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Report for 1958

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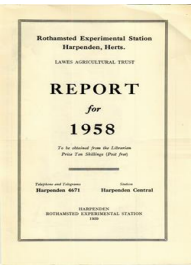
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Statistics Department

F. Yates

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STATISTICS DEPARTMENT

F. YATES

M. H. Westmacott left to take a post with Shell-Mex and B.P. Ltd. New appointments were: A. J. Vernon, from the Department of Agriculture, Nigeria, and Beryl Turner from Bedford College, London. S. F. Buck is in the Department on a two-year Agricultural Research Council scholarship. N. E. G. Gilbert has been seconded part-time from the John Innes Horticultural Institution for a further year to continue his co-operation with the Animal Breeding Research Organisation. Ten temporary workers were accommodated during the year, seven of them from overseas.

Yates spent two months with the Indian Council of Agricultural Research on a United Nations Food and Agriculture Organization assignment (12.3). He also attended a Study Group on Immunological and Haematological Surveys in Geneva at the invitation of the World Health Organization. Healy attended the Fourth International Conference of the Biometric Society at Ottawa. Church attended an O.E.E.C. Conference in Paris on the optimum use of fertilizers (12.1), and Leech the Deuxième Journée Biométrique of the Belgian Region of the Biometric Society. Lipton attended the International Congress of Mathematicians in Edinburgh in August (12.16). Patterson returned in April from a six-months visit to the Institute of Statistics, North Carolina.

Lessells returned to work in May after recovering from a severe attack of poliomyelitis.

THE ELECTRONIC COMPUTER

Steady progress has been made in the use of the electronic computer, and the volume and range of computations done on it have increased. The machine continues to be reliable, but the peripheral equipment gives trouble.

Two useful modifications were made to the machine. The first is the addition of a further three immediate-access registers, on the lines indicated in last year's annual report. The second is an arrangement whereby a set of n numbers located in successive addresses on a track can be added in n word-times (n less than or equal to 128). Previously in the 401, as in other computers in which data are stored on a drum or disc, approximately n revolutions ($= n \times 128$ word times) have been required for this operation. (A word time $= 0{\cdot}1$ msec.) This modification also enables the sub-total of a selection from up to 34 numbers located in successive addresses to be formed in 34 or less word times, the actual selection being determined by the pattern of ones and zeros contained in a word set in one of the registers. This latter facility has proved to be of value in forming the various sub-totals required in some types of factorial experiment. It has, for example, been used in the analysis of the Bihar series of $3 \times 3 \times 3$ trials referred to below.

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Using this modification, the actual computing time required for the analysis of a single $3 \times 3 \times 3$ trial, including the computation of the main effects for each block separately, is 5 seconds, in contrast to approximately 1 minute taken by our standard $3 \times 3 \times 3$ programme. Three further by-products of this modification may also be noted: it is now possible to store links in a register and obey them directly; it is much easier to count the number of ones in a word or part of a word; and the logical OR of two words can be derived quite simply.

A further small modification displays on indicator lights the number of the relay track (track 7) in circuit.

Our experience with the special-quality valves has been followed up by detailed examination by the manufacturers. They now recommend a simple and less-stringent test than the one we had been using. We propose to prolong the life of these valves by adopting the revised standard unless we find evidence of machine failure.

Progress with the installation of a magnetic-tape unit has been disappointingly slow, partly owing to the demands of routine and other maintenance, but more especially because of maintenance and design troubles with the equipment. The main hold-up now is the poor quality of signal which is being recovered, and we await the result of an experiment being run with this type of unit at the Cambridge Mathematical Laboratory on an out-of-contact head. We have now reached the stage where magnetic-tape equipment is urgently required, and unless there appears to be good prospect of getting the present unit functioning soon, the question of getting some other type of unit will have to be considered.

The Ferranti tape readers have not been as reliable as we should like. The checked code employed usually detects reader errors before any damage can be done, but occasional duplicate readings of single characters have been reported. It is proposed to reconsider the present circuit design to see whether running conditions can be improved.

The Hollerith reader was used more this year. The high-speed relays have continued to give trouble, probably because the low pulsed currents are passed across the points. Trials are being made with a new type of relay designed to deal with the small currents involved.

The tape-to-card equipment delivered in January 1958 has not yet been much used. From our present experience we can hope for about the same standard of reliability as in the other punched-card equipment installed.

We also obtained one of the complete Creed verifier systems, but this has proved to be disappointingly unreliable. A local modification was made to give warning of a faulty condition on the machine and thus help the operator, but eventually Creeds called in all the verifiers they had produced to modify the verifier keyboard. Our equipment was only returned in December, so that we cannot comment on the reliability of the modified equipment. It is quite clear, however, that they have increased the keyboard spring tensions. Measurements show that the verifier keyboard now requires 1·5 lb. pressure to operate a key, which is about three times the pressure of a normal keyboard.

