

concentric circular cuts of three or four sizes can be harvested at each spot. Standard sizes of 12.57, 50.27, 100.88 and 201.06 sq. ft. are being used at present.

I presented experimental material before the Royal Statistical Society, from which it appears that circular cuts of 2 ft. radius (area = 12.57 sq. ft.) leads to an over-estimation of the order of 14–15 per cent on an average when the work is done on an extensive scale by a large field-staff scattered over a whole province (for example, Bengal, comprising about 70,000 sq. miles). There is, however, practically no bias when the size is increased to a radius of 4 ft. (area = 50.27 sq. ft.). For example, in the work on *aman* (winter) rice in Bengal in 1945–46 comprising 2,569 sets of three concentric cuts, the weighted average for cuts of 50.27 sq. ft. was 99.7 per cent of the weighted average for cuts of 100.88 sq. ft. Along with such extensive experiments carried out by the ordinary field-staff, arrangements were also made to study the size bias in the case of work done under the direct supervision of trained statisticians. It is interesting to observe that in one series of experiments on *aman* rice in 1945–46 at three different centres the pooled average rate of yield based on 236 cuts was 1,183 lb. of rice (not in husk) per acre for circular cuts of 12.57 sq. ft. against a pooled average of 1,168 lb. per acre for cuts of 72 ft.  $\times$  72 ft. = 5,184 sq. ft. (a little less than 1/8 acre), showing that the over-estimation had become practically negligible.

To come back to the cause of the size bias, I am now inclined to rely more on the line of explanation offered by F. Yates<sup>6</sup> in the paper cited by Dr. Sukhatme. Discussing the observed bias in crop yields harvested from within hoops (of area 10 sq. ft.) supposed to have been thrown at random on fields in the United Provinces, Yates suggested: "The bulk of the bias, however, is probably due to the tendency, conscious or unconscious, to cast the hoop on the good parts of the crop". The fact that the over-estimation with cuts of small size becomes practically negligible when the work is done under adequate statistical supervision, but is quite appreciable when it is done by the ordinary field-staff, suggests the following explanation. It is possible that there are patches of greater fertility distributed either in a random manner or in a mildly patterned form. In locating the sample-cuts, ordinary investigators may unconsciously tend to favour these more fertile patches by slightly shifting the exact location of the 'random point' on the field. Under adequate supervision, it is possible that the location of the 'random point' is carried out in a proper manner, thus successfully eliminating this particular source of bias. Unconscious pulling in of plants on the border line (as suggested by me four years ago and recently repeated by Dr. Sukhatme) may also be a contributing factor of importance.

It is relevant in the present connexion to mention the danger of under-estimation in using comparatively large sample-cuts demarcated on the field with pegs and ropes. It is doubtful whether the ordinary field investigators can measure the sides of the square (or of whatever other shape of cut is used) with sufficient accuracy. Sagging of stretched ropes would reduce the actual area harvested and would lead to under-estimation. Then there is a real difficulty about the allowance to be made for the boundaries (called *ail* in India) between different fields. This point is particularly important in a province like Bengal, where the average size of individual fields is less than half an acre. In fact, the concept of the 'whole-field'

is difficult to define in an unambiguous manner. The subject obviously requires further investigations.

Another point deserves notice. In recent work done by our field-staff, we found an over-estimation of about 15 per cent for cuts of size 12.57 sq. ft. Yates had reported an over-estimation of 13.9 per cent (with standard deviation of mean of 2.97 per cent) for hoops of size 10 sq. ft. These two results are in broad agreement. In Dr. Sukhatme's work the over-estimation was much higher, namely, 42.4 per cent (in both the series reported in *Nature*) for sample-cuts of size 12.5 sq. ft. Dr. Sukhatme has not given the standard error, but the much higher over-estimation suggests that his field-staff had greater bias than the Bengal field-staff. This naturally raises the question of validity of the results. In the Indian Statistical Institute great importance is attached to the field survey being conducted in the form of two (or more) interpenetrating but independent networks of samples, each of which furnishes an independent estimate and hence supplies information relating to the effective margin of error. I have discussed this point elsewhere<sup>3</sup> and would content myself by remarking that it would appear advisable to provide such controls in the schemes which are in Dr. Sukhatme's charge. This was also the advice given by R. A. Fisher in the memorandum to which I have already referred.

