

to the absence of clay-particles the soil can be worked at any time, wet or dry, without danger of puddling. The entire absence of clay-particles is indeed a matter for regret. On the Kaingaroa Plains, owing to the alternate freezing and thawing, the young plant may be "heaved" out of the ground. This is due to the upward expansion of the surface soil in freezing, the plant-root being thereby ruptured. On thawing, the soil surrounding the upraised plant is apt to settle down, especially in the case of rain, leaving the stock and roots exposed either to drying or freezing, as may be. It is a matter of common remark that the clovers grow luxuriantly in cleared-bush pumice lands; and even on the scrub lands, where the wild horses and cattle have tramped and manured the soil, the white clover has successfully established itself. This is no doubt due to several reasons: the chief is that clover-seed has been introduced by stock, but there are also the facts that it germinates under favourable soil-conditions. The droppings of stock act extremely favourably as an ameliorating agent on pumice soils. The complex organic acids formed by the decomposition of organic matter (humic acids) act strongly upon the more readily decomposable silicates in the soil, and in the course of time will dissolve out most of the plant-food. The underclays of coal-beds and the lower portions of peat-beds, as well as peat and coal ashes, are almost wholly destitute of mineral plant-food (Hilgard). It has been shown that the richer the organic matter humified is in nitrogen the more energetically it acts in rendering available the mineral matter of the soil for plant-nutrition (Snyder). With the increase of humus in the soil there is also a corresponding increase in the amount of mineral plant-food which may be extracted from a soil by 4-per-cent. ammonia (Ladd). The intensity of nitrification is dependant upon the porosity of the soil (Hilgard). The greater the porosity the more intense the nitrification, by which is meant the conversion of the inert nitrogen of humus into active soil nitrogen, the most expensive fertilizer-ingredient. It is probable that in these pumice soils the oxidation of humus will be exceptionally rapid, and the valuable nitrates will be washed away and lost unless some check is imposed. It is always found that humus accumulates if the soil be kept covered by vegetation, whereas if the soil be kept stirred, or if vegetation is unable to cover the surface, the humus is fast oxidized, and the soil thereby depleted of this all-important constituent. The clothing of these desert scrub plains with a permanent sward of vegetation would therefore suggest itself as a possible method of treatment, but before this is accomplished it may be necessary to sow green leguminous crops such as clovers, alsike, cow-peas, vetches, and plough them in. The dominant plant-food required for legumes is potash, and this is present in abundance in the pumice. The selection of a suitable crop must be carefully considered, and plot experiments should precede any extensive planting, in order that the dictates of theory may be verified. It may be found possible to grow lucerne as a permanent crop, though the altitude and inland situation must be remembered in considering what is a suitable leguminous crop to introduce. Where the pumice is loose and apt to be blown about by the wind the planting of belts of quick-growing trees (even though such may be useless for purposes other than shelter) and live fences, such as gorse and broom, should be experimented with in an endeavour to mitigate the effect of wind and frost. Some areas richer in humus will be found suitable for the growth of root crops such as beet, mangolds, and turnips, which would form a most welcome addition to the pasture ration of stock. The depth of the pumice layer and the nature of the underlying rock are important points to be ascertained. It is possible that this will exercise a considerable influence on the fertility of the super soil. At Tongariro, for instance, there is beneath the pumice a rock richer than it in plant-food (Thomas). Leguminous deep-rooting plants such as lucerne are able to obtain their food several feet below the surface. To effectively establish lucerne may require dressing with lime, and this entails railage facilities from Te Kuiti. Improvement in pumice soils must depend largely on increasing the store of humus and by application of phosphatic fertilizers. There is some evidence that superphosphate is the most suitable phosphate to apply. I attach great importance to the need of increasing the content of humus on pumice lands not only because it will improve the mechanical condition of the soil, but because a very great increase in the availability of the plant-food may thereby be effected. There is not wanting evidence that pumice soils are capable of very great improvement. Where humus has accumulated large amounts of available phosphoric acid and potash are found—for instance, at East and West Taupo (J 853-4), at Tokaroa Plains, at Arahiwi (G 37), Oteroa (M 798), and Rotorua (L 1121)—and this is not due to there being a greater amount of plant-food in the original rock, for the total amount shown by analysis is often not greater in the richer soil than in the poorer. It seems certain, then, that when once these sandy plains are covered with vegetation they may be expected greatly to increase in fruitfulness.

5. *Mr. Newman.*] You said it was the copious rainfall that saved the situation?—I think so.

6. What is the effect of rainfall on manure—does it wash it right through?—In the case of nitrates it would wash it out, but nitrates are not the only class of ingredients valuable in fertilization; phosphates are always retained. The ground is full of potash. It is not all in an available condition; but all the samples I have analysed have been rich in available potash.

7. Without nitrates the vegetation would be very poor?—You must have nitrates.

8. Have you tried practical experiments on this soil?—No, unless analyses are practical experiments. You mean plot experiments?

9. Yes?—They are being tried at the present time.

10. Your experiments have been in the laboratory entirely?—With one exception I think. We have a series of experiments at present going on at Te Pu, near Rotorua—that, of course, is on pumice soil—but they are not completed yet. I have personally seen those experiments, and it is from those experiments that I consider superphosphates will have a great ameliorative effect on this pumice land.

11. What quantity of superphosphates per acre do you estimate will be wanted?—From 3 cwt. to 5 cwt.