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Rothamsted Report for 1947

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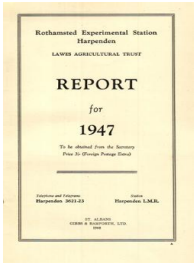
Rothamsted Experimental Station
Harpenden
LAWES AGRICULTURAL TRUST
REPORT
for
1947

Statistics Department

F. Yates

F. Yates (1948) *Statistics Department ;* Rothamsted Report For 1947, pp 44 - 48 **- DOI: https://doi.org/10.23637/ERADOC-1-89**

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DEPARTMENT OF STATISTICS

By F. Yates

The demand for statisticians trained and experienced in agricultural and biological work, mentioned in the 1946 Report, has continued to affect the Department. Following the loss of Mr. Kempthorne, on his appointment to an Associate Professorship in the Statistical Laboratory, Ames, Iowa, at the end of 1946, Mr. Quenouille was appointed to a Lectureship in Statistics at Aberdeen University on completion of his year's study leave at Cambridge, and Mr. Anscombe has been appointed to a Lectureship in Statistics in Cambridge University in succession to Dr. M. S. Bartlett, who was appointed to the newly created Chair of Statistics at Manchester University. Mr. Anscombe left to take up his appointment in January, 1948. In addition to these University appointments, Mrs. Mathison has been appointed Statistician to the East Africa Groundnut Scheme. Fortunately the increased recognition of statistics in the Universities is already beginning to bear fruit, and it may be confidently expected that the number of able mathematicians who become interested in biological and agricultural research statistics in the course of their university careers will increase considerably in the future.

In order to encourage more recruits to agricultural statistics, the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland have instituted post graduate Scholarships in Agricultural Statistics, and three of these were awarded to scholars for study and training at Rothamsted during the year 1947–48.

Agricultural Research Statistical Service

Final arrangements for the setting up of a general Agricultural Research Statistical Service were completed during the year, and the following announcement was circulated by the Ministry of Agriculture and Fisheries to Research Institutions and the National Agricultural Advisory Service in December, 1947:

> On the basis of proposals made by the Agricultural Research Council and the Agricultural Improvement Council, it has been agreed between Rothamsted Experimental Station and the Ministry that the Statistical Department at Rothamsted should be expanded into a general Research Statistical Service.
>
> The Department has had long experience in dealing with statistical problems arising in design and analysis of experiments, the planning of field experiment programmes (so as to ensure the best utilisation of experimental resources), the planning and analysis of scientific surveys, and the critical analysis of large bodies of experimental material, and the new Service will in the main specialise in these classes of problem, though it will be prepared to assist in other work in so far as resources permit.
>
> It is intended that the Research Statistical Service shall give assistance to agricultural research stations, the National Agricultural Advisory Service and similar bodies in handling statistical problems beyond their resources. It is expected that

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the Service will be of value both to Institutions which have their own statistical staff and to Institutions and workers who have not at present any proper statistical facilities.

It is not intended that this expansion should preclude the appointment of staff with statistical knowledge in Research Institutions where the nature and volume of the work appear to justify such a course. At the moment, however, the supply of trained and experienced statisticians is inadequate and it is hoped that the Research Statistical Service will be able to bridge the gap that at present exists as well as providing a source of trained statisticians for the future.

The use of Hollerith punched card equipment is planned to assist in the analysis of data from large-scale surveys, and to facilitate research into improved methods of analysis of material of this type.

Institutes or individuals wishing to make use of the Research Statistical Service should communicate direct with the Head of the Statistical Department, Dr. F. Yates, at Rothamsted Experimental Station, Harpenden, Herts.

It is not intended that any charges shall be made for the use of the Service by Agricultural Research Institutes or the N.A.A.S.

The setting up of this Service has already resulted in an expansion in the work of the Department. In particular the Provincial Experiments Committees of the N.A.A.S. are consulting us freely on problems arising in the design of their experiments, and Dr. Boyd has been actively engaged in making personal contact with the various Provincial Centres. The Department has also done a good deal of work for a number of research centres.

The Department has been extensively consulted by research workers from the colonies on the design of field experiments, particularly long-term experiments of fertility in tropical Africa. In this work Dr. Yates and Dr. Crowther actively collaborated.

United Nations Sub-Commission on Statistical Sampling

Dr. Yates was invited by the Foreign Office to become a member of the United Nations Sub-Commission on Statistical Sampling, which held its first session at Lake Success in September, 1947. The other members of the Commission are: Professor G. Darmois (France), Dr. W. E. Deming (U.S.A.), Professor R. A. Fisher (U.K.), Professor P. C. Mahalanobis (India). This Sub-Commission was set up largely at the request of the Food and Agriculture Organisation, with a view to the introduction of sound sampling methods in the World Census of Agriculture which is planned for 1950. The work of the Sub-Commission is also of importance in connection with the World Census of Population planned for the same year. The Sub-Commission has drawn up a report on the use of sampling with particular reference to these Censuses, which has already had considerable influence with those concerned with the planning of the Censuses. The Food and Agriculture Organisation held a conference of representatives of various countries concerned in the administration of under-developed areas in London in December, 1947, with the object of discussing the procedure of the Agricultural Census of such countries. Dr. Yates attended this conference as the representative of the United Nations.

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One of the recommendations of the Sub-Commission was that a manual should be prepared, as a matter of urgency, giving instructions on the use of sampling methods in censuses and surveys, with particular reference to the projected Agricultural Census. Dr. Yates undertook to prepare a draft of this manual, and considerable progress has already been made.

