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## SCIENTIFIC AND INDUSTRIAL RESEARCH.—IV

WE have now considered the questions which arise in regard to personnel, whether of its quality or of the tactics by which the best use can be made of the men and women trained for scientific and industrial research. We have seen that some regard must be paid to our needs, not only in respect of quality but also of the numbers of such workers. Any serious discrepancy between the output of such trained men and women from the universities and technical colleges and the demand of the nation for their services must have serious consequences, either by impeding the immediate execution of our research programmes, for example, or by discouraging men and women of the highest ability from entering on such careers.

No attempt can be made to estimate our quantitative requirements in regard to research workers and other classes of scientific workers without some consideration of the actual programmes of research at which they will be required to work or of the openings for their services in other fields. This, accordingly, is the next step to be taken in approaching the consideration of the actual organization to be set up for the planning and execution of our research programme. If, as the Nuffield College statement suggests, the vital question at present is how much Great Britain must spend at once on scientific and industrial research in order to reap the fullest possible advantage of her resources of man-power and productive capacity, the answer can only be given after consideration of specific needs and projects, and as a result of the elaboration of concrete plans of development in a great number of particular fields. Moreover, it is only as such specific plans take shape that we can see at what points development is uneven, what gaps require filling and what weaknesses should be strengthened.

The Nuffield College statement is not concerned with such specific plans, and largely excludes from its survey the needs of agriculture, health and other fields which make a special call on trained biologists. None the less its paragraph on the claims of biological science is clear warning that there must be some consideration of the relations of the particular programmes and the demands they involve in order that our available resources may be distributed to the best advantage, and our research effort not badly thrown out of balance. It may well be doubted whether hitherto biological studies have attracted anything like a high enough proportion of the best scientific minds, and if that is so, the position is one that can only be remedied over a period of years. Advances in the biological sciences are fundamental for progress in agriculture, horticulture, forestry, food preservation, fisheries, conservation of water supplies, health education, and for the solution of other pressing world problems. They are vital for the future of tropical countries, for the mastery of soil erosion and for the repair of much of the devastation wrought by man upon his environment during the years of wasteful exploitation of natural resources.

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It was suggested by the Parliamentary and Scientific Committee in its report on "Scientific Research and the Universities" that the future impact of biological advances in agriculture, medicine, nutrition and sociology may be of the same order of importance as that of physics and chemistry in the past fifty years. The demand for biologists in the post-war world is bound to be very large, and Great Britain is not well equipped to supply it. Moreover, the Nuffield College statement further points out, the experience of the War has shown that the trained biologist is a highly adaptable person, capable of making most valuable contributions to the solutions of problems quite outside his special field of study. That has a bearing on the position of biological science in the content of our general plan of education, and there are other considerations which should induce us to give general biology a higher place in the curriculum. At least it can be said that the place of biology in reconstruction demands a special survey, with an expansion of research and the formation of further chairs at the universities in such related subjects as genetics, ecology, biochemistry, and veterinary science.

Closely related is the question of social biology. The contribution which biology might make to the ordering of a new world, not merely as a corrective to mechanized planning but also as a guide to a true way of life, to the establishment both of greater control over our environment and over ourselves has been well emphasized by Sir Walter Langdon-Brown (*Nature*, 152, 166; 1943) as well as by Dr. K. E. Barlow in "The Discipline of Peace". That contribution may be as vital to the wise use of our natural resources as to the development of the appropriate organization of our affairs, both in regard to the conduct of scientific and industrial research, and the better ordering of international relations. Discussions such as those proceeding on world security at Dumbarton Oaks need to be examined, and their proposals require objective criticism by those trained in the scientific method so that disciplined and well-informed judgments based on values and not on extravagant and prejudiced opinion are reached.

