1110

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actually leached out of the soil by the heavy rains. By injudicious grazing and overstocking the better and finer grasses tended to disappear, and poorer types of indigenous vegetation and weeds were left in possession of the land. Overstocking was bad enough in normal seasons, but in drought years it led to disastrous results. In such years the better types of native grasses were eaten or killed out owing to their slow growth and non-seeding habits. These grasses were replaced by such plants as barley grass (Hordeum murinum), and the useless soft Brome (Bromus mollis), barren fescue (Festuca Bromides), thistles of various kinds, Cape weed, and plants of low grazing value. Even in normal times many stock-owners carried stock in such large numbers that the good grasses had no chance to seed. It was natural that the grazier should endeavor to carry as large a number of stock as possible, but though he might gain a temporary advantage with heavy stocking, in the long run the financial results must be unsatisfactory. Pastures should neither be overstocked nor grazed in large areas. Even the evil effects of drought might be greatly lessened by the conservation of fodder in good seasons, improvement in the water supply, increase of irrigation areas, provision of greater transport facilities, which would permit of speedy agistment of stock in such years.

The amount of mineral nutrients removed from the land by the annual crops of live stock was considerable. Of these nutrients the phosphates were of special importance on account of the low phosphate content of Australian soils. During the past 5 years the average number of cattle slaughtered in Australia had been 1,600,000 per annum, and the number of sheep 12½ million. The average amount of phosphoric acid in a sheep carcase was 2½ lb., and in cattle carcase, 15 lb. Hence each year there was removed from the pastoral properties and farms of Australia 25,000 tons of phosphoric acid. If they added the amount of phosphoric acid removed in wool, milk, cream, cheese, pigs, and rabbits, the amount of phosphoric acid removed from stations and farms, apart from what was taken out by the wheat crop, would probably equal 30,000 tons. The amount of 22 per cent. superphosphate required to replace these phosphate losses from pastoral properties and farms would amount to 136,000 tons per annum. As a very small proportion of the grasslands and pastures had received any addition of artificial fertilisers, it could be seen that huge quantities of phosphates were needed to restore their phosphate content. In addition to the removal of mineral nutrients by animals, there were losses by leaching from the soil, especially in regions of heavy rainfall. The main nutrients washed from the soil were nitrates and lime. Fortunately, both phosphoric acid and potash were firmly held by the soil, and the losses of these constituents by leaching were negligible.

### Improvement of Grass Lands.

Grass lands might be improved in three ways: 1. Sowing down with native or introduced grasses; 2. Growing a cereal or root crop, and using liberal dressings of fertilisers; 3. Top-dressing the pastures with suitable fertilisers, e.g., superphosphate, or with certain soil amendments, e.g., lime or gypsum. The growing of introduced grasses and clovers was possible only in the higher rainfall areas—the coastal region and the highlands. The seeding of native grasses was a difficult and expensive matter on account of the low vitality of the seed, e.g., its low germinating power, and the scarcity and high price of the grass seed on the market. The type of native grass that could be sown to best advantage was dependent mainly on the amount of rainfall and its seasonal incidence. In the summer rainfall region of North Australia, the dominant species were the Panic grasses (Panicum), Mitchell grasses (Astrebla), the Blue grasses (Andropogon), and the various species of Erianthus. In the drier parts the salt bushes were of considerable importance. These were great drought resisters, and highly adapted to hot dry localities and soils with high saline contents. Of the various genera Atriplex, Kochia, and Rhagodia were of greatest economic importance. It was a curious fact that while California imported seed of these Australian fodder plants for cultivation on the drier lands they in Australia were indifferent to the cultivation either of these edible forage plants or their very valuable native grasses. A great field of work awaited investigation in the improvement of Australian grasses. The pastoral industry was such a valuable asset that every means should be taken to conserve the native grasses and to aim at improving them in bulk, succulence, seeding capacity and in stock-carrying capacity. In the winter regions of Australia—the coastal areas and the highlands—the growth of introduced grasses offered a sure means of increasing the stock-carrying capacity. For the areas dependent on summer rains the summer growing grasses, e.g., paspalum, Rhodes grass (Chloris), &c., were extensively used. For areas within the winter rain region, i.e., the southern coast of Australia and the adjacent highlands, perennial rye grass, cocksfoot, prairie grass, and Kentucky blue grass were the most useful grasses, and white, perennial red, and alsike the most valuable of the clovers. The rich coastal flats strawberry clover (T. fragiferum) was a most valuable clover, and on suitable peat and subterranean clover (T. subterraneum) had proved of great value. Subterranean clover was likely to prove of great value to the coastal portions of South Australia and the hilly country of the Mount Lofty Ranges. It spread rapidly, furnished good succulent pasture, and did remarkable well on relatively poor land. It was very responsive to applications of soluble phosphate. For the slightly rainfall areas Wimmera rye grass (Lolium subulatum) was worthy of trial.

