ROTHAMSTED RESEARCH

# Report for 1953

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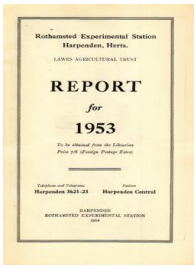


## Statistics Department

### F. Yates

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# STATISTICS DEPARTMENT

F. YATES

There have been no major changes in our lines of work during the year, but the possibility of utilizing modern electronic methods of computation is under active consideration. M. J. R. Healy and D. H. Rees attended a course on programming methods for electronic machines held at the Mathematical Laboratory, Cambridge.

A new temporary building adjoining Rivers Lodge, sanctioned in 1952, is now almost complete, and will provide much-needed additional accommodation for staff and temporary workers. The Hollerith equipment will also be transferred to this building from its present cramped quarters.

F. Yates spent two months in India advising the Indian Council of Agricultural Research on the development of their Statistical Branch. This work was sponsored by the Food and Agriculture Organization of the United Nations, and was carried out in co-operation with Dr. D. J. Finney of Oxford, who spent a year in India (October 1952–August 1953). A report on this work is now almost complete.

D. A. Boyd acted as consultant on experimental design to the F.A.O. Working Party on Mediterranean Pasture and Fodder Development, and spent six weeks (October–November) in Rome, Greece and Cyprus. G. E. Hodnett was one of the instructors at the African Training Centre for Agricultural Statistics at Ibadan, Nigeria, which was conducted jointly by the Colonial Office and F.A.O. The course lasted for eight weeks (July–September), and was bi-lingual (English and French). Hodnett was responsible for giving the lectures on sampling methods in English and for advising on the application of these methods to problems of local importance. A duplicated set of lectures in summary form has been issued by F.A.O. (177).

F. Yates, M. J. R. Healy and F. B. Leech attended the 3rd International Biometric Conference held at Bellagio from 1st to 5th September, and F. Yates also attended the 9th International Genetics Congress (also at Bellagio) and the 28th Session of the International Statistical Institute from 7th to 12th September in Rome.

F. Yates was awarded the Weldon Memorial Prize by the University of Oxford for outstanding work in biometrical science.

M. H. Westmacott was granted leave of absence for six months to join the Everest Expedition.

Eight temporary workers were accommodated in the department during the year, two from Great Britain, five from the Colonies and one from Greece.

## DESIGN AND ANALYSIS OF EXPERIMENTS

Work has continued on the problem, outlined in last year's report, of deciding what amount of experimentation is economically justified when questions of immediate practical importance have to be settled. A fairly full investigation has now been completed by

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P. M. Grundy, M. J. R. Healy and D. H. Rees of the case in which a decision has to be reached whether to adopt some new treatment of the all-or-nothing type and there is only time to carry out one further batch of experiments after the initial experiment. This situation is somewhat similar to the double-sampling technique used in industrial quality control, but our approach has been different. Given the cost of a unit of experimentation and the gain resulting from a given difference between the old and the new treatments, it is possible to determine on the basis of the estimate provided by the preliminary experiment whether to carry out any further experimentation, and if so, how many experiments should be undertaken. A paper outlining the results of this work was given by Healy at the Biometric Conference. The solution of this problem has indicated that our previous ideas on the fully sequential problem in which units of experimentation are successively undertaken until a decision is reached require reconsideration. This problem is now being actively pursued.

A number of long-term Rothamsted and Woburn experiments are now reaching the stage where their termination or modification has to be considered. The three-course rotation on the effects of ploughing in straw was re-designed at the end of 1951, and the four- and six-course rotations are now under consideration. A plan for the re-design on modern lines of the rotation experiment laid down by Lawes and Gilbert on Agdell Field has been drawn up, but has not yet been put into operation, as certain irregularities on the field due to acidity have first to be corrected. Various other problems in the analysis of long-term experiments have been studied, and a paper has been prepared on the analysis of experiments containing different crop rotations (168).

There has been the usual volume of routine work on the design and analysis of field and laboratory experiments for Rothamsted and other research stations and for the National Agricultural Advisory Service.

The Unit of Animal Experimentation has been fully occupied. We have continued to assist various research stations and N.A.A.S. farms in the planning and analysis of their experiments. F. B. Leech's report to the Agricultural Research Council on the effects of thyroxine and iodinated casein on lactating cows has now been published (165).

## Surveys and Operational Research

A survey of hill and livestock rearing farms has been begun in Wales and the Welsh border and in marginal and upland areas in Northern England, Yorkshire, Lancashire and the South-west. D. A. Boyd and B. M. Church are in charge of this work. This is a follow-up of the survey of marginal land which was undertaken in 1949–50. The object of the present survey is to find out how far improvements based on assistance given under the Hill Farming and Livestock Rearing Acts have affected the production, economy and working conditions. The surveyors are also estimating the scope for further improvements. Since most schemes are not yet completed, the present work will provide only a provisional estimate of the value of improvements, and it is planned to revisit the farmers

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in four or five years' time to estimate the full effect. In addition to a random sample of improvement schemes, all those farms which have had schemes accepted under the Act are being visited, and further records are being taken covering areas of land which were already improved in 1949 to assess the long-term value of land improvement. The field work is now in progress, and it is anticipated that this survey will be completed by June 1954.

A survey of fertilizer practice has been carried out in eight districts. These districts were mostly new to survey or had not been surveyed for many years, and were chosen because of their particular interest to the advisory chemists concerned. A report is almost complete, except for one district, from which results have not yet been received.

