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Fertilisers and Soil Fertility.

THE extent to which the phosphatic fertilisers have dominated the outlook of farmers all the world over is well seen by the fact that when a country first embarks upon anything approaching a large scale use of artificial manures, it is the phosphatic fertilisers that are almost invariably employed, to the practical exclusion of all others. This is understandable, and within certain limits entirely reasonable: for when rainfall and sunshine are adequate, and where leguminous plants can thrive abundantly, a deficiency in phosphates is often the sole limiting factor to greatly increased production, and under these conditions phosphates frequently occasion results of such a pleasing magnitude that the farmer is, perhaps naturally, not in a hurry to look for methods of still further increasing his productivity—although, of course, it seldom happens that the addition of phosphates is all that is necessary to produce the highest yields obtainable.

Thus, for example, in a pastoral country like New Zealand, in the main with abundant rainfall and conditions potentially favourable for the spread of leguminous plants, the benefits from phosphatic manures have been enormous, and the increase in their use during the last decade very remarkable; while in the case of those areas in the wheat belts of Australia where the methods of fallow practices have been perfected and water conserved to the maximum, it has been found remunerative to increase the dressing of superphosphate very appreciably above the amounts that were originally considered adequate.

The position of South Africa (the Union and Southern Rhodesia) is perhaps unique, and agriculturists—not only of that continent, but also of the world at large—should derive inspiration from Sir Frederick Keeble's critical survey\* of the fertiliser position, part of which appears elsewhere in this issue (p. 417), and more particularly from the penetrating suggestions he makes as to the problems which South Africa sets the scientific investigator for solution.

Sir Frederick has had the advantage of studying extreme conditions. In South Africa, as he tells us, not only are enormous tracts subject to slight precipitation, but also mineral deficiency is universal—and, we might add, leguminous plants are not abundant, for there, unlike New Zealand, wild white clover has not run riot, and, unlike large

\* "Agricultural Problems in South Africa." Paper read before Section M (Agriculture) of the British Association at Bristol on Sept. 5

areas in Australia, a host of little European annual clovers have not become tantamount to wild plants. What are the limiting factors to a satisfactory scale of production in South Africa? This is the question Sir Frederick has set himself, if not to answer, at least to explore; not, he thinks, by any means necessarily the scant precipitation, but rather the inherent deficiency in plant foods—first and foremost an acute deficiency in phosphates and in lime, and secondly, a deficiency in nitrogen.

From the point of view of grassland, the effects of drought are no doubt greatly accentuated by the prevailing mineral deficiency, which must tend to stunt even the native vegetation and render colonisation by a more desirable and nutritious flora impossible, and in this connexion it is probable that a scarcity of available nitrogen must rank with a scarcity of phosphates as a contributing factor of no mean importance. That this is indeed the case is rendered the more likely from the results of experiments recently conducted in Great Britain, which have shown that in dry seasons it is the pastures manured with a complete and well-balanced combination of fertilisers that not only maintain the highest productivity, but also suffer the least damage. It is significant, too, and corroboratory, so far as it goes, of Sir Frederick's far-reaching thesis, that it is scarcity of plant food rather than of water that is the outstanding cause of low productivity in South Africa; that experiments with which we have been concerned on soils of very low fertility have shown that the difference between success and failure in the establishment of new sward-forming plants, through the intermediary of seeds, may turn upon the application of a complete and well-balanced manurial dressing at or a little before sowing. Sir Frederick adduces cogent reasons in support of his view that the South African grasslands are not only on the face of it likely to be, but also in fact are, nitrogen-starved; and by reference to small-scale experiments conducted by Mr. T. D. Hall, shows that these grasslands, despite the inherent deficiency in phosphates, none the less show a remarkable response to ammonium sulphate when applied by itself—the response, however, being greater when the added nitrogen (in sufficient quantity) is supported by phosphates, and greater still when supported by phosphates and lime.

The position that clovers may possibly be made to take in the improvement of South African grasslands, in our view, therefore, deserves greater emphasis. White clover, for example, is by no means unknown in the Union, and it is more than

probable that by sowing the seed in conjunction with heavy phosphating this all-valuable pasture plant, or for that matter some kindred legume, might be established on a telling scale, and consequently we should like to see added to the experiments and researches that Sir Frederick suggests, trials with a large number of species and strains of leguminous plants; but further than this, such trials should in all cases be supported by inoculation, for it is more than probable that the organism appropriate to the several legumes is but sparingly present, or totally absent, in these mineral-deficient soils. On the evidence placed before us, there would seem to be little doubt that the careful balancing of manurial ingredients will have to play a more than usually important rôle in the improvement of South African grasslands, but the economic prospects will be greatly enhanced if by proper manuring it is thus rendered possible to introduce better species of plants, and especially if these can be made to include legumes, the successful introduction of which would not only add to the nitrogen-calcium content of the ration offering to the grazing animal, but also react economically on the nitrogen-phosphate balance that the scheme of manuring adopted should aim to maintain.

