

CONFIDENTIAL.

C.S.

1926
1924.

No.

C/4/1926

S. of S. Conf. Circ. Dispatch

SUBJECT.

1925

6. XI. 25

MINERAL CONTENT OF NATURAL PASTURES

Previous Paper.

G.O. C/6/1926

*Interim Report by Chairman of
Sub-Committee of Committee of
Civil Research.*

MINUTES.

1-2.

*Conf. Circ. Dispatch from Secy. of State. 6. XI. 1925
Extracts from Minutes on G.O. C/6/1926*

H.C. For information.

2. Will you please detach for record in your office, one copy of circular, and copy no. 298 of the Interim Report.

3. It seems almost unnecessary that any reply to circular should be made from this Colony, but as one is asked for I attach a draft.

4. When convenient will you please send you copy of circular, and interim report to Hon. G. Rowley for his personal and return: although ~~secret~~ report is marked secret I think that as a member of Ex. Co. he should see it.

Int. J. M.

25.1.26.

Subsequent Paper.

H.C. Para. 2 - Copy of circular, and copy no. 298 of Report withdrawn and registered in this office.
Para. 3 - Typed dispatch forwarded herewith

Para. 4 Noted for necessary action.

(Insd) J.D. C.
29.1.26

Hon. G. Bonner.

For your perusal

Read with great interest

G.W. Bonner

16/4/26

J.D.
16.4.26

Confidential Circular despatch from Secretary of State
3 0th September, 1926. 4.-6.

Copy of Report
was also sent
to Hon. G. J. Felton
by J.E. +
returned by
Hon. Felton 11/9/26

Copied from G. O. C/6/1926.

H. C. S.

Please withdraw duplicate copy of despatch
and copies Nos. 202 and 203 of each of the enclosures.

2. When opportunity permits Hons. G. Bonner and
G. J. Felton should see.

3. Chief Inspector of Stock also should see.

(intd) A. E. B.
4th Nov. 1926.

Chief Inspector of Stock.

To see enclosures in vol 6 files.

J. Walker
Asst. Sec.

27. 11. 26.

The Hon
Asst. Sec.

Thank you - Dear

T. W. Carter
C. I. S.
29/11/26

f. 23. 12. 26
pe 1. 12. 26

SECRET.

Copy No. 298

C.R. (C) 6.

COMMITTEE OF CIVIL RESEARCH.

SUB-COMMITTEE ON THE MINERAL CONTENT OF NATURAL PASTURES.

INTERIM REPORT BY THE CHAIRMAN.

THE question of the mineral content of natural pastures was considered in its general aspect at a meeting of the Sub-Committee held on the 9th July, 1925. The Sub-Committee were informed that the Board of Agriculture for Scotland were trying to arrange for Dr. J. B. Orr, of the Rowett Research Institute, to visit South Africa in the near future in order to confer with Sir Arnold Theiler, Director of Veterinary Education and Research to the Union Government. The Sub-Committee felt that advantage should be taken, if possible, of this opportunity to enable Dr. Orr to visit Kenya, where this question might prove of great economic importance, and as a result of the representations made by the Sub-Committee arrangements to this end have now been made.

The Sub-Committee further considered that research in this country would be greatly assisted if more adequate information was available regarding the problems arising out of varying mineral contents in natural pastures. They felt that it was particularly desirable to collate all available information regarding the steps taken to deal with this question in other parts of the Empire, and they accordingly decided to prepare a Memorandum giving the substance of the scientific results at present achieved and containing a short questionnaire to indicate the lines on which further information was desired. The Sub-Committee recommend that copies of the Memorandum should be communicated to the India Office, the Department of Dominion Affairs, the Colonial Office and the Foreign Office, for communication to the Government of India, the Dominion and Colonial Governments and the Government of the Sudan, who should be asked to forward observations and replies to the questions submitted.

I accordingly submit for the consideration of the Committee of Civil Research the Memorandum prepared by the Sub-Committee, and invite the Committee's authority for its circulation to the Governments of the Empire in the manner proposed by the Sub-Committee.

(Signed) W. E. ELLIOT,
Chairman.

(Signed) A. F. HEMMING,
Secretary to the Sub-Committee.

2, Whitehall Gardens, S.W. 1,
September 23, 1925.

MEMORANDUM PREPARED BY THE SUB-COMMITTEE.

Origin of this
Sub-Com-
mittee.

THE Committee of Civil Research is a body established under a decision of His Majesty's Government of the 28th May, 1925. The President of the Committee is the Prime Minister, and in his absence the regular Chairman is a Minister nominated by the Prime Minister. In the present Government the Chairman is the Lord President of the Council.

