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Rothamsted Report for 1963

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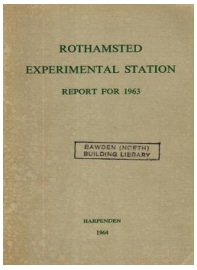

Statistics Department

F. Yates

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C. W. Fielding left and D. A. Preece and Winifred Johnson were appointed to the staff.

Church was seconded for an 18-months assignment in Ethiopia under the United Nations Technical Assistance Board to advise the government on the collection of official statistics by sample surveys. Vernon was seconded to work three years for the Cocoa Research Institute of Ghana.

Yates was Chairman of a United Nations Ad Hoc Sampling Group set up to revise the manual on the preparation of sampling survey reports compiled by the United Nations Sub-Commission on Statistical Sampling in 1948. Boyd spent three weeks in Rome advising on the planning and analysis of fertiliser experiments organised by the Food and Agriculture Organisation Freedom from Hunger Campaign. Rees spent four weeks at the Bell Telephone Laboratories, New Jersey, studying the operation of a large computer system.

Four temporary workers, one from overseas, spent various periods in the department during the year.

The 401 and 402 Computers

The 401 and 402 computers continued to give satisfactory service. The total time worked by the two machines was 15% greater than in 1962 and the productive time was 20% greater (Table 1). The 402 enabled the

TABLE 1

Record of machine operation for 1957, 1961, 1962 and *1963*

	1957	1961	1962	1963		
				401	402	Total
Total hours worked	2,622	3,688	4,126	2,954	1,777	4,731
Productive work, hours	1,305	2,666	2,938	2,250	1,278	3,528
Percentage overtime	32·6	86·5	65·2*	50·6	—	—
Percentage of time:						
Productive work	49·8	72·3	71·2	76·2	72·0	74·6
Programme development, etc.	22·6	11·8	10·9	3·6	7·0	4·9
Idle time	4·4	0·3	1·8	0·5	6·1	2·6
Maintenance, etc.	23·3	15·6	16·1	19·7	14·9	17·9

* 401 only. The 402 was operational from August 1962.

increased work to be handled without undue strain; the percentage overtime worked on the 401 in 1963 was 51%, compared with 86% in 1961 and 76% up to July 1962 when the 402 became operational. The increase in productive time was wholly accounted for by survey analysis, which occupied 1,402 hours (40% of all productive time) in 1963 compared with 815 hours (28%) in 1962. Analysis of experiments accounted for 25% of productive time in 1963, miscellaneous computations for 35%. There is clearly a developing demand for survey analysis; our facilities for this will be

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greatly improved by the Orion, with its magnetic tape and better card-reading equipment.

As soon as the Orion is working reliably and is adequately programmed we shall get rid of the 401 and 402, and move the tabulating equipment to the room at present occupied by them. We first obtained the 401 in April 1954 through the good offices of the National Research Development Corporation, and the 402 was presented to us in 1961 by Elliott Bros. We shall thus have had about 10 years' service from the 401. Apart from the initial period, its performance has been consistently satisfactory; the only major breakdown was the magnetic disc failure in 1960. The performance of the 402 has been equally satisfactory. Since we have had the 401, Rees has immensely improved it, and our only unsuccessful venture was our effort to install magnetic tape. Scientifically it has been of great value. By having a machine in the Department we have been able to explore and develop the application of computers to research statistical problems much more than would have been possible otherwise, and this is undoubtedly stimulating similar applications elsewhere.

The Orion Computer

The Orion computer passed its factory acceptance trials in November, and was delivered in December. It is now installed and is being commissioned by ICT/Ferranti engineers. We have already started to use the machine for small jobs of programme development. The size of the core store has been doubled, so that the machine now has 8,192 words of core store, 32,768 words of drum store (two drums), three magnetic tape units, a card reader, three 5- or 7-hole paper tape readers, and two 7-hole paper tape output punches.

We had considerable trouble with the installation of the air conditioning plant. Fortunately Rees monitored this work very closely and as a result the plant as finally installed has reached the high engineering standards we were seeking and is operating satisfactorily. Mr. R. J. Fiddes of H.M. Treasury Technical Support Unit, who assisted in drawing up the specification and consideration of the tenders, also gave us invaluable help in the commissioning and spent several days at Rothamsted observing the performance of the plant. There are still a few minor defects, but we do not expect further serious trouble.

The courses on the Orion for workers at other research institutes were held as planned. Two courses were held at Rothamsted, each of 5 days, in January and February, and one was held in Aberdeen in April with the co-operation of the Agricultural Research Council Statistics Group. Fifty-seven people attended the two Rothamsted courses and 30 attended the Aberdeen course.

