1952 FARRER MEMORIAL ORATION.

THREE NOTABLE DEVELOPMENTS IN AGRICULTURE.

Dr. B. T. Dickson.
Retired Chief, Division of Plant Industry, C.S.I.R.O.

My first duty and a very pleasant one, is to say how much I appreciate the honour of being selected to receive the Farrer Memorial Medal for 1952. The kind of man Farrer was, modest, dignified, truly scientific in outlook and work, together with the quality of the work he did thoroughly justify all the encomiums which it is customary now to apply to his memory. So it is that one cannot help but feel a certain inward glow of quiet pride to have been subjected to review by one's colleagues and chosen to receive an award established in honour of and named after so great a benefactor to agriculture and so true a scientist.

The Chairman of the Farrer Memorial Trust, Dr. R.J.Noble, told me that it is customary for the recipient of the Medal, on the occasion of the presentation, to deliver an address known as the Farrer Memorial Oration, and that of recent years it is the custom to give the address during the meetings of the Annual Conference of the Agricultural Bureau of New South Wales.

The term Oration is quite in keeping with the dignity of the Memorial but it places a responsibility on the speaker of giving an address of a high order and the fact that it is given before such an audience as is here present means that it will be received critically but kindly. With these thoughts to guide me I had to choose the subject on which to talk. Naturally it would be appropriate to give you an address on the establishment and work of the Division of Plant Industry of C.S.I.R., now C.S.I.R.O., of which I was Chief for twenty-four years. Had I done so the address would, of necessity, have been rather subjective in treatment because it would include so many hopes and plans and on that score it seemed more appropriate to leave to the objective judgment of others in years to come any assessment of that programme.

Then it occurred to me that during travels in other countries and at international scientific conferences the most frequent enquiries with reference to Australia are about such things as prickly pear and its control, subterranean clover, the importance of trace elements, the seriousness of soil erosion and more latterly myxomatosis and the rabbit problem. Because of this definite interest on the part of other countries I decided that it might be of interest to us if on this occasion we recall to our minds briefly what has been done in some of these fields and I have chosen to talk on prickly pear, subterranean clover and mineral deficiencies in pastures.

First then let us consider the pest prickly pears which captured so large an area and their control by an insect to which a memorial hall has been erected by the farming community of Boonarga, near Chinchilla, Qld.

There are between three and four hundred species of plants native to the Americas, mainly subtropical, which are very succulent, leafless when mature, but spiny with jointed stems having a chlorophyll content satisfactory for photosynthesis, which produce striking flowers and very hard, long-lived seeds.

The discovery of the New World led to their introduction elsewhere and ultimate establishment in such parts as the Mediterranean region, India, South Africa and Australia. As botanical curiosities they are interesting but they can, and do, escape from garden control, soon becoming problem plants and as you know it is contrary to Quarantine Regulations to import them, or parts of them, into Australia today. In some instances they are grown for fruit and some of you have seen fruit of Opuntia ficus-indica exposed for sale in Italy for example. In the latter part of the 19th Century cochineal red was the dye for the redcoats of the army. The cochineal insect lives on certain Opuntias and so any establishment of the cochineal industry meant the establishment of suitable prickly pear. Captain Arthur Phillip seems to have introduced some cochineal insects in 1787 on a prickly pear, most likely O. monacantha, but this is not the pest pear. No-one really knows how the two main pest pears, Opuntia inermis and Opuntia stricta, got here and whoever did it can no longer tell us. There is some ground for the belief that Parramatta may have been the centre of distribution in the early 1830's. Suffice it to say that these two shrub Opuntias were brought here, they got away from control and they spread with increasing momentum over the years. Like all weeds their beginning was unobtrusive and no-one bothered much about them. You can compare this today with skeleton weed and mint weed if you like.

By 1900 it was estimated that ten million acres were carrying pear to some extent and then the great drought caused stock owners to use pear as feed, thus spreading it within districts. In the next two decades it is believed that the land covered in dense pear down to scattered plants was nearly sixty million acres, or an area about the size of England and Wales, from the Hunter River to Mackay, west of the Dividing Range. And by 1925 it was estimated that the annual front of advance was about one million acres.

The problem of eradication was one of cost, because dense pear control by the most up-to-date poisoning methods meant expenditures from £5 to £20 an acre. Even so settlers attempted to get control on small holdings but many had to give up in despair and abandon their blocks. Had there been no other means of control than mechanical or chemical we would today have a still greater pear area. Biological control had been suggested quite early, about 1900, and the fact that the pest pear had been brought here and had developed free from natural enemies gave the suggestion considerable merit.