The Committee, like the Committee of Imperial Defence, is an advisory body. It is charged with the duty of giving connected forethought from a central standpoint to the development of economic, scientific and statistical research in relation to civil policy and administration, and it will define new areas in which enquiry would be valuable.

The Civil Research Committee works by Sub-Committees, set up *ad hoc*, of a very elastic composition.

Special
Problem
under
consideration.

A case apparently suitable for consideration by such a body was brought to the Prime Minister's notice in the heavy losses amongst stock running on certain pastoral areas of the Empire, including Great Britain, and the difficulty in other areas of grading up low-grade stock without mortality losses so heavy as to make the improvement entirely uneconomic.

Scientific work in recent years has pointed to the possibility of widespread sickness arising not only from infection, but also from a lack of some essential but little-known substances in the ration. Much work along these lines has been done in various parts of the Empire, *e.g.*, in Scotland, South Africa, Australia and New Zealand. This problem is also receiving attention in the United States of America. A concrete example was the heavy death rate amongst the sheep stocks of the Falkland Islands which has just been investigated at the Rowett Institute in Scotland and by Mr. Hugh Munro, of the New Zealand Department of Agriculture, at the request of the Governor of the Falkland Islands. This was found to be due in all probability to the great deficiency of lime in the soil and pasture. Another such case was brought up unofficially by certain stock farmers of Kenya, and is at present under investigation in consultation with the Colonial Office and the Government of Kenya.

Decision to
Investigate.

On consideration of the facts as known, it was decided to set up a sub-committee to go into this whole subject. The sub-committee as constituted contains representatives of various research departments, and of the English and Scottish Departments of Agriculture, and of the Colonial Office, the India Office and other Government Departments.

Procedure
Adopted.

At the first meeting of this sub-committee it was decided to send to the various Empire Governments a short general statement of the present information available to the Committee on this subject, with a request for any further papers, &c., which they might have available. It is believed that most of the scientific papers from Empire sources dealing with this subject have already been read and considered by the scientific members of the Committee, but there may be some which have escaped their notice, and in any case a file of all available papers would be of great value to the Committee.

It was also thought that there might be some data not yet published which could be submitted in draft form, and that in some areas where there have been no facilities for a systematic investigation, practical observations of potential value may have been made, and that notes on these observations with the views of the observers might be obtained by this Committee.

Questionnaire
(Appended).

In addition, it was decided to attach a short questionnaire (appended) to obtain information from any Governments which had not so far specially considered the question.

Information
to be ---
Confidential
to Cabinet.

It is recognised that in some cases there may be a desire that the information supplied with regard to privately-owned lands or herds should not be divulged. When this is indicated, the information will be regarded as confidential. (All information communicated to the Committee of Civil Research and all proceedings of the Committee are strictly confidential to the Cabinet. Information so given is not even published in résumé form.)

It is intended to circulate a résumé of the information obtained by this Committee to the Governments concerned, for issue if desired, to all those who have supplied information or are contemplating collecting information on the subject.

The memorandum annexed summarises generally the present information on the subject so far as is known to the sub-committee.

MEMORANDUM ON AVAILABLE INFORMATION ON CERTAIN DEFICIENCIES IN PASTURE
AND THEIR EFFECTS ON THE GROWTH AND STRENGTH OF STOCK.

(Figures refer to references, which are given at end of Memorandum.)

The results of recent research have shown that the mineral content of the diet has a profound influence on the health, rate of growth and productive capacity of domestic animals, and that serious losses occur through the use of rations in which there are marked deficiencies or excesses of one or more of the essential mineral elements (1), (2), (3). Though most of our information on the effects of deficiencies or excesses of minerals in the diet have been gained from observations on animals being fed on rations consisting chiefly of concentrates, it is known that animals feeding on pasture may also develop pathological conditions due to deficiencies of one or more mineral elements in the pasture.

Mineral Con-
tent of
Foodstuffs.

Mineral
Content in
relation to
Pasture:

The mineral content of pasture depends to some extent on the composition of the soil in which it grows. On cultivated land the composition of the soil is affected by "manuring," the main object of which is to supply either nitrogen or mineral elements thought to be deficient in the soil. Hence there must be a tendency for cultivated pastures to approximate to a common type, which experience has shown to be suitable for the nourishment of domestic herbivorous animals. It might be presumed that the mineral content of this type would be suitable for herbivora, and, as a matter of fact, it has been found that the cultivated pastures proved of most value for feeding, contain the essential mineral elements in the amounts and proportions nearest to those required by the animals feeding on them (4).