Punched-card equipment. We have now replaced our old punched-card equipment by a larger and more versatile tabulator with full 80-column alpha-numeric printing and 60 counter-wheels, a new reproducer summary punch and a high-speed sorter. A counter-sorter is due for delivery in 1964. All this is ICT equipment.

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Methods of recording field data directly on punched cards are being tried at various research stations and by the National Agricultural Advisory Service. The IBM Port-a-Punch system is most favoured. In this, 40 columns of the card are pre-perforated, and the holes required are punched in the field through a template by a stylus. Subsequent machine handling of these cards presents problems, but it is hoped these can be overcome.

Programming Developments

Much work was done on programmes for the Orion computer. The Survey and Experiments Programme (SEP) is now nearly complete, and it was found possible to implement almost without change the scheme which was presented to the training courses (Gower, Simpson, Martin and Ross). In addition, Healy worked on a general regression programme, and Ross on a classification programme, a maximum likelihood programme and a sampling scheme for genetic correlations. Our programmes are not yet operational, as testing has been seriously hindered by lack of machine facilities. Some testing was done on the Orions in Manchester and London, but less than we had hoped; we have also had valuable assistance (thanks to Dr. R. Taylor) from the Orion at the Rutherford High Energy Laboratory, Harwell. Now that our own Orion is coming into operation, testing should proceed much more rapidly. Our programming work was also hindered by delay in the development by the manufacturers of the essential basic programmes.

Fortunately a version of Extended Mercury Autocode (EMA) is now complete, though this lacks certain functions, such as card reading instructions, which we require. Nor is it yet guaranteed to be fully correct, so that trouble can be expected from residual errors. However, the Extended Mercury Autocode, which is an amplified version of the well-known Mercury Autocode, and will accept programmes written in Mercury Autocode, will enable workers here and at other research stations to programme special jobs in this language for themselves, and so begin to use the Orion as soon as it is operational. Ross and Dr. J. T. Walker, Department of Genetics, Birmingham University, have written a programme in Extended Mercury Autocode for the study of advances under selection pressure, and a number of other programmes are being written by workers at other institutes. We are also collecting statistical programmes written for Mercury machines in Mercury Autocode and intend to make these available for use on the Orion as soon as they are tested. The main difficulty in using these programmes is that many of them contain small parts written in Mercury machine code. These have to be identified and transcribed into some code acceptable to the Orion, a task that may well be tiresome and time-consuming.

Little programming was done for the 401, but Ross wrote General Experiments Programme routines for 7×7 lattice squares and for balanced incomplete blocks, and also programmes providing maximum likelihood solutions for various problems.

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Experiments

Slightly more experiments were analysed in 1963 than in 1962, in spite of the growing computer facilities in universities. We are increasingly receiving requests for more elaborate analyses involving several variates; these should be much more practicable on the Orion, as should the analysis of long-term experiments. One of the main difficulties, in fact, in fulfilling the need for this type of analysis is likely to be advising what analyses are really required; many of the analyses requested are clearly unlikely to give the information sought, so extensive monitoring of the work will be needed if results are to be satisfactory.

We were again consulted on many problems of design and interpretation and did much miscellaneous work on the computer on data arising from experiments. Patterson gave a paper to the Royal Statistical Society describing his work on the theory of cyclic experiments for comparing different crop rotations (12.15). This is the most difficult aspect of the design and analysis of long-term experiments, to which he has made notable contributions. Boyd summarised the results of a set of 124 factorial NPK experiments on maincrop potatoes, done by the National Agricultural Advisory Service Soil Chemists in 1955–61 (12.7); in these experiments the responses could be related to soil series. He also reported on the results of a series of investigations on the relative merits of different methods of soil analysis for determining responses to phosphate manuring (12.6). Yates contributed a paper to the 5th International Biometric Conference at Cambridge on the history of the development of Fisherian methods for the design and analysis of replicated experiments (12.20).

TABLE 2

Numbers of replicated experiments analysed in the department

	Number of experiments			Number of variates on computer	Variates per experiment
	By hand	On computer	Total		
1934	115	—	115	—	—
1951	437	—	437	—	—
1955	384	419	803	834	2·0
1957	98	1,253	1,351	5,041	4·0
1959	67	2,649	2,716	11,102	4·2
1961	89	2,862	2,951	15,184	5·3
1962	107	2,613	2,720	13,423	5·1
1963	72	2,770	2,842	14,357	5·2

Surveys

The analysis of the large 1962 survey of fertiliser practice was completed and reported (12.5). A sub-sample of fields from 11 districts of this survey was selected for sampling for lime requirements in 1963; these fields will be resampled in 1967 and records of cropping and applications of lime in the intervening period will be kept. Church prepared a paper on current information on lime requirements (12.8).

