GENERAL.

A REVIEW OF RECENT WORK ON THE MINERAL CONTENTS OF PASTURE GRASS AND OTHER FEEDING STUFFS AND THEIR EFFECT ON LIVE STOCK.

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From the earliest days of Agricultural Chemistry a great deal of the time and attention of its exponents has been devoted to the study of the nutritive values of feeding stuffs, one of the most important of which is pasture grass Investigation was however confined to a very large extent to the organic constitutents of feeding stuffs and their energy values, and it is only within comparatively recent times that research has been carried out on the rôle of the inorganic constituents of these feeding stuffs in animal nutrition. Such information as has been obtained has thrown an entirely new light on the subject, as a result of which it has come to be regarded as one of great economic importance in the science of animal husbandry. To the British Empire in particular any conclusive results in this field of research must have far-reaching effects as statistics show that there are no less than 128 million sheep in Australia and the British Isles alone, 188 million cattle in India and the British Isles, in addition to the millions of herbivora in Canada, South and East Africa and other parts of the Empire.

That deficiency in the mineral contents of pasture grass and other constituents of the rations of herbivora and other farm animals has had distinctly harmful effects on the animals so fed, the following examples would conclusively demonstrate. Thus Theiler, Green and du Toit(8) have shown that deficiency in phosphorus in the Veld soils of South Africa resulting in a corresponding deficiency in the pasture " is the cause of pica (depraved appetite) which is prevalent in cattle in certain districts there and leads to the ingestion of the organism which causes lamziekte; and that this condition can be prevented by feeding bone meal or any foodstuff rich in phosphorus." Aston (10) has shown that deficiency in iron in the pasture in certain districts in New Zealand is the cause of malnutrition in the animals grazing on it. The symptoms of the disease are relieved by feeding iron salts and the condition entirely avoided if the animals are transferred to an area where the pasture is richer in iron. Munro (11) has drawn attention to the high mortality among sheep in the Falkland Islands as a result of deficiency in calcium and phosphorus in the pasture. Ingle (2) has shown that ' osteoporosis ' which affects horses, donkeys and mules in certain districts in Transvaal, is due to the great excess of phosphorus and the deficiency in calcium in the pasture and fodder crops. Davis (9) as a result of his investigation concludes that the very low percentage of phosphorus in the crops and soils of the Bihar district in India is the cause of the very low milk yield

of cows in this State. Tuft (13) has shown that the most frequent cause of ' osteomalacia ' in cattle in Norway is an insufficiency of supply of minerals, particularly lime and phosphoric acid. Elliot and Crichton (3) of the Rowett Institute, Aberdeen, have more recently demonstrated that ' bent-leg ' in sheep is due to mineral deficiency and can be averted by a mineral supplement. Hart, Steenbock, and Humprey (1) have noted " that deficiency of calcium in the diet of cows may lead to the birth of dead or weakly calves, and Ennis Smith has shown that the deficiency of iodine in the food of pigs may lead to the birth of dead young, although there is not in either case, any obvious pathological condition apparent in the mothers."

Sufficient evidence has therefore been furnished to show that deficiency in the rations of animals may have very harmful effects on them. In many, if not in most cases, however, improvement follows the adjustment of the mineral balance in the food, instances of which have already been cited. Besides these, others may be mentioned. Thus Kellner has obtained an increased rate of growth in calves by the addition of calcium salts to the diet on which the animals grew at an average rate (1). In Ohio, Scotland and North Ireland, egg-production in poultry has been increased by the addition of salts which are present in but small quantities in the rations (1). Again at Ohio and at Aberdeen addition of salts lacking in the rations of dairy cattle has resulted in a rather greater yield of milk, and in an increase in breeding capacity and decrease in disease.

Within recent years a great deal of work on the subject has been done at the Rowett Research Institute, Aberdeen, by W. Elliott and his co-workers, and the results of their investigations have been published in a series of articles in a recent number of the Journal of Agricultural Science, Vol. XVI., Part 1. Their work was comprised of a study of the mineral contents of pasture grasses of Scotland, England and Wales; the differences in composition between ' natural or uncultivated ' pasture and ' cultivated ' pasture; the effect of the addition of mineral salts on the rations of sheep and the seasonal variations in, and the effect of fertilisers on, the mineral content of pastures. The results of these investigations are summarised by Dr. Elliott thus:—

" (1) The results of previous investigations, showing that there is no striking difference in the energy value between good and pure pastures, are fully confirmed.