Here we touch on a further field where our research effort in the past has been inadequate and where our technique is yet only being developed, because the limitations of the scientific method in situations involving judgments of value have not always been fully recognized. In his admirable little survey of the British universities in 1930, Sir Charles Grant Robertson urged that the advancement of knowledge could not without grave danger be limited to research in the physical sciences. In a revised edition of that book, which has just appeared, his argument is reinforced by all the experience of the past fifteen years, and he affirms his conviction that the only knowledge worth advancing is 'related knowledge'—knowledge of which the affiliations to, and contacts with, all other forms of knowledge are recognized and the total sum of which is purposively related to the ends of a civilized society seeking to fulfil a spiritual interpretation of life.

Sir Charles Robertson's plea is essentially that the universities can make themselves the central arsenals

of a true humanism, but this question of social and economic research goes further and has a close bearing on many of the material problems with which we are confronted. The Nuffield College statement, in a passing glance at research in relation to social and economic policy, indicates how fruitful such research could be even from the point of view of securing more effective use of the results achieved by advances in industrial research in the physical field. Indeed the determination of the best form of structure, both government and non-government, for bringing about a co-ordinated study of economic and technical problems so that the machinery devised for shaping general economic policy will effectively relate the needs of consumers to the real potentialities of the productive system, in respect of type of product, quality and price, in the light of impartial scientific evidence drawn from both fields of research, is pre-eminently a matter for the consideration of Nuffield College.

The whole trend of the recent report "Government and Industry: A Framework for the Future" issued by a Fabian research group encourages the hope of a more impartial and objective approach to such problems. The importance of this field and the wide scope for impartial inquiry it offers can well be seen in the annual report of the National Institute of Economic and Social Research and especially in the recently published account of its publications and programmes. The need for a more equitable distribution of our research effort between the social and biological and the physical sciences, whether at the fundamental level in the universities or in the attack on the practical problems of production and administration, is well illustrated in an article on the "War-time Social Survey" contributed by its director, Mr. Louis Moss, to *Public Administration* of October-December 1943. Mr. Moss pointed out that social research assists the administrator by enabling him to take the major relevant social facts into consideration in framing his policy, to measure the extent to which his policy has been successful after it has been put into operation, and to decide what changes, if any, are necessary to ensure its success; he also indicates five main spheres in which the Social Survey could be of assistance to Government departments in the post-war period.

The significance of the Social Survey's studies of food and clothing habits, and particularly the improvement of sampling methods, and the bearing of such studies on cost-of-living indexes and inquiries are obvious. Similarly, the work already done in checking the effectiveness of the educational publicity of the Ministry of Health and in exploring resistance to such schemes as child immunization against diphtheria is a promising aid to prophylactic measures which could raise the general standard of health. The value of the techniques by which the Survey has during the War rapidly secured a fairly good picture of the nutritional situation of the nation as a whole, or of particular groups, is also clear. Social research can also make an effective contribution to the removal of obstacles to a complete productive effort and thus assist in the full use of our skilled

man-power which is likely to be no less important after, than during, the War, and finally it should equally assist in eliminating many of the errors in housing and building policy which have arisen through imperfect contact of the administrator and expert with public needs.

This function of social research is, of course, essentially the elaboration of an effective liaison system, thus enhancing the adaptability of our social and industrial organization—the vital problem in elaborating an effective organization, as Dr. J. T. MacCurdy insists. Without going into further detail, it should be emphasized that not only are research workers required in these broad fields of biology and economics and social science but until, in some degree, the programmes of research are formulated, we cannot forecast approximately the numbers of workers in these fields which the universities are expected to provide. Furthermore, as is brought out to some extent in the statement "A Post-War Policy for Science", issued by the Association of Scientific Workers, these programmes themselves at times impinge on programmes for the development of natural resources and may determine their expansion or contraction. Nor can we well consider the re-orientation of our research effort until the broad programmes of work proposed in the different fields are seen in sufficient detail for a true perspective to be obtained.

It must not be imagined, however, that it is only in the social and economic field that there are gaps in our research effort, or special reasons for expansion. Sir Ernest Simon, for example, has directed attention to the neglect of aeronautical engineering, and to the active intervention of the Ministry of Aircraft Production to found an effective school of aeronautical engineering research. Again it is only possible to assess the importance of such gaps when we obtain from the broad programmes a picture of the general position.

