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# PROBLEMS OF DISEASE AND FERTILITY IN SHEEP PRODUCTION

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## SUMMARY

Some general aspects of disease and fertility in relation to sheep production are discussed. These include a consideration of how losses are caused by disease, and the problems posed by lack of knowledge of economic losses associated with both overt and inapparent disease. Some problems of disease and fertility, the necessity to remain constantly aware of the dangers of exotic diseases, and the effects of higher stocking rates on sheep health are also discussed.

IN A SYMPOSIUM such as this it is customary to allocate the subject matter to the speakers involved in accordance with some facet of the general problem in which they happen to be particularly interested. It is true that the writer's particular interests lie in the field of disease, especially infective processes, but it is comparatively fortuitous that they are associated with defects of reproduction. This is a reflection of the importance of efficient reproduction, and the extent to which infective processes are apparently involved, rather than a direct particular interest in fertility. There are at least as good grounds for associating nutrition and fertility, or breeding and fertility, as there are for associating disease and fertility, in so far as total impact on productivity in the sheep industry is concerned. These are properly the province of the nutritionist and geneticist, respectively, so the remarks on fertility in this paper will be confined largely to disease and fertility.

There is no doubt that the principal means of promoting livestock production lie in better breeding, better feeding and the control of disease. There is also little doubt that these three facets of efficient husbandry are frequently considered as separate entities which, although subserving the same end, should be studied and discussed in isolation. However, it should be borne in mind that alteration in genetic constitution and nutritional status have a bearing on disease status, and that, with each new artificially imposed factor which results in increased production, there is an alteration in the ecological balance, which in turn may give rise to conditions that may be recognizable to us as overt disease. This means that each successive step in the process of intensification of production will produce a new

ecological situation to which the animal must adjust, and that failure of adjustment will lead to disease. It also means that the pattern of disease will be constantly changing, and that the problems of today will almost certainly not be the problems of tomorrow.

The problems of disease and fertility in relation to sheep production cover so broad a range of activity that it is impossible to deal with the details of each individual problem, so this paper will deal with generalities rather than specificities except in so far as they serve to illustrate a particular problem. Nor is it intended to attempt a synthesis of present knowledge of the interrelationship between breeding, feeding and disease. Suffice it to say that in considering problems of disease it is necessary to be constantly aware that the disease status of a particular group of animals is not independent of heritable and nutritional factors.

#### WHAT IS DISEASE?

At first sight there appears to be no difficulty in defining what is meant by disease, but in reality it is one of those terms like "normal animal" or "typical New Zealander" which are quite self-explanatory until precise definition is attempted. Possibly the best approach is a somewhat oblique one. If health is defined as a condition in which the animal is in complete harmony with, or adaptation to, its surroundings, then disease or non-health may be defined as failure of adaptation. And since it is unlikely that any animal is in complete harmony with its environment, it is quite possible to conclude that efficient production is dependent on the control of disease. This serves to exemplify the very real relationships which exist between the study of breeding, feeding, and disease, the effects of which are reflected in the degree of harmony which is achieved with the environment. However, since it is customary to consider only gross failure of adaptation as disease, it is in this sense that the term will be used in this paper.

#### HOW ARE LOSSES CAUSED BY DISEASE?

In considering losses caused by disease, it must be remembered that disease is not a state; it is, rather, a process, ever-changing in its overt manifestations, a process which may end in death or recovery, which may be acute, rapid and easily observable, or which may give rise to a slow process of attrition which is covered by the term

"ill-thrift". That losses occur from death or failure to thrive is easily seen but it must also be remembered that there are other causes of loss. For example, there are diseases affecting wool quality, such as copper deficiency, the effects of external parasites, and the effects of microorganisms. There are also diseases which do not necessarily give rise to animal health problems, but may be capable of affecting humans either from the living animal, or from the carcass, as for example, salmonellosis and toxoplasmosis. Then there are also those conditions, such as hydatid cysts in the liver, or calcified lesions resulting from caseous lymphadenitis, that are aesthetically undesirable. And, finally, there are those losses from failure of the reproductive process, since the capacity to reproduce is a function of the normal, healthy animal.

