THE USE OF SMALL ANIMALS IN AGRICULTURAL RESEARCH

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SUMMARY

The value of small animals as aids in agricultural research is discussed. They contribute information which is useful in:

(a) Disease detection and prevention.

(b) Detecting and measuring substances in pasture and crop species which affect large animals.

(c) Providing "pilot" information for larger animals.

(d) Stimulating the minds of research workers.

Some examples, mainly from recent or current New Zealand work are given.

THE WAYS in which work with small animals contributes information useful in agriculture may be considered under the following headings.

(a) In disease detection and prevention.

(b) As detectors of or measuring instruments for substances which affect large animals or consumers of farm products.

(c) As "pilot" animals in such work as nutrition research.

(d) In stimulating the minds of those engaged in or associated with agricultural research.

DISEASE DETECTION AND PREVENTION

Because the ways in which small animals are used in connection with disease detection and prevention are probably well known to all the members of the Society only a few examples will be given. The importance of this work to agriculture does not need emphasis.

IN DETECTION OF AGENTS CAUSING DISEASE

Reactions following intradermal injections of suspected material into guinea-pigs and rabbits are used to detect toxins (diphtheria, salmonella, etc.). Intravenous inoculation of mice, combined with neutralization of possible toxins is used to help

pullets are used to help determine whether tuberculosis is of human, bovine or avian type. The use made of guinea-pigs in facial eczema research is well known.

In Chemotherapy

Small animals are used to find which drugs or antibiotics can be used to combat specific diseases.

In Immunological Studies

Small animals are commonly used for testing the pathogenicity of organisms, for supplying serum in which to grow organisms and to test the immune response in large animals. As an example, the current work of Mr Reynolds of the Massey College Veterinary Department on leptospira may be mentioned. Rabbits are used to provide serum containing a growth factor, and guinea-pigs for other phases of work.

AS DETECTORS OF SUBSTANCES WHICH AFFECT LARGER ANIMALS

In addition they may be used to obtain estimates of the activity present in different materials.

One example of this is the use of mice to detect and measure oestrogenic activity in pasture species, work in which we are engaged at Massey College and Plant Chemistry Division (D.S.I.R.). Mice have been used to test for oestrogenic activity a number of the species in which the plant breeders at Grasslands Division (D.S.I.R.) are interested.

Extracts of plant material and specific substances isolated or synthesized by Dr Wong of Plant Chemistry Division (D.S.I.R.), have been tested for oestrogenic activity, and the activities of those found to be oestrogenic have been compared by bioassay methods. As the fund of knowledge obtained with chemical methods increases there will be less need for mice, but if, as appears to be the case with lucerne, oestrogen inhibitors and potentiators are found to exist in clover, they will continue to be valuable for a considerable time.

In these studies the gap between the farm animal and the plant has been partly bridged by some determinations of the oestrogenic activity in mice, of red clover known to affect the mating behaviour or reproductive performance of sheep grazed on it. The sheep were in the experiments of T. S. Ch'ang, of Massey College. As new pasture species are developed from very small numbers of plants, it would be a very slow and costly business testing for such activity in farm animals, and it would not be possible to isolate or synthesize sufficient pure compounds

to test with farm animals. However, because of differences in the metabolic processes of small animals and ruminants, it is important to do as much as possible to check that the types of compounds in the pasture species which are effective in small animals are those which are effective in ruminants.

Another example is provided by work done by Mr Ronaldson, Dr Edgar (Ruakura) and the writer. Mice were used in a bioassay to test whether all the progestational activity in ewe's blood serum could be accounted for in terms of progesterone, the concentration of which was determined chemically. In this case the biological method is very slow and cumbersome to use, in fact it would be a huge task to follow properly the change in progestational activity in the blood of the ewe during the reproductive process by this means.

ANIMAL NUTRITION

While it is true that much of our basic knowledge about such nutritional requirements as vitamins, essential amino acids and trace elements has come from experiments with small animals (including here the chicken), such work has not had much effect on the way we feed our farm livestock, except in the case of pigs. Most farm animals are ruminants, and no miniature ruminant suitable for experimental purposes has yet appeared. Other herbivores, like the guinea-pig and rabbit which rely on caecal digestion and bacterial assistance during a cycle involving coprophagy, or the marsupial (*Setonix brachyurus*) which has a sacculated stomach in which it breaks down crude fibre (Calaby, 1958), do not seem to be suitable as pilot animals for the true ruminants. They may have a place, however, in detecting differences between foodstuffs, this detection having to be followed up by finding what the differences mean to sheep or cattle.

An interesting experiment in this respect is that of Thacker (1959) who found that a diet of timothy hay for rabbits could be effectively supplemented by minerals with organic anions (which are converted to CO_2 and H_2O in metabolism) but not by the same minerals attached to inorganic anions. This result may be important in our farm animals, especially pigs which are often given mineral supplements.

Small animals may play a useful role in such things as assessing the effects of different methods of processing and storage of farm products on their nutritive value, although it is to be expected that to an ever-increasing extent their use will be replaced by chemical methods.