Some attempt has been made by the Association of Scientific Workers in the statement already mentioned to cover the ground, and a number of particular programmes has already been outlined, such as that of the British Coal Utilization Research Association, for a thorough scientific study of the fundamental properties of coal. Despite the stimulus of the proposals of the Hot Springs Conference no adequate programme of nutritional research or of agricultural research has yet been formulated. Some of the main specific topics in the latter field are indicated in the Association of Scientific Workers statement, while, as we have already seen, the former involves not merely biological research but also the co-operation of workers in social science.

Closely related to this last is the field of medical research, and it may well be expected that one consequence of a national service for health will be a fresh impetus to research on the elimination of conditions responsible for sickness absenteeism, accidents, industrial disease and low standards of health or physique. The man-power situation is also likely to increase the importance of such work, as is the general age-structure of the population. Apart from this there is the

stimulus that is derived from the striking advances in chemotherapy during recent years and from the realization of the immense resources which science has given us for preventing and eliminating disease apart altogether from its treatment. Besides this, as Dr. Alan Gregg has suggested, increasing attention to the geography of disease and, as a natural corollary, to the study of the relation of climate to disease and health, is called for. The effect of differences of environment on genetically similar organisms, biophysics, and the application of genetics to the study of human disease and human physiology, as well as both chemotherapeutic and pharmacological research, are likewise fields where he considers development is needed and probable.

In deliberately directing attention to fields where research has been comparatively neglected, or where at least exceptional expansion is required, it is not suggested that other fields of research, either industrial or fundamental, should not figure prominently in our post-war programme. From the point of view of the national economy the main problems in some branches of manufacturing industry, in transport, and in communications may well be, as the Association of Scientific Workers suggests, concerned chiefly with effective planning and co-ordination in a policy of full employment and social welfare. In other branches of industry, progress is dependent on fundamental research on such questions as the mechanical and magnetic properties of metals, their corrosion and lubrication, the molecular physics and mechanics of rubber and plastics, including the various synthetic fibres, while the position of petroleum as a raw material is shifting the whole outlook of organic chemical industry, raising important economic as well as technical problems. Nor can our survey of programmes be limited to our own internal needs: we are already committed to large and to growing programmes of Colonial research, including industrial, agricultural, geological, fisheries, animal health, forestry and medical and social research, and topographical and geodetic surveys.

As we have already emphasized, if proper use is to be made of our available resources, both of man-power and materials, it is imperative that at an early stage there should be some overall view of the main objectives, as distinct from detailed or particular subjects in all the main fields of industrial and the chief branches of pure and applied science. Only so can be put together some rough estimate or global figure in terms either of men or financial or material cost. Until that has been done we are neither in a position to make the intelligent allocation of priorities of grants, of men and of materials, which in the early post-war years will be essential, or to see at what points there are gaps likely to delay progress, or obstacles to the prosecution of fundamental research for advancing the boundaries of knowledge on a broad front on which the ultimate success of any programme of research depends.

There can be no disguising the tremendous demands which this task of reviewing or co-ordinating the programmes of research in so many different fields will make. Scepticism as to the adequacy for such a

purpose of particular proposals as that of the London Chamber of Commerce in one of its recent reports should not induce a *non possumus* attitude. On the contrary, experience of what has in effect been achieved in the prosecution of the war effort should inspire a new attempt to improve on that organization, to adapt it where necessary, and, profiting by the mistakes of the past, to seek to deal with the research problems of the peace on lines retaining sufficient flexibility to avoid constricting the spirit of free inquiry, while ensuring that problems which are most urgent from the point of view of the public interest receive priority of effort and supplies; and that there is no neglect of important fields or problems vitally affecting public welfare, or the advance of either industry or of science because they are not sufficiently the concern of any particular body.