Three categories of disease problems, all of which affect production, can then be recognized:

- (1) Animal health problems in which loss is incurred by failure to reproduce, failure to thrive, or death.
- (2) Human health problems caused by diseases transmissible to man, the sheep acting as a reservoir of infection.
- (3) Marketing problems due to the effects of disease on the final product.

#### ECONOMIC LOSS ASSOCIATED WITH SHEEP DISEASES

It is usual, in surveying problems associated with disease in livestock, to attempt to hazard some estimate of the resulting economic loss, but in the case of the sheep industry in New Zealand any estimate would be at the best a wild guess. There is little information on the extent of mortality as a cause of loss, let alone the extent of losses due to occult disease. Such surveys as have been conducted suggest that, for example, perinatal mortality might account for an annual loss, conservatively estimated at 15%. It is highly probable that losses due to diseases that do not usually result in death cause more serious economic loss than death losses. Recent work at Wallaceville by Brunson (1963) has provided some interesting data on the effect of suppression of parasite burdens on body weight and wool production during the first year of life. He found increases of more than 30% in liveweight (more than 50% in carcass weight), and more than 30% in fleece weight for treated over untreated animals, and this under pasture con-

ditions which could be found in numerous other parts of New Zealand. Such work as this has become possible only since the advent of more highly efficient anthelmintics, but it serves to illustrate the impossibility of giving anything but an ultra-conservative estimate of economic losses due to disease.

#### AETIOLOGICAL FACTORS ASSOCIATED WITH DISEASE PROBLEMS

It is possible to classify diseases in many ways of which the simplest is that which deals with causation. The causes of disease can be somewhat arbitrarily divided into seven categories as follows:

- (1) Congenital effects.
- (2) Insufficiency of food, including energy and accessory factors, or oxygen.
- (3) Infections.
- (4) Parasites.
- (5) Trauma.
- (6) Physical irritants.
- (7) Chemical poisons.

Of these, those which have the greatest impact on sheep production are inadequate nutrition, parasites, and infections. As a generality, the first two, inadequate nutrition and parasites, tend to occur at the flock level, that is, most animals are affected to a greater or lesser extent, while infectious conditions tend to be associated with individuals. This distinction between flock problems and problems which are essentially a problem of the individual animal is very important, both from the point of view of determining what are the disease problems of the sheep industry, and also in devising suitable control measures.

#### WHAT ARE THE DISEASE PROBLEMS OF SHEEP PRODUCTION?

To ask this question is not the same as asking, "What diseases occur in sheep?" The position today is that many of the overt diseases that occur in sheep have been characterized, but very little is known of the extent to which they occur, and the economic losses associated with them. It seems that this position has arisen for two major reasons. First, much existing knowledge of disease has stemmed from studies of the human animal where the problem is

one of the individual, and much thinking has been conditioned by this historical fact. It is only natural to see whether similar conditions occur in sheep. But secondly, and more importantly, it is necessary to identify disease conditions, and if possible their causative agents, accurately, before it becomes possible to determine the extent of particular diseases, and the various factors and conditions which determine their frequencies and distribution in a particular community. It is not sufficient merely to identify a disease condition and then attempt to devise control measures for it. Only when adequate knowledge exists of such factors as the various manifestations of a disease, accurate methods of diagnosis, knowledge of incidence in terms of geographical distribution, seasonal or annual variation, the effect of breed, sex, age, and so on, does it become possible to take appropriate measures directed at prevention, control or eradication.

The difficulties associated with accumulation of such data are tremendous, and constitute one of the greatest problems of disease in relation to sheep production. Yet this problem must be faced some time, or acknowledgement made that we are powerless to do anything about it. In fact, a start has been made in the trace element field, by defining areas in which trace element deficiencies occur and in which prophylactic measures should be employed. Yet in the field of infectious disease comparatively little has been attempted, although the need is at least as great. The reasons for this are not difficult to see, and are associated with diagnosis, geographical distribution, predictability of reoccurrence, and comparatively easy evaluation of the effect of control measures.

