actual net gain was probably considerably larger, since under-manuring of sugar beet (and other crops) was common before the War.

The determination of the most economic number of experiments in a situation of this type is complicated, owing to the fact that there is an additional random component of variation in response from year to year due to variation in meteorological conditions, and there is also a possibility of long-term changes due to changes in agricultural conditions. Without going into details, which will be dealt with elsewhere, it may be stated that an analysis of the variation in the nitrogen responses indicates that as far as this fertilizer is concerned about sixty experiments per year, possibly falling to forty per year after the first few years, may be regarded as most economic. In view of the fact that many farmers do not as yet follow at all closely the recommendations emerging from such experiments, the programme can be regarded as about adequate for the simple function of determining optimum uniform dressings. Indeed, from this point of view, the most serious defect of the experiments was the fact that the selection of the sites was not fully random, so that appreciable biases may have been introduced into the results.

The experiments were, however, quite correctly undertaken with the additional and more ambitious aim of investigating possible differences in response on different soil types, and establishing relations between responses and chemical analyses of the soils. In the case of nitrogen, for example, it was confirmed that the responses to nitrogen on fen soils (constituting 10 per cent of the sugar beet acreage) were very small, and would not pay for the cost of nitrogenous fertilizer. This fact is still not fully appreciated by the farmers concerned, 85 per cent of whom, according to a 1945 survey of fertilizer practice, applied nitrogen averaging 0·3 cwt. nitrogen per acre. Omission of this nitrogen would save about £25,000 per annum at present prices, that is, about twenty times the annual cost of the experiments. Considerably larger gains may be expected from the better utilization of the differences in response to phosphate and potash on different soil types and their relations with the chemical analyses of soils. That there is room for substantial economies is obvious when it is realized that the total cost of fertilizers applied to sugar beet is of the order of £3 million per year. For these more ambitious objectives a larger number of experiments would certainly have been economic.

But if the experimental work on sugar beet must be judged to have been scarcely adequate for the purposes for which it was undertaken it is, in fact, the high-light of all experimental work on fertilizers in Great Britain. Sugar beet is the only crop on which any co-ordinated series of modern well-designed factorial experiments has been carried out and the only one for which there has been any attempt to secure a selection of fields for the experimental sites which would be reasonably representative of the whole of the land growing sugar beet. For no other crop is there any adequate series of experiments for which chemical analyses of the soils of the experimental sites have been made, or for which there are any adequate descriptions of these soils. On the more difficult questions of fertilizer practice, such as how to use fertilizers on grassland, and the residual values of phosphate and potash, the amount of co-ordinated experimental work is negligible.

If experimental work in agriculture is to be expanded to a more economic level it will, of course, require a complete reconstruction of the existing machinery for experiments. More work is required not only on fertilizers but also on the many other aspects of crop and livestock production that are capable of simple and exact investigation by empirical experiments. If properly organized, such activities need not interfere with more fundamental scientific research, since technicians rather than research workers are the main requirement. The principal functions of the research workers will be to determine what experiments are worth while, to see that they are properly planned, and to examine the results for relationships which are unknown or only suspected when the experiments are begun.

I have chosen an example from agriculture because this is the field with which I am most familiar, and because it can be demonstrated by the principles set out in this article that the amount of empirical experimentation is here entirely inadequate. The general principles enunciated are of wide application in many other fields, and in particular in many branches of industrial research. The technique of empirical experimentation on highly variable material is relatively new, depending in large part on statistical developments made by British workers during the past thirty years. We have yet to learn how to use this technique to the best advantage, but that it justifies wider and more thorough use there is no question.

[1] Fifth Annual Report of the Advisory Council on Scientific Policy (1951–1952). (H.M.S.O., London, 1952, Cmd. 8561.)

[2] Yates, F., "Sampling Methods for Censuses and Surveys" (London : Griffin, 1949).

[3] Wald, A., "Statistical Decision Functions" (New York : Wiley, 1950).

[4] Crowther, E. M., and Yates, F., "Fertilizer Policy in Wartime : the Fertilizer Requirements of Arable Crops" (*Emp. J. Exp. Agric.*, **9**, 77–97, 1941).

[5] Ministry of Agriculture and Fisheries, "Arable Crops on the Farm", Bulletin No. 72, H.M.S.O., London, 1937.

OBITUARIES

Prof. H. A. D. Neville, C.B.E.

Agricultural education and the University of Reading have both suffered a heavy loss by the death on June 17 of Prof. H. A. D. Neville, emeritus professor of agricultural chemistry in the University of Reading.

Neville was born at Blackburn in 1880 and was educated at Queen Elizabeth's School and the Technical College, Blackburn, obtaining, from the latter institution, the degree of B.Sc. (London) as an external student. After a brief spell as demonstrator under Prof. W. J. Pope, at the Manchester College of Technology, he returned to Blackburn as lecturer and demonstrator under Dr. R. H. Pickard. From there he went, in 1906, to the County Laboratories at Chelmsford, and it was here that he made his first contacts with agricultural chemistry. In 1911 he proceeded to Cambridge to work with Prof. T. B. Wood and Prof. F. Gowland Hopkins ; there he was in the midst of agricultural chemical teaching and research. August 1914 found him in the Royal Engineers. He rose to the rank of captain and was mentioned in dispatches. By 1917 he was carrying out research in the Munitions Investigation Department. Neville returned to Cambridge early in 1919, but by September of that year he was appointed to the chair of agricultural chemistry at University College, Reading. Within a year he was elected dean of the Faculty of Agriculture and Horticulture, and continued to hold these positions in the College, and later in the University, until he retired in 1947. In 1948 he was awarded the C.B.E.