The results of the 1952 survey of rabbit damage to winter wheat were examined, and a paper has been published (159). The survey gave the following estimates of losses in yield :

| Province | Number of sites | Mean yield over all plots, cwt./acre | Estimated reduction in yield of grain, cwt./acre |
|---|---|---|---|
| Eastern .. .. .. | 15 | 26·6 | 1·7 ± 1·4 |
| East Midland .. .. | 21 | 23·8 | 2·1 ± 1·3 |
| South-eastern (Reading) | 21 | 25·3 | 1·0 ± 1·5 |
| South-eastern (Wye) .. | 14 | 20·8 | 1·9 ± 1·8 |
| West Midland .. .. | 23 | 24·3 | 1·2 ± 1·0 |
| South-western .. .. | 25 | 21·0 | 1·6 ± 1·0 |
| All provinces .. .. | 119 | 23·6 | 1·6 ± 0·5 |
| Kent, spring wheat, 1950 | 22 | 16·7 | 3·0 ± 0·7 |

A close correlation was found between the rabbit grazing observed in January and the final loss of yield, as is shown in the following table :

| Extent of rabbit grazing in field | Percentage of sites | Mean yield: Fenced plots (cwt. per acre) | Mean yield: Unfenced plots (cwt. per acre) | Loss on unfenced plots (cwt. per acre) |
|---|---|---|---|---|
| None .. .. | 30 | 25 | 25 | 0 |
| Slight .. .. | 36 | 25 | 24 | 1 |
| Moderate .. | 21 | 25 | 21 | 4 |
| Severe .. .. | 13 | 20 | 16 | 4 |

This provides satisfactory confirmation of the validity of the survey methods.

On the animal side F. B. Leech has continued his work in collaboration with F. W. Withers on the survey of diseases of dairy cattle carried out under the direction of the Veterinary Laboratory, Weybridge. This survey has now been extended to cover part of Devonshire besides being continued in Surrey, Berkshire and Wiltshire. The Ministry of Agriculture, Northern Ireland, are also about to investigate diseases and husbandry practice of cattle, sheep, pigs and poultry. We are assisting in the planning of this survey.

The survey of bloat carried out in Wales during 1952 has been

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analysed and briefly reported on, and further work has been carried out in 1953. The results of this are now awaited.

We have co-operated with the Veterinary Investigation Officer at Leeds in the planning and survey of incidence of loss in pregnant ewes in Yorkshire. The results of this survey are now being analysed here.

We are also assisting various other departments in the planning of surveys and the analysis of the resulting data.

On the methodological side B. M. Church has carried out an investigation into the errors obtained in past surveys of fertilizer practice with a view to improving the efficiency of design and estimation processes. A paper has been prepared and is now being revised.

D. A. Boyd and W. J. Lessells have carried out a review of fertilizer experiments on grassland, and a paper on this subject was read to the British Grassland Society at their December meeting (158). They have also summarized all available experiments on the effect of seed rate on the yield of potatoes (157).

A paper by G. V. Dyke and P. R. D. Avis has been published on estimates of potato yields by sampling methods, based on the results of the survey of maincrop potatoes (161).

In the second edition of *Sampling Methods for Censuses and Surveys* (155) a method of sampling—lattice sampling—was described by which the effects of two or more cross classifications can be simultaneously eliminated. H. D. Patterson carried out an investigation into the appropriate methods of estimating the errors in the more complicated applications of this type of sampling (167).

F. Yates and P. M. Grundy carried out an investigation into selection without replacement from within strata with probability proportional to size (171).

## Colonial Work

G. E. Hodnett has continued his work in advising and assisting workers in all parts of the Commonwealth in statistical problems. Five colonial workers have stayed in the department for periods of up to two months, and twenty others have paid brief visits. As already mentioned, Hodnett assisted in the African Training Centre for Agricultural Statistics at Ibadan. Reports on the analysis of sugar-cane experiments in British Guiana, Mauritius, Barbados and Antigua have been sent to the Colonial Office (178), and a combined paper is being prepared for publication. Hodnett also assisted D. H. Constable of the Rubber Research Institute of Ceylon in the preparation of a paper on a manuring experiment on rubber (160).

## Other Work

The fourth edition of *Statistical Tables for Biological, Agricultural and Medical Research* appeared during the year (156).

F. Yates, D. J. Finney and V. G. Panse prepared a joint paper on the responses of food grains to fertilizers in India, summarizing the readily available experimental results (170). Yates gave an address to the Indian Society of Agricultural Statistics on the wider

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aspects of statistics, in which he drew attention to the important contributions that can be made by statisticians to the planning of research and the utilization of the results in practice (169).

F. B. Leech assisted A. B. Paterson of the Veterinary Laboratory, Weybridge, in the analysis of an experiment on tuberculin reaction in the guinea-pig, and a joint paper is in the press (166).

M. J. R. Healy has contributed a chapter on biological assay to a new text-book on *Methods of Plant Analysis*, in which he discusses direct, parallel line, slope-ratio and probit assays, giving the appropriate statistical techniques and some suitable experimental designs (163). In this field of work he has devised a method of evaluating tests of fly-repellant sprays. In a common technique, sprayed and unsprayed mice are exposed to *Stomoxys* flies, and comparisons are made on the basis of the proportion of flies attacking the mice. The attack rate may vary widely from one occasion to another, and the problem lay in finding some stable basis for comparison (162). Jointly with G. V. Dyke, he has described a method for solving to three-figure accuracy large systems of normal equations that arise in survey analysis, using only a Hollerith sorter and tabulator (164).

As usual, a large number of papers have been referred to the department for refereeing; during 1953, forty-one papers were received. The work involved is very considerable, as the statistical analysis and presentation are often very unsatisfactory, and direct collaboration with the authors is frequently necessary in order to effect the required revision.

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