In general, trace element deficiencies are characterized by failure to thrive, a condition which is easily recognizable by any competent observer. Secondly, they tend to occur in reasonably well defined areas, as evidenced by the names which have been given to cobalt deficiency, as for example, "coast disease" in Australia, "bush sickness" and "Morton Mains" disease in New Zealand, "hill sick" in Florida, "lake-shore disease" in Michigan, and "moor sickness" in England. Thirdly, once an area has been characterized as trace element deficient, it tends not to alter its status through the operation of natural factors (although the degree to which animals are affected may be influenced by seasonal or annual variation) and, lastly, the efficiency of treatment can be measured by procedures easily applicable in the field, as, for example, by measuring weight gains.

The position with infectious diseases is vastly more complicated. First, the number of different organisms which may be associated with a particular effect, such as abortion or neonatal mortality, is considerably greater — *e.g.*, in infectious conditions resulting in perinatal mortality at least eleven different organisms have been incriminated. Secondly, even an experienced pathologist cannot distinguish with certainty by morbid anatomical examination the organism responsible. Confirmation frequently requires comparatively costly and time-consuming laboratory procedures. Thirdly, there is less tendency for there to be a well defined geographical distribution. Fourthly, the infectious disease status of a flock can be easily altered by both natural and artificial factors. And, lastly, the effects of any preventive measures tend to be much more difficult to evaluate.

Yet what has been achieved in the trace element field must be duplicated in the field of infectious disease, despite the obvious difficulties, if the control of infectious disease is going to be based on rational well-documented evidence rather than isolated impressions. It may well be that infectious diseases will be found to be of comparatively little importance, but even this finding would be a considerable advance. In the sheep industry where the value of the individual animal is comparatively low, the cost of control procedures must be carefully balanced against the actual losses that can be confidently anticipated. And this can be achieved only by the initiation of long-term epidemiological studies; either that, or present control measures must continue without ever knowing if they are warranted or not.

In the sheep industry at present vaccination for the control of infectious disease appears to be a very fashionable procedure, and is often the only deliberate application of the methods of preventive medicine. Yet there are inherent weaknesses in relying too heavily on vaccination as a means of disease control. In the first place, the type of protection conferred by vaccination is highly specific, and directed against a single organism. Secondly, once a programme of vaccination is instituted, it becomes a recurrent annual event, with its attendant cost, unless vaccination is regarded as a means to an end rather than an end in itself. And, thirdly, it is difficult to see how vaccination could be economically employed to control perinatal mortality, in which a multiplicity of organisms is involved. This is not to say that vaccination has no place in controlling infectious disease in sheep, but merely an expression of its

present limitations, and the necessity to look for alternative methods of controlling infectious disease.

If one were a farmer, it would be a matter of no particular concern to think of vaccinating one's flock for the next five or even ten years. But it would be a matter of real concern to envisage continuation for twenty, thirty or forty years without really knowing what return one was getting for the investment. The more that vaccination is encouraged and applied, the greater will be the difficulty of evaluating the economic return. In addition, since vaccination will lower the actual weight of infection, the temptation to cease vaccination could easily become overwhelming. This in turn could result in a build-up of infection, the necessary susceptible animals would be at hand, and the cycle could commence again.

There is no reason to suspect that intensification of production by means of genetic and nutritional advances will lessen the problems of infectious disease. The interdependence of all forms of life, of which the host-parasite relationship is but a single example, is part of the natural order of things. On the contrary, not only can no diminution of problems be expected, but accentuation is possible. Therefore, although the problems which appear to be of immediate importance must be attacked, if possible the problems of the future must be anticipated. Principles must be established that have broader application to the whole field of infectious disease, rather than attack being confined to problems associated with a single organism. Only by extension of knowledge of epidemiology, both by field research and laboratory research, can there be hope of keeping up with the kind of disease problems occurring in sheep flocks. Only by extension of intimate knowledge of host-parasite relationships can anything be done about it.

