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Mr G.H. Holford: Do you think there are any possibilities in soya beans and sugar beet?

Reply: Soya beans have been tried and they give a very successful crop, but only in restricted areas. Following some temperature comparisons made by Sir John Russell, between European conditions where soya beans are grown successfully, it would seem that New Zealand temperatures during the growing and cultivation period for soya beans are not such as to lead to good and regular growth of the crop. Temperatures are satisfactory in some seasons but cannot be regularly depended on.

Sugar beet will yield well in many parts of New Zealand but the difficulty will be to get the farmers to grow it. Sugar beet residues are very highly valued as stock feed, but the biggest trouble arises through the dislike of the farmer to grow the crop. There is, moreover, a large capital expenditure on the factories associated with the industry. Grown by themselves they are a useful food for pigs and might well replace mangolds.

Mr W.M. Webster: Are there any prospects for sorghums in this country?

Reply: I would say that sorghums have distinct possibilities in the warmer parts of New Zealand. They give good yields in the Aucklan district and in North Auckland, and they might well be considered in those districts which suffer occasionally from summer droughts. They might be thought of as one of the supplementary crops leading to the laying down of better grasses.

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"THE ANIMAL IN RELATION TO FOOD PRODUCTION"

by

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As hunting and fishing are both older than agriculture it may probably be safely assumed that meat and fish have always had a place in the human diet. Experiments conducted with omnivorous animals have in general indicated that the addition of animal products to a basic vegetable diet, (especially a grain diet), is beneficial. Amongst human animals there would appear to be general positive correlations between stature, length of life, and freedom from disease and the consumption of animal products, though it must be admitted that low consumption of animal products sometimes goes hand in hand with semi-starvation. Even so-called vegetarians recognise the value of animal foodstuffs as they generally include in their diet eggs, milk, butter, cheese and sometimes fish and poultry. The beneficial effects of food derived from animals are generally attributed to their protein content. In addition, some of them are valuable sources of vitamins and minerals and it is more than probable that eggs, glands, and milk contain hitherto undiscove ed constituents which are essential for animal metabolism.

It is of course possible for adults to exist on a purely vegetable diet. It is possible that chemists may eventually produce a reasonably palatable and adequately nutritious diet from raw materials of vegetable origin. In this connection it is well to remember that animals are extremely inefficient in producing human food from the food which they themselves consume. There is probabl no animal industry which is more than 20% efficient in the production of human food protein or energy from the corresponding constitutents in the animal diet. Much higher figures are sometime quoted; e.g., a cow producing daily 6 gallons of milk containing

3.5% butterfat has an efficiency of 40.9% for energy and 47.0% for protein; but an average English cow producing annually 600 gallons of milk, with the same test, during a five year life has an efficiency of only 13.9% for energy and 18.1% for protein, even when the carcases of herself and her calves are taken into account. (1) Watson (2) states that the highest efficiency achievable in the production of beef is 8.6% for energy and 10.5% for protein. In war time this low efficiency has necessitated the wholesale slaughter of animals where they were being fed on products, such as grain, which are suitable for human food. In New Zealand animals subsist very largely on grass which, notwithstanding the royal example of King Nebuchadnezzar, has never figured prominently on the menu. Even here it may not be wise to underestimate the potentialities of what a recent visitor to New Zealand termed the "dastardly machinations" of the chemist. It seems certain, however, that during the war and again during the post-war reconstruction period there will be an extremely large demand for animal food products. Moreover, the best and perhaps the only methods of competing with artificial substitutes are greater economy in production and improvement in the quality of the foodstuffs derived from animals. No apology is offered therefore for exploring the means of attaining these ends.

There would appear to be three main ways whereby an increased amount of high quality animal products can be made available for human consumption:

(1) An improvement in the genotype of food producing animals.

(2) An improvement in the environment of these animals.

(3) An improved utilisation of the products of these animals.