(a.) Culti-
vated Pasture.

But natural or uncultivated pasture grows on soil which has not been treated by the addition of mineral manures, and its mineral content is, therefore, likely to vary in different localities. In their natural state, herbivorous animals are free to range over wide areas, and in their choice of pastures are doubtless guided by their appetite to vary their feeding ground, so that in the whole of their grazing there would be no constant deficiency or excess. It is probable that some of the migrations of herbivorous animals are determined as much by the necessity for the proper quality of pasture in this respect as for quantity.

(b.) Unculti-
vated Pasture.

In the natural evolution of types of herbivorous animals, development in different areas would be towards a type whose size and rate of growth could be supported by the pasture of the area. This idea was put forward over fifty years ago by Brown (5), who showed that the different breeds of sheep in Britain were correlated with differences in the geological formation of the areas where they were found.

From the foregoing considerations it is evident that disturbances in nutrition due to deficiency of minerals in natural pastures would be liable to occur under one of the following conditions:—

Conditions
under which
Deficiencies
might occur

- (a.) When animals accustomed to select their grazing over a wide area are confined to a limited range within that area.
- (b.) When a type of animal with a rapid rate of growth, usually reared on cultivated pasture, is transferred to a natural pasture which contains markedly less of one or more mineral elements than the pasture on which the type has been evolved.
- (c.) When, over a long period of years, a grazing area has been depleted in those mineral elements which are used as constructive materials in growth, by the removal of animals, or animal products such as milk, without any measures being taken to restore to the soil amounts of minerals equal to those carried off in the bodies and bones of the animals, or in their products.

As a matter of fact, it is under these conditions that malnutrition in herbivorous animals due to mineral deficiencies has occurred. Thus Murphy (6) records that in certain districts of Australia, when the land was fenced, cattle suffered from characteristic bone lesions and paralysis associated with deficiency of phosphorus, milk cows and growing stock being worst affected. When the soil was fertilised with the deficient minerals the stock were maintained in good condition.

Instances
where Stock
Diseases due
to such
Deficiencies
have
occurred:
Australia.

In the literature there are many recorded cases of domestic animals failing to thrive after being transported to new countries and fed on the natural pasture there. One of the most interesting cases is that recorded by Theiler (7), who has shown that the deficiency of phosphorus in pastures in the Transvaal limits the rate of growth of young stock, and the milk yield of cows, in the imported type of cattle being bred. He has also shown that the feeding of substances rich in phosphorus, such as bone

South Africa.

meal, or the phosphatic manuring of the soil, prevents the development of these results of malnutrition.

Falkland
Islands.

It seems probable that the Falkland Islands afford an excellent example of the effects of depletion of pastures. Sheep have been reared and exported from these islands for about forty years, and neither foodstuff nor manure has been imported. During the last twenty years it has been increasingly difficult to rear lambs, and it seems evident from the result of an investigation recently carried out at the Rowett Institute, Aberdeen, that the difficulty can be attributed to malnutrition, the primary cause of which seems to be deficiency of calcium in the soil.

Signs of such
Diseases (as
reported in
the Falkland
Islands).

The signs of malnutrition which appear in animals suffering from deficiency of one or more of the essential mineral elements have been described by several observers. Probably the most recent observations available are those recorded by Munro in a report to the Colonial Secretary of the Falkland Islands (8). He notes that there is a "steady decrease in size of matured animals from one generation to another (unless maintained by importing breeding stock periodically from other countries) In this country young sheep require from six to nine months longer to reach maturity than they do elsewhere, and it is held that if even the best-developed ewes are used for breeding purposes when 18 months old it permanently interferes with their development to an appreciable extent. Besides which the percentage of lambs obtained from them is extremely small. The fact is well recognised that after breeding from local mares and stallions for a few successive generations the progeny become reduced to the size of ponies, and for this reason horses must be imported regularly from South America for breeding purposes. Cattle also, which are the progeny of several generations of locally-bred animals, are very small, averaging only about 500 lb. when fat. They have the dry coat and hidebound appearance which is so typical of cattle suffering from malnutrition. Cattle grazing on country where there is a deficiency quickly develop a depraved appetite, which is evidenced by the chewing of bones, wood and other articles for which they would evince no desire on healthy country. Here both sheep and cattle have developed depraved appetites to an unusual degree. Cattle eat up all the old skeletons of sheep, and sheep have a great appetite for the excrement of penguins and wild geese I have been informed that a lot of sheep hang about the coast to eat the kelp, but what they really are after is the salt and other valuable chemicals that are always associated with salt in small quantities."

