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WHEAT PRODUCTION.

INCREASE IN YIELD POSSIBLE.

ADDRESS BY DR. RICHARDSON.

The wheat crop, South Australia's most important staple product and main source of wealth, is capable of very great expansion, both in acreage under crop and in acreage yield per acre before the limits to production are reached, according to Dr. A. E. V. Richardson.

The Director of the Waite Agricultural Research Institute (Dr. A. E. V. Richardson), addressing farmers attending the annual winter school at Roseworthy College, said competent authorities estimated that the area of land suited for wheat culture in South Australia was at least 16 million acres. It was reasonable to expect that of this area, four million acres would ultimately be sown each year to wheat. The present yield per acre averaged 12½ bushels. It might readily be permanently raised to 15 bushels per acre. That would give a total yield of 60 million bushels, or double the present output. There were two ways of speeding up production:—(1) Increasing the acreage under crop; (2) Increasing the average yield per acre. Both methods would accelerate production.

The increase in acreage under crop was largely dependent on providing increased facilities for transport, water supplies, opening up of additional Crown lands, and the fuller utilisation of existing lands. It was largely a matter of Government policy and administration. The second method of increasing production was by improving the average yield per acre. That was a matter of vital importance to farmers, for it meant a general increase in prosperity to the man on the land, a higher standard of comfort in the rural areas, and a contented and enlightened rural citizenship. But increased yield per acre demanded a higher standard of efficiency on the part of the farmer, and the bringing of all the resources of science to the assistance of the farmer through an organised system of agricultural education and research. That was the lesson of experience in all the great agricultural countries of the world, and South Australian progress would be greatly accelerated if that fundamental fact was accepted.

To obtain a material increase in the output per acre demanded more intensive working of the soil, and a clear understanding of the principles underlying the practice of wheat-growing. It required a higher standard of farming, an adequate knowledge of the principles of fallowing, and thorough working of the soil, the proper use of fertilisers, methods of crop rotation, the recognition of the principles involved in the adjustment of the time and rate of seeding to the condition and tilth of the seed-bed, and the nature of the season, and the methods whereby the heavy annual toll exacted by fungoid diseases might be reduced. The increase in the yield per acre was largely a question of improving the farming methods of the State and applying the teachings of science to every branch of production.

Results of Investigations.

Investigations conducted by the Department of Agriculture of Victoria over a period of five years, showed that, with moderate rainfall, every inch of rain received by the wheat crop during the growing period was capable of producing three and a half bushels per acre. The average composite winter rainfall for the wheat belt of Victoria was 11½ inches. Therefore, the maximum possible yield of wheat for the whole State was over 40 bushels per acre. The average yield of wheat for Victoria was 14½ bushels, so that on the whole, the farmers were obtaining little more than one-third of the maximum possible production. In the Wimmera district the farmers averaged about 2[illegible] bushels per acre, which was nearly two-thirds of the possible production. There were, however, 10 wheat-growers in the Wimmera district who had actually secured three and a half bushels for every inch of winter rainfall, and whose average for five years was over 40 bushels per acre.

Investigations for the past two years at the Waite Institute had shown that in the Adelaide district an inch of rain was worth slightly more than three and a half bushels of wheat. The average rainfall for the growing period of wheat at 20 representative centres in the wheat belt of South Australia was 11½ inches, so that 40 bushels per acre was the limit of production imposed by the rainfall. But South Australian wheat-growers were actually securing considerably less than one-third of that yield. It was therefore evident that a material increase in the yield per acre was possible before the limits imposed by the rainfall were approached. The evidence, which was accumulating, seemed to suggest that an average yield of 18 to 20 bushels per acre was within the bounds of possibility. If such an increase could be materialised, the financial stability of the State would be placed on an unassailable basis, and wheat-growing would be a permanently profitable industry.

Factors for Success.

