



THURSDAY, DECEMBER 2, 1920.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be
addressed to the Publishers.

Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

The Application of Science to Agriculture.

THE circumstances of the time call for the fullest possible utilisation of the national resources of both men and material, and never has there been more urgent need for the high training and intellectual interests that science can give to mankind, or for the properly directed application of science to national problems. When rapid changes are coming about before our eyes, and the community is being shaken to its foundations, it is essential to inquire whether the guardians of scientific studies in this country are still able to maintain the work at a proper level of efficiency. What, for example, is the position of the application of science to agriculture—the greatest of our industries? There have been some recent developments, though on a relatively small scale. If, however, a satisfactory organisation is possible in this case, there will be much ground for hope that the more general problem of the application of science to industry as a whole can be solved.

Prior to the war the application of science to agriculture was brought about in the main by the enterprise of a few individuals such as Lawes and Gilbert, of Rothamsted; Spencer Pickering, at the Woburn Fruit Farm; the Voelckers, father and son; and a few others. The landowner, as a rule, looked on in a not unfriendly way, but, his education never having been good, he was unable to understand what the man of science was trying to do. Character was his strong point; he administered justice in the village, while his wife

dispensed charity; both were, as a rule, conscientious, hard workers, strong in the faith that they were doing the right thing, and true to the ideals that had been handed down to them by a long line of ancestors like themselves. It was not until 1894 that any sort of beginning was made in the country, when the so-called "whisky money" was available for technical education, and the county authorities had the option of developing agricultural education.

A few did so: Kent and Surrey combined to open the Wye Agricultural College; Norfolk and the eastern counties supported a school at Cambridge. The county bodies, however, did little for science. A distinction was made between "education" and "research"; if a teacher were repeating something already known, he was eligible for a Government grant, and was, therefore, a person who could be encouraged; but if he were seeking to discover something unknown, he was not eligible for grants, and was rather a problem for the authorities. Fortunately, however, institutions in the country cannot be completely governed from Whitehall, and common sense has a way of prevailing; much scientific work was, in point of fact, carried out by keen men working on their own account, and often in part at their own expense.

It was not until the passing of the Development Act in 1911 that Government support was forthcoming for scientific investigations in agriculture. The Act set up a Development Fund which subsidised certain institutions and allowed of much needed expansion. Considerable experience has been gained during the past ten years of the best method of utilising the available resources. The broad result is a threefold scheme, including: (1) Research institutions where agricultural science is developed; (2) colleges and farm institutes where instruction of various types is given to students wishing to become experts, farmers, etc.; (3) county advisers attached to some of the foregoing institutions, whose function it is to advise farmers on the various problems or difficulties with which they may be confronted.

At the beginning a rather large number of research institutes was set up, mainly at the universities. Of recent years there has been a tendency towards centralisation, four of the new institutes being afterwards transferred to other institutes already in existence. This was not originally intended, and, so far as is known, formed no part of a deliberate policy; it was the inevitable result of workers in different lines finding so much

common ground that close association became essential. An institute such as Rothamsted, with excellent laboratories and library, standing in its own grounds of 300 acres, right out in the country, with well-kept historic field plots and a staff of assistants highly trained in field work, has obvious advantages over a university department situate in a town remote from agricultural practice and interests, and one is not surprised to find that it has grown and is still growing. The larger institutes now are: Rothamsted, for soil, plant nutrition, plant pathology (including entomology, helminthology, and mycology); the Imperial College, South Kensington, for plant physiology; Cambridge, for plant breeding and animal nutrition; Long Ashton and East Malling, for fruit; Reading, for dairy; Aberdeen, for animal nutrition; and Oxford, for agricultural economics.

Success or failure, however, depends on the men working the scheme, and shortly after the Armistice the Ministry of Agriculture put into operation a research service scheme, which has been found satisfactory in its essential features, and has enabled the leading research institutions to attract a body of highly competent workers and to retain those who wish to stay. Automatic increments of salary are made annually, subject to proved service, up to a certain maximum, and there is the possibility of promotion to a higher grade. As the scheme stands at present, a young man or woman taken on the staff begins with a salary which, including bonus, amounts to 45*ol.* per annum, and he or she can rise continuously to a salary which, with bonus, amounts to 101*ol.* per annum. It does not follow that all will rise to this level; there are stopping places at 51*ol.* and 78*ol.* respectively, beyond which further progress may be impossible for a given individual. In addition, there is a superannuation scheme, to which the institute makes an annual contribution equal to 10 per cent. of the salary. There are also still higher posts as directors, etc.

In the commencing or third grade the substantive salary is 30*ol.* per annum, with bonus of 15*ol.*, total 45*ol.*, rising by annual increments of 20*ol.* to 360*ol.* plus 15*ol.*—*i.e.* 510*ol.* per annum. Should it appear that the holder is unsuited for the higher posts, the institute may terminate the appointment after three years. On the other hand, if paucity of posts or other reasons render promotion improbable, the institute may make the appointment permanent, provided sufficiently good work has been done to justify this course. Prob-

ably, in most institutes—certainly in the larger ones—there are excellent workers in the third grade for whom promotion into the second grade is only a remote contingency.