In the early days, Neville worked with Pope and Pickard on problems chiefly concerned with the optical activity of a variety of organic compounds. However, his Cambridge days show a complete change of subject, and his researches there dealt with such matters as the fat of yeast and the mucilage of linseed; he was also joint author of a paper on the relative value of white and wholemeal bread. Neville was always described as an excellent analyst and research worker by those who knew him, and in some ways it is to be regretted that the turn of events at Reading led him into administration. Nevertheless, he was the guiding spirit behind the many excellent soil surveys which were carried out by members of his staff between 1925 and 1940.

What was lost to research was gained by the University and the Faculty, for Neville was a first-class administrator. He was one of a small body of men who guided the University College in those important years immediately before the granting of the charter in 1926, and he was the real architect of its Faculty of Agriculture and Horticulture.

The committees connected with university work and particularly with agricultural education on which Neville served are too numerous to mention here; but it was through these that he became known to, and respected by, a large number of people.

H. A. D. Neville was a wise administrator, an excellent teacher and a very good conversationalist; he is gone, but the Faculty of Agriculture and Horticulture of the University of Reading will ever be his monument. CYRIL TYLER

Dr. F. B. Pidduck

FREDERICK BERNARD PIDDUCK, whose body was found on July 1 on a Lakeland mountainside, had lived at Keswick after his retirement in 1950 from a long and distinguished career in scientific research and teaching at Oxford. Born on July 17, 1885, at Southport, he proceeded from Manchester Grammar School to Exeter College, Oxford, where he gained first-class honours both in mathematics and physics, and also the junior and senior mathematical University scholarships. He then studied for a short time at the Technische Hochschule, Charlottenburg. From 1907 he was a Research Fellow of the Queen's College, Oxford, whence in 1921 he became Fellow and Tutor of Corpus Christi College, where the rest of his official life was spent. During 1916–18 he rendered war service as a research officer in ballistics, with rank of captain, at Woolwich Arsenal, where his work gained official commendation. In 1923 he was awarded the D.Sc.(Oxford) for a thesis that included two important contributions to the kinetic theory of gases. In 1927 he became University reader, having previously been lecturer, in applied mathematics; this position he resigned in 1934. Electrical theory was one of his main interests, and he published two text-books on it, in 1916 and 1937, a technical treatise on currents in aerials and high-frequency networks (1946), and, with R. K. Sas, in 1947, an account of the M.K.S. system of electrical units, for which he was an enthusiast.

He was an extremely able mathematician, who preserved his intellectual originality and vigour to the end of his life. He wrote a series of important papers on the magnetron oscillator, and one of his last papers completes a theory of diffraction which he believed would ultimately take a fundamental place in optics. He was also a skilled experimenter, and long acted as senior demonstrator at the Electrical Laboratory, Oxford.

Active and athletic, Pidduck was an all-the-year-round swimmer, and an amateur photographer. He entered little into the life of his Colleges and University, and was apt to dwell on grievances. His reclusive habit unfortunately deprived his fellow workers of valuable contact with his able and wide-ranging mind, and may have contributed to what with some justification he felt to be an undue lack of public recognition of his notable achievements. One of his characteristics that he took trouble to conceal was his private generosity. S. C.

Colonel W. C. Devereux

BY the death on June 21 of Colonel W. C. Devereux, science has suffered a loss which is more serious than would normally be the case in the passing of an important and colourful industrial figure. For 'Dev', as he was universally called by his friends—and these included his work-people—combined success in industry with a real appreciation of the value of scientific and industrial research.

This was based not so much on philanthropy as on a knowledge that scientific research was commercially sound and indeed an essential basis for the new and expanding industry of light metals. After the First World War, during which he was superintendent of the first national aircraft factory, he developed the technique of forging light alloy pistons and was in frequent contact with Dr. W. Rosenhain and his team at the National Physical Laboratory in their work on *Y* alloy. The success of the forged piston in practice led to the formation in 1927 of High Duty Alloys, where the research laboratories, which were constantly expanding, were always an essential and integral part of the organization. Constantly in touch with the foundry and factory, the research laboratories none the less produced results of fundamental importance, as instanced by the work of Dr. L. Frommer on stress analysis by X-ray methods and on spectrographic analysis, and the studies of Dr. R. F. Hanstock and his collaborators on damping capacity.

On resigning from the office of chairman and managing director of High Duty Alloys in 1945, Colonel Devereux formed Almin, Ltd., and took the opportunity of founding the Fulmer Research Institute at Stoke Poges. His contacts with research and development in the United States during the Second World War had convinced him of the need in Great Britain for an organization for carrying out sponsored research to supplement the work of private industrial laboratories and co-operative research associations. The growth of that organization, which has more than doubled its staff (which now includes more than thirty graduates) and trebled its income, is an indication of the soundness of his judgment. Although confident of the continued success of the Institute, we cannot over-estimate the loss we have suffered in the dynamic and zestful personality of our late chairman, who quickly became a personal friend to those of us who had the privilege of working for him. E. A. G. LIDDIARD