In considering the factors for successful wheat culture in South Australia, it was necessary to remember that the bulk of the wheat was grown on areas of limited rainfall, and that 70 to 75 per cent. of the annual rain fell during the growing period of the crop. From the point of view of maximum production, four essentials were necessary:—1. Conservation of soil moisture by early fallowing and the thorough working of the fallows. 2. Liberal use of soluble phosphates. 3. Regular crop rotation and association of sheep with wheatgrowing. 4. The use of the most productive varieties of wheat and the rational use of seed. The observance of those principles would make for the production of good crops and the maintenance of soil fertility. They were the foundations of successful wheat-growing from the cultural standpoint. But more than that was required to make a successful wheat-grower. Business methods and executive ability were quite as important as production methods, for if the wheat and sheep were produced at too great a cost or marketed unwisely, the farm might bring in but little profit. An effort must be made to cheapen production at every possible point by good business management and the use of efficient plant and labor. The wheat-grower must try to discover the point at which increased labor and fertility applied failed to produce more than a corresponding increase in the crop return, and endeavor to reach this point but not pass it. Two additional factors which made for success were efficient implements and plant, and good management and business ability.

The Keynote of Success.

It was a matter of common observation that well-fallowed land in the wheat districts would grow bushels more wheat per acre than land that had been merely stubble-ploughed. Various experiments in the drier parts of the wheat belt, as well as the practical experience of farmers, had both conclusively demonstrated that more wheat could be grown over a period of years on a given block of land by cropping it every other year than by growing wheat continuously on the same land every year. In these days of costly labor it was becoming more and more necessary to carry out a thoroughly efficient system of cropping. It did not pay to raise small crops. The most profitable system of agriculture under existing economic conditions in the wheat belt was to grow the largest crops possible on those parts of the farm reserved for grain. The way to do that was to raise such grain crops less frequently, precede the wheat with a bare fallow, and either pasture occasionally or use forage crops for feeding down with sheep and lambs in a rotation with wheat. That was the keynote of successful wheat-farming in those areas.

It was often stated that the continual practice of bare fallowing deprived the soil of organic matter—the soil's most valuable constituent—and therefore it might be supposed that bare fallowing would gradually impoverish the land. If the land was impoverished, the fault was not so much with the practice of bare fallowing as in growing too many grain crops and carting them off the farm instead of growing them in rotation with forages and pasture for feeding down by sheep and lambs. With the adoption of judicious rotation there need be no fear that the practice of fallowing would ultimately result in soil depletion.

Fallowing Methods.

The fundamental principle underlying the practice of fallowing was that it conserved soil moisture—the limiting factor for successful agriculture in an arid country, and it enabled a considerable portion of the rainfall of one year to be conserved in the soil through the summer, and thus augment the supplies which fell subsequently to the sowing of the crop. It placed at the disposal of the wheat crop the rainfall of two seasons. It distributed the work of the farm evenly throughout the year, and enabled the wheat-grower to have ready in autumn large areas of land in the best possible state of tilth to receive the seed as soon as the weather conditions were favorable to seeding. That was a matter of considerable importance in the drier parts of the State, where the normal seeding season was so restricted. When favorable conditions for seeding existed, it was necessary for the farmer to concentrate his energy, not on the ploughs, but upon the drills. If the ploughing had to be done at seed time, the subsequent seeding would be delayed, and danger would arise from the ill-effects of a non-consolidated seed bed.

When it was realised that the main object of fallowing was to conserve moisture, it would be obvious that the sooner it was commenced, the more the moisture that could be conserved, and the better the ultimate prospects of success. It had been repeatedly demonstrated that land fallowed early gave, in normal years, heavier crops than land fallowed late, whilst in dry seasons the crop grown on early fallowed lands was worth bushels per acre more than that raised on land fallowed late. No set methods were to be followed for all districts, but the principle of maintaining a loose shallow mulch on the soil throughout the summer months should be adhered to if heavy yields were to be obtained. No good purpose was served by merely cultivating the soil when the surface mulch was loose and dry. Cultivation was needed only to break up the surface crust after rain or to destroy weeds. Sheep were very useful on the wheat farm for that purpose. They consumed weeds on the fallow and assisted in consolidating the seed bed.

