THE INFLUENCE OF RABBITS ON FARM PRODUCTION

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NEW Zealand has several problems in common with other countries which were opened to settlement during the nineteenth century. These problems are the result of the tremendous ecological changes which have occurred in a relatively short period. Within a few decades large tracts of bush, scrub and swamps were turned into cattle or sheep country. In addition to the increasing number of stock, various exotic animals were liberated. Improvement in the meagre food supply, later sentimental reasons, and finally sport and utility, provided the main incentive for a very vigorous policy of acclimatisation. Approximately 50 species of mammals and 125 species of birds were liberated in New Zealand. Of these, 32 species of mammals and 31 species of birds became established.

There is little doubt that the majority of the introduced wild animals which became established in New Zealand have to a varying degree an important and direct effect on our farm production. They constitute major ecological and economic problems. One of the earliest liberations which gave rise to a major economic problem was that of the rabbit.

The rabbit was liberated at the time of the first organised settlement and thirty years later it had become a major problem. About 1874 enormous numbers of rabbits began to spread to many districts of both Islands. The first legislation attempting to control the rabbit was passed as early as 1876. The rabbit problem in New Zealand has existed therefore for nearly three-quarters of a century.

The following general conclusions have a tentative character.

It is assumed that rabbits have occupied all suitable areas, with few exceptions, in New Zealand. The appearance of rabbits near Te Kao, north of Auckland, in 1946 is an example of recent colonisation. The absence of rabbits in the Poverty Bay area and on the East Coast might be explained by successful control activities which have arrested further spread.

The present distribution of rabbits seems to be influenced mainly by the following three inter-dependent factors:—

(1) Physiographic and vegetational, natural barriers.

(2) Arable and heavily topdressed farming areas.

(3) Certain soil conditions.

Native forests and heavy undergrowth, and to a large extent exotic plantations, form natural vegetational barriers. The same applies to high mountain tops, although it is known that with favourable soil conditions the altitudinal range may be considerably extended.

There is an indication that in arable or heavily topdressed areas there are no rabbits or only a slight infestation. Intensive farming produces pastures with abundant lush feed which seems to be unsuitable to rabbits. Tall, dense English grasses also form a wet

medium disliked by the rabbit, and act as a further obstacle to its spread. Finally ploughing and the frequent movement of large numbers of stock are possible reasons for the disturbance of rabbits. Also, generally speaking, conditions are created which it is believed assist rabbit control.

Soil drainage is the third contributing factor, and the interplay of this with the other factors is of major importance as a key to the present rabbit distribution. With the assistance of the Soil Bureau, Department of Scientific and Industrial Research, the heavy and medium rabbit incidence in the North Island was compared with a map of soil types. It was shown that heavy and medium rabbit incidence occurs in the main on friable, well-drained soils, either sands or sandy loams, of the podzolic group or friable silt loams and clay loams of the yellow-brown loam and brown granular loam groups.

It appears that rabbits thrive best on dry, loose soils, but there also exists a correlation with rainfall and cover. Thus in Taranaki, the majority of rabbit infestations are on soils probably formed at a former period under a low rainfall, such as loose sands, river-flat soils and yellow-grey loams. Where the rainfall is light, rabbits may multiply freely on soils with heavy impermeable sub-soils such as yellow-grey loams, as in Hawkes Bay. In other places, cover supplied by gorse, hedges, manuka scrub, etc., may compensate to a certain extent for less favourable soil types. The lack of a complete soil map of the South Island prevented the checking of the degree of correlation between the incidence of rabbits and the soil types. The available information seems to indicate that the relation of the rabbit incidence to soil types is similar. Summing up, it is safe to say that with the assistance of a soil map the limits of many rabbit infestations and the delimitation of many potentially dangerous areas may be predicted.

It may be added that Man-induced ecological conditions such as continuous burning or over-stocking are, together with the above mentioned factors, also responsible for the present incidence of rabbits, particularly in the South Island.

The reduction of sheep-carrying capacity and the depletion of soils through erosion are the most important ways in which rabbits affect farming.

Munro and Wright (1933) and other students of the rabbit problem estimate that "six or seven rabbits equal one sheep." In 1946 it was found that amongst a population of 1,117 South Island rabbits the average weight was 3.17lb. According to Wilson and McCartney (1940) and some experiments by Dr. I. Cunningham, Wallaceville, a rabbit of 3.17lb. requires annually approximately 32lb. of S.E. for maintenance. As a conservative estimate, fifty per cent. had to be added to those maintenance requirements in order to cover the difference in food consumption between rabbits kept in captivity and those in the wild state. The total food requirement of a wild rabbit would be therefore about 50lb. S.E. per annum. A breeding ewe of 120lb. live weight requires approximately 750lb. S.A. per annum. An estimate of fifteen rabbits to one sheep probably over estimates the requirements of a hill-country ewe and underestimates the consumption of a rabbit.