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### The Use of Cereal and Root Crops.

The method of developing grass lands—feeding the grass through the use of liberal dressings of fertilisers applied to cereals, e.g., wheat, oats, roots, or feed crops—was practicable over the whole arable area of the State. In the wheat belt there was no question that the stock-carrying capacity of the farm was greatly increased by the use of liberal dressings of superphosphate on the wheat crop. Experience had shown that the use of liberal dressings of superphosphate not only guaranteed a full wheat crop, but materially stimulated the stock-carrying capacity of the grass and herbage that followed the wheat. This led to increased stock-carrying capacity, more sheep being kept on the wheat farm, and this, in turn, assisted the farmer to secure higher wheat yields. For arable areas in a large rainfall country, this was undoubtedly the best means of securing an increase in the stock-carrying capacity of the farm. Top-dressing with artificial fertilisers was a sure means of improving grass land. The response to top-dressing was dependent on rainfall, and was most marked in regions of heavy rainfall, because the lands had been longer settled, and had been more continuously grazed than those of the lighter rainfall country. Experimental work throughout Victoria had clearly demonstrated that the stock-carrying capacity of land in regions of over 20 in. could be doubled by the use of moderate applications of soluble phosphate. The application of liberal dressings of phosphate to soil resulted in an increase in the phosphate content of the grass and an improvement in the health and vigor of the stock. Soluble phosphates had several important effects on the growth of crops and grass. They encouraged deep root development and were beneficial where drought conditions were likely to prevail. Experiments had shown that the bulk of herbage had in many cases been more than doubled by the application of phosphates, that the proportion of clovers and trefoils had been greatly increased, and that stock had always shown a decided preference for the top-dressed grass. Superphosphate was the most profitable form in which the deficient phosphate supply might be made good. The amount of phosphate to use per acre and the frequency of application were matters which must be determined in each of the climatic regions of the State.

### Agricultural Education.

To determine the value of education and research work in agriculture, they must turn to those countries where systematic and organised instruction in agriculture had been in vogue for several generations, and where opportunity had been provided for testing the value of such educational work. Among such countries, the United States and Germany stood pre-eminent. After 60 years of effort, the American agricultural colleges and research stations had become the most unique, popular, and useful group of educational institutions in the country, and received the widest possible support from all classes of farmers. On no form of education and research had the States and Federal Government provided funds so freely as on agricultural education, and it was universally admitted that in no form of public expenditure had there been such magnificent returns for the nation in the form of increased production and better citizenship. Because of the large number of students attending the agricultural colleges—most of which were of university rank—specialisation had been carried to a degree not yet contemplated in Australia. From the ranks of these specialists the leaders necessary for the development and diversification of agricultural industries were recruited. Australians could not be said to have developed a strong national sentiment towards agriculture. No matter from what angle the problem of agricultural education was viewed, it resolved itself ultimately into the problem of providing a sufficiency of trained teachers, agricultural specialists, investigators, and extension workers, and using them as units in an organised scheme of instructional, investigational, and extension work. That was the clear and unmistakable lesson to be learned from the educational efforts of other countries.