Tillage.

Thorough tillage, which had as it aim—(1) Preservation of a loose mulch; (2) fining and firming the seed bed; (3) destroying weeds; (4) promoting aeration and bacterial activity—was essential for successful cultivation in regions of low rainfall. The wheatgrower should always bear in mind that the next season might be a dry one, and the tillage methods adopted should be such as would ensure a successful crop if the rainfall was below the average. The methods which would secure a favorable crop in a dry year would be suitable also a normal season. In excessively wet seasons the differences between well-worked and neglected fallows were to some extent levelled down because both tyres of fallows had sufficient moisture to mature a heavy crop. Such seasons occurred but infrequently in the wheat belt, so that on the whole the farmer had to adapt his practice to meet the exigencies of normal seasons and years of low rainfall. The imporatnce of early fallowing and summer fallowing was obvious, but neither early fallowing nor summer fallowing would be of much avail if the fallows were neglected through the summer. A neglected fallow was little better than stubble-ploughed land for raising wheat crops. There was an old saying that "tillage was the best manure." Very little was known of the changes that took place in the soil constituents as a result of tillage. It was known, however, that nitrates were rapidly formed in well-worked fallows, and that by seed time sufficient was available in the soil to bring the heaviest wheat crop to maturity.

There was reason to believe that other mineral nutrients were made available for the use of the crop, though it would doubtless be very difficult to show this by chemical analysis. The soil contained enormous reserves of dormant plant food, and the aim of the farmer should be to render as much of that available as possible by thorough and frequent cultivation. The more thoroughly the soil was tilled, the more available plant food would be formed, and the less would be the manure bill. It was in that sense that "thorough tillage was a substitute for manure." Jethro Tull recognised that fact over 150 years ago, and founded his "Horse-hoeing Husbandry" on it.

A fine illustration of the value of thorough tillage was shown in the results of the wheat manurial tests at Longerenong in Victoria. The unmanured plots at Longerenong for a 10-year period averaged 2½ bushels. For the past decade a well-worked fallow, without fertiliser, had averaged at that centre nearly 30 bushels per acre—a yield more than double that of the State.

Finally, apart from conservation of moisture, extermination of weeds, and production of available mineral nutrients, there was one other important advantage from thorough tillage, namely, the consolidation of the seed bed. Every experienced wheatgrower knew how important it was to have a firm, finely divided, consolidated seed-bed for his wheat crop. Oats or barley would thrive on loose open seed-beds, but for wheat, a firm, finely divided seed-bed was essential for success. The consolidation of the seed-bed could not be secured in a week or a month. Time was a necessary factor for the process, and the consolidation was brought about by the packing action of the rain, and the frequent stirring of the soil. Such a seed-bed, resting on a moisture-laden subsoil, was in the very best condition, not only for resisting dry spells, but also for yielding heavy crops. The advantage of a fine, firm seed-bed in a dry season was very marked. The finely divided soil particles acted as an unbroken series of force pumps on the storage reservoir below, and kept the roots rapidly and constantly supplied with moisture.

With a loose, open, cloddy seed-bed capillary action was slow and irregular, and in time of stress the crop would suffer. Such a seed-bed was the invariable result of hasty preparation of the soil. The best preparation for a wheat crop in districts with a limited annual rainfall, the bulk of which fell between April and October, was to fallow early and well, to keep the soil thoroughly cultivated through the summer, and to be ready to concentrate the whole strength of the farm on the drills and cultivators when the first favorable autumnal rains fall.

The benefits of preceding the wheat crop with fallow were shown by the results of ten years' tests at Longerenong in the Wimmera district of Victoria, where the average rainfall was 17 in.

Wheat continuously, 11.1 bushels per acre.

Wheat after bare fallow, 34 bushels per acre.

Wheat, pasture, bare fallow, 35.5 bushels per acre.

