on Deccan traps are interesting. Rocks taken from different flows show different values. Systematic investigation of the Deccan trap rocks may throw some light on the effect of environmental conditions existed during their formation, on the velocity. Unusually high longitudinal velocity of the order of 7,000 m./sec. in Manditog marbles is of interest. Study of deformation of marbles and other rocks will throw some light on the strength of rocks. Measurement of longitudinal velocities in rocks under simple compression, in directions parallel and perpendicular to the direction of compression upto rupture point will give us some evidence for rock deformation. Such studies are likely to suggest possible explanations of the mechanism of rock bursts.

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ROTHAMSTED EXPERIMENTAL STATION—1956

THE Rothamsted Experimental Station is devoted to agricultural research. It is the oldest institution that has been continuously engaged for 113 years in search of the basic principles underlying crop growth and improvement, and has contributed in no small measure to the evolution of British agriculture and has been a source of inspiration and guidance to workers outside Britain.

Agriculture makes contact at various points with a number of widely differing branches of science. The scientific work of the Station is organised in thirteen departments—Physics, Chemistry, Pedology (Soil Science), Soil Microbiology, Botany, Biochemistry, Plant Pathology, Nematology, Insecticides and Fungicides, Entomology, Statistics and Field Experiments. To supplement and enlarge laboratory work in the field, there are two experimental farms—one at Rothamsted on heavy soil and the other at the ancillary station at Woburn on light soil.

The report is a record of the work of the several departments during the year 1956. All are interesting and informative. Much of the work is the continuation of that commenced in the previous years. In the space of a short review, it is impossible to do justice to the work of each of the several departments or even to that of one department. From a reading of the report with those of the earlier years the reader recognises old facts and problems in new settings and learns new ones. Attention will be paid to a discussion of one or two of them.

The Rothamsted Station had its origin in the controversy on plant nutrition between the German chemist Liebig and the British squire Lawes, and the chemist Gilbert. In the year 1840, Liebig made an analysis and synthesis of the then available facts and ideas and propounded his mineral theory of plant nutrition. According to this theory, plants could obtain from the atmosphere, all the carbon and nitrogen required for their growth and development and all that was required was to apply phosphates after making an analysis of the soil for its phosphate content. Lawes and Gilbert, while appreciating the great implication of the problem of soil fertility, doubted the ability of plants to obtain their nitrogen from the atmosphere. They set about experimenting in the laboratory and in the field and provided evidence that plants required supply of combined nitrogen in the form of nitrates. Thus began in the year 1843, the Rothamsted Station and its experimental work.

Experience over a century at Rothamsted and outside, has shown Liebig as well as Lawes and Gilbert to be both right and wrong. Certain plants under certain circumstances are capable of utilising atmospheric nitrogen for their growth and development, provided the phosphate need is met; while certain other types of plants are unable to utilise atmospheric nitrogen and require supplies of combined nitrogen. As stated elsewhere, an year or two ago, by the Director of the Rothamsted Station, the high hopes entertained, that a chemical analysis of the soil would provide the farmers with precise information regarding their soils and manuring their crops, have not been realised and that today, with his present knowledge, the chemist can do little to keep the farmer in deciding the exact amounts he should apply on the basis of chemical analysis of the soil.

This is so, particularly in respect of soil nitrogen and more particularly in India, where climatic, physical and biological factors are involved and the reactions and interactions proceed faster than in the temperate climate of Rothamsted. In their investigations on nitrogen fertilisers described in the report, the Rothamsted workers mention losses of nitrogen by denitrification.

The most important consideration from the scientific and practical aspects of soil fertility is that concerned with the input and outgo of the nitrogen in the soil, which is a major plant nutrient taken from the soil. Soil micro-organisms have long been known to fix atmospheric nitrogen, to produce nitrates and to bring about loss of nitrogen either as gas by denitrification or by the leaching of nitrates through the soil and thus bring about what is called nitrogen-cycle. This view is universally accepted. Evidence has been growing in recent years in support of the view of Indian workers that besides micro-organisms, purely physico-chemical factors also contribute to the processes of the nitrogen cycle in the soil under natural conditions. This view is not universally accepted. Whatever may be the nature of the process, there is unanimity in the view that nitrogen fixation occurs in the soil, that inorganic and organic nitrogenous substances in the soil are converted into nitrates (the form in which plants take up nitrogen) and that loss of nitrate nitrogen occurs either by leaching or by denitrification or by both.

If nitrate is a plant nutrient, what is the significance of the provision in the soil for the readily occurring loss of nitrogen in different ways? What is the relationship, if any, between nitrogen fixation and nitrogen loss with nitrification in between? We do not know. If part of the added nitrogen is lost and part is taken up by plants, how can a mere soil analysis be depended upon, as the basis for determining fertiliser schedules for the soil? We do not know. When the premises themselves are in doubt, the appeal to statistical analysis and significance in support of correlation between soil analysis and crop response will end in providing undue accuracy for empiricism and unwarranted assumptions.

In the departments of physics, pedology and chemistry, new ideas and techniques have been applied in recent years, to studies on the soil *per se* and as the medium for crop growth, designed for more and better understanding of an agricultural soil. Attention continues to be given to studies on soil genesis, soil profiles and horizons and to the study of soil clays, their minerals, and soil organic matter. A great deal of information has been obtained in these directions, but comparatively little of it has yet found application in agricultural practice. The conception of an agricultural soil continues to be made to accommodate itself to the facts that it has to explain. We are still very far from a precise conception of the soil based on studies with soil isolated and purified.

A few years ago, workers in India attempted to reduce the soil to its basic silicate stage by chemical methods and to interpret the colour and other physico-chemical properties by simulating the soil with superimposed treatments. The work appeared to be promising but there have been no further reports. The Rothamsted workers report attempts at a synthesis of clay minerals from silica-alumina gels. Using pressures and temperatures above 300 atmospheres and 300° C., they have obtained a product answering to the tests for kaolins and halloysites. Attempts to prepare these minerals at temperatures closer to those found in soil are not so far successful. Recent Russian work shows that secondary minerals such as calcite, arragonite, chalcedony and even bidellite are formed in the soil from the chemical elements liberated by the breakdown of plant remains. This finds some support from another line of work at Rothamsted. The workers there have found that extracts of leaves of a number of plant species can reduce and mobilise iron compounds in a soil—a process attributed to the combined action of relatively simple aliphatic acids and reducing phenolic compounds in the leaves of the plants.

These and other observations of an isolated nature over some years are promising. Their immediate value lies in indicating that profile formation and horizon structure and composition in agricultural soils is not a one-way process from surface downwards, as was supposed from an examination of virgin soils, and that in cultivated soils the reactions in the so-called heterogeneous mixture of organic and mineral matter build up new compounds and minerals. The discussion at the International Congress in 1956 is a warning against the temptation to correlate soils purely on their morphological basis without first ascertaining that all morphological characters are identical and that the environmental histories are similar.

It may reasonably be expected that the preliminary stages of studies in the science of soil and soil science will soon come to a close and that attention will be directed from generalisations to studies of details for a more useful fundamental knowledge of agricultural soil.

B. V. N.