This does not apply only to the field of infectious disease, caused by microorganisms, but has equal application to other manifestations of the host-parasite relationship, as, for example, infestation by intestinal worms. A recent internal report at Wallaceville by Dr L. K. Whitten has stressed the importance of the establishment of principles, as well as continuing the conventional methods of parasite control such as testing the "recent flood of new anthelmin- . . . Greater emphasis should be given in the future to parasitological principles such as might apply in other environments and other host parasite systems. In the nematodirus work, principles are being worked out and later these can be tested with other species which possibly

may be more important but are inherently more difficult to handle experimentally". This also emphasizes the fact that, on occasion, we can profitably study diseases which cause no immediate economic loss, in the search for general principles.

#### THE PROBLEM OF OCCULT DISEASE

As mentioned previously, the stage has been reached where a good deal is known about the causes of overt disease in sheep, and it is recognized that one of the outstanding problems lies in defining the extent of losses caused by them. It is fairly certain, however, that there still remain causes of occult or inapparent disease which have not yet been characterized, or incriminated as potential sources of economic loss. By inapparent disease is meant those diseases that cause no well-defined clinical syndrome, and are frequently referred to by the vague term "ill-thrift". There is a corollary to this and that is that the "normal" of today may well be the "ill-thrift" of tomorrow.

Thus far emphasis has been on those diseases with effects easily recognizable by clinical or morbid anatomical examination or by obvious failure to thrive. This is no longer sufficient if health is to be thought of in relation to production, rather than in relation to overt disease. An attempt must be made, on an ever-increasing scale, to measure the effects of disease on growth rate, food conversion rate and fertility, which at the present state of knowledge are more sensitive indicators than laboratory examinations. There must, of course, be concomitant advances in understanding of "how" and "why", as well as the causes and end results.

This "production" approach has been widely used in the trace element and parasite fields, but has been largely neglected in the field of infectious disease. It is possible, however, that diseases now regarded as subclinical are more important causes of loss than those that cause obvious ill-health. For example, a high proportion of lambs have lesions in the lungs, unaccompanied by any gross symptoms of ill-health or at least not recognized as such. Who can say what effect this has on growth rate, or food conversion rate? It is known, however, that the clinically mild disease associated with so-called "virus pneumonia" in pigs resulted in marked reduction of growth rate and food conversion rates. There is a need for similar studies with regard to sheep, not only in relation to diseases of the lung, but to other clinically mild diseases.

### THE PROBLEM OF FERTILITY

There is no necessity to stress the importance of fertility to the sheep industry, both from the point of view of maintaining or increasing flock numbers, and of increasing the number of animals that can produce marketable commodities. Fertility is synonymous with fruitfulness or productiveness. In the narrower sense, where the term fertility is used in relation to reproduction, it must be remembered that effective fertility is governed not only by the ability to reproduce, but also by the number of young each female bears, and the number of ewes a ram is capable of impregnating. It must also be remembered that the reproductive process does not end with parturition, but lasts until the young are capable of independent existence, that is from conception to weaning.

The pattern of disease is extremely complex, involving as it does, genetic factors, hormonal influences, and environmental factors such as management, nutrition and infectious disease. It is difficult to determine the role that each of these factors plays in the problem of fertility, and the weight that should be attached to any particular aspect. It seems that the best approach to the problem at present is to concentrate on particular aspects as though they alone were involved before an attempt is made to unravel the complex interrelationships that are assumed to occur. Only when there is adequate information on the causes and effects of single factors will it become possible to appreciate the more superficial, let alone the more subtle interrelationships between them.

### DISEASE AND FERTILITY

Diseases which affect fertility can be divided into three main classes according to whether the effects are mainly on the health of the adult breeding sheep, directly on the reproductive tract, or mainly on the foetus.