Further
Signs:
South Africa.

The work of Theiler, Green and du Toit in South Africa is so well known that it need not be referred to in detail. Depraved appetite, with resulting "lamziekte" through the consumption of putrefying carcasses containing pathogenic organisms, emaciation and general unthrifty condition have been noted by these workers.

India.

Fragility of bones has been frequently noted as a result of deficiency of either calcium or phosphorus (Tuff (9), Ingle (10)). In dairy cows in India low milk yield occurs in areas in which the soil is also deficient in phosphorus (Davis (11)), and failure to breed and also increased incidence of certain diseases are observed in deficiency of calcium (Meigs, Erf, Orr and Crichton (12)).

Scotland.

In these cases to which reference has been made, the correlated deficiencies were either calcium or phosphorus, the two mineral elements which are required in largest amount by animals. There are cases, however, in which malnutrition may arise from lack of some of the other essential minerals.

Other Special
Deficiencies.

Iron (New
Zealand).

Aston (13) has shown that in certain extensive areas in the North Island of New Zealand, where "bush sickness" occurs in ruminants, the pastures are deficient in iron. The symptoms of this disease are anæmia and emaciation, with a high mortality. The development of the condition can be prevented by "drenching" the animals with certain iron salts or by grazing them periodically in other districts where the pasture has the normal amount of iron. It is interesting to note that if the animals at an early stage of the sickness be removed from these pastures and put on to other pastures they will thrive and fatten for a time after they are returned to the iron-deficient pastures. The animal is able to store up in its system a reserve of iron, and the pathological conditions do not develop until this reserve is exhausted. This power of the animal to accumulate reserves occurs also in the case of certain other mineral elements, so that animals may thrive for a time on pastures which are deficient and no sign of malnutrition may develop if the animal has a free range on which it may change its feeding ground as its appetite and instincts direct.

Salt (Aus-
tralia).

The evil effects of deficiency of sodium chloride on the health and quality of the wool of sheep have been noted by several observers. This has recently been emphasised by Reid in the case of sheep in Australia. In most of these cases it is

probably chlorine that is deficient; in other cases, however, this deficiency may be sodium.

Deficiency of iodine has been noted in certain inland districts. In breeding animals there is high mortality in the young (Ennis Smith (14)). Enlargement of the thyroid gland causing a characteristic swelling in the neck sometimes occurs. In young animals there is a slowing in the rate of growth (Orr (15)). Some recent work at Ottawa seems to suggest that deficiency of iodine reduces resistance to certain infectious diseases.

From what has been said above it is apparent that deficiency of one or more of the mineral elements should be suspected, when the following signs of malnutrition are prevalent in certain areas and cannot be attributed to any other cause:—

1. High mortality, especially in young animals.
2. Low breeding capacity and slow rate of growth.
3. Depraved appetites.
4. Abnormally low milk yield from breeds of cows which are known to have a normal yield in other localities.
5. Increased incidence of disease when slow-growing or slow-producing native types of animals are graded up by the introduction of rapidly maturing improved breeds (which have a higher requirement for minerals than the slower-growing breeds).
6. Excessive fragility of bones or deformities or weakness of the limbs.

It is known that these deficiencies occur in various pastoral areas throughout the Empire. In districts in South Africa, New Zealand, Australia and India, the nature of the deficiency has been found, and in most of these cases further investigations have shown that it is possible to rectify the dietary error, either by feeding substances rich in the deficient minerals or by altering the composition of the pasture by the application of mineral fertilisers to the soil, though the second of these methods is not always economically possible. In a recent investigation on the cause of malnutrition and high mortality of sheep in certain hill pastures in Great Britain, it has been found that the nutritive value of the pasture, as determined by the condition of the sheep and the incidence of disease, can be correlated with the mineral content of the pasture (Elliot, Orr and Wood (4)). Reference has already been made to the case of the Falkland Islands, the recent investigation of which has shown the cause of the prevalent malnutrition and high mortality to be deficiency of calcium in the soil. In some districts, such as Kenya and Cameroon, where systematic investigations have not yet been carried out, some of the signs of malnutrition, noted above have been observed, and it is probable that investigations now being conducted will lead to the identification of the deficiencies. It is believed that there may be a number of other pastoral areas where malnutrition due to these causes has already appeared or will appear when the native breeds have been graded up by the introduction of rapidly maturing or heavy producing breeds. The pooling of information on this subject, and the dissemination of it in these pastoral areas, may accordingly lead to investigations which will yield results of considerable economic value to those parts of the Empire concerned.