In 1912 the Queensland Government appointed Professor Harvey Johnston and Mr. Henry Tryon to travel overseas as an investigating commission and they strongly recommended in 1914 the introduction of certain insects and diseases from the Americas. Actually at that time a small stock of Cactoblastis cactorum caterpillars was brought to Australia by Mr. Tryon but unfortunately he failed to rear them in Brisbane. However some cochineal insects from Ceylon were reared by Dr. Jean White-Haney and effectively controlled O. monacantha, thus affording a striking demonstration of the possibility of biological control. The Commonwealth Advisory Council of Science and Industry suggested to the governments of Queensland and New South Wales the establishment of a co-operative investigation and after the war the Commonwealth Prickly Pear Board was established for the purpose of pursuing biological control studies and continued until 1940, by which time 22 million acres of land in Queensland formerly covered densely with pear was available for closer settlement and millions of other acres which had pear on them have been cleared of that pest.

Obviously much had to be done in the provision of laboratory and field station facilities, feeding and breeding cages, means of transport, records, etc., as well as personnel in Australia and overseas. All this sort of responsibility and work tends to be overshadowed by the spectacular achievement which eventuated. Also tending to be overshadowed is the immense amount of painstaking exploration for insects among pear in the Americas, the study of insects thought to be safe and worth sending to Australia and their ultimate despatch in Wardian cases to headquarters at Sherwood, Qld. For example, during the years 1927 and 1930 more than half a million insects, mostly in the larvae stage, comprising some 48 different species, were shipped in 67 consignments from the U.S.A., Mexico and Argentina.

Then followed a period under strict quarantine conditions when insects were reared from eggs, larvae or pupae and tested for feeding on economic crop plants. You must picture the difficulties at this stage in getting insects to live in the new conditions and to become acclimatized sufficiently to enable the feeding tests to be made. In some instances large numbers were imported several times only to be discarded eventually because it seemed impossible to get them acclimatized. This would apply particularly to insects from North America with seasons opposite to ours. While the insects were being reared in cages they had to be watched with meticulous care because of the possible occurrence of disease under the condition of high population and small space. Were an epidemic to occur the patient work of a year or more could be nullified in a few days. Cage-breeding had to be continued beyond quarantine requirements when it became necessary to maintain continuing stocks for distribution in the prickly pear areas while establishment trials were still in progress.

Out of the 48 species of insects introduced 12 were established but the remarkable effect of Cactoblastis cactorum made it unnecessary to continue with the others. Originally it was thought reasonable to expect that it would require a group of different species to deal with such a widespread pest plant but by good fortune one was found which was effective and the outlook was changed.

One consignment only of Cactoblastis cactorum eggs was introduced from the Argentine to Australia in March 1925 and this, after leaving a part in South Africa, totalled 2,750 eggs. By March 1926 there were just over 2½ million eggs and liberation began. Cage-rearing continued until the end of 1927 when 9 million eggs had been obtained and released. During the next three years about 3,000 million eggs were spread through the prickly pear country. Mr. Alan P. Dodd, who was the officer in charge of the work found that the prickly pear was destroyed so rapidly in the period 1930-32 that the insect outgrew the food supply. So there was a period of two years when regrowth of the pest got ahead but the insect population again caught up with the consequent destruction of the regrowth. It is likely now that there is a balance between the still potent Cactoblastis and the scattered stands of prickly pear and so long as the insect remains active it will keep the plant in practical control.

One interesting feature to me was the fact that so often the pear plants would collapse suddenly to a rotten mass and it recalled to mind the effect of a bacterial organism known as Bacillus carotovorus, a vigorous soft-rotting organism gaining entry through wounds, which I saw being tested by Mr. Lewcock, the Board's plant pathologist, while he was at Cornell University, U.S.A. I think it may have played an important part in the ultimate breakdown of pear in Queensland. If it did so it had to be inoculated into the plants by the insect and one has therefore to agree that without the insect it would be ineffective.

We come therefore to the conclusion that the work of the Board, a magnificent co-operative effort between the Commonwealth, New South Wales and Queensland, led by Professor Harvey Johnston and then by Mr. Alan P. Dodd with their able colleagues on the scientific staff resulted in the effective control of a pest plant which had taken possession of a province of Australia. The world salutes such an achievement and we have every reason to be proud of it.