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The use of mark-sensed punched cards (whereby the punching is done mechanically from pencil markings on the card) was tested, but it seems doubtful whether this system will be of great value for recording much of the experimental and survey data that require machine processing.

Table 1 records machine operation over the last 2 years, and shows the machine worked more hours in 1958 than in 1957; the percentage of overtime beyond normal laboratory hours in 1958 was 45 per cent and 33 per cent in 1957. Production time has increased by 28 per cent, compared with an increase of 9 per cent in the total time run.

TABLE 1

Record of machine operation for 1957 and 1958

	Hours		Percentage	
	1957	1958	1957	1958
System modification... ...	16	69	0·6	2·4
Scheduled maintenance ...	324	398	12·4	13·9
Unscheduled maintenance:				
Computer	163	65	8·0	3·7
Peripheral	47	42		
Programme checking ...	467	382	17·8	13·3
Programme tape preparation	126	101	4·8	3·5
Production runs	1,305	1,676	49·8	58·4
Abortive efforts:				
Computer	34	39	2·3	3·1
Peripheral	25	49		
Idle time	115	48	4·4	1·7
Total	2,622	2,869	100·1	100·0
Normal laboratory hours ...	1,977	1,977		
Percentage overtime ...	32·6%	45·1%		

Several new programmes were prepared, and some of the existing programmes amended, clarified and standardized; but much further work of this nature is still required (12.2, 12.22). (Yates, Rees, Healy, Leech, Lipton, Gower, Simpson and Chedzoy.)

Experimental design and analysis

The 6 years' results of the modified Rothamsted three-course rotation experiment on the use of straw and fertilizers were examined and briefly summarized on p. 167. The results of the whole experiment will shortly be published.

The examination of the National Agricultural Advisory Services' dairy heifer rearing experiments has been completed (Westmacott 12.21), and the results of various long-term experiments on the N.A.A.S. Experimental Husbandry Farms are being examined (Patterson). During his stay at the Institute of Statistics, North Carolina, Patterson worked on extra-period change-over designs in collaboration with Professor H. L. Lucas (12.18), and is preparing a bulletin with him covering the whole subject of change-over designs.

The survey on the effect of farmyard manure on fertilizer responses has been completed (12.4), and two reports on the correlation of soil analyses with response of potatoes to fertilizers have been prepared for the N.A.A.S. (12.25). (Boyd.)

A summary of the N.A.A.S. and National Institute of Agri-

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cultural Botany 1955–57 series of variety trials which included nitrogen as an additional factor has also been made (12.24). (Boyd and Lessells.)

With Dr. J. Cooper of the Glasshouse Crops Research Institute a study of the effect of heating and lighting variation on the ripening of tomatoes was started. (Gower.)

The electronic computer has continued to be successfully used in the analysis of experiments. The programmes were extended to handle general factorial experiments and certain lattice designs. The additional speed with which the analyses of experiments can be completed is particularly appreciated by the National Agricultural Advisory Service. We have this year been able to summarize several series of N.A.A.S. experiments covering several centres and seasons.

Table 2 shows the increase in the number of experiments analysed since the introduction of the electronic computer. There was a further increase in 1958 of one-third in the number of experiments and one-quarter in the number of variates analysed on the computer. Some of the experiments analysed in the past year have been exceptionally large.

TABLE 2

Numbers of replicated experiments analysed in the Department

	Number of experiments: By hand	On computer	Total	Number of variates on computer
1934	115	—	115	—
1951	437	—	437	—
1955	384	419	803	834
1956	181	683	864	1,701
1957	98	1,253	1,351	5,041
1958	182	1,664	1,846	6,260

An interesting test of the use of the computer in summarizing the results of a set of co-operative fertilizer trials was done on a set of 230 $3 \times 3 \times 3$ trials (each in 3 blocks of 9 plots) on rice on cultivators' fields in the State of Bihar, India. In these trials each of the blocks of a trial was on a separate field in a village. In the first stage of the analysis, therefore, the responses were calculated for each block separately, in addition to estimates of error and of interactions for each set of three blocks; in the second stage the variability of the responses to each of the factors within and between villages, etc., and their association with soil type and irrigation, were examined by means of a set of analyses of variance. The programming of the analysis took considerably longer than was expected, but the machine work is now nearly completed. The experience gained should prove valuable in the analysis of many such co-operative trials, which are now beginning to be much used in countries where little is known of fertilizer requirements; but the amount of numerical work involved, particularly when such trials are of the factorial type, is very considerable, and there seems a clear case for evolving methods for analysing results of this type on electronic computers. (Lipton and Yates.)

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Surveys

A survey of maincrop potato growing was undertaken in co-operation with the National Institute for Agricultural Engineering and the Potato Marketing Board. This covers some 3,000 fields on 1,000 farms in Great Britain, and is on similar lines to the 1948 survey. The field work is now complete and the analysis is in progress.