Any disease that affects the general health of the animal may also affect the reproductive efficiency, as, for example, acute specific infections, intoxications such as facial eczema, metabolic disorders like pregnancy toxæmia, quantitative or qualitative nutritional deficiencies, or chronic infections such as footrot. These diseases are primarily associated with the general state of health, and the effect on fertility may be considered as secondary.

The second category, namely, diseases affecting the reproductive tract, are those that are commonly thought of in

relation to fertility. These comprise the infections whose main symptoms are referable to dysfunction of the genitalia, from brucellosis and suppurative epididymitis in rams, to derangements of the maternal-foetal relationship associated with brucellosis, vibriosis and toxoplasmosis.

The third category, namely, diseases whose predominant effect is on the foetus, is possibly the most important of the three. This group constitutes those diseases which cause little perceptible effect on the general health or reproductive organs of the mother, and which manifest themselves directly in increased morbidity or mortality, or indirectly in lowered resistance to infection or other injurious environmental effects both during pregnancy, and for a considerable time thereafter. Typical examples of this type of condition are congenital goitre, and congenital white muscle disease, associated with iodine and selenium deficiency, respectively, in which there are markedly greater injurious effects on the foetus or neonate than can be observed in the mother. This suggests that the nutritional requirements of the young growing embryo with its rapidly dividing cells are quantitatively different from those of the mature animal. The effects of this are obviously reflected in lower birth weights and weak lambs, but there may be secondary effects such as lowered resistance to environmental influences and infection.

It is highly probable that other aetiological factors are involved in the production of small weak lambs, including other nutritional stresses and infections. If this is so it may be possible to regard the small lamb as a better indicator of the nutritional status and health of the mother, than her apparent condition. Losses during the first few days of life, regardless of whether the death itself is attributed to starvation, exposure or infection, may, in fact, be more associated with pre-natal influences, than the apparent direct cause of death.

#### INFECTION AND FERTILITY

It is difficult to decide exactly the extent of the losses associated with infertility that may be ascribed to infectious agents. It is known that inherited, nutritional and hormonal factors can modify the effects of infectious agents, with regard to both systemic and local infections. Thus even when a particular organism is associated with a particular effect, it is never quite certain whether it is the primary aetiological agent or whether it is secondary to some other

pre-existent predisposing factor. For example, toxoplasmosis appears to be endemic in many flocks, and, on the basis of serological evidence, to infect a high proportion of ewes, 50% or more. Yet few abortions or neonatal mortalities ascribed to toxoplasmic infection may occur. On the other hand, losses on individual farms with similar infection rates may be quite severe.

This sort of situation exemplifies not only the difficulties, but the fascination of working in the field of infertility. It also emphasizes how, at every turn, consideration must be given to associated factors, as well as the main line of study. The temptation to branch out into the broader aspects of infertility is frequently overwhelming, but in many instances unrewarding, because much more basic knowledge of the effects of various individual factors is still required before suitable models for the study of interactions can be constructed.

Much of the work that has been done on infectious infertility in sheep in New Zealand has been concentrated on those organisms whose overt effects are readily discernible by clinical examination. These include *Brucella ovis* which causes epididymitis in rams and abortion in ewes, an unnamed organism which causes suppurative epididymitis and systemic effects in ram hoggets, and *Vibrio fetus* and *Toxoplasma gondii* which cause abortion in ewes. It is not known whether there are other infections which cause less easily recognizable effects such as failure to conceive or early embryonic mortality. In this connection it is of interest to note that there is evidence to suggest that natural transmission of toxoplasmosis occurs following the commencement of tupping, and that ewes that become serologically positive require more services per conception than serologically negative ewes. This particular observation occurred more by good luck than good management, but it serves to illustrate the point that little is known about the possible infectious agents which could affect fertility in the absence of any definitive clinical signs.