Concerning now that remarkable plant subterranean clover, we do not know how and when it first reached Australia, in that sense being like the pest pears and many other plants.

Fortunately for us instead of becoming a pest plant it became extremely beneficial and is in fact now vital to the welfare of agriculture in the southern part of Australia.

In Louden's Encyclopaedia of Plants, 1829, it is listed as Trifolium Subterraneum, an annual occurring in England on barren heath and sandy loam soils. It is a wild plant of quite common occurrence in southern England, especially in coastal areas. It is also to be found in coastal Mediterranean lands to Asia Minor, and the Mediterranean may be its original home, with the possibility that seeds were taken to England by Phoenician traders centuries ago.

In the absence of factual knowledge of how sub came to Australia there is a tendency to assume that somehow it got here from southern Europe or the Mediterranean area, but Dr. J.G. Davies points out that it could have come from England. In support of this he reminds us it is known "almost everywhere along the coast of southern England and Wales from the Wash around to the banks of the Dee, with the exception of the chalk cliffs of Kent and Sussex. It was widespread in the Thames Valley, and the sandy heaths and village greens of London always carried subterranean clover. It was recorded in Hyde Park and Kew Gardens, it is still present at Hampton Court; around the coast near Deal and Rotherhithe and plentifully present near Southampton, Falmouth and on the Cornish coast and the Scilly Isles. The writer has specimens grown from seed recently collected by him at Hampton Court and at Aberystwyth. It is not impossible, therefore, that some of the subterranean clover today in Australia came from England and not from the Mediterranean. This is suggested by the presence of the plant near all the large ports of southern England which have served Australia".

We are uncertain too about the date of its becoming a New Australian plant and can only go by records which go back to the 1880's and early 1900's. It is recorded by Audas as being naturalized in Victoria by 1887, it was found by A.W. Howard at Blakiston, S.A., in 1889 and Maiden identified it from Wagga Wagga in 1896. Not until 1902 does it seem to have been noted in Western Australia according to Gardner and Dunne, although they also refer to their First Early Strain as having been naturalized in the Blackwood district for over 40 years, which would put the introduction at about 1890.

Certainly A.W.Howard is the one who took the first steps to bring the new plant to the notice of agriculturists, and the story is told by Rowland Hill in the November issue of the South Australian Journal of Agriculture for 1936.

Howard saw the plant on property adjoining Mount Barker Springs about 1889 and shortly after found it growing on his own property at "Beauvale" and on many surrounding farms. There is little doubt that with such a distribution it must have been present for some considerable time before Howard saw it and Hill says "Searching enquiries have convinced me that the plant existed on several farms in the Mount Barker and surrounding districts in the very early days of settlement and although recognised as a palatable and nutritious food for livestock, its name was not known and its growth was very limited".

Howard proceeded to get the name and says in January 1906 "although it may be well known to some botanists, the nearest approach to a name for it that I have been able to get is Trifolium subterraneum. Whatever its botanical name may be it is here called a clover". Although he was a nurseryman apparently he did not fully appreciate the significance of the Latin name.

He struggled to develop a method of harvesting a clean seed and in early 1906 was able to sell 30 lbs. of clean seed to Messrs. E. and W. Hackett, seedsmen of Adelaide, at 2/6d. per pound. From then on he consistently advocated the value of this legume, increased his production of seed and fostered improvements in machinery to deal with the harvesting difficulties. In 1923 his son Cecil imported a clover huller from the U.S.A. and thereby brought about an increase in seed harvested from 23 cwts. in 1922-23 to 807 cwts. in 1923-24.

Prior to this, as we saw earlier, there were recorded references to this clover and farmers, mostly in South Australia, but also in other States and in New Zealand, as a result of Howard's propaganda and sending samples of seed, were interested in it. Not until 1922 however was it recommended officially by a Department of Agriculture and in that year H.A. Mullett of Victoria gave advice on its use and establishment. Spafford in South Australia presented a complete review dealing with establishment, management, fertilizer requirements and harvesting seed in Vol.27 of the Journal of Agriculture of South Australia. In Western Australia considerable farmer attention was given to sub clover, so that about this time it was recognised as "the principal pasture plant of the South-West, being widely grown for pasturage, hay and ensilage".

