ADDENDUM

SOILS AND FERTILIZERS IN NEW SOUTH WALES

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"Yet there are many who, if accustomed to it, can easily bear three full meals a day." —HIPPOCRATES.

"Whoever makes two blades of grass to grow where only one grew before renders a service to the State." —VOLTAIRE.

It is useful to consider developments in these two fields against the background of agricultural developments generally in the period under review.

AGRICULTURAL DEVELOPMENT AND AGRICULTURAL SCIENCE

By 1866, much of the coast had been settled, but clearing was not general. Improved species such as perennial rye grass, cocksfoot and clover had been introduced but little or no fertilizer was used.

Inland, the great era of closer settlement was under way following the passing of the Robertson Land Act of 1861. By 1883, some 20,000,000 acres of New South Wales had been occupied and the era of cultivated land had risen greatly. Cropping without fertilizer was the rule, while sheep and cattle were grazed on cleared land with natural pastures.

Exhaustion of fertility became common over much of the cultivated land by the turn of the century when superphosphate began to be used.

The period since has seen a change from exploitative agriculture and low production over broad acres to more intensive use and care of the soil, widespread use of fertilizer and improved pastures, with a consequent lift in per-acre production of both crops and livestock.

During this stage, agricultural science has been the hand maiden of agricultural practice, clearing many barriers and pointing the way to increased productivity.

This period saw the setting up of the State Department of Agriculture in 1890, the founding of the Agriculture Faculty at Sydney University in 1910, and the establishment of the C.S.I.R. (later C.S.I.R.O.) in 1927.

SUPERPHOSPHATE AND WHEAT

Demonstration of a marked response to phosphate was one of the earliest successes of agricultural chemists in New South Wales.

The N.S.W. Department of Agriculture showed big yield increases from superphosphate in wheat plots at Wagga and elsewhere in 1900-1903, following success with this fertilizer in South Australia. Later, Wild was to demonstrate in the eastern States that, contrary to popular belief, Australian soils were relatively infertile by comparison with Britain and North America, at least so far as phosphate was concerned (0·03% total phosphorus compared with 0·045% for England and 0·045-0·09% for the United States).

Superphosphate Production

The introduction of superphosphate into wheat-growing stimulated the superphosphate industry in New South Wales. Production of superphosphate had been first undertaken in Australia in 1878 at Yarraville, Victoria, by Cuming, Smith & Co., using degreased bones as the phosphate source. A little later, in 1883, the Adelaide Chemical Works began commercial production of super. The C.S.R. Company began commercial production of super from bone char in 1886. This was mainly used for cane-growing. Production from Pacific Island rock phosphate began about 1900 in New South Wales.

The introduction of fallowing in the late 1880's and of superphosphate at the turn of the century arrested a serious decline in wheat yields. From 1861 to 1870, wheat yields had declined from 12·8 to 7·3 bushels per acre, but showed a rise after the introduction of super. Super dressings on cereals were static for forty years, usually at the rate of half to one cwt. per acre. Recently it has been demonstrated that payable responses can be obtained up to four cwt. per acre in New South Wales.

During and after the Second World War, studies on the residual value of past super dressings showed that once soil phosphate has risen to a level, varying with the soil, "maintenance" dressings only need be used thereafter.

Fertilizer and Pasture Improvement

Improvements of pasture by fertilizer came somewhat later than for cropped land. The early work on introduction of improved species capable of higher production than the more hardy native types included the introduction of paspalum to dairying areas in 1883. But it was not until the 1920's that superphosphate began to be used on pasture in New South Wales, although earlier work in South Australia and Victoria had demonstrated its value on clovers—notably the use of super on subterranean clover by A. W. Howard at Mount Barker in 1905.

In 1927, 19,300 acres of pastures were topdressed with super in New South Wales. By 1948, this had risen to 875,700 acres, although the practice was checked by the Second World War. In 1939, Australia consumed 1·1 million tons of super, while by 1943, this figure had fallen to 0·48 million tons. Consumption in 1965 was 3·4 million tons.

After the war, the fertility-building capacity of topdressed clover pasture was realized generally. Donald and Williams showed in 1954 an increment of 85 lbs. of nitrogen per cwt. of super applied to sub. clover pasture, and in 1957 they further demonstrated increases of 6·3 lb. per acre of exchangeable potassium and 30·7 lb. per acre of exchangeable calcium plus magnesium in the surface soil as well as increases in organic matter.

The widespread use of "sub and super" has meant a revolution in the pastoral industry, the additions to soil nitrogen alone from this source being worth several thousand million dollars.

Clover Leys and Nitrogen

The introduction of clover pastures into rotation with wheat also arrested a second decline in wheat yields which had become apparent around 1930 despite the use of super. Bare fallowing, which was exploitative of soil nitrogen, had masked the steady decline in this nutrient over the years. Restoration of soil nitrogen has made possible a steady rise in wheat yields since that time. By 1956, 60% of super applied was used on pastures in contrast to the 32% used on pastures in 1939.