First, then, how should we set about breeding better animals? But before this question can be answered we must decide what sort of animal we want to breed. Nature answered the question quite simply by ensuring the survival of only those animals which are best adapted to their environment. Early in human history it was realised that such animals were quite inadequate to provide for the needs of the rapidly increasing population of meat eaters, amongst which man was becoming progressively more important. This of course led to domestication of animals and the improvement of their productive capacity. In addition to ignorance of the principles of genetics, two factors have limited progress in this direction. It has proved difficult to provide an environment adapted to the needs of very high producing animals, and where this has been possible it has often been economically unprofitable. The animal with the highest productive capacity is therefore not necessarily the animal which we should seek to breed. We could perhaps describe the ideal animal as the one which is capable of optimum production from the point of view of agricultural economics It is realised that this definition will only be really satisfactor if there is a reasonably close and constant correlation between prices and real nutritive values, but this is a problem for the political economist, and so outside the scope of this paper. One o the important factors in determining economic production is the proportion of an animal's life during which it actively produces. For example, a Jersey cow which calves first when 2 years old and dies, after five lactations of nine months each, when 7 years old, has been in active production for only 45 out of the 84 months of her life. Consumption of fodder is of course at a reduced rate during the first two years and in calculating the ratio of produci period to consuming period a fair approximation may be obtained by reckoning these as one year. On this basis the cow already described has a production/consumption ratio of 62%. If she lives for only six years this is reduced to 60%, while if she misses one lactation in a seven years life it is reduced to 50%. Any other factor such as mastitis or abortion which reduces the production period without reducing the consuming period will have a similar marked effect in reducing efficiency. The dairy industry has recognised this principle by insisting that "effective average production" be assessed by dividing production by total potential producers which are consuming fodder. Would it not be wise to adopt the same procedure in expressing averages under the Group Herd Testing System, instead of eliminating cows which have not been in production for 100 days? This of course bring up the vexed question - is it safe to breed for production without considering all those factors which are loosely grouped under the hallowed term "constitution"? If by production is meant production per day of producing period, without any reference to the ratio of that period to the total consuming period, the answer must surely be in the negative. But if production be measured as a function of total consuming period then for that particular environment, all factors have been taken into consideration.

It is with this thought in mind that I approach with some trepidation the subject of progeny testing. The superiority of this system of selection over phenotypic selection should need no further emphasis. It may, however, be not unprofitable to examine existing methods of progeny testing. As a basis of comparison let us first conduct a complete survey of a hypothetical ideal dairy sire which retains high fertility to the age of 9 years and for whose daughters lifetime production records are available in every case. The complete survey will not be available until his youngest daughters are 7 years old, i.e. 17 years after he was born, and 8 years after his death. By this time it would be possible to form a complete and accurate estimate of the bull's genotypic value. If this is outstandingly high and further research enables us to keep his semen viable for over 8 years, it could then be used with every confidence. However, even the progressive improvements in artificial insemination technique which are constantly being reported hardly warrant our waiting until such a flawless procedure is available.

It is obvious that some compromise is required which will enable a sire's genotype to be assayed by progeny testing in a period which is sufficiently long to make his evaluation reasonably reliable and at the same time short enough to leave the largest possible proportion of his life in which to use his services widely In New Zealand the Herd Recording Department of the Dairy Board have adopted the following procedure(3) Preliminary surveys are based on the performance of the bull's first crop of two year old daughters; intermediate surveys take into account the first two lactations of daughters in the preliminary survey, together with the first lactations of any further daughters born a year later; final surveys include three lactations of the first crop, two lactations of the second crop, and one lactation of the third crop of daughters. On the completion of preliminary, intermediate and final surveys a bull will be at least five, six or seven years old respectively. A minimum of ten daughters is required. All productions are age corrected, and lactations of less than 200 days and lactations which are sub-normal on account of accident or disease are excluded, while only the production of the first 320 days is recorded in lactations lasting longer than that period.