Let us now turn to the next phase of development. It is well known that when a species is introduced in a new environment and widely spread in that environment there is the possibility that it will develop types or strains which are sufficiently different in some characters as to be classified into strains. This has happened in the case of subterranean clover. J.E. Harrison in 1929 was responsible for collecting 150 lots of seed from Australia, England, New Zealand, Germany, France and the U.S.A. which were sown in plots of 100 single plants and compared for differences between leaves, stems, flowers and fruits as well as such other characteristics as maturation time, leafiness, seed development and so on. He grouped the different strains into early, midseason and late flowering amd today everyone knows Bacchus Marsh as an early type and Tallarook as a late type.

In Western Australia too it has been possible to determine strains on stipule characters, colour of calyx tube, and markings on leaflets so that there are now five of them, First Early from Dwalganup in the Blackwood district and sometimes known as "Dwalganup Clover", Daliak, Northern Early, Midseason and Brunswick Late or Wenigup, which is only suitable for cultivation in wetter areas.

As a result of Harrison's work on strains in subterranean clover and other pasture plants the Department of Agriculture in Victoria established a system of seed certification to ensure farmers getting seed which is true to type and of standard purity and viability. Other States developed schemes and in March 1949 a conference was held at which all were represented, to devise uniform procedure for adoption by the States in their several seed certification schemes. It is of interest to note that for subterranean clover it was resolved that for certified mother seed which is primarily to be used for seed production no seed of any other strain is tolerated and the package should have a blue seal, but for certified standard seed there was to be a tolerance of not more than five per cent of other strains, and the package sealed in red. Furthermore the importance of certifying strain was to be indicated by using different coloured labels, Dwalganup red, Bacchus Marsh green, Mt.Barker blue, Yarloop orange and Tallarook brown.

So we have the story of a plant which is of no consequence in its native habitat, reaching Australia no-one really knows how, becoming established in various places, attracting the keen interest of one man who successfully advocated its worth in our South, and eventually becoming of such economic importance that it is well-nigh impossible to imagine, much less estimate, what its use has meant to this country.

In our short time we, in the various Departments, have been introducing plants, under strict quarantine, which seem to have worthwhile characteristics for use in different parts of Australia and particularly in our northern areas. It is a task calling for scientific knowledge, great patience and considerable optimism because there may still be other plants as valuable as subterranean clover can we but find them.

In this brief account I have not referred to any management problems which arise from the use of subterranean clover or from the effects of that use but it must be evident that they will be far-reaching and perhaps revolutionary. Instead I want to lead into the third part of this address by reminding you that the adequate nutrition of a plant is basic in importance as with animals and man. If then we transport a plant to a new environment which in some places may be quite different in soil characteristics from those obtaining in its native habitat, we may find ourselves in difficulties when trying to establish the plant in those places. This has in fact been the case.

The importance of certain nutrients - nitrogen, phosphorus and potash - has been known for over a hundred years and we have known for about fifty years that certain other elements are necessary for the nutrition of plants to enable them to produce flowers and seed. Little was known however about the part played by some of these elements in the field until some twenty-five years ago when Samuel and Piper published the first reference to the effect of a lack of manganese on oats grown on black soil near Mt. Gambier, in South Australia. The deficiency of this element gave rise to a condition in oats known as "grey speck".

The list of known nutritional disorders arising from the lack of some special element is now impressive and probably thorough surveys would show that the deficiencies are more widespread than we think at present.

I propose to mention a few in the horticultural and agricultural fields to illustrate their range and then turn to pastures for an evident reason.

Where boron is in short supply in the soil it is impossible to grow cauliflowers and root crops in the southern States.

Exanthema of citrus in Western Australia, Victoria and New South Wales is regarded as due to copper deficiency and cereals and field crops give decided responses to applications of copper in Western Australia, South Australia, Victoria and King Island.

Since the study of "grey speck" of oats manganese deficiency has been reported in citrus and stone fruits from New South Wales and Victoria and in apples in Western Australia and Tasmania. Interestingly enough an excess of manganese may adversely affect crops grown on acid soils as with citrus in some parts of the Murray Valley, in north-west Victoria and at Gosford, N.S.W., Mr. Millikan believes there is an association between this element and molybdenum so that eventually it may be shown that application of molybdenum will reduce the manganese content of unhealthy plants below toxic level.

Deficiency of molybdenum is being noted especially in crops grown in acid soils as in whiptail of cauliflower and leaf scorch of flax and linseed, where the application of small quantities of ammonium molybdate per an acre will remedy the condition. This element is an essential requirement for nitrogen fixation by rhizobial bacteria and so legumes respond to it.