Rabbit exports are the only available figures giving an indication of the rabbit population in New Zealand. Table 1 gives an estimate of losses resulting from displacement of sheep by rabbits. It is estimated that in addition to rabbits killed and exported, about one-sixth more are destroyed annually. The value of sheep displaced is expressed in the form of the production from one ewe, i.e. a lamb and about 8lb. of wool per year. It seems that this can be conservatively estimated at between 20s and 30s a year.

TABLE 1.

Year	Estimated Number of Rabbits Destroyed	Declared Value of Rabbit Exports	Value of Ewes Displaced	Net Loss	
				Ewes at 20s	Ewes at 30s
		£	£	£	£
1944	16,200,000	905,291	1,080,000	175,000	715,000
1945	20,619,000	1,046,427	1,375,000	329,000	1,016,000
1946	18,382,000	1,451,301	1,225,000	226,000	386,000
1947	19,430,000	1,120,219	1,295,000	175,000	822,000

It has to be emphasised that this estimated loss does not include such losses as damage to forests or fouling of pastures. Furthermore, it deals only with the rabbits destroyed. Little is known of the total rabbit population of the Dominion. It is, however, conservatively estimated as oscillating between forty and fifty millions. The total losses in sheep-carrying capacity would therefore represent an annual loss of not less than three to four million and might even reach five million pounds.

In addition to the loss in sheep-carrying capacity there are other more serious losses through the depletion of soil cover and subsequent erosion. Evidence is also advanced that rabbits' selective feeding is inducing new plant communities dominated by various weeds which may subsequently lead to a scabweed community. In the North Canterbury district the selective feeding of rabbits seems to help a vigorous spread of the **Nasella** tussock. Concluding, it may be said that although it is impossible to make even an approximate estimate of the damage to soil cover and of the subsequent depletion of soils, these losses are very considerable, and in some cases when associated with a larger amount of natural erosion hardly reparable. In addition, about £180,000 is spent annually from public funds on rabbit control.

A previous part of this paper indicated that the influence of various ecological conditions is a factor limiting the spread and incidence of rabbits in their various New Zealand habitats. For a more efficient control of rabbits it is equally important to have further knowledge of the rate of increase of rabbits, especially in areas of medium or heavy incidence.

Little has been recorded on this subject and Table 2 summarises most of the information available.

TABLE 2.

	Live-stock Districts with breeding period extending									Total districts
	12	10	9	8	7	6	5	2mths.	Not stated	
North Island	18	4	4	—	1	—	—		3	30
South Island	3	5	12	2	3	2	—	—	1	28

There is little recent information on the occurrence and role played by parasites and disease or the average number and size of litters and the survival rate of young rabbits.

On the other hand, there is an indication that the New Zealand rabbit population is far from being static, and that it displays cyclic fluctuations.

One would expect the existence of a correlation between the number of rabbits exported and the price of skins and carcasses. These calculations gave the following results:—

Total number of rabbits exported (x) v. average price of skins (y) r = .54.

Total number of carcasses exported (x) v. average price of carcasses r = .56.

Of the total variation in the number of rabbits exported, only 30 per cent $(0.544)^2$ is due to the variation in the price of skins, the remaining 70 per cent. being due to other factors.

Elton (1942) after perusing a large amount of historical and other records and with the results of his own and his collaborators' researches showed the existence of regular cycles in many animals such as voles and mice, lemmings, snowshoe rabbits as well as in their various predators such as lynxes, foxes and raptorial birds. At periodical intervals, but of varying length in different species, the numbers of a species build up to a certain point followed by a "crash" usually associated with an outbreak of disease, appearance of large numbers of predators, etc., when the existing large numbers are drastically reduced. Little is known of the nature of the factors controlling cyclic variations embracing sometimes very large areas, except that climatic fluctuations play a major part.

It appears that in England the average period of a rabbit cycle is over 8 years, while in New Zealand slightly over 11 years. It may be noted that such cyclic variations if they could be predicted would be of major importance in the problem of control.

References—

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Munro, D., and Wright, R., "The Rabbit Pest and its Control." N.Z. Journ. Agric. 46, (1), 26-37. Jan., 1933.

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Discussion on Dr. Wodzicki's Paper

Mr. LONGWILL: I was interested in the estimate of 50lb. starch equivalent being the requirement of the wild rabbit per annum. I notice that Dr. Wodzicki gave the maintenance requirements first of all, and then an estimate on top of that to cover the extra as between the domestic and the wild rabbit but no mention was made of the reproduction requirements.

Dr. WODZICKI: The figures presented are the result of a preliminary survey only. In the beginning the average weight of a New Zealand wild rabbit was not known, therefore it was not possible to make an assessment of the food requirements. About 1,100 rabbits were weighed giving 1.44k.g. as the average weight of a rabbit. The maintenance requirements of a domestic rabbit of this weight according to Wilson and McCartney is about 32lb. of S.E. Dr. Cunningham kindly ran, at our request, some experiments which gave results amazingly close to this estimate. Growing and breeding rabbits definitely require an additional amount of S.E., and an allowance must also be made for rabbits running free, so 18lb. of S.E. per annum was added. The total food requirement of a New Zealand wild rabbit would be about 50lb. of S.E. per annum which seems to be a conservative estimate.