To what extent does this evaluation of a sire's genetic worth fall short of the complete survey previously described? Three points appear to call for comment. First - very little indication will be obtained concerning the fertility of the bull, especially during his declining years. This is probably of considerable importance as Blake (4) has shown that low fertility is common in dairy bulls and is probably inherited. Secondly - very great emphasis is placed on early production and no information is available concerning lifetime production. If ten heifers from each of the first three crops of daughters are surveyed and there are no casualties, the final survey will be based on 30 first lactations, 20 second lactations and only 10 third lactations.

[illegible] RESEARCH BRANCH, WELLINGTON, N.Z.

Thirdly - the elimination of sub-normal lactations and lactations under 200 days would appear to invite the perpetuation of short lactation periods and predisposition towards mastitis and other diseases tending to reduce lactation. It is, of course, necessary to eliminate the effect of fortuitous accidents, but there appears to be no adequate reason for eliminating sub-normal lactations which are unexplained or which can be attributed to the normal environment, which at present includes exposure to mastitis and contagious abortion.

With all its limitations progeny testing is probably the best available method for assessing the true genetic worth of a sire. But this does not necessarily mean that it offers a practical means for rapidly increasing the average production of our dairy cattle. Artificial insemination would enable us to dispense with all but the best 10% of our bulls and future improvements in technique may further reduce the number required. This year, however, greater difficulty has been experienced in obtaining eight proven sires with a survey of 380 lbs. of butterfat. An examination of the list of preliminary, intermediate and final surveys up to 31st October, 1943, (5) showed only 252 "merit" bulls ten years old or under. This means that, of the 6,000 bulls which would be required for general use of artificial insemination, progeny testing had discovered at most 252 bulls capable of lifting average production to 350 pounds or more of fat on a maturity basis With the eliminations allowed in progeny testing the average peak production of 252 pounds of fat reached in New Zealand in 1940-41 becomes approximately 295 pounds. The average survey of the 252 "merit" bulls was in the region of 375 pounds of fat. Even on the generous assumption that in the first crop of calves they each left 150 daughters with a maturity production of 375 pounds of fat this would lift the New Zealand average production by less than two pounds of fat. While there is every reason for believing that the number of sires being surveyed will increase materially, it does not seem likely that the present system will ever produce sufficient proven sires to meet the needs of the industry.

Ward (1942) (6) gave surveys for 34 sons of proven sires in which it was shown that they had left daughters averaging 364 pounds of fat out of dams averaging 359 pounds of fat. In view of the small number of proven sires available, there would therefore appear to be every justification for using sons of proven sires in any artificial insemination scheme. If numbers available permit of selection, the dam should be considered as well as the sire in this regard. Ward (1942) (6) has shown that sons of lifetime merit cows (cows producing 2,500 pounds of fat in not more than eight lactations) left daughters with an average of 370 pounds of fat. As sire survey records become more complete it should be possible to take into account not only the production of the young sire's dam but that of her daughters.

Let us hark back to the complete survey of our ideal sire and look at his last crop of sons out of seven year old cows. By the time these are two years old, the first daughters of their dams will have completed four or five lactations, and the first three crops of daughters of their sire will have completed five lactations even if he were not used until two years old. Correspondingly less data will of course be available concerning his earlier crops of sons as two year olds, but except where they are first calves, some information will be available about the daughters of their dams in addition to the survey of their sires' daughters. Such data should surely be of value in assessing a young sire's genotype in regard to lifetime production in the normal dairying environment.

There is, moreover, a great economy in using a bull for artificial insemination from the time he is two years old. Under present conditions it may be estimated that a bull will leave 30 calves annually by natural service and 300 by artificial insemination. On this basis a bull which is used first as a two year old and retains his fertility until he is nine years old, by natural service only will leave 240 calves; by natural service until six years and then by artificial insemination 1,320 calves; and by artificial insemination from two years old 2,400 calves. One other calculation seems worth while. If the 252 "merit" sires were used this year in pedigree herds and left only 100 calves each, only 50% of the bull calves would be needed to provide two year old sons of proven sires in 1947 to artificially inseminate all the dairy cows in New Zealand.