References.

- | | |
|--------------------------------|--|
| (1) Hutvya and Marek | "Pathology of Diseases of Domestic Animals," Baillière, Tindall and Cox, 1913, vol. I, pp. 930-966. |
| (2) Mendel | "Nutrition," Yale University Press, 1923, pp. 29-56. |
| (3) Orr | "Trans. Highland and Agricultural Soc.," 1923, 5th series, vol. XXXV, p. 3; "Nature," October 3, 1925. |
| (4) Elliot, Orr and Wood | "Scot. Jour. Agr.," 1925, vol. viii, No. 4. |
| (5) Brown | "British Sheep Farming," Adam and Charles Black, 1870. |
| (6) Murphy | "Journ. Dept. of Agr., Victoria," 1917, vol. XV, part 8. |
| (7) Theiler and others | "Journ. Dept. of Agr., South Africa," May 1924. |
| (8) Munro | "Report of Investigation into the Conditions and Practice of Sheep Farming in the Falkland Islands," 1924. |
| (9) Tuff | "Journ. Comp. Path. and Therap.," 1923, vol. 36, p. 143. |
| (10) Ingle | "Journ. Agr. Sci.," 1908, vol. III, p. 22. |
| (11) Davis | "Agr. Journ. of India," vol. XXII, p. 77. |
| (12) Meigs | "U.S. Dept. of Agr. Bull.," 945, 1921. |
| Erf | "Proc. World's Dairy Congress," 1923, vol. II, p. 1055. |
| Orr and Crichton | "Scot. Journ. Agr.," 1925, vol. VIII, No. 3. |
| (13) Aston | "Trans. New Zealand Institute," 1924, vol. 55, p. 720. |
| (14) Ennis Smith | "Journ. Biol. Chem.," 1917, vol. 29, p. 125. |
| (15) Orr | Presidential Address, Section M, British Association, August 1925. |

Iodine :
Canada.
Scotland.

General
Summary
of Conditions
found in such
Deficiencies.

Wide-spread
Nature of
this Problem :
South Africa.
New Zealand.
Australia.
India.

Great Britain.

Falkland
Islands.

East Africa
(Kenya).
West Africa
(Cameroon).

Possible
Further
Areas.

QUESTIONNAIRE.

1. Are there within the territory administered by your Government areas where the death rate of stock (apart from germ diseases) is notably high? If so, please state where and add any information in your opinion relevant.

2. Are there areas where stock show unusual or unnatural appetites and cravings—if so, whether at certain seasons of the year and under certain conditions of the herbage? If so, please state where, &c.

3. Are there areas where difficulties are found in the parturition of breeding animals or where the young are still-born or born deformed?

4. Are there areas where the milk yield is low, or percentage of young animals reaching maturity is low, or where sterility is high? If so, please state where, &c.

5. Are there areas where grading up of stock leads to a high death rate in second or third crosses? If so, please state where, &c.

6. Are there areas where a lessening of size or decrease of fertility is taking place amongst stock or a greater difficulty is being experienced in maintaining previous numbers of stock on the same area.

7. Is there any further information which can be supplied by your Government which you consider relevant to this problem and not covered by above questions?

CIRCULAR.

(2)

CONFIDENTIAL.

Downing Street,

6th November, 1925.

Sir,

I have the honour to transmit to you herewith, for your information, a copy of a letter from the Secretary to the Committee of Civil Research enclosing copies of an Interim Report from the Chairman of the Sub-Committee on the Mineral Content of Natural Pastures.

21st October

2. *I have to request that you will be so good as to furnish me with observations on the questions dealt with by the Sub-Committee in so far as they concern the territory under your administration, and in particular with any information which may be at the disposal of your Government in regard to the matters set out in the Questionnaire on Page 6 of the Memorandum prepared by the Sub-Committee. It will be observed that the Chairman of the Committee of Civil Research would be glad to have a general statement on these questions in the course of the early part of next year.*

I have the honour to be,

Sir,

Your most obedient, humble servant,

L. S. AMERY.

The Officer Administering

the Government of

[Enclosure in Circular despatch dated 6th November, 1925.]

COMMITTEE OF CIVIL RESEARCH,
OFFICES OF THE CABINET,
2, WHITEHALL GARDENS,
LONDON, S.W.1.

21st October, 1925.

Sir,

I am directed by the Earl of Balfour to request you to inform the Secretary of State for the Colonies that at its meeting on the 12th instant the Committee of Civil Research had before them an Interim Report from the Chairman of the Sub-Committee on the Mineral Content of Natural Pastures.