### Forms of Service.

Three types of service were required for the agricultural community (1) Agricultural instruction; (2) Agricultural research; (3) Agricultural extension. The formal instructional work in agriculture was fairly well provided for in Australia, but the numbers attending these agricultural colleges had been small in comparison with the farming population, and very small indeed in comparison with agricultural colleges in other countries. In the 55 agricultural colleges of the United States there were 130,000 students, and of these 16,000 took a four-year course for the degree of agricultural science. Ninety-five per cent. of the graduates either went on the land or took up some form of agricultural work requiring investigation or extension work. Of those who did not graduate, practically all returned to the land. The building up of a body of systematic knowledge by careful investigation and experiment was essential for the sound development of agriculture in any country.

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The field of the research station was the whole field of agriculture. The acquisition of knowledge must precede its application. The work of the research station was progressive. It built on what had gone before, and aimed at finding out principles underlying an agricultural problem so that the problem might be solved. In fact, it was the vital part of any system of agricultural education, and must form the basis for framing a sound policy for future agricultural development. Sixty of these stations were established in the United States, and the average expenditure on each exceeded £20,000 per annum. It was demonstrable that the added wealth of the State of Wisconsin each year, as a result of the activities of the Experiment Station, was many times the whole appropriations made by Wisconsin for all branches of agricultural education. Of the seven tests widely used in dairying, six originated at the Wisconsin station. The contributions made by this station were regarded as the most important ever made to dairy science, and enabled Wisconsin itself to rise from an obscure position to first rank among the states for the production of both cheese and butter. The dairy products of the state had risen in 20 years from £4,000,000 to £18,000,000 per annum. New and prolific varieties of maize, oats, and barley evolved at the station had added millions sterling to the annual revenue of the state. The field for agricultural investigation in a new country such as their own was illimitable, and at the present time they were largely dependent on what might be termed the scientific basis for agriculture of principles established under climatic and economic conditions unlike their own. There was an immense field for work in the confirmation of what were supposed to be the basic principles of their great national industry.

**It was to be earnestly hoped that generous support would be forthcoming to extend the scope of agricultural investigation work in this State, and that the necessary facilities and equipment would be provided to carry out a vigorous policy of agricultural research.**

On no form of public expenditure would there be such a sure and permanent return as that devoted to agricultural research. There were many farmers who regularly secured double and treble the yields of their neighbors. A barb wire fence frequently separated the grower of a 30-bushel crop from the grower of a 10-bushel crop. To encourage the many to do what the few were doing was the objective of extension work. American experience showed that there was no influence comparable with that of a trained scientific agriculturist working as a county agent in a circumscribed area in co-operation with local community organisations. Since the experiment stations were founded, there had been gained by patient investigation sufficient knowledge of soils, crops, and stock to enable the total wealth from agricultural production to be greatly augmented if the information could be widely disseminated and brought home to the last farm and the last farmer. The county agent's office was the clearing-house of agricultural information in his district. He was continually observing what the best farmers were doing. Any new development of note in any one district, or any other discovery, was immediately made known to other districts. The less progressive a man was the less he cared what others were doing. Consequently the aim in effective extension work was to reach out and get in touch with those men who were usually responsible for bearing down the average yields of the state. The county agent did succeed in reaching these farmers because he was permanently located in the district, and by making farm to farm visits he gave the personal touch which was notably lacking in all other forms of extension work. The main features of the agricultural education system of the United States were:—(1) A group of agricultural colleges, providing a four-year course of instruction for students, and short courses for farmers who could only afford a few weeks each year; (2) a group of agricultural research stations; (3) [illegible] publicity men, and county agents; (4) a Federal Department of Agriculture working in closest co-operation with the colleges and experiment stations in the work of education and investigation. The United States expenditure on agricultural education and research now exceeded £12,000,000 annually. In the 15 years prior to the war, primary production increased at the rate of £90,000,000 per annum. A remarkable development had resulted in Germany during the 25 years prior to the war, largely owing to the policy of encouragement of agriculture by the German Government. During this period the number of cattle increased from 8½ to 20 millions, and the number of pigs from 5½ to 22 millions. The composite average yield of wheat, oats, barley, and rye increased from 20.5 to 35.6 bushels per acre.