Nitrogen Usage in Agriculture

Although the role of nitrogen in plant growth has been known for a century or more, until recent times, little nitrogen fertilizer was used in Australia. "Australia had pinned her faith to pasture legumes as a means of improving the nitrogen status of the soils and the nitrogen nutrition of non-legumes." (Stephens and Donald, 1958.) Low consumption was due to the high price of nitrogen fertilizer and a prejudice against its use. In recent times, nitrogen producing capacity in Australia has expanded very greatly, with a consequent reduction in price, and this, together with the recent introduction of a Commonwealth bounty, has begun to raise nitrogen consumption.

Other Nutrient Deficiencies

In more recent times, potash deficiency has become more widespread in New South Wales pastures, and current work is directed to detecting deficiencies and recommending adequate dressings.

All potassium fertilizers are imported into Australia either from Europe or North America.

The use of potassium in pastures is growing in Victoria and Tasmania. The first recorded response to potassium fertilizer on pastures in Victoria was in 1932. Potassium deficiency can be induced by heavy hay cuts. A large number of Australian soils have a marginal potassium status. This may be accentuated as more soils are more intensively farmed.

Sulphur deficiency was demonstrated by McLachlan in the early post-war years, and the work of Cradock and Weir, Spencer, McLachlan and others in the 1950's showed considerable areas of deficient soils on the tablelands in New South Wales.

Trace Elements

Following earlier spectacular results achieved with trace elements in Western Australia and South Australia on sandy and gravelly soil, deficiencies were discovered in New South Wales—magnesium and copper in citrus in 1930, boron deficiency in apples, zinc deficiencies in citrus and apples, copper and zinc deficiencies in pasture and wheat and, in 1940, molybdenum deficiency in pastures and vegetables. McCleery, of the N.S.W. Department of Agriculture, conducted the first field trial of randomized block design in 1930 to examine copper deficiency. Australian scientists have led the world in trace element work and a significant contribution has been made in New South Wales to this success.

History of Soil Work in New South Wales

Among the earliest work on soils in New South Wales was that of Guthrie who, in 1890, instituted soil analysis for landholders to determine the fertility of their soils. Not surprisingly, little success attended these pioneering efforts. It is only in recent times in New South Wales that Colwell, of C.S.I.R.O., and Bradley, of the N.S.W. Department of Agriculture, have shown that chemical soil tests can be a useful guide to superphosphate rates for wheat.

Guthrie early advocated a systematic mapping and classification of New South Wales soils, and in 1909, was successful in having H. T. Jensen appointed for this purpose. Jensen's book, "The Soils of New South Wales", published in 1914, was one of the earliest on this subject in Australia. He classified soils according to their parent rock, whether transported or in-situ and whether leached or unleached. Interestingly enough, he rejected as inapplicable the genetic classification of the Russian and American schools. The genetic approach was later adopted in Australia, but in recent times has been shown to be inadequate.

The need for close attention to soils in irrigation areas led to the appointment of J. K. Taylor to C.S.I.R.O. in 1927. He carried out the first surveys of irrigation areas at Renmark in 1927. A systematic coverage of irrigation areas has since been done, although Guthrie's ideas of a survey of the whole State has never been carried out, except as part of very broad-scale soil maps of Australia. In this regard, New South Wales soils have been mapped out on a broad scale in three successive maps of Australian soils—Prescott in 1944, Stephens in 1960, and Northcote in 1965.

Following Guthrie, Parberry, of the N.S.W. Department of Agriculture, investigated many chemical problems and, in the 1930's, showed the great phosphate fixing capacity of the red basaltic soils of New South Wales. He also demonstrated the acidifying effect of continued sulphate of ammonia applications, especially on poorly buffered sandy soils, as well as finding several nutrient deficiencies in vegetable soils.

Professor Hallsworth and his students of Sydney University made a notable contribution to genetic studies of soils in the post World War II period, while since 1950, the Soil Survey Unit of the Department of Agriculture has carried out many soil surveys, particularly for closer settlement.

Since the war, C.S.I.R.O. has made notable contributions to pedological studies in New South Wales, as well as carrying out many soil surveys. In the early 1950's, the discovery of layered soils led Butler and van Dijk to the theory of periodicity in soil formation, a major contribution to the understanding of soil genesis and late Pleistocene geological history.

In recent years, investigation into drainage of irrigated soils has been given considerable attention and satisfactory formulæ developed for designing economic tile drainage systems for irrigated horticulture.

Although the history of soils and fertilizers in New South Wales is a brief one, many outstanding contributions by world standards have been made in diagnosing deficiencies and reclaiming desert lands. The end is in sight of the discovery of new deficiencies, but the problem of the poor physical nature of many New South Wales soils has hardly been tackled. Now that the pioneering phase of agriculture is largely over in this State, attention is turning to increasing production per acre, especially in the more favourable climatic regions. Attention to soil structure improvement, a search for improved species and varieties, increasing use of fertilizers, especially nitrogen and potash, and better utilization of pasture and fodder crops are among the major tasks for the future.