From all these considerations the following brief and perhaps over-simplified suggestions are made for a scheme for improving the genotype of our dairy cattle:-

(1) That sons of proven sires, in addition to proven sires, be used as widely as possible by artificial insemination, as all available evidence suggests that they are better than the average bulls at present in use.

(2) That if numbers permit attention be given to the performance of the dam and the dam's daughters in selecting sons of proven sires.

(3) That every effort be made to progeny test sons of proven sires being used by artificial insemination.

(4) That annual culling of bulls take place on the basis of progeny tests and that replacements be two year old sons of proven sires.

(5) That pedigree breeders be encouraged to use the best proven sires available to provide sons of proven sires for the industry.

Progeny testing, of course, is just as valuable for improving production in beef cattle, sheep, pigs and poultry, as it is in dairy cattle, and its application to these stock in New Zealand is long overdue.

Just a word about type and production. Some breeders appear to have the same outlook on type as the dog and pigeon fanciers who deliberately breed their pets for the sake of their beauty or oddity. When the chemists have made the cow unnecessary as a producer of human food, these breeders may well serve a useful purpose in providing gazelle like creatures to ornament the landscape. It has already been indicated that where lifetime production is the yard stick, the type which goes with "constitution" will look after itself. There remains the breeder who contends that type is an indication of the genotype necessary for production. Unfortunately, no close correlation between type and production has ever been established, but the value of such a marker of genes is so incalculable that it would be unwise to discourage any prospector. Recently Wisconsin workers (7, 8) have discovered some 30 readily identifiable red blood cell characters whic are inherited as simple Mendelian dominants. Amongst some thousands of animals, only identical twins have been found to have identical distributions of these characters. Work has been commenced in New Zealand, and it is intended to survey some of our proven sires in the hopes of at last locating a means of identifying the genotype for production, without recourse to tedious breeding trials.

Although for topical reasons in this paper considerable attention has been devoted to breeding, it is more than probable that the most rapid improvement in production can be made by improving the environment of our producing animals. In this connection New Zealand is one of the riddles of the universe. A land where no grazing animal, nor any productive pasture species was evolved, which has now become the most famous grazing country in the world. In such circumstances it is not surprising that environmental problems have arisen. Simple deficiencies of mineral elements such as Copper Cobalt and Iodine have been discovered and corrected. More complicated problems, such as facial eczema and the spring ailments of dairy cattle, have been recognised but are still imperfectly understood, while it is more than probable that there are environmental effects, arising out of the reactions of our introduced animals and pastures to their surroundings, which are still unrecognised. The potentialities of our pastures have been demonstrated by the amazing production which is sometimes achieved, but the ability to repeat this on a large scale will come only from the extensive and intensive study of that complex biological system, the grazing animal in its environment.

Pathogenic organisms form part of the environment of all living things, but New Zealand is not cursed with many of the scourges which make animal husbandry such a hazardous undertaking in other countries. The control of infectious disease may be summed up in three words - quarantine, immunity, treatment. While veterinary science has still a great deal to learn about the application of these principles, much knowledge is available and it is gratifying to notice the growing recognition of the value of veterinary services and the energy with which stock owners are seeking to organise them so that they may be used to the best advantage. Veterinarians must, of course, play their part and ensure that they are qualified not only to treat disease, but to advise on problems of animal feeding, breeding and management. Modern stock cannot adapt themselves perfectly to an environment which lacks a competent veterinary surgeon.

Where production is based on the exploitation of a physiological process such as lactation, it is only natural that it should be influenced by the environment in which that process finds its expression. The mechanisation of milking has proved an undoubted boon, but our knowledge concerning its application is still imperfect and it seems likely that a study of the physiology and mechanics of milk extraction may prove very profitable.