With regard to the grasses, no preconceived reservation should be made as to what species might prove valuable: thus for certain difficult situations in New South Wales such an unlikely grass as tor grass (*Brachypodium pinnatum*), which is nothing but an objectionable weed in Britain, has been shown to be of possible value and worthy of more serious trial; while on soils as deficient in minerals as those of South Africa, creeping soft-grass (*Holcus mollis*), perhaps the least desirable of grasses in British pastures, might prove to have a certain, though probably very limited, application.

The extreme poverty of South African soils in organic matter must tend to create an unsatisfactory soil condition from the bacteriological point of view, and this leads Sir Frederick to the opinion that the chief chemical rôle of organic matter is perhaps to supply carbon for the soil bacteria, and that a substance rich in organic carbon should contribute to complete fertilisers. To make good, so far as possible, the humus deficiency of these soils is obviously of the first importance, not only to maintain soil fertility, but also, perhaps almost equally, as a means of ameliorating the influence of drought, and consequently the farmer needs to adopt a system of management which will so far as possible augment the plant residues returned to, or retained in, the soil.

Thus in this connexion the time of application of nitrogenous fertilisers in support of phosphatic manures is perhaps as important as its presumable effect on the plant's ability both to collect and utilise water to the best advantage, since the root system (the development of which is favoured by phosphatic manures) of an arable crop must bear a close relation to humus formation in the soil. Consequently, investigations designed to establish 'the most water-economising' scheme of manuring applicable to different crops should go beyond merely an exploration of the factors which influence the economic use of water by the plant in the production of dry matter of the part or parts of the plant constituting a particular crop.

The insistence on the significance of humus deficiency adds emphasis, we think, to the importance of a crop like lucerne in the economy of South African husbandry, and the more so if, as Sir Frederick considers probable, the nitrogen-fixing organism associated with the wattle (another leguminous plant) is also capable of bringing the phosphates of the soil into organic combination. The growing of lucerne does not, however, represent the only cultural means of increasing the humus content of arable soils; the same end could be achieved by maintaining leys consisting of other plants, or by encouraging, in the first instance by the purposeful sowing of seeds and the generous application of manures, a volunteer flora of annual grasses and clovers such as undoubtedly contributes to the fertility of the Australian wheat belts.

On the balance, there would seem to be evidence to suggest that the evolution of high farming in Australia and in South Africa presents something in the nature of an antithetical parallel. In Australia, it was when the husbanding of water by improved fallow methods became well understood that the need of artificial manures (still chiefly phosphates) was fully appreciated and the potential usefulness of the alien annual flora realised; in South Africa, perhaps it will be when the deficiencies in plant foods have been artificially rectified that an impetus will be given to further endeavour in the direction of conserving moisture, and to the introduction of valuable sward-forming and humus-creating plants.

The problems of the two countries are in many respects very similar, and Sir Frederick's final suggestions, though made to the geneticists of South Africa, are equally applicable to those of Australia, as indeed they are in their broad implications to the whole body of economic plant breeders. In laying emphasis on the desirability of discovering

racers of maize with male inflorescences which will continue to produce pollen over a long period, he in fact directs attention to the need of the fertilisation affinities of our cultivated races of plants being in accord with the restrictions imposed by the conditions under which we expect them to grow. It is probable that the chances of successfully inducing the spread of a plant like white clover through some of the grasslands of South Africa would be increased in proportion as early and abundant seeding races could be selected for introduction, while it is equally probable that the most successful pioneer plants in regions of low rainfall are self-fertile annuals with the maximum ability for setting and ripening seed quickly. The plant breeder who seeks to take up Sir Frederick's challenge and to breed varieties of crops designed to utilise manures to the most economic advantage may take heart from the fact that it is undoubtedly true that different strains of grasses of one and the same species, at all events, react to fertilisers, both qualitatively and quantitatively, in an appreciably different manner.

#### Future of Australian Aborigines.

FOR some time past certain sections of the public in Australia have been much exercised by the present conditions and the future of the aborigines. The question was brought into special prominence some five or six years ago by Dr. Basedow, the anthropologist, on his return from one of his expeditions to Central Australia. As a result of his observation of conditions among the aborigines on that occasion, he organised a number of public meetings in Adelaide and elsewhere and aroused a public feeling sufficiently strong to secure the setting aside by the South Australian and Western Australian Governments of a reservation for the aborigines of 62,000 square miles lying across the boundary of the two territories.

There is, however, reason to believe that the hopes for the amelioration in the condition of the aborigines then entertained by the promoters of the movement have not been fulfilled, and it has been stated categorically by Prof. Wood Jones, in an address to the Australian Association for the Advancement of Science, that the provision forbidding the granting of concessions for the exploitation of minerals within the reserved area has been deliberately ignored by one of the governments concerned. At present the aborigines come under the respective State governments, each of which has its own Protector of the Aborigines, with