The middle- or second-grade appointments are limited in number—usually to half of those in the commencing grade—and the possibility of promotion thereto depends on the accident whether or not a post happens to fall vacant. Such cases inevitably arise under any scheme. The salary with bonus begins at 550*l.*, and rises by increments of 23*l.* to 780*l.* The highest or first-grade posts are also limited in number, being generally the same as the second grade; the commencing salary with bonus is 780*l.*, rising by eight annual increments to 1010*l.* The terms of appointment to these two grades are the same as those of a permanent reader at a university, so there is ample security of tenure. Above these come the directors, posts which, however, vary according to the institute.

Although the scheme is put forward, financed, and imposed on the research institutes by the Ministry of Agriculture, the holders of the posts are neither Civil Servants nor officers of the Ministry. The appointments to all these posts are made by the governing bodies of the institutes, which retain all rights of such bodies. In case of a grievance, any holder of a post has, however, the right of appeal through the governing body to the Ministry.

Promotion to a vacancy in a higher grade is possible only on the recommendation of the governing body and with the approval of the Ministry. There is a provision that all vacancies in higher grades must be notified to all likely candidates in the lower grades at all research institutes, but the appointment rests with the governing bodies, which, in the interest of their institutes, will presumably select the best candidate, whether in the service or out of it. As the scheme was originally put forward, there was a seniority clause giving preference to men or women already in the service; but this met with so much opposition from those responsible for the efficient conduct of the institutes that it was abandoned. A research institute is no place for promotion by seniority. Such promotions would stultify the whole purpose of research; they would stifle initiative, blot out all possibility of bringing in new ideas, lead to stereotyped dogmas, and do infinite harm to the cause of progress. At all costs, a research institute must choose the best possible man or woman, regardless of other con-

siderations. Only in this way is it possible to bring in the new ideas and the new light which alone make research successful.

The reception of the scheme by the younger scientific workers has been very satisfactory, and the responsible authorities of the institutes have been in the gratifying position of finding excellent candidates for their posts. At no time in the last twenty years have the research institutes been better staffed than now.

Provision has also been made for the creation of a link between the university and the research service. The Ministry of Agriculture awards scholarships of the value of 200*l.* per annum to men and women, possessing an honours degree or equivalent qualification, who are desirous of entering the service. The successful candidates are attached to whichever institutes they may prefer, and have their opportunity in the event of a vacancy occurring. They will, however, usually find other scholarship holders at the institutes—1851 Exhibitioners, various university scholars, and other post-graduate workers also waiting for posts—and they can hope for appointments only if they happen to be the best of the available candidates.

Thus the scheme provides for selection from the universities of the most promising young men and women for research work; it allows of a probationary period in which each candidate can show his or her fitness for the work; it affords permanent posts for those finally chosen; it gives increments of salary commensurate with the value imparted by experience; and for the highly gifted worker it affords prospects of promotion to posts which, considering their freedom from routine duties and from worries, must be regarded as distinctly good. The scheme is economical and effective; it works with the minimum of friction and without interference with the individual research worker; and it may confidently be recommended as a model to other Government Departments which are concerned with the promotion of scientific research.

Philosophy of Relativity.

The General Principle of Relativity: In its Philosophical and Historical Aspect. By Prof. H. Wildon Carr. Pp. x+165. (London: Macmillan and Co., Ltd., 1920.) Price 7*s.* 6*d.* net.

PROF. WILDON CARR has produced in this little volume a really valuable book. There was an hiatus in the current expositions of the
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principle of relativity. Its significance and importance had been clearly set forth in their bearing on mathematical physics. But the doctrine had not been connected with its position in the history of general philosophical thought. This Prof. Carr has now done, and with great knowledge of philosophy.

After explaining the old difficulties, he shows how Descartes and Leibniz had partially recognised their origin. The exposition of the discussions by each of these thinkers is lucid and informing. In particular, there is an admirable explanation of the Leibnizian theory of monads, and of how Leibniz was driven to its adoption. Both philosophers were mathematicians of great eminence. They saw that the explanation of matter must come after that of movement, and could not precede it. Extension was not "stuff." The explanation of gravitation given by Newton follows. The book goes on to deal with the difficulties that led to Einstein's revision of the whole of the Newtonian hypothesis of space and time as absolutely existing frameworks. The special principle of relativity is then explained, and it is shown that the general, or later, Einstein principle is simply a full statement of what is implied in its earlier form. The first dealt with a definite phenomenon—the velocity of light. The second extends the explanation to the laws of Nature generally. There is no longer a particular finite velocity taken to be a constant and limiting one. As soon as we extend the special case of relativity to non-uniform and rotational systems of motion, the doctrine of equivalence between the experience of the observer taken to be at rest, and the experience of the observer in another system relatively to which the observer taken to be at rest is regarded as being in motion, becomes apparent. The explanation of the possibly non-Euclidean character of space systems, and of the necessity of correlating observations by adequate formulæ of transformation, becomes clear. The idea of pure objectivity disappears. Mind appears as relating the centre of a universe which is no longer infinite in the sense given to the word as applied to Newtonian space. For the observer is not a fixed point existing at a fixed instant. "Space and time are not containers, nor are they contents; they are variants. They change as my system of reference changes."

One of the difficulties experienced in reading even Einstein himself is the lack of a thoroughgoing connection of his principle with the new character really given by it to space and time. They are discussed as though they remained changed, not in kind, but in degree' only, and