The efficient utilisation of animal food products lies more in the realm of economics than that of animal husbandry, but it is perhaps permissable to touch on one phase of the question. In the introduction it was indicated that the animal has a notoriously low efficiency in producing human food, and this is still true when the material on which it is fed is itself of animal origin. Here we have a geometric progression in wastefulness. Stock feeds of animal origin are mainly the by-products of meat, fish and milk. Meat and fish meals are perhaps not important, though a large proportion of rejected meat and fish could be rendered wholesome and nutritious for human use. This might not be very palatable, but men suffering from protein starvation should not prove more fastidious than over-fed epicures who tickle their palates with putrescent game. But when our utilisation of milk by-products is examined it becomes difficult to understand how such waste has been so long condoned. It takes approximately five gallons of skim milk to produce one pound of pork. The milk contains 1.7 pounds of protein of the highest biological quality, while the pork contains approximately 0.1 pounds of protein. A better idea of the situation can be gained from the national figures for the 1942-43 season, as shown in the following table:

BALANCE SHEET FOR PORK PRODUCTION 1942-43

	Quantity	T.D.N. x 10^6 lbs.	Dig.Protein x 10^6 lbs.
Barley	20,000 tons	35.26	4.166
Meatmeal	7,000 tons	11.57	7.934
Molasses	1,000 tons	1.27	0.020
Whey	170,000,000 gals.	108.70	15.300
Buttermilk	35,500,000 gals.	32.12	11.650
Skim milk	519,000,000 gals.	446.40	181.700
Total Pig Food		635.32	220.770
Pig Meat	41,000 tons	98.40	9.313
Deficit		536.92	211.457
Total Lamb	173,000 tons	298.80	46.490
Total Cheese	101,700 tons	233.10	54.710

No allowance has been made for New Zealand grown grain, roots or pasture consumed by pigs and a digestibility of 100% has been assumed for pig meat, lamb and cheese. In spite of this, the deficit in total digestible nutrients (T.D.N.) is equal to the sum of T.D.N. for the annual production of lamb and cheese, while the loss in digestible protein is nearly double that contained in these two. It is realised that the collection of skim milk and its conversion into convenient forms such as skim milk cheese or dried skim milk present difficult problems, but surely with the present demand for increased human food, nothing can justify such fantastic waste of food of the highest biological value. In the post-war years New Zealand will have to meet keen competition from Canada and Europe in regard to pork and bacon, and the price differential in favour of margarine is bound to affect the demand for our butter. It would seem, therefore, that New Zealand's economic interests and the world's needs both demand much more efficient utilisation of our skim milk and whey. Until this can be organised, every effort should of course be made to utilise our dairy by-products as efficiently as possible in the production of pig meat.

Summary:

To produce more high quality human food of animal origin economically New Zealand must do three things: She must breed better stock, and that means progeny testing, with the most efficient use of proven sires and their sons by means of artificial insemination. A better environment must be provided for our stock, and that requires a more complete knowledge of how to handle our pastures and how to milk our cows, together with a better organised Veterinary Service to maintain the health of our livestock. Methods must be discovered for eliminating the present criminal waste of our dairy by-products.

Aknowledgements:

So many people have assisted in the preparation of this paper that it would perhaps be more fitting if I were designated its editor rather than its author. To mention them by name might appear to infer that they shared the responsibility for the views expressed. I thank them all.

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(1) Leitch, I. and Godden, W. Imperial Bureau of An.Nut. Tech. Comm. 14.

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(3) Ward, A.H. and Campbell, J.T. (1940) Ibid. 8, 32, 249.

(4) Blake, T.A. (1944) Unpublished data.

(5) Report. Dairy Herd Testing in New Zealand. Herd Wastage and Investigational Work. 1942-43 Season p. 26.

(6) N.Z. Dairy Board 18th Annual Report (1942) p. 28.

(7) Ferguson, L.I. (1941) J. Immunology 40, 213.

(8) Ferguson et. al. (1942) Ibid. 44, 2, 147.

DISCUSSION

Mr R.E.R. Grimmett: I feel that Dr Filmer's main points about the utilisation of our products and improvement of our stock are important, and I don't want to raise a side issue, but in his introductory remarks I understood him to say that the eating of animal food did tend to lengthen life. I wondered whether he meant to indicate that long-lived species were mainly animal eaters as against short-lived species which were vegetable eaters.