I am to explain that in submitting his Report the Chairman of the Sub-Committee forwarded a Memorandum giving the substance of the scientific results at present achieved and containing a short questionnaire to indicate the lines on which further information was desired.

The Committee of Civil Research concur in the recommendation of the Sub-Committee that this Report should be communicated to the India Office, the Colonial Office, the Department for Dominion Affairs, and the Foreign Office, for communication, to the Government of India, the Colonial Governments, the Dominion Governments and the Government of the Soudan, who should be asked to forward observations and replies to the questions submitted.

I am, therefore, to express Lord Balfour's hope that the Secretary of State for the Colonies will be so kind as to forward this Report (of which 200 copies are transmitted under separate cover) to the Colonial Governments with the request that they should forward in due course to His Majesty's Government their observations on these questions and in particular any information at their disposal in regard to the matters set out in the questionnaire on page 6 of the Memorandum prepared by the Sub-Committee.

Lord Balfour realises that adequately to answer the questions raised by the Sub-Committee would, in many cases, involve great delay but he hopes that the Colonial Governments will be in a position to furnish your Department, for the information of the Committee of Civil Research, in the course of the early part of next year, with a general statement on these questions in so far as they affect the local situation.

I am, etc.,

THOMAS JONES,
Secretary, Committee of Civil Research.

The Under Secretary of State,
Colonial Office.

FALKLAND ISLANDS.
CONFIDENTIAL.

(3)

GOVERNMENT HOUSE,
STANLEY,
25th January, 1926.

Sir,

I have the honour to acknowledge the receipt of your Confidential despatch of the 6th of November, 1925, transmitting a copy of a letter from the Secretary of the Committee of Civil Research enclosing copies of an interim report from the Chairman of the Sub-Committee on the Mineral Content of Natural Pastures, and to state that all the information at the disposal of this Government in regard to the matters set out in the Questionnaire on Page 6 of the memorandum prepared by the Sub-Committee is contained in the reports of Dr. J. B. Orr, Director of the Rowett Research Institute and Mr. Hugh Munro of the New Zealand Department of Agriculture to which reference is made in the memorandum.

I have the honour to be,

Sir,

Your most obedient,

humble servant,

J. Middleton.

THE RIGHT HONOURABLE

L. C. M. S. AMERY, P.C., M.P.,

SECRETARY OF STATE FOR THE COLONIES.

CONFIDENTIAL.

Copy No 202

C.R. (C.)—18.

COMMITTEE OF CIVIL RESEARCH.

SUB-COMMITTEE ON THE MINERAL CONTENT OF NATURAL PASTURES.

(A.)—OBSERVATIONS ON REPLIES TO QUESTIONNAIRE.

(1.) IN many pastoral areas within the Empire, where the food of herbivora consists entirely or chiefly of natural pastures, the occurrence of malnutrition is common.

(2.) In some cases the pathological conditions reported are of a specific type and occur in fairly well-defined areas. Thus, Bush sickness, a condition characterised by anæmia and emaciation, is found in an area in the North Island, New Zealand (37).* A similar condition is reported to occur in Tasmania (36), Kenya (24) and the South of Scotland (64). Animals suffering from the disease recover if moved to pastures outside the area, and after recovery may be brought back to the disease-producing area, where they will thrive and fatten for a further period. Other specific conditions are Styfsiekte (20), which occurs in parts of South Africa, and Goitre, found in West Africa and in Canada (30) (39). It seems probable that similar, more or less specific, pathological conditions occur in other areas, but, owing to the fact that they have not been systematically studied, they are regarded merely as exaggerated forms of malnutrition, due to general "poverty" of the pastures.

(3.) General symptoms, reported as occurring in parts of most of the Dominions and Colonies, are slow rate of growth, high mortality, low milk yield in cows and low birth rate.

(4.) Where attempts have been made to improve native breeds by crossing with imported sires, it is frequently reported that, while the first cross remains healthy, further improvement is accompanied by increase in the death rate. Further, if there is not a continuous importation of sires of improved breeds, the stock tends to revert to the original type.

(5.) In most of the replies it has been noted that, where the above conditions exist, animals suffer from "Pica," the abnormal craving being for inorganic substances. The nature of the pica varies in different districts. Thus in Bechuanaland (22) the pica is for bones, while in certain parts of East Africa (24) bones are untouched, but earth from "Salt Licks" is eaten in considerable quantities at regular intervals.

(6.) There are a number of causes which contribute to produce the above pathological conditions. Important factors are shortage of pasture in droughts and overstocking. Where such general nutritional difficulties arise, they tend to obscure the problem of deficiencies of particular constituents, such as minerals.