Insofar as the specific infectious diseases of the genital tract are concerned, it should be possible to devise suitable methods of control, if warranted, by the application of time-honoured empirical methods. There remains, however, the problem of those organisms associated with perinatal mortality which are not usually capable of affecting the foetus *in utero*. Because of the large number of potentially pathogenic organisms involved in perinatal mortality, and their ubiquity, it is

difficult to envisage their control by conventional methods of prevention or treatment. If these infections are secondary to pre-existent abnormalities associated with lowered resistance, which is a distinct possibility, it may be profitable to study them from this point of view. This concept is admittedly speculative but, if correct, has important implications. It may give a lead to environmental defects, it may provide a suitable model to study the vexed question of interrelationships between breeding, feeding and infectious disease, and finally may lead to control of the infections themselves.

The study of infectious diseases associated with infertility has important aspects other than those of devising suitable control measures for specific conditions. The pregnant ewe happens to be a cheap, superior sort of natural incubator for the rearing of germ-free animals. Because there is no transplacental transfer of antibodies, it is possible to study the development and nature of the antibody-forming apparatus and other basic aspects of host resistance. This could lead to a better understanding of the host-parasite relationship, and in turn, to the discovery of alternative methods for the control of infectious disease.

#### THE PROBLEM OF EXOTIC DISEASES

New Zealand is in the happy position of having managed to keep out many of the serious epidemic diseases which afflict sheep production in other countries. Although this may not be considered a disease problem affecting production, the effects of the introduction of exotic diseases could cripple the whole sheep industry. There is, therefore, a continuing need to stress the importance of maintaining an adequate quarantine service, the necessity for constant and unremitting vigilance in the field, and for trained laboratory staff who can confirm or deny suspected outbreaks of exotic diseases.

#### INTENSIFICATION AND SHEEP HEALTH

There is little doubt in many people's minds that intensification of production in the sheep industry will give rise to new problems of disease. It is important, however, to distinguish between increases in production, due to higher stocking rates, and increases due to higher *per capita* production. It is possible that higher *per capita* production will result in increased resistance to disease, and that speculations on the results of intensification will prove to be

groundless. For example, it is well established that an adequately fed sheep is more resistant than a poorly fed sheep to most parasitic diseases. At the same time, a nagging doubt persists that increased stocking rates, despite maintained and increased production of the individual animal, will lead to new disease problems as well as accentuation of familiar problems.

The trouble, of course, is that there are limited factual data on the incidence of disease, say, 20 years ago, compared with the incidence of disease today. During this period the national ewe flock has increased by more than 60%, largely as a result of intensification rather than increased availability of land, but it is still difficult to incriminate particular diseases with increased stocking rates, with the possible exception of trace element deficiencies. It may be that there is an increased incidence of particular diseases, but in the main the present attitude to the effect of intensification is based on impression rather than fact. It is not known how much of any apparent increase is due to greater awareness of particular diseases, to better and more accurate methods of diagnosis, and how much is a true result of intensification.

It is impossible to predict the future disease patterns affecting production in the sheep industry. One can merely assume that disease problems will continue to occur and attack them as they arise. The introduction of new methods of increasing production will proceed, as it has in the past, without full awareness of their capacity to cause or influence the disease status of our flocks. Therefore, research must continue on all aspects of disease, whether they are of immediate importance or not, for who knows what is going to occur tomorrow.

#### REFERENCE

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#### DISCUSSION

DR G. R. MOULE: Mr Te Punga has rightly stressed the need to elucidate biological principles, and also the need for an economic assessment of the importance of diseases. The Bureau of Agricultural Economics found, from a survey, that annual losses due to cattle tick in Australia may amount to between £12 and £15 millions. Similarly, though there are few basic data from which estimates can be made, parasitism may be causing serious economic loss to the sheep industry.