STIMULATING THE MINDS OF RESEARCH WORKERS

Perhaps one of the most valuable contributions which work with small animals can make to agriculture is through stimulating the minds of research workers, and others associated with research, and by providing information on things such as types of physiological and genetic mechanisms which might be found in larger animals. A good example comes from recent work at Palmerston North.

Differences in the thyroid gland sizes of sheep grazing different types of pasture (Flux, *et al.,* 1960), seemed to be satisfactorily explainable in simple terms of differences in iodine and pro-goitrogen intake, except for a fairly strong suggestion that perennial ryegrass was goitrogenic. This was surprising although a possible reason for it could be suggested. However, Mr Ulyett of Massey College carried out an experiment with guinea-pigs, using both H1 and perennial ryegrasses and found that in the guinea-pigs both were goitrogenic if fed at high levels, but not at lower levels. This suggests that the causes of differences in the weights of thyroid glands in our sheep may have been much more complex than we first thought, and we would probably have remained unaware of that unless the small animal work had been done. Thanks are due to Mr Ulyett for permission to quote from his unpublished results.

Some examples may be taken from animal breeding work. Dr Cockrem at Massey College, who is interested in sheep breeding, has been using mice to obtain information about genetic correlations and what short of response might be obtained by selection for two correlated characters, working "against" the correlation.

It is probably correct to say that Dr Brumby's (Ruakura) experience with "maternal effects" in mice has coloured his thinking about selection problems in farm animals.

This type of work with small animals does not, of course, obviate the necessity for experiments with farm animals. Some experiments with farm animals are much more costly in terms of labour, facilities and materials than those with small animals. Others are not, if productive performance is not greatly affected and labour and facility costs are not abnormal, as is the case with some breeding experiments. But farm animal experiments are almost always costly in terms of time.

Work with small animals can contribute by making the large animal experimenter more aware of what to look for and record, of how to plan his large animal experiments, and may

help in interpretation of results so that they are likely to provide useful information more rapidly than if no small animal work had been done.

In addition to these more direct contributions to the benefit of agriculture, work with small animals has played a very large part in building up the general pool of human knowledge which can be drawn upon by biologists interested in animals of any sort, or in humans.

Each year several million mice used in cancer research contribute to knowledge of the mechanisms involved in growth. A large part of what knowledge we have of the genetics of animals has come from work with mice. A great part of the information of our biochemical, endocrinological and other physiological mechanisms has stemmed from work with rodents. This is brought home forcibly to anyone who searches for information on other species.

This large background of information has undoubtedly contributed a tremendous amount to human welfare in general, but how much agriculture, as distinct from this, has gained it is very difficult to gauge. However it is clear that the total contribution of small animal work to agriculture is of very considerable value.

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DISCUSSION

DR J. F. FILMER: *While there is a great saving in cost in working with small animals as opposed to farm animals, nevertheless the cost of rearing and providing small animals is not inconsiderable. In the U.K., at Compton, a central depot was set up for providing small animals to those who did not have rearing facilities. I wonder if there would be any support for a similar idea in N.Z.?*

A: A central breeding establishment for small animals is undoubtedly very convenient for users whose requirements are intermittent. However, other users need to have a complete knowledge of the previous history of the animals which they are using and prefer to breed their own. Use of special strains (within species) of animals for special purposes does not fit easily into a system of centralized supply. For these reasons, establishment of a central breeding depot would not obviate the need for smaller colonies at individual research centres. The cost of animals from a central depot may be as high or higher than that of animals from small colonies, particularly if the capacity of the central depot is large enough to enable it to

supply occasional requests for large numbers of animals at irregular intervals and with little warning. Small colonies may be maintained at a very small labour cost if a technician does the required work as a small part of his duties and overtime labour costs for holiday work are kept low.

Q: *Would Dr Flux elaborate on the possibility of using the small marsupial employed at the Animal Health Laboratory in Melbourne, since it is akin in its digestive processes to ruminants?*

A: The only work with a small ruminant which I have read about is that at Perth, Western Australia, to which reference has already been made. Calaby's results suggested that it would not make a very suitable replacement for ruminants.

DR L. R. WALLACE: *Is there not in the South American jungle a true ruminant about the size of a cat or small dog?*

A: There may be one, but I do not know of it. To be really useful, an "experimental" ruminant would have to be really small, because sheep and goats themselves are cheap, plentiful, and very convenient to use in experiments. It is only when the supply of foodstuff, metabolites or hormone of interest is very limited that there would be a need for a small "pilot" ruminant.

E. D. ANDREWS: *It is perhaps worth noting in this context that bacteria might be considered as small animals. They have been extensively used in antibiotic and vitamin work. Has the goitrogen in ryegrass been established as a source of goitre in sheep or small animals or both?*

A: All that can be said at present about the goitrogenic effect of ryegrass is that guinea-pigs fed high intakes of either perennial ryegrass or short-rotation ryegrass, and sheep grazed on perennial ryegrass, have had enlarged thyroid glands. Whether this is caused by low levels of available iodine or some specific goitrogens in the food, or some other dietary complications, such as those involving increased faecal excretion of organic iodine reported by Van Middlesworth (1960) or a combination of these, is not known.