(2) Wide differences, however, do exist in the proportions in which the mineral constituents are present in different pastures.

(3) These differences correspond closely with the respective value to the stockman of the pastures in which they occur, a high mineral content being associated with a higher nutritive value.

(4) The demonstration that the non-energy yielding constituents of the pasture is of an importance at least equal to that of the energy yielding constituents opens up possibilities of a very far-reaching kind, both economic and scientific."

To turn now to some of the individual investigations. Elliot and Crichton (3) carried out a series of experiments on the effect of the addition of mineral salts to the rations of sheep. 'Bent-leg' in sheep was definitely shown to be due to mineral deficiency in the pasture, "which may be averted

or postponed by the addition of mineral supplements or of cod liver oil which increases the assimilation of the mineral matter already present in the ration. Pasture analysis indicated that grave mineral deficiencies do occur in large pastoral areas, and that these areas are correlated with high stock death rates." Godden (4) reports on the chemical analysis of pasture from various areas in the British Isles. He divided the samples into the following groups:—(1) grass grown on cultivated (*i.e.*, fertilised land), (2) " Grass eaten " by herbivora from hill pasture, and (3) the corresponding " grass not eaten." The results of numerous analyses of each group as shown in the table below conclusively demonstrate that (a) cultivated pasture is decidedly richer in nitrogen, silica-free ash, calcium, potassium and phosphorus, and poorer in sodium than the natural hill pasture grasses; (b) the " grass not eaten " is much poorer in nitrogen, silica-free ash, and in each of the other elements than is " grass eaten."

	Calcium Oxide.	Phosphoric Acid.	Sodium Oxide.	Potass Oxide.	Chlorine	Nitrogen.
Average for Cultivated Pastures.	1·004	·735	·246	3·178	·95	2·83
Average Hill Pasture (grass eaten).	·648	·673	·366	2·66	·64	2·50
Pasture (grass not eaten).	·304	·371	·166	1·61	·33	1·82
Rich Pasture.	2·47	·997	·70	2·40	·50	3·56
Very poor Pasture (Falkland Islands).	·225	·49	·29	1·98	·58	1·65

In the above table are also given for comparison the mineral compositions of a typical rich pasture and of a very poor pasture, *e.g.*, the pasture from the Falkland Islands. It will be noted that wide differences in the mineral contents of the two types do exist. Miss Cruickshank (5) studied the seasonal variations in the mineral contents of pastures. That the mineral content of pasture will vary with the season is only to be expected, and analyses of pasture carried out at Aberdeen at various seasons bear out this expectation. Previous to this other workers had found seasonal variations in the mineral content of pastures. Theiler (8) found that the phosphorus content of the herbage of the South African veld steadily decreased from 6 per cent. Phosphoric Acid in the dry matter in November to ·09 per cent. in June. Armstrong (7) studying the variations in the dry matter of Leicestershire pastures found that the highest percentage of nitrogen and phosphorus in the dry matter occurred in May-June. Miss Cruickshank's results and conclusions are summarised thus " (1) There is a definite seasonal variation in the mineral content of the pastures examined between the months of May and October, which is most clearly shown by the calcium oxide which rises to a maximum and then steadily falls, and to a less extent by the silica-free ash, phosphoric acid and sodium oxide. (2) The chlorine content did not show a corresponding variation: its tendency being to maintain its high percentage through the later part of the season. (3) The nitrogen, on the whole, showed a variation corresponding with the calcium, though the range was markedly less. (4) The range of the seasonal variation was definitely greater

in the good types of pasture than in those of inferior quality. (5) The period at which the maximum content was reached varied in the different fields, and it is suggested that it was influenced to a considerable extent by the nature of the grazing." Godden (6) investigated the effect of fertilisers on the mineral content of pastures. His results indicate that " the application of artificial fertilisers to grassland may result in considerable modifications in the mineral content of the herbage of pastures. The constituents which appear to show the biggest variations are calcium and potassium, and to a certain extent, phosphorus." Liming resulted in an increase in the percentage of calcium, a tendency for the phosphorus to remain constant or to be depressed, and in a slight rise in the percentage of nitrogen. The application of slag or super in certain types of pastures result in a marked increase of crop.