Finally, zinc deficiency has been reported from all States, but particularly from the Wimmera of Victoria where it has been essential to apply five pounds of zinc sulphate per acre to cereal crops at sowing.

In certain areas the element deficiency may be multiple, for example zinc shortage may be associated with an insufficient supply of available copper and manganese. When such a complex of deficiencies occurs it is possible that one of them may be the key deficiency, so that until it is applied there is no evident response to a supply of any of the others without the key essential as is the case with copper in South Australia.

Let us now turn to a brief consideration of the pasture position and here we start with the late Dr. A.E.V. Richardson, who did so much for pastures in Victoria and South Australia in particular and in Australia generally by his influence. In 1925 he became the first Director of the Waite Agricultural Research Institute in South Australia and among the early projects he undertook to develop was the study of pastures with respect to mineral deficiencies. He organised a team of young men for this work and although Richardson has passed on his influence continues through their work.

Particularly important is the work of Riceman and Anderson who in 1933 determined the fact that there may be a deficiency of both zinc and copper in certain coastal areas where attempts to establish cereals and pastures were not successful except in the case of rye.

The need for such investigations was made evident by another piece of work by Marston and his colleagues published in 1937 on "coast disease" wherein they demonstrated that this disease is the result of a deficiency of cobalt and copper in the diet of sheep grazing on plants grown in highly calcareous soils such as are found along the coast of South Australia. In 1937 and 1938 Riceman, Donald andEvans did a series of trials which confirmed the fact of a severe copper deficiency and showed that a single application of a dressing of 17 lbs. of copper sulphate per acre had a residual effect in the second year.

Anderson and Smith in a series of experiments over the period 1941-45 done on heath country at Woods Well, S.A., showed that a satisfactory growth of a mixed pasture containing Bacchus Marsh subterranean clover could be developed by suitable applications of superphosphate, copper sulphate and zinc sulphate.

You know about the result of all this work done so patiently and accurately since 1930, beginning with studies on coast disease.

There was an area known as the Ninety-mile Desert and the Big and Little Deserts in Victoria. Enjoying an assured rainfall of 17 inches in the north to 22 inches in the south and with a plentiful supply of underground water, these areas were not deserts in the arid sense. They were of little use because they were unproductive.

Beginning in 1947 settlers began to supply the knowledge developed as a result of scientific work, but there are large areas not settled and requiring considerable capital outlay to make a beginning. It is decidedly interesting to find that the A.M.P. Society has undertaken a developmental scheme in this area. Special legislation has been passed in both South Australia and Victoria and already about 40,000 acres are in course of being cleared, and all the necessary surveys, road making, etc., are under way. Not all of the three areas will be completely available for development because they are not the same physiographically, in soil type or vegetation cover. But we will have in the course of the next few years an added new province for food production in Australia.

Before leaving the fascinating subject of mineral deficiencies it is appropriate to refer to certain other points. Copper deficiency is a common problem in Western Australia, where it is believed to be responsible for what is known as "stalling" of subterranean clover. Anderson has recently shown that there is a molybdenum deficiency on the southern tablelands of New South Wales and that for the satisfactory establishment of subterranean clover in mixed pastures it is necessary to apply molybdenum trioxide at the minute amount of 1 ounce per acre with the superphosphate applications. And the most recent finding by Anderson and Spencer is that there may be sulphur deficiency in granitic and basaltic soils of the N.S.W. tablelands and the application of sulphur improves nodulation of subterranean clover.

I close this part of the address by saying that undoubtedly we are going to learn a great deal more about deficiencies because the problem is not as simple as merely applying a dressing to acres of land. Scientifically we need to know more about what goes on in the plant and more about what happens in the soil to all the living and other material in it and more about interactions between these essential elements. Truly an increase in knowledge begets the need for more knowledge.

And now to bring to focus the main ideas of this address I wish to suggest some thoughts for you to take away.

First of all, the work on the control of prickly pear, the development of strains of subterranean clover and the determination of the mineral deficiencies of soils underline the need for continuing to give strong support to scientific work on behalfof agriculture and in scientific work I include extension work as being as essential as research work.

Secondly, the example of A. W. Howard, as one chosen out of many possible, illustrates the part which may be played in developing the primary wealth of a country by the producers themselves.

Finally, I think you must agree that, in these days, as people primarily responsible for production in this land, we cannot justify holding it if we do not faithfully make it fully productive and at the same time maintain, and even improve, its fertility for the sake of our children's children.