FARRER MEMORIAL MEDAL, 1951

Oration Delivered on The Role of Nitrogen in Soil Fertility

"Professor L. J. H. Teakle, Dean of the Faculty of Agriculture, University of Queensland, was awarded the Farrer Memorial Medal for 1951, and delivered the Memorial Oration during the Annual Conference of the New South Wales Agricultural Bureaux last month at Hawkesbury Agricultural College, Richmond."

Dr. R. J. Noble, Under Secretary and Director of the New South Wales Department of Agriculture, and Chairman of the Farrer Memorial Trust, said the award not only served to perpetuate the memory of William Farrer, but enabled the Trust to honour those who had rendered distinguished service in agricultural science.

"Professor Teakle, who was appointed to the Chair of Agriculture at Queensland University in 1947," he said, "was Research Officer and Advisor in Plant Nutrition of the Western Australian Department of Agriculture for nearly twenty years—and, more recently, Commissioner of Soil Conservation for that State.

"In 1927, for post-graduate research work in America, he was granted the degree of Ph.D. by the University of California—and he has studied agricultural practices in Great Britain, France, Belgium, Holland, Germany, Italy, and New Zealand."

(Following Report of Oration is acknowledged by courtesy of "Country Life.")

"In every century there are outstanding individuals who, by their vision, persistence and energy, have led the way to progress and achievement. In the Australian scene, Mr. William Farrer, the man whose name we honor, was one of these. Not only did he achieve much himself, but he inspired young men to work with him and the inspiration of his life and work has been passed on in expanding circles to many young men in succeeding generations—his influence grows with the years.

"Farrer saw the need for crop improvement and adaptation to the Australian environment—his attack was by breeding wheats from parents carefully selected for desired qualities such as rust resistance, flour quality and convenience of mechanical harvesting. He anticipated the science of genetics by decades. My approach to crop improvement is through the soil, an approach which, I believe, is in keeping with the spirit of Farrer's own work.

"Of all the elements provided by the soil for the nutrition of the plant, nitrogen is undoubtedly the best indicator of changing levels of soil fertility. Its value as an indicator is recognised in spite of the fact that it is impossible to establish any standards for the nitrogen status of a soil. The nitrogen content of the soil varies with soil type, with climate and with vegetative cover. It is the change in level of soil nitrogen that occurs under the various systems of management which is of greatest significance in indicating trends in soil fertility.

"There is evidence from all over Australia of changing levels of soil nitrogen. Most encouraging is the build-up observed under clover pastures top dressed with superphosphate. It must not be forgotten that millions of acres of land in southern Australia are now vastly richer than they were 50 years ago as a result of clovers and suitable fertilisers.

"There is also the alarming evidence of declining soil fertility on millions of acres of arable land—chiefly land under wheat. Research work on soils from many parts of the Australian wheat belt points irrefutably to substantial loss of nitrogen after a few decades of cultivation. Losses as high as 50 per cent. have been recorded, but many range between 10 and 30 per cent. With this loss of nitrogen is deterioration in the structure of the soil, lowered capacity to absorb water and, frequently, disastrous soil erosion.

"How may the soil nitrogen be replenished? Various agencies contribute. A few pounds per acre are washed down in the rainfall; there may be gains from the activities of free-living, nitrogen-fixing organisms in the soil, such as Azotobacter; the symbiotic nitrogen fixer Rhizobium is a major contributor. Jensen, when Macleay Bacteriologist of the Linnean Society of N.S.W., obtained evidence interpreted to depreciate the importance of Azotobacter, but Rhizobium, operating in the root nodules of leguminous plants, is known to have an astonishing capacity to fix nitrogen. As a result of investigation on the effect of clover pastures on soil nitrogen at the Rutherglen Research Station in Victoria, Penman concluded that a good, vigorous sward of subterranean clover could add as much as 200 lb. of nitrogen per acre per annum. Taking good years and bad years into account an annual increase of at least 50 lb. per acre could be expected under clover ley.

MANAGEMENT VITAL

"The actual nitrogen content of any particular soil is determined largely by the system of management, and within any one system of management the nitrogen content is relatively stable. Under a system

of bare fallow alternating with cropping a low nitrogen status develops; green manuring introduced into this system will effect some improvement; a good clover ley will effect great improvement.

"The great bulk of soil nitrogen is in a form unavailable to the plant—only one of two per cent. of the total nitrogen is normally available in an ordinary fertile soil. The available forms are largely nitrate and ammonia which are formed by the action of micro-organisms in the soil.

"The build-up of nitrate and ammonia nitrogen in the soil is greatly affected by the supply of readily decomposable carbonaceous matter in the soil which acts as a source of energy for many types of micro-organisms. If there is an excess of carbon in relation to nitrogen, free nitrate and ammonia will be absorbed and bound in an unavailable form for the time being. The carbon:nitrogen ratio is of more importance in the question of availability than the mere quantity of nitrogen. This explains why heavy additions of straw may induce a deficiency of available nitrogen; why nitrogen-starved leguminous plants make poor green manure. In fact, only when the added material contains at least 2.5 per cent. nitrogen is a consistent increase in available nitrogen for the succeeding crop assured.

"An abundance of available nitrogen in the soil does not necessarily mean that the plant can utilise it. Unless the plant has adequate supplies of certain other elements, it is unable to assimilate the simple nitrogen compounds absorbed into their complex plant tissues. Very interesting examples are molybdenum and manganese. It is known that molybdenum is necessary for the activity of the enzymes which promote the change of nitrate into a suitable form for building plant tissue. A molybdenum-deficient plant commonly contains excessive amounts of free nitrate. Shortage of manganese often leads to a similar build-up of nitrate in the plant tissues, but the effect is due to a different enzyme failing to work effectively.

"Soil fertility is a very complex phenomenon. It is dependent on the supply of nitrogen, which is affected by the system of land use, by the climate, by the plant cover and soil micro-organisms, and by the amount of readily decomposable carbonaceous material. Its value to the plant in turn is dependent upon adequate supplies of other elements, such as molybdenum and manganese already mentioned, as well as others such as sulphur and phosphorus. The best known method of maintaining soil fertility in general agricultural systems is the ley system in which crops, pasture and stock are integrated into a permanent and profitable agricultural practice."