An instance quoted by Godden of how manuring may affect the mineral constitution of pasture grass is that of two adjacent fields A and B on similar soil. B was sown down in 1910 and received no manure since. A was sown in 1916, manured with 10 cwt. slag per acre and a further 5 cwt. in 1919. In 1915 it had received, when carrying a root crop, 5 cwt. phosphates and 2 tons waste lime. Analyses of the herbage carried out in 1914 revealed wide differences in the composition and mineral contents of the pasture of the unmanured and manured plots as the following table will show :—

	A (manured).	B (unmanured).
	% on dry matter.	% on dry matter.
Calcium oxide	1·42	0·56
Phosphoric acid	·70	·52
Sodium oxide	·84	·36
Potassium oxide	2·90	1·96
Chlorine	·92	·55
Nitrogen	3·33	1·75
Ether extract (fat)	3·96	2·22
Fibre	20·7	28·1
Silica-free ash	8·09	4·48

CONCLUSION.

In the foregoing pages are summarised the results of scientific investigations on the mineral contents of pasture grass and other feeding stuffs and their effect on herbivora and other farm animals. Sufficient has been written to show the economic importance of this aspect of the science of animal husbandry. To the stock-breeder these results must decidedly be of very

great interest and importance, in as much as they would reveal to him a probable cause of the symptoms of malnutrition he may have observed among his stock. Even to a country like Ceylon, where live-stock are not of such economic importance as in many of the other British Dominions and Colonies these results must be of some significance. It does not require much observation to note that our local breed of cattle to a great extent, show many of the symptoms of malnutrition, *e.g.*, slow and stunted growth, low milk yields, high mortality, etc., which recent research has associated with deficiency in the pasture and other constituents of the rations of essential mineral elements. Cases of " osteoporosis " in horses have also been reported as being of not infrequent occurrence in Ceylon, and it is probable that as in South Africa, deficiency of mineral elements in the pasture and fodder may be the cause of the disease. Our soils are well known to be poor in phosphorus and lime, and it seems reasonable to expect a corresponding deficiency in these elements in the pasture. Analyses have already been made of the mineral contents of " cultivated " grasses from the Experiment Station, Peradeniya, but the number of such analyses has not been sufficiently great to warrant a definite statement being made on the results obtained. Besides these analyses of samples of grasses from the different parts of the island will have to be made before " average " figures for the mineral contents of Ceylon " cultivated " grasses could be secured. The results so far obtained seem however to indicate that our grasses are deficient in phosphorus and to a lesser extent in lime. What is perhaps of equal importance is the analysis of the mineral contents of the ordinary " uncultivated " pasture grass, on which it is presumed the majority of our cattle feed, as undoubtedly, malnutrition is more rampant among these unfortunate animals than among those more carefully tended. The seasonal variation in, and the effect of manuring on, the mineral contents of both cultivated and uncultivated grasses are also problems that need investigation. These have not been lost sight of, and it is hoped to deal with them as the opportunities present themselves.

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PADDY CULTIVATION COMPETITION IN KEGALLE DISTRICT.

A paddy cultivation competition for Beligal Korale, Galboda-Kinigoda Korales and Paranakuru Korale of the Kegalla District was held during Maha season of 1926, and the following have been adjudged winners:

Beligal Korale:

1st prize	...	W. M. Ukku Banda of Yatthawala,	Rs. 30.
2nd prize	...	S. A. Ausadahamy of Kehelwatugoda,	,, 20.

No. of Competitors: 29.

Galboda-Kinigoda Korales:

1st prize	...	H. Tikiribanda of Kumbaldiwella,	Rs. 30.
2nd prize	...	D. Punchirala of Kadigamuwa,	,, 20.

No. of Competitors: 14.

Paranakuru Korale:

1st prize	...	N. U. Arachchie of Rahala,	Rs. 30.
2nd prize	...	W. R. Mudalihamy of Malawita,	,, 20.

No. of Competitors: 44.

In the above competition there was a marked improvement in the methods of cultivation adopted, and the competitors showed great keenness. The crop was good.