Dr. CUNNINGHAM: Dr. Wodzicki has told you that I did a few experiments measuring the amount of feed rabbits ate. He mentioned 750lb. S.E. for 100lb. sheep and 32lb. S.E. for a 3 or 4lb. rabbit. Those figures are quite correct. We fed rabbits and measured their intake of food carefully and we were very surprised to find that the amount of food was so much out of proportion to the larger domestic animals' intake and even that of smaller animals like rats and mice and it impresses on me that the rabbit is a real menace when it is eating fodder that our other animals could eat.

PROF. CAMPBELL: Is there any information on the movement of the rabbit population? Is there any system under which information is recorded regularly at selected points throughout the country? Are there in any Government Departments officers whose job it is to record some estimates of the state of the rabbit population so that even rough figures would give some indication of the movement and state of the population?

Dr. WODZICKI: It was during this survey that the first attempt to record the distribution and density of the rabbit population was made. No estimates of the state of the rabbit population are, so far as I am aware, regularly or sporadically recorded. The present data are open to criticism because so far no scientific methods have been applied to assess the rabbit population of New Zealand. The work of Elton of the Animal Population Bureau in Oxford on the rat incidence and rat control in the docks of Port London indicated the importance in control, of making a census of rabbits or rats before and after control measures are applied. Then only can we say whether our attempts to reduce their numbers were successful or not. I can mention a particularly interesting incident given by Mr. Lockley of Skokholm Island off the west coast of Britain. This island was over-run by rabbits, and just prior to the war, he and his friends spent a year in using every possible means of exterminating the rabbits of this island, and he gave figures, showing that after one or two years of these operations they succeeded in lowering the population of rabbits to a few pairs in the cliffs which could not be attacked at all. As a result of this the stock-carrying capacity of the paddocks rose considerably within the next two years. Mr. Lockley and his friends then went to the war. The rabbits on the cliffs started to breed extremely prolifically, not only increasing the number of young per litter but extending the time of breeding and on his return these few pairs had

again invaded the island to the same extent as when he first took over the island.

Mr. KORRICK: Is there any information available as to the number and size of litters dropped by the wild rabbit during its life-time?

Dr. WODZICKI: There are no data because no work of such kind has been attempted in New Zealand. Recently during the war in Britain, apparently they discovered that there are more rabbits than is generally admitted and Prof. Brambell Rogers of Bangor, Wales, has started a most interesting series of investigations on such problems as the number of ova shed and the number of embryos that survive, etc., but as yet no final conclusions are available.

Dr. CUNNINGHAM: I would like to ask what reliance can be placed on the figures of exported skins given as an indication of cyclic variation? Many other factors must play a part in collecting rabbit skins and selling them and there must be many rabbits destroyed from which no skins are collected. Strong consideration must be given to the influence of other factors in the collecting and selling the skins.

Dr. WODZICKI: The export of rabbit skins and carcasses and their declared value are the only figures which are available. In my paper I have stated that only 30 per cent. of skins are affected by the price, the remaining 70 per cent. due to other causes. It should be added that according to three rabbit trade experts from Dunedin, 90 per cent. of skins come from professional rabbiters and only 10 per cent. are supplied by Rabbit Boards. Therefore in order to obtain a conservative estimate of the number of rabbits annually destroyed, I have added one sixth of the total number of rabbits annually exported, including rabbits locally consumed or shot, fumigated and gassed and not retrieved. I would like to point out the regularity of the cyclic variations in the period under investigation, and also the fact that the latest increase in the number of skins exported occurred when manpower was extremely short. Of course more research in this subject is necessary.

Mr. CORBETT: Cyclic variations in population seem to be a universal characteristic of all animal populations. If one takes a population of beetles, starting off with a thousand beetles in each year, and they live 3 years, and one estimates that half of the beetles die before they reach the second year and a third of the remainder die before reaching the third year and they only have six offspring, in 4 years one gets back to the thousand in each year. This was of importance in England, particularly before the war, when the Pig Board was trying to control pig fluctuations. It was stated that farmers were mainly responsible for the fluctuations owing to the prices, again depending on the amounts offering and it was questioned whether farmers really did control the supply or whether it was a natural fluctuation. It might possibly be suggested that the ageing of the population in England and of the European continent is due to a little fluctuation—and we may get the young people balancing it out again when the fluctuation moves the other way.

Dr. WODZICKI: I do not think we can compare animal populations with human populations for various reasons into which I shall not go. The fluctuations in populations of mammals have been studied by Elton and others. They range in cycles from a few to many years. For instance the cycle of voles in English forests is four years, rabbits in Britain fluctuate in a little more than 8 years, etc. Probably climatic reasons, and food supply may be amongst the important factors which have an influence on these cycles. These cyclic changes are sometimes of a tremendous magnitude as is the case with some rodents and other animals of the North American continent where these cycles embrace the whole country from Labrador to British Columbia. The climate can vary within this range, and yet various species have been increasing or decreasing simultaneously over thousands of square miles of country.