### APPLICATION TO AUSTRALIA.

There were many ways in which they might increase their production. Some of these lay along political channels. A bold immigration policy, the building of developmental railways, the provision of improved transport facilities, the promotion of land settlement schemes, the extension of irrigation enterprises, the conservation of water, the opening up of new markets abroad, the development of mining, agricultural industries—all these would aid agriculture, bring new areas under cultivation, and develop this country. But something more was required to make the agriculture of a country permanently productive and profitable. They might increase the agricultural output of the State and the Commonwealth by all these methods, and temporarily stimulate production by the fixing of prices, bonuses, and by many other artificial aids, but the only way to secure a genuine and permanent increase in the output from the land was to improve the farming methods of the country, and apply the teachings of science to every branch of primary production. This was the clear lesson of experience in all the great agricultural countries of the world. The black soil plains of Southern Russia were among the richest wheat belts of the globe. Thirty years ago the average yield of wheat in Russia was 10 bushels. It was still 10 bushels per acre. On the other hand Germany's wheat yield was 18 bushels 20 years ago. To-day it was 33 bushels. The progress was due to the enlightened policy towards agriculture, and the adoption of a comprehensive policy of agricultural education. They could make immense progress in Australia. They could certainly treble their output of wheat, and double their output of dairy products, and at the same time greatly increase the fat stock industries. The degree to which they could progress towards intensified agriculture depended very largely on the personnel of the average farmer and the extent to which that efficiency might be increased. The establishment of a comprehensive system of agricultural education and research must form the basis of any scheme for agricultural development and agricultural advancement. The farmers of the future, namely, the youths of the present day, must be given the opportunity for acquiring a sound training in agricultural science along with the broad, liberal training that makes for good citizenship. The farmers of to-day must be provided for by a scheme of extension work which aimed at reaching the last farm and the last farmer. Finally, a comprehensive scheme of investigational work must run parallel with the work of instruction and extension in order to elucidate the basic facts, and discover new knowledge which would form the basis for further development in agriculture. One important fact must not be overlooked. A long time was required to realise on all educational work. Some years must elapse before the full effect of what was done to-day for agricultural education was reflected in increased production. A long range and liberal policy for agricultural and research was required—a policy which would look beyond the immediate present and map out the requirements of the State for the next ten years and make provision for its steady and gradual accomplishment, a policy which would place agriculture on a safe and progressive basis both economically and educationally.

— END.

NEWS. 8.8.25.

## AGRICULTURAL RESEARCH

### Lack of Co-ordination

While much has been accomplished in the direction of agricultural research in South Australia well-informed authorities consider that more might be done.

The establsihment of the agricultural bureau system, largely at the instance of the late Mr. A. Molyneaux, marked a great step forward in agriculture in this State, particularly in the direction of co-ordinated effort in wheat growing, but it is considered in some quarters that the usefulness of the branches of the bureau might be extended if results achieved were tabulated.

More could, it is also thought, be done in the direction of a stocktaking of actual results accomplished by experimental farms and forests. Wheat growing tests, grading, and classification of soils, often extending over several years, are conducted, yet a review of the value or otherwise of such work for distribution among agriculturists is often not attempted.

"There is plenty of theory, but not enough practice," stated one agriculturist. "I do not desire to detract from what has been done by such fine institutions as Roseworthy College, and several of the experimental farms, but something more might be done in the direction of collating and disseminating the results of the work so that it could be of greater value to farmers and agriculturists generally throughout the State.

"In America bulletins are issued, broadcast, and although valuable reports have been made available by the South Australian Department of Agriculture from time to time in respect to soil testing, in view of the annual expenditure not enough use is made of the knowledge gained.

"Just what has been accomplished by the experimental farms, the type orchards in the Adelaide Hills, and the forest reserves is a question that should be easily answered by the officers of the departments controlling them," he continued, "but I doubt if that could be done."

NEWS. 6.8.25

Drs. I. B. Jose and L. C. F. Lindon have been appointed honorary assistant surgeons at the Adelaide Hospital.