The remaining twenty-three districts covered by the 1957 Survey of Fertilizer Practice have been analysed and reported on (12.23). A further twenty-one districts in England and Wales have been surveyed by the N.A.A.S. and the Fertiliser Manufacturers' Association in 1958, and the results are being analysed as they are received (Church and Hills). The electronic computer has also been used to analyse data from the Scottish surveys of fertilizer practice which are run by the Scottish agricultural colleges in conjunction with the Agricultural Research Council Unit of Statistics, Aberdeen.

The field work of the first national survey of disease in dairy cows is now nearly complete, and the analysis is being planned. Most of the work will be done on the electronic computer, using both tape and card input facilities. The analysis of a number of pilot and small-scale surveys of animal diseases is now almost complete (Leech), and the second survey of losses in breeding ewes in Yorkshire and Lancashire is finished (12.14). (Leech and Sellers.)

H. R. Simpson has done excellent work in programming most of the survey analyses undertaken on the computer. In the light of experience gained during 1958 we hope to make further progress in the extension and generalization of our programmes during the coming year, particularly in the direction of simplifying and speeding up the examination of supplementary questions suggested by the results of the main analyses.

So much survey analysis has had to be handled that the survey computing staff was overloaded, which has unfortunately resulted in delays in the reporting of some pilot surveys on the manuring of fruit and vegetables that are unsuitable for machine analysis.

In addition to the surveys mentioned above, advice has also been given in the design and analysis of other small-scale surveys. Church completed a report to the Government of Ethiopia on his survey work there (12.5).

Entomology

The effect of sterilized males on a tsetse population, in collaboration with Mr. W. H. Potts of the Tsetse Committee, has been completed. At the request of Mr. Yeo of the Colonial Pesticides Research Unit, Tanganyika, the effect of repeated insecticidal applications on a tsetse population has been studied (12.26). (Simpson.)

Marjory G. Morris has continued her co-operation with R. M. Dobson of the Entomology Department. (See above, p. 138.)

General work was continued for the N.A.A.S. entomologists and a note prepared on soil sampling for cereal-root eelworm (12.6). (Church.)

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Genetics

Collaboration with Dr. E. C. R. Reeve of the Institute of Animal Genetics, Edinburgh, on the effect of inbreeding has continued (12.19). (Gower.)

Work has been done on tabulation of certain distributions required when there is selection for a variate subject to errors of measurement, for Dr. D. J. Finney and Mr. R. N. Curnow of the A.R.C. Unit of Statistics, Aberdeen (Lipton and Gower). A preliminary account of some of the results has been given at the Biometric Conference in Brussels, September 1958.

A large set of data from Danish artificial insemination centres was analysed for W. P. Jaffe of Bristol University, to discover whether there was evidence that fertility in bulls is heritable. The ratio of the mean squares between and within sires was so large that the usual additive model led to a negative environmental component. Data on the fertilities of the sires to supplement the present analysis are now being sought. Another large set of data on the characteristics of bull semen examined by the Ministry of Agriculture in connection with the approval of animals for use at artificial insemination centres has been examined for P. G. Millar of Weybridge, who is preparing a report. (Leech.)

Much work on the electronic computer has also been done for the Animal Breeding Research Organization, Edinburgh. (Gilbert.)

Advice and computing assistance has been given in the estimation of gene frequencies of β-globulin polymorphism for Mr. G. C. Ashton of the Animal Health Trust (Ashton, G. C., *Nature, Lond.*, 182 (1958), 370). (Gower.)

Colonial Work

Vernon has been in charge of our advisory work for Commonwealth workers since Westmacott left. The electronic computer is being increasingly used to analyse experimental results from Commonwealth countries. Seven Commonwealth workers have stayed in the department for varying periods.

Other Work

Of many miscellaneous problems from various research institutes dealt with by members of the department, most of which have involved the use of the computer, the following may be mentioned:

1. Work for Dr. P. H. Leslie of the Bureau of Animal Population, Oxford, on population dynamics with two competing species has been completed (12.15). A similar problem concerning the population interaction of predator and prey is now being investigated. It is hoped to do further work of this sort on the Mercury electronic computer at Oxford when this is installed. (Gower.)
2. Work on factor analysis and multivariate techniques (Healy).
3. Analysis of experiments on growth rate (Healy and Leech, 12.13).

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4. Fitting of exponential and other curves (Patterson (12.17) and Lipton).

5. A numerical study of some contagious diseases relevant to epidemics, in collaboration with Dr. C. C. Spicer of the Central Public Health Laboratory (Lipton, 12.20).

6. Various medical and human growth studies (Healy, 12.9, 12.10, 12.12).

7. An investigation into double iterative methods for evaluating inverse powers of numbers (Gower, 12.7).

Work on the Cattle Efficiency Project of the Agricultural Research Council has been temporarily stopped. The work completed showed that the prediction equation originally used was not satisfactory.