The results of four districts of the Scottish survey of fertiliser practice in

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1962 were analysed on the computer. Professor W. Ellison, Boyd and Church examined the accumulated results of the surveys of reseeded hill land in Montgomeryshire (12.9). A survey on the growing and storage of maincrop potatoes was done in 1963 on 905 farms; records are now coming in. Assistance was given to the National Institute of Agricultural Engineering in the analysis of the farm building survey on the computer. (Simpson)

Reports on the brucellosis survey (12.12), on the second general survey of diseases in dairy herds (12.13) and on a survey of losses of breeding ewes (12.14) were completed. The field work of the survey of calf husbandry and losses is finished and the data are being transferred to punched cards by the Ministry of Agriculture.

Six large analyses of the survey type were done for the Milk Marketing Board.

Commonwealth and Overseas

The results of various experiments from overseas were analysed, and we were consulted on problems of experimental design. The value to overseas workers of having a computer available is illustrated by the analysis of a set of 7×7 lattice selection trials on cotton in Uganda. Variances and covariances of measurements were required to construct discriminant functions; the whole analysis (which had previously been done in an approximate manner and with great difficulty in Uganda) had to be completed in a month to enable next year's selection to be made. When the Orion is fully programmed more work of this type should be possible.

Methodology

Healy discovered a property of the multinomial distribution which is useful when assigning optimum scores to items belonging to one of a number of classes (12.11). He also contributed a note on fitting a quadratic (12.10). Gower continued his work on classification problems.

Ross, in collaboration with J. H. Rayner, Pedology Department, investigated the fitting of an "after-effect" function to carbon residue data. This function arises as a Laplace transform of a log-normal distribution and was tabulated by numerical integration.

The sixth edition of *Statistical Tables* was completed and is now published (12.1).

In the course of an obituary memoir for the Royal Society, Yates reviewed R. A. Fisher's contributions to statistical theory and methodology (12.4). This stimulated an article on the teaching of statistics (12.19), and a discussion on this subject has been arranged by the Royal Statistical Society at which Yates and Healy have been invited to give the opening paper.

Vernon and Allison devised a new method of calculating net assimilation rates, using smoothed data, which gives considerably more accurate estimates than the customary method (12.17).

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Other Work

The many miscellaneous statistical investigations in which members of the Department collaborated include:

(*a*) Evaluation of genetical components of variance, etc., for the Animal Breeding Research Organisation, the National Agricultural Advisory Service and others, including the analysis of a large set of Danish data on Landrace pigs. (Ross and Hills)

(*b*) Discriminant analyses for Dr. E. H. Ashton, Birmingham University, on primate scapulae; for Dr. C. C. Spicer, General Register Office, on blood biochemistry in breast cancer; for Dr. H. Barnes, Marine Station, Millport, on barnacles; for Dr. J. M. Tanner, London University, on growing children and on Olympic athletes; for Dr. M. J. Delany, Southampton University, on fieldmice from the Scottish islands and mainland (Healy); also for the Ministry of Agriculture on tuberculosis in cattle. (Leech and Martin)

(*c*) Classification investigations for Mr. J. B. Harborne, John Innes Horticultural Institute, on *Fritillaria*; for E. W. Buxton, Plant Pathology Department, on *Fusarium*; for Dr. J. G. Sheals, British Museum of Natural History, on *Hypoaspis–Androlaelaps*; and for J. H. Rayner, Pedology Department, on soils. (Gower)

(*d*) An investigation into the quality of milk and its relation to udder disease for a Joint Technical Committee of the Milk Marketing Board, the National Agricultural Advisory Service and other interests. (Leech)

(*e*) Analysis of a set of 10,000 records of artificial inseminations of pigs, for Mr. D. H. L. Madden of the Hampshire Cattle Breeders' Society. (Leech)

(*f*) Analysis of laboratory data on pathological material from sheep flocks suffering from abortion, for Mr. W. A. Watson of the Ministry of Agriculture's Veterinary Investigation Service. (Vessey (12.18))

(*g*) Work for the National Survey of Health and Development. (Simpson (12.16))

(*h*) Miscellaneous investigations for the Medical Research Council and other medical units. (Healy and Ross)

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