J. W. STICHBURY: *The question of the incidence of disease in relation to stocking rate also arises in the dairy industry. A recent comparison of general disease wastage in relation to stocking rate in dairy herds showed no differences between different stocking rates. Are data available from such places as Ruakura on the incidence of disease in sheep in relation to stocking rate?*

W. A. TE PUNGA: I am sure that some data would be available from places such as Ruakura on the incidence of disease in sheep in relation to stocking rate, particularly with regard to overt disease resulting in death. I am not so sure that similar figures would be available for inapparent losses, such as could be caused by parasitism. Satisfactory data on the effects of disease in relation to intensification could only be built up over an extended period of time, and under a variety of environmental conditions.

DR D. G. EDGAR: In experiments at Ruakura comparing 4, 6 and 8 sheep per acre there was no difference in the incidence of disease. When sheep are crowded very densely as for facial eczema control, outbreaks of salmonellosis are liable to occur.

DR N. F. ROBERTS: *Part of the cost of disease to the sheep industry would be assessed if the total expenditure on drugs by sheep farmers were known and the cost of labour of administering these drugs was estimated. Is the expenditure on drugs for sheep in New Zealand available?*

MR TE PUNGA: Not as far as I am aware, but even if such figures were available, it would still be difficult to relate them to the actual total losses due to disease.

DR A. H. CARTER: *Is there not a danger in the development and application of prophylactic control measures of infectious diseases in that it may reduce the building up of natural immunity? In terms of breeding improvement, a case exists for putting some emphasis on natural selection, both in terms of infectious and inherited diseases.*

MR TE PUNGA: There is always a risk that prophylactic methods of controlling infectious diseases will result in a higher proportion of susceptible animals in a flock but, provided that these prophylactic measures are continued, this should occasion no particular trouble.

It must be remembered that the term "immunity" used in this context does not refer to an absolute state, but rather to a condition which can be considerably modified by environmental factors. In other words, natural immunity which suffices in one set of environmental conditions, may break down under another. Because of this, it seems to me that over-reliance on natural selection to increase resistance to disease would be a retrograde step. The approach that we have adopted is that prophylactic methods of disease control such as vaccination are a useful interim solution, until such time as we know more about the epidemiology of infectious diseases, the mechanisms of both natural and acquired immunity and alternative methods of control.

DR D. S. HART: *How can the problem of exotic diseases such as "scrapie" be dealt with in order to allow the introduction of sheep with high production qualities from Europe?*

MR TE PUNGA: It is not for me to say how the problem of exotic diseases such as "scrapie" can be dealt with, but I should think that there are two important points to consider. The risk of introducing a disease like "scrapie", which is extremely difficult to diagnose during the latent period, would have to be weighed against the potential advantages of introducing new blood, and, secondly, the adequacy of the animal health services of the country of origin would obviously have an important bearing on the advisability of importing new breeds.

Q: *Would Mr Te Punga indicate whether it would be possible to improve general field diagnostic methods to enable better records to be obtained of the extent of disease in sheep flocks?*

MR TE PUNGA: The answer to this question revolves round what is meant by "general field diagnostic methods". If the term means more accurate diagnosis by people in the field, I would suggest that this could result in the accumulation of masses of data which would not give an accurate picture of disease problems as a whole. If, on the other hand, the improvement of general field diagnostic methods meant a change of approach to examine the broad picture initially, and then its component parts, I am sure that better records of the extent of disease would be obtained.

Q: *If one suspected disease existing in a flock of sheep what initial, indicative, measurements would be taken as indicators of the condition?*

MR TE PUNGA: The manifestations of disease are so varied that it is impossible to define general premonitory symptoms apart from inappetence, disinclination to move, and so on. At a later stage, however, the main indication would be death or failure to thrive.

Q: *Would evidence from freezing works be of benefit regarding diseases affecting efficiency of production?*

MR TE PUNGA: At present evidence from freezing works would have some value in determining the extent of diseases which have an effect on marketing the final product, but would have limited value with regard to diseases which are animal health problems *per se*. It is possible, however, that, as we accumulate more data on the effects of inapparent disease, evidence from the freezing works will become more valuable.