology could be wasted. The social and financial incentives needed to maintain the impetus to hill-country farming need to be defined more clearly in order that more effective assistance can be given.

CONCLUSION

(1) There is need to make a definite and renewed commitment to the sustained development and intensification of hill-country farming. In the national interest hill country must be well farmed, and both its farm and servicing sectors should receive a steady level of inputs.

(2) The physical potential for production in hill country has not plateaued. It is my contention that existing technology,

if applied, could increase production from hill country by at least 50%. With the further development and application of appropriate technology, at least a doubling of productive volume appears quite feasible over much of this land resource.

(3) Attention to remedying socio-economic problems is essential before this physical potential can be achieved. The access roads and, as appropriate, the educational, social, communication and other services must be upgraded. These are at present major disincentives to hill-country farming.

(4) The net short-term cash profitability (after tax) should be sufficiently high to attract more capital and labour to hill country. If necessary, reduced rates of taxation on current and increased production should apply to ensure that the net cash surplus of hill-country farming is at a high level. This incentive to increased production is essential for continued viability. As hill country is the sector within agriculture with the highest potential for growth, the collapse of hill-country farming cannot be allowed to occur. Already there is a decline in the remote rural populations with slower rates of land appreciation and high relative costs.

(5) Sufficient is known to define in broad terms the skills and fields of research needed to provide a sound technical basis for the improved efficiency of hill-country production. The existing research inputs now specifically directed towards the relevant production and economic problems of hill country are inadequate relative to other sectors and the scope of the problems. A considerable increase in inputs will be needed to fill this technical vacuum. This improved technology must be developed and applied to maintain a competitive advantage for our products. Without a progressive technical development, the intensification of hill-country farming and the further processing and improved marketing of products will be less than optimum. Such relevant multi-discipline research can be expected to return a high dividend because of the lack of previous research and development and the large area of land and stock units to which this technology can be applied.

(6) Solution of current socio-economic problems and the limitation of technical resources is needed over a short period if the viability of hill-country production is to be maintained.