<sup>1</sup> *Nature*, 157, 630 (1946).

<sup>2</sup> Hubback, J., "Sampling for Rice Yields in Bihar and Orissa", *Imp. Agric. Research Inst. Pusa, Bull.* 186 (1927), recently reprinted in *Sankhya*, 7, 3, 281.

<sup>3</sup> Mahalanobis, P. C., *Sankhya*, 7, 3, 272.

<sup>4</sup> As stated in a memorandum submitted by Prof. R. A. Fisher to the Imp. Coun. Agric. Res. (India) on March 2, 1945, and quoted by me in *Sankhya*, 7, 3, 269.

<sup>5</sup> Mahalanobis, P. C., *Phil. Trans.*, B, 231, 509 (p. 409).

<sup>6</sup> Yates, F., *Ann. Eug.*, 6, 2, 211.

## MELLON INSTITUTE ANNUAL REPORT FOR 1945

ADDITIONAL interest is lent to the thirty-third Annual report of the director of the Mellon Institute, Pittsburgh, Pennsylvania, Dr. E. R. Weidlein, covering the year ended February 28, 1946, by recent discussions on the possibility of developing similar institutions in Great Britain (see p. 787 of this issue of *Nature*). Since 1942, the activities of the Institute have been concerned mainly with urgent problems of war science and technology, and during the year under review there were only twenty-nine individual and fifty-three multiple fellowships operating, of which thirty-two had been proceeding for ten years or more and a further twenty-eight for five years. The industrial research staff of 261 fellows and 264 assistants is an increase of nineteen fellows and thirty-two assistants on 1944–45. Fellowships on adhesives, optical cements and silica gel began during the year, and the programme on adhesives was completed, as well as fellowships on cellulosic moulding, constructional resins, disinfectants, phenol chemistry and tar derivatives; the last two have been merged in the multiple fellowship on tar synthetics.

From this long report it is possible to select for mention only a few items illustrating the wide range of activities. An investigation on the development of a vitreous enamel coating for fixed wire-wound resistors, capable of high resistance to thermal shock

and moisture, undertaken at the instance of the War Metallurgy Committee of the National Research Council, led to the use as coating of a silicone paste originated by a fellowship of the Corning Glass Works. This fellowship has now been returned to work on porcelain enamels and has already led to the development of a high-titanium cover-coat enamel of very high opacity and resistance to acid. Another fellowship has been concerned with the reactions occurring during the sintering of iron powder compacts, while the American Iron and Steel Institute's multiple fellowship on acid recovery has completed eight years study, in co-operation with public health officials and industry, of waste pickle liquor. A multiple fellowship on magnesium is concerned with fundamental studies on magnesium and its alloying properties, with the prime purpose of producing alloys with superior properties. New nickel compounds and catalysts of special promise are being prepared under another project, and evaluated in co-operative programmes with industrial and government laboratories. This inclusive multiple fellowship is sponsored by the International Nickel Co.

Work in coal chemistry has led to the discovery that the gradual deterioration in the quality of re-cycle benzene is due to the preferential accumulation of paraffins. Many advances have been made in gas by-products, and a thorough study made of the polymerization of vinylnaphthalene which, contrary to published statements, is found to be a rapid process. New processes for purifying benzene, a novel type of 1-in. laboratory column, and a universal type 3-in. fractionating column are other achievements in this field, which includes a broad programme on alkylation and dealkylation from which the process of ethylating benzene at Koluta came.

