

has fallen to a very marked extent—further evidence of the permanent improvement that has been effected in combating the malady. Some years ago the Rotorua office of the Department was supplying an average of 40 lb. to 50 lb. of iron citrate a month for use in connection with bush sickness, but at the present time months often pass without a single pound of the preparation being sold."

The Whakamarama district, West of Tauranga, was the subject of investigation and report at the request of the Settlers' Association. Mr. C. R. Taylor in his report states that the whole district is covered with from 3 in. to 6 in. of fine Kaharoa pumice ash overlying a coarsely textured creamy-brown pumice of over 3 ft. depth. A mild degree of bush-sickness exists, especially in the early stages of development, but this has been overcome with the aid of limonite, and with correct farming practice the district should become a productive one.

Analyses of the soils showed them to be sandy silts deficient in total and available phosphoric acid, normal in available potash, and rich in nitrogen. Although they showed a fair lime requirement, liming was not advocated on account of its known unfavourable effect on pumice bush-sick soils.

In the Ruakaka district, on the south side of Whangarei Heads, there are considerable areas of soil composed of blown sand, much of it very little above sea-level. Several settlers on the portions bordering the coast have experienced difficulty in rearing calves, and some mortality has occurred in grown stock. A form of bush sickness was suspected, and this appears to be confirmed by the favourable results secured from the use of limonite. Samples of soil have been collected for analysis.

A mild form of bush sickness apparently occurs on loamy-silt pumice soils near Morrinsville. The farms concerned are on low rolling hills, and it was found that the trouble was greatest where the subsoil was lightest—that is, had the least clay. Considerable improvement has resulted from the use of limonite, and it would probably be good policy to feed a little limonite on any of the lighter soils derived principally from pumice. Even on the loam soils of the Mairua district, where lime is deficient, it is reported that a limonite lick resulted in great benefit to a flock of sheep.

Further favourable reports have been received of the results of limonite-feeding in the Morton Mains district, Southland.

Limonite.—Further investigation of the nature and composition of various "limonites" has been carried out, and a paper was published in the September, 1934, *Transactions of the Royal Society of New Zealand*. It was also found that extracts made with tenth normal hydrochloric acid contained appreciable amounts of cobalt and zinc, and some preliminary feeding trials with these elements are being carried out. Some investigators claim that in bush sickness and similar conditions in other countries it is not iron but some accompanying metallic element which is lacking and which is supplied in traces in iron-licks such as limonite. Copper, cobalt, zinc, manganese, arsenic, are among such elements. Such trace elements may act in one of two ways: they may be essential, providing links at some stage in the metabolism of iron in the body, or they may merely be stimulants urging the blood-forming organs to greater or perhaps more economical functioning. The only element definitely proved at present to be essential to iron metabolism is copper, and there is the strongest ground for claiming that there is no deficiency of copper associated with bush sickness, the main proofs being—

(1) Numerous livers of animals dying of bush sickness have been analysed and found to contain the normal or more than the normal amount of copper.

(2) Blood analyses conducted during the year from a number of experimental sheep have shown no significant difference in copper-content between bush-sick and healthy sheep.

(3) Two healthy sheep at Kaharoa drenched daily with 1 fluid ounce of a one-per-cent. solution of copper sulphate for three months without access to limonite lost condition and became very bush-sick. On the other hand arsenic has been found in some instances to exert an apparently curative effect on bush-sick animals, but there is little doubt in this case that the action is merely a stimulating one. The effect is only temporary. Arsenic was determined on a number of bush-sick and healthy pastures, and was found to have the same range of values in both cases—namely, from 1 to 7 parts per 10,000,000 parts of dry matter. Workers in South Australia and West Australia claim that cobalt is an essential element, the lack of which is responsible for a sheep disease resembling bush sickness. Their claim cannot be considered proved, however, until animals on the affected country have been carried in health through more than one generation by means of cobalt.

PAMPAS-GRASS.

During the year a considerable amount of work has been done on the chemistry, culture, and utilization of pampas-grass as fodder. The cell-wall constituents have been determined and compared with other forage plants. Pampas-grass contained from 4 per cent. to 5 per cent. total reducing substances (as glucose), from 13 per cent. to 24 per cent. total hemicellulose (differing in composition from recorded analyses of hemicelluloses of most grasses), from 37 per cent. to 41 per cent. cellulose (Cross and Bevan), and from 17 per cent. to 19 per cent. lignin, as compared with from 6 per cent. to 17 per cent., from 16 per cent. to 21 per cent., from 21 per cent. to 33 per cent., and 18 per cent. respectively for other common fodder grasses. It is therefore comparatively very rich in cellulose and hemicellulose without a corresponding increase in lignin, and as cellulose and hemicellulose are split up by bacteria in the digestive canal of ruminants into glucose, and therefore have about the same feeding-value as starch, while lignin is indigestible and may reduce the digestibility of cellulose by its encrusting action, it is possible that in pampas the lignin has very little protective action on the cellulose against bacterial attack. This is also likely to be accentuated by the fibres in pampas being spread out in numerous fine strands so that the leaf is easily broken and disintegrated, whereas in toetoe, for instance, the fibres are collected into closely knit bundles or ribs giving the leaf great strength, while the bundles themselves are difficult to disintegrate. Pampas is comparatively poor in protein, the green leaves containing about 10 per cent. and the succulent bases about 5 per cent. in the dry matter, which is 25 per cent. of the green weight. It is therefore to be compared chiefly with other carbohydrate or energy