(7.) In many cases, however, it seems certain that the chief cause of malnutrition is a deficiency of essential mineral elements in the pasture. Chemical analyses show that the soils and pastures on the areas where malnutrition occurs have an abnormally low content of one or more of these elements

* NOTE.—Numbers refer to paragraphs.

(20, 34, 37, 41, *et al.*), and the feeding of these minerals has been accompanied by the disappearance of the pathological conditions and by a marked improvement in the rate of growth of the animals (20, 36, *et al.*).

(8.) In some districts, although little or no experimental work has been done, the local officials have been able to suggest, from the nature of the signs of malnutrition and the results of experimental work elsewhere, the deficiencies which are probably to be found in the pasture (30, 39, 43, *et al.*).

(9.) It has been noted that, in some districts where grazing has been continued for a number of years without any return of mineral nutrients to the soil, the pastures have become of less feeding value. The carrying capacity has been reduced or some of the signs of malnutrition noted above have increased. This has occurred even though there has been no perceptible decrease in the bulk of the pasture (41, 21, *et al.*).

(10.) The following are the main lines along which investigations have already been carried out in different parts of the Empire:—

(11.) *Chemical Analyses of Soils and Pastures.*—About 400 samples of pastures from various parts of the British Isles, and about 50 from various other parts of the Empire, have been analysed at the Rowett Institute and the School of Agriculture, Cambridge. The results of these analyses seem to indicate that there is a definite correlation between the mineral content of pasture and its feeding value (65–70). Similar work has been done in South Africa, Australia and New Zealand. The results show that specific pathological conditions such as Bush-sickness, Styfsiekte, and fragility of the bones can be correlated with deficiency of certain minerals in the pastures (37, 48, 56–58).

(12.) *Experimental Work.*—Experimental work planned for the purpose of finding means of preventing the occurrence of the conditions noted above has been directed along two different lines:—

(13.)—(A.) *The Application to the Soils of Mineral Fertilisers rich in the Constituents in which the Pastures are deficient.*—This is being done in many different areas. It has been generally noted that areas so treated yield an improved type of pasture, as shown by the fact that animals graze on the treated areas in preference to untreated areas, and that animals grazing on treated areas are healthier and grow faster than those on untreated pasture (35, 36 *et al.*).

(14.)—(B.) *The direct Feeding of Mineral Salts.*—There are many wide pastoral areas where the application of mineral fertilisers would not yield an economic return. The only possible method of treatment on these areas is to feed mineral salts direct to the animals, which requires very much smaller amounts than those needed to give an appreciable return if applied to the soil.

(15.) In South Africa the feeding of phosphorus-rich substances such as bone-meal has been found to prevent Styfsiekte and the pica which causes cattle to chew rotten carcasses, from which they get the organism which causes Lamsiekte. In addition to preventing these diseases, the feeding of bone-meal is accompanied by a marked increase in the rate of growth of young animals, and in the milk-yield of cows (20).

(16.) In New Zealand Bush-sickness is prevented or cured by feeding iron salts (37). In Tasmania excellent results have been obtained by feeding Parrish's Chemical Food, bone-meal and mineral mixtures rich in calcium and phosphorus (36). In Canada goitre is prevented by feeding iodine (39).

(16A.) In Scotland experiments are in progress in several centres in feeding to sheep substances containing lime, phosphorus, &c. (67).

(17.) In several other parts of the Empire work of a similar nature is in progress, and satisfactory results are being obtained, but the results have not yet been published.

(18.) In the appendix are notes of special interest taken from the replies received. These show the extent to which malnutrition, causing loss in the live-stock industry, occurs throughout the Empire. They further show that similar pathological conditions, and therefore similar problems, occur in widely separated districts.

(19.) The Sub-Committee are of opinion that the investigations at present being carried on should be extended, and that an effort should be made to correlate the work being done in different parts of the Empire. They have, therefore, recommended that further work should be carried on along the lines indicated above.

(B.)—SUMMARY OF REPLIES TO QUESTIONNAIRE.

Africa.

(20.) *Union of South Africa.*—(a.) Styfsiekte occurs in certain areas. Phosphorus deficiency is the overriding factor, but there may also be calcium deficiency.

(b.) A pica for bones is prevalent in certain areas, due to phosphorus deficiency.

(c.) Feeding substances rich in phosphorus prevents styfsiekte and pica and markedly increases rate of growth of young animals and milk yield in cows.

Extensive researches on this subject are described in various publications [48].