In the course of his visit to the United States, Dr. Yates attended the International Statistical Conference in Washington, D.C., where he contributed a paper to the Session on the Theory of Statistical Sampling (59). He also paid visits to the Statistical Laboratory at Ames, Iowa, the Institute of Statistics at Raleigh, North Carolina, the Connecticut Agricultural Experimental Station, New Haven, and various other institutes. Two outstanding impressions gained on these visits were the wide adoption of the modern methods of experimental design developed at Rothamsted, particularly the use of lattice designs in variety trials and plant breeding work, and the great developments that have occurred in the use of sampling methods both in agricultural and other surveys.

Research in statistical methodology

Mr. Anscombe continued his work on the sampling theory of negative binomial and logarithmic distributions, which is required in the study of insect populations, etc. Two papers on this subject have been prepared for publication (43), (44).

Dr. Yates completed his investigation of problems arising in systematic sampling, that is, the taking of sampling points evenly spaced along a line, or over an area, instead of randomly located sampling points (56). This work involved a good deal of heavy computation in which a number of members of the Department gave considerable assistance. Mr. Quenouille also carried out an investigation in this field (51).

While at Cambridge, Mr. Quenouille made a study of the analysis of time series, such as arise in meteorology, agriculture and economics. He has prepared a number of papers on this subject (46), (47), (48), (49), (50). A paper on an earlier investigation arising out of a problem in bomb distribution, which he undertook shortly after he came to Rothamsted, is being published (52). He also contributed a mathematical appendix to a paper by P. C. T. Jones and J. E. Mollison on the estimation of soil bacteria (53).

Dr. Yates investigated the methods of analysis appropriate to data derived from genetical experiments involving all possible reciprocal crosses of a number of parental strains (54), and also methods of analysing two-way contingency tables in which one or both the classifications refer to characters, such as grades, having an underlying quantitative basis (55).

The problem of the estimation of the sampling errors of the mean of a number of sample determinations in stratified sampling when certain sampling units are missing has been investigated by Mr. Healy, and a note on the subject is being prepared. This problem arises in sampling for mean egg weight by trap nesting on particular days, since hens do not lay eggs on all days. Mr. Read has prepared a note on the practical aspects of this problem.

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DESIGN OF EXPERIMENTS

No papers have been published in this field other than those which have already been prepared at the end of 1946, but various problems in experimental design have been under investigation, particularly in connection with long-term experiments and animal nutrition experiments. It is hoped that papers on these subjects will be prepared in the course of the coming year.

In addition, the need for a new text book on experimental design is becoming increasingly apparent. Descriptions of many of the more modern methods, which are now in current use, are only available in papers published in scientific journals, and reprints of many of these papers are now no longer available. It is intended to begin work on this text book as soon as the sampling manual is completed.

SAMPLING SURVEYS

During 1947 field work for the Survey of Fertiliser Practice was continued in the South-Eastern Province, and was completed in the South-Western and Welsh Provinces. Duplicated reports have been issued for the following counties: South Essex, Isle of Ely, Lincolnshire (Holland), Lincolnshire (Lindsey), Warwickshire, Yorkshire (West Riding). Reports are in preparation for three counties of the Northern Province, and the analysis of the survey data for a further six counties was completed.

Arrangements have now been made by the Ministry for the publication of all the reports of this survey and revised copies of a number of reports have already been transmitted to the Stationery Office. It is hoped that in future the issue of duplicated reports will be unnecessary, their place being taken by the immediate publication of the final report.

The data provided by the Survey on the extent of combine drilling of cereals and other crops in different parts of the country were summarized and a report has been published in *Agriculture* (58).

A survey of the conditions under which milk is produced on farms was planned for 1947 by the Field Experiments Committee of the Agricultural Improvement Council, but it proved impossible to undertake any field work. It is intended, however, that a pilot survey shall be undertaken in 1948. The planning and analysis of the results of this survey will be the responsibility of this Department.

ASSESSMENT OF YIELDS OF GRAZED PASTURES BY GRASS CUTTING TECHNIQUES

The work begun in 1945 in collaboration with the Chemistry Department and the Grassland Improvement Station on the evaluation of the yield of pastures by grazing and grass cutting was continued in 1947, samples being taken throughout the season on the Highfield grazing experiment. Statistical analyses of these experiments and of others carried out in other Provinces are being carried out by Dr. Boyd. It is intended that a report of the work shall be published shortly.

RESAZURIN RESEARCH SCHEME

Work on this scheme has continued during the year under the supervision of Mr. Eddison. The analysis and report of an

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experiment dealing with temperature compensation for storage prior to test was completed. The preliminary analysis of an experiment designed to determine the variability of milks from day to day and from churn to churn was also completed. A field trial of the methods evolved in the previous work has been instituted.

Entomology and Parasitology

In addition to work for the various departments of Rothamsted, Mr. Anscombe has acted as statistical advisor to the Advisory Entomologists. The scheme of observations of certain important pest insects ("Calendar insects") has been running smoothly. Some special observations were made last winter, 1946-47, to find out how many soil borings need be taken per field to obtain a reliable estimate of potato eelworm cyst infestation. Further observations, which should give all necessary information, are being taken this winter (1947-48).

An experiment carried out by the Parasitology Department, St. Albans, in 1946 on the use of D.D. against potato root eelworm was analysed, and six similar experiments carried out in 1947 are now in course of analysis.

A small co-operative experiment to see if different laboratories could get similar results in the determination of pyrethrin content of samples of pyrethrum flowers was examined and reported on. A much larger international experiment has been discussed.

National Institute for Research in Dairying

Mr. Healy has acted as statistical advisor to the National Institute for Research in Dairying. A thorough analysis of certain change-over nutrition experiments on dairy cows was carried out and points in the theory of the design and analysis of these experiments have been elucidated. Other items of work have included interpretation of milk flow curves, the development of tactile tests in rheology (which has application to cheese making) and hormonal treatment of goats.