Finally, it must be remembered that from the point of view of scientific workers themselves some attempt to sum up the requirements of research from a national point of view and to indicate the broad fields to be intensively developed is equally important. First, it provides the universities with a rough basis on which to estimate the numbers of trained workers required both in total and in different branches of knowledge. Demands for workers in the natural sciences can be balanced with those for workers in the growing body of statistical, economic, sociological and psychological studies of no less importance to the community and to industry. But beyond this, it brings to research workers in any field a growing awareness of the relations of their problems to those of students in other fields. That consciousness, with the more intimate contact with research workers who are asking other questions and employing other methods, which should flow from the new and fuller integration of our research effort, should help to break down the isolation with which scientific workers have sometimes surrounded themselves in the past, and it should impart not merely a quickening sense of social or public service but also that fertilizing cross-current of ideas which always lies at the roots of creative thought and intellectual advance.

## A SURVEY OF THE U.S.S.R.

The U.S.S.R.

An Economic and Social Survey. By Dr. S. P. Turin. Pp. xiii+220. (London: Methuen and Co., Ltd., 1944.) 16s. net.

ENGLISH readers often find it difficult to obtain trustworthy information about the U.S.S.R. They suspect anything that looks like propaganda and much prefer a cold and clear-cut account that aims only at presenting the facts without bias one way or the other. For this reason much that has been written has lacked permanent value, and has probably had far less influence than its authors had hoped. On the other hand, the official statistics, which are good, are not easily accessible to the ordinary reader.

Dr. Turin's survey has the special value that it is

based on official statistics, elucidated often by diagrams and presented objectively. He begins with an account of the geography and ethnography of the U.S.S.R.; then he discusses its regional structure, with which many readers will be unfamiliar. The centralization of production in the hands of the State has meant the welding of great areas into huge industrial units. The Moscow industrial region, or *oblast*, for example, has a radius of about 100-120 miles with Moscow as its centre, but every town, every village and every hamlet within it forms part of one big industrial concern. The importance of this particular *oblast* is that although it represents only about 1 per cent of the U.S.S.R. territory, it contains about 10 per cent of the total population and more than 25 per cent of the total industrial population.

Next follows an account of the industries themselves, beginning with agriculture. Before the Revolution, about 75 per cent of the population were engaged in agriculture; the 1939 census, however, showed only about 50 per cent so occupied. The figures are not quite clear, however, because in the summary table the workers on the State farms are apparently grouped with town workers, while those on the collective farms are given separately. The change from the older inefficient peasant system to more modern methods, and the great development of mechanization, enabled men to be released from the farms for the staffing of the new factories without any loss of food-producing power; there has, on the contrary, been a gain. The products, however, still remain in the same order of importance as before: grain still has the first place and livestock represents only about one quarter of the value of the output: relatively less than in 1913 and not much more in actual value.

The author recognizes the profound change in character of the collective farms since their inception, although the name has been retained throughout, and in an appendix he gives a clear translation of the rules set up by the central authority in 1935 and still valid. Of the cereals, wheat is the most important, and its output, which fell for many years after the Revolution, has risen since the second Five Year Plan began in 1933. The author does not, however, mention that in that year a new method of estimating yield of cereals was introduced which gives higher values than the old method; it is almost certainly a better method and its results are more likely to be trustworthy, but the change makes comparisons difficult. It is stated on p. 109 that the yields used to be over-estimated; but the evidence appears to point the other way. Rye comes next in importance, but its output has not expanded since 1913 although the population has grown. Oats have the third place, and these have increased to about the same extent as wheat, a result of the increased output of livestock products. The tables would have given a more faithful picture of the cereal position had they been continued beyond 1937. That was a magnificent season for cereals, and the yields in many places exceeded all records. As the author points out, 1930 was also an exceptionally good year for wheat, and the output jumped up to 35 per cent above its general level for the two years before and after: in 1937 the jump was even greater. I myself saw both these crops, and there was no doubt about their exceptional character.

Other branches of agriculture, especially technical, market garden and fodder crops, have developed