Work in petroleum technology has included fundamental theoretical studies of distillation, particularly of rectification processes, and investigations on the physical properties of petroleum waxes, the mechanism of catalytic reactions and the nature and structure of catalyst surfaces. New and improved lubricants have been developed for aviation instruments as well as new testing methods for such products, and the report includes some information on the synthetic lubricants developed under the organic synthesis multiple fellowship of the Carbide and Carbon Chemicals Corporation, which has now operated continuously for thirty-two years. Progress in applications of 'Vinylite' resins from dispersions has been accelerated, and extensive studies of the effect of the composition of the liquid vehicle on the viscosity of the dispersion have provided a sound technical basis for formulating the coatings. Investigation of the chemistry of allyl compounds has led to industrial processes for 2:3-dichloropropanol, 3-chloro-1:2-propanediol and epichlorohydrin; also phenylmorpholine has been produced on a sufficient scale for development. Military requirements initiated researches for non-ionic surface-active materials, and the vitamin section of the Heinz multiple fellowship on food varieties has thrown light on the effects of storage on the vitamin content of regular and fortified strained foods. The value of yeast as a therapeutic agent and as a source for vitamins, and the improvement of malt processing, have also been investigated.

A programme assigned to the Institute by the Air-Sea Rescue Agency of the Armed Services has led to the development of a treated superfine "Fiberglas" which promises to replace kapok for use

in life-jackets on all naval vessels, and also for other purposes where its fire-proof qualities are of first importance. Careful studies on methods of evaluating buoyancy and of the role of packing density and column heights have led to a broader understanding of the mode of function of fibrous buoyant materials. Correlated studies of the physical and chemical properties of cotton fibres are also in progress, and during the War a continuous programme of testing threads and tapes for their ability to resist tropical conditions was carried out. A new field is being opened up in the use of recovered synthetic fibres to make textiles with desirable properties of their own. The utilization of industrial proteins, including stabilized zein resins, as shellac substitutes, and the industrial uses of a chemically modified zein, the development of improved catalysts for the synthesis of butadiene from ethyl alcohol and of organic coating compositions for lining the wing tanks of aeroplanes as well as for steel to permit its use under conditions of severe corrosion, have all received attention; while investigations on the organosilicon compounds have led to the use of polysiloxane fluids as anti-foaming agents in petroleum products and moulding rubber and organic plastics.

Besides referring to the work of the fellowship on chemical hygiene, particularly in the study of newly available chemicals, from the point of view of hazards to health, the report includes notes on the Industrial Hygiene Foundation, which has strengthened its staff of specialists and completed a study of the control of sweeping dust in the pottery industry and of the technique of determining the safe limits of silica content in industrial dusts. Reference is again made to the synthesis of new antimalarial drugs, particularly hydroxyethyl analogues of the pamoquine series, involving the synthesis of 8-amino-6-hydroxy-ethoxyquinoline and the use of a new hydroxyethylating agent, by the Department of Research in Pure Chemistry. An examination of the lepidyl carbinols, the preparation of 4-(*p*-dialkylaminobenzylidene)- and 4-(*p*-dialkylaminobenzyl)-aminoquinolines and the function of alloxan in causing experimental diabetes in animals, in the course of which two colour tests for alloxan have been developed, are other subjects under investigation in the Department.

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### ANNUAL REPORT FOR 1945

THE annual report for 1945 of the director of research of the Ontario Research Foundation at Toronto, Dr. H. B. Speakman, refers to the transition period through which the Foundation passed during that year. Steps taken soon after the termination of hostilities to restore to normal the available space enabled the Foundation to respond to the increased demand for fellowship facilities, and before the close of the year the available laboratory space was fully occupied. Available statistics show that there are about eleven thousand industrial units in Ontario, of which only three hundred are large enough to justify the maintenance either of a research laboratory or a fellowship unit at the Foundation, and some of these consist of branch companies looking to a parent company in the United States for research and technical direction.