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The Application of Statistical Methods

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THE DISEASES OF BEES

The researches of the Bee Department fall into three categories—(1) work on the physiology, behaviour and morphology of the healthy bee; (2) investigations on the pollination of fruit and seed crops; (3) researches on the diseases of adult bees and their brood. An advisory service is also maintained and some 4,000 to 5,000 samples of bees and combs suspected of disease are examined every year free of charge.

The spread of the disease known as foul brood had been viewed with some concern during the years preceding 1939. On the outbreak of war it was feared that the spread might be accelerated by the call-up of beekeepers and the consequent neglect of their colonies. The Rothamsted Bee Research Advisory Committee therefore drew up a plan for the control of foul brood by means of legislation which eventually became law as the Foul Brood Disease of Bees Order, 1942. It provides for the inspection of any premises on which bees are kept, within three miles of a suspected outbreak of foul brood, and for the compulsory destruction of all infected colonies in the area. The application of the Order has shown that in many areas the incidence of foul brood was in fact much higher than had been suspected and that the introduction of legislation was necessary. The returns for 1945 justify the hope that the cumulative effects of widespread neglect of the foul-brood problem prior to 1942 are now being overcome and that continued vigilance will result in a steady decrease in the incidence of disease in future years.

The use of sulphonamides fed in sugar syrup to colonies infected with American foul brood, first reported to the Department by Mr. C. A. Ekins of Surrey, has given highly promising results, and further work is in progress with a view to obtaining a method of treatment as an alternative to destruction of colonies infected with either American or European foul brood.

Another activity of the department is a survey of adult-bee diseases. During the 1914-18 war Isle of Wight disease caused losses estimated at 90 per cent. of the bee population of Britain. The situation was restored by a re-stocking scheme, by the discovery of the causal agent of the disease and by the subsequent development of control measures, though the trouble, better known now as Acarine disease, continued to occur in many districts. Surveys carried out in 1941-42 and 1943-44 were designed to determine the incidence and distribution of Acarine and other adult-bee diseases and to reveal, in time to prevent the possibility of disaster on the 1914-18 scale, any tendency for a disease or diseases to assume epidemic proportions. Fortunately there was no evidence of any serious situation arising and, as regards Acarine disease, the position showed some signs of improvement in the interval between the surveys.

THE APPLICATION OF STATISTICAL METHODS

On account of the great demand for statistical assistance in connection with a wide variety of war-time activities including military operations, new researches in statistical theory and method had necessarily to be curtailed. Apart from the war, however, the trend was in the direction of the fuller development of already

established principles, for each type of problem requires its own specialised approach. There had in the past been a tendency to over-generalised treatment, and insufficient account was taken of the complexities to which each problem is subject. Many improvements on method and refinements of technique have been introduced, however.

One of the most valuable contributions of the statistician is in the design of experiments and the planning of experimental programmes. It is now becoming more generally recognised that the modern type of factorial design can greatly increase the information obtainable. If all combinations of several different sets of treatments or "factors" are included in one factorial experiment a number of interrelated aspects of the same problem can be studied simultaneously with considerable economy of space and with the advantage that the dependence of one treatment on the intensity of another can be determined. The advantages that come from being able to study variable material quantitatively, from asking several questions at a time and from obtaining unbiased measures of the effects of treatment and of experimental error are obviously invaluable in biological work.

Various references have already been made to the application of statistical methods in the work of the Station. Not only are practically all the field experiments of Rothamsted and its associated centres dealt with, but also many of the laboratory and other experiments. Numerous enquiries are also received from other institutions both in this country and overseas.

One of the most valuable contributions of the Statistical Department has been the preparation of critical quantitative reviews of all the experimental data on certain problems. An example is the summary of fertiliser trials already mentioned. Another instance is the investigation of the effect of changes in level of feeding of dairy cows on milk production. This review showed that overstringent rationing resulting from shortage of foods might result in a serious reduction in milk supply without any equivalent saving in food.

An investigation has just been begun to compare the economic value to the livestock farmer of temporary leys as compared with old grass. This forms only a small part of a much more general problem which is, broadly, the study of the agronomic and economic value of ley farming compared with other farming systems. This complex problem is naturally the affair of many other research stations besides Rothamsted.

During the war the importance has been realised of having accurate and reliable information on farming conditions, on agricultural practices, and on the incidence of diseases and pests. Such information is also useful in peace-time—for instance in the planning of research, but it was particularly necessary in war-time in planning the utilisation of scarce resources. The Statistical Department has been closely concerned with three major pieces of survey work of this kind: the Survey of Fertiliser Practice, the National Farm Survey and the Wireworm Survey. These projects are described in the detailed report.

The Survey of Fertiliser Practice revealed, amongst other things, the fact that farmers ploughing up old grassland had failed to

recognise the deficiencies of lime and phosphate so common in such land. The National Farm Survey deals with such aspects as tenure, condition of farm, incidence of insect pests, quality of farming and supplies of electricity and water. The object of the Wireworm Survey was to evolve methods suitable for assessing wireworm infestation of particular fields so that advice could be given to farmers on cropping and preventive measures.

THE CLASSICAL AND OTHER FIELD EXPERIMENTS

Field experiments continue to occupy a prominent place in the Rothamsted programme, and in addition to the large number of experimental plots on the farms at Rothamsted and Woburn many field experiments have been carried out on private and institutional farms in various parts of the country.

For many years, there has been co-operation with Mr. A. W. Oldershaw at Saxmundham and Tunstall, and this has been continued. In spite of, or perhaps because of, the war the number of modern experiments as distinct from the classical experiments on the Rothamsted farm has increased greatly. There are long-term experiments, including rotation experiments, to study the effects of deep ploughing, various methods of returning straw to the land, the response of fertilisers in relation to season, and several other problems. There are also annual experiments in which the effects of treatments are measured in a single crop.

The classical experiments have been continued. The earlier work by the Botany Department on the reduction of the weed-seed population of arable land by fallowing led to the establishment of a five-year cycle on Broadbalk whereby one section is fallowed each year. Samples taken annually over a long period of years support the conclusion that the routine fallowing of one section per year has fully justified itself, as the weed-seed population has not only been kept in check but has also decreased during the 15 years that the system has been in force. This is particularly so in the case of poppy which has been decreasing steadily since periodic fallowing was instituted in 1925. Recently, however, trouble has arisen from the spread of species of wild oats, and special experiments are being carried out to find, if possible, some effective way of controlling this weed.

The botanical analyses of the herbage of Park Grass and High Field that were slowed up during the war years are now being dealt with, and the accumulation of analytical and observational data for many years is being examined and prepared for publication in order to bring the ecological history of the plots up to date.

Because of the urgent need for food production the non-experimental areas on the farm at Rothamsted were farmed as intensively as possible. Old grassland was broken up and the arable acreage increased from 137 in 1938-39 to 308 in 1944-45, whilst the value of the produce sold for these years rose from £2,922 to £7,401.

The timber in Knott Wood was not included when the farm was purchased in 1934, and, when it was felled, we were left with an area of about 74 acres of derelict land full of tree stumps. Part was replanted and part has still to be dealt with, but an area of about 24 acres was reclaimed in a variety of ways. In one section the land