Wheat, oats, bare fallow, 38 bushels per acre.

Use of Soluble Phosphates.

The guiding principle in the use of manures was to encourage the formation of soluble mineral nutrients by thorough tillage, and supplement any deficiencies with fertilizers. Actual experiment was the best means of determining those soil needs. The problem for the farmer was to discover the most economical and profitable way of supplying those needs. Speaking generally, the chief deficiencies of South Australian wheat soils were organic matter and phosphoric acid. Increasing the organic content of the soil was a very difficult problem for the wheatgrower on account of the large area of a wheat farm, and the very limited supplies of organic matter available for that purpose. Indirect means, e.g., crop rotations and pasturing, might possibly counteract the great losses of organic matter which resulted from bare fallowing. The rate at which organic matter was lost and might be replenished in South Australian wheat soils was a matter for urgent investigation.

Except in wet seasons and in districts of heavy rainfall, the use of stable manure did not materially increase wheat yields. Though the organic content of South Australian wheat soils was low and the amount of nitrogen present much less than in European soils, experimental work had shown that nitrates were unnecessary in all but the wetter areas, when wheat was sown on fallowed land. At the Waite Institute there was evidence to show that nitrates might prove very useful and necessary supplement to phosphates where wheat was sown on stubble land. Practical experience and the results of numerous experiments had demonstrated that the most profitable method of applying phosphates was in the form of superphosphate. The amount to be used with greatest profit depended on the rainfall, the soil, and the thoroughness of cultivation. Other things being equal, lighter dressings were required in regions of light rainfall. Where the rainfall was ample for crop needs, heavy dressings might be used. Well fallowed land was very responsive to liberal dressings of phosphate. The more thorough the cultivation methods the greater the effect of liberal dressings of phosphates.

Experiments at the Waite Institute had shown that the result of the application of liberal dressings of soluble phosphate was the economical use of the water supply of the soil and a low transpiration ratio. That did not mean that a manured crop required less water than an unmanured crop. In fact, a manured crop generally used more water because its grew vigorously and usually had a greater leaf surface from which transpiration took place. With a liberally manured crop, the plant grew vigorously without check, and it was increasing in dry matter economically throughout the whole period of growth. But on an unmanured soil in which soluble phosphates were wanting, the plant transpired water continuously, but owing to the lack of phosphates, growth, i.e., increase in dry matter might be suspended, with the result that more rain was required to mature a bushel of wheat than on the soil liberally dressed with soluble phosphates. On soils rich in calcium carbonate, heavy dressings of soluble phosphates might be used to obtain full wheat yields because in these soils reversion of soluble phosphate took place very rapidly. Finally, the amount of soluble phosphate that could be profitably applied depended on the thoroughness of the cultivation methods.

With indifferent cultivation the level of production was always low, no matter what quality of seed was used or how much fertiliser was applied. Liberal use of fertilisers could not make up for deficiencies in cultural methods, but with the adoption of thorough tillage methods, the full benefit of liberal fertilising was obtained. The indirect effect of heavy applications of fertiliser should be noted. Heavy dressings of superphosphate to wheat crops led to increased growth of pasture when the land was left in pasture. This was a common experience in the wheat belt. Not only was the maximum wheat crop obtained from liberal dressings of superphosphate, but the quantity and certainly the quality of the pasture was greatly improved.

There could be no doubt as to the value of soluble phosphates for the whole of the wheat belt, but the quantity of phosphate to apply would vary with the rainfall, the soil, and with the standard of the cultural methods employed, and the tendency would be for more liberal dressings of fertiliser to be used. The best quantity to use in any district could be determined only by carefully conducted field experiments over a series of years. Liberal dressings were justified, especially if cultural methods were thorough, to give the maximum yield possible on the rainfall, and to stimulate the subsequent growth of grass on the stubbles and increase the stock-carrying capacity of the farm.

Regular Crop Rotation.

The outstanding weakness in the system of wheat culture in South Australia was that in many cases little or no provision was made for the restoration of organic