(21.) *Basutoland.*—(a.) Abnormal desire for salt, and to a lesser degree craving for bones.

(b.) Serious degeneration in stock during last 25 years, attributed to overstocking and droughts.

(c.) Deterioration in quality and quantity of pasture has been "the greatest contributing factor to the general deterioration" of the Basuto pony—a short-legged, big-boned, weight-carrying animal.

(22.) *Bechuanaland.*—(a.) Native stock very small, with low milk yield (attributed to inbreeding).

(b.) Death rate in improved stock higher than in native stock.

(c.) Lamziekte occurs in certain areas. (*Note.*—Lamziekte occurs only in areas where phosphorus is deficient.)

(23.) *Swaziland.*—(a.) Native cattle small and deficient in bony skeleton (attributed to inbreeding).

(b.) In parts where good percentage of lime in soil animals are bigger and develop more quickly.

(c.) Pica in uplands and middle veld, where little lime in soil.

(d.) The report states, however, that "It has never been found necessary specially to feed animals with a view to augmenting the natural supply of minerals."

(24.) *Kenya Colony.*—(a.) Definite signs of malnutrition suggestive of deficiency of mineral elements in natural pastures.

(b.) Malnutrition most marked in improved breeds.

(c.) Pica common.

(d.) Suggested deficiency of phosphorus.

(24A.) *Tanganyika.*—(a.) "Cattle mature slowly and are not fully developed until six or seven years old."

(b.) Birth rate is low. "Cows do not become pregnant as a rule until the calf at foot is nine months to one year old. About 7 per cent. of cows become sterile often comparatively early in life."

(c.) The nature of the soil appears to have an important bearing on the health of farm stock. "Horses and mules do not thrive on red residual volcanic ironstone soil," but "can be kept in health on granite sandy dry soils either at considerable altitudes or at sea level." In the best cattle and sheep districts the rock outcrops are granite. This is considered significant.

(25.) *Northern Rhodesia.*—European breeds only recently imported. Problems of deficiency obscured by infectious diseases and general malnutrition occurring in dry months. Following points of interest noted:—

(a.) Percentage of animals reaching maturity amongst native stock is low.

(b.) A disease, "veld poisoning," occurs in cattle. It cannot be transmitted by any known means. "Grade" cattle, *i.e.*, improved breeds, more susceptible than native cattle." (Symptoms of this condition not stated.)

(c.) "Lessening of size" of animals (attributed to inbreeding).

(d.) The feeding of bone meal followed by "very considerable benefits."

(26.) *Uganda*.—Importation of improved breeds “not yet begun.” Following observations refer to native cattle:—

- (a.) Area in Western Province where young cattle develop rickets.
- (b.) In another area unless animals get access to “salt pans” they lose condition. Composition of soil of salt pans unknown. (Analytical work on soils has been begun in this Protectorate.)
- (c.) Sterility common (inbreeding regarded as contributory factor).
- (d.) Milk yield low (attributed to bad milking methods).

(27.) *Somaliland*.—Veterinary Department not in existence long enough for accurate statistics to be available, only general opinion available. Seasonal droughts cause starvation, which masks symptoms of deficiency disease. No attempt possible so far to improve breeds. Following observations refer to native cattle:—

- (a.) “The mortality of young stock and the slow rate of growth are very apparent.”
- (b.) Pica: chewing bones observed. Natives recognise importance of “periodic access to salt licks or to pastures known to contain salt.”

(28.) *Nyasaland*.—(a.) “Conditions due to or aggravated by malnutrition caused by deficiencies in the diet of live-stock are specially prevalent in the high plateau of the Protectorate, where soil conditions undoubtedly produce grasses deficient in the qualities required to supply live-stock with a complete diet. The animals are hidebound, the calves and animals up to 2 years of age emaciated, and there is a death rate up to as high as 10 per cent. of the young cattle with no other symptoms to account for the deaths than profound anæmia.”

(b.) Second or third crosses more susceptible to enzootic diseases and less capable of living on natural pastures without artificial feeding.

(c.) Grading up of live-stock becomes abortive owing to retrogression to original or inferior type unless new blood is constantly introduced.

(d.) Pica observed, but not common.

(e.) Cattle in low country when grazing is good are “singularly free from disease and are in remarkably good condition.”

(29.) *Sierra Leone*.—(a.) Cattle small in size. Uncertain whether small size due to mineral deficiencies or inbreeding.

(b.) Analyses of pasture shows deficiency of phosphorus, calcium and potassium, as compared with English pastures.

(30.) *Gold Coast*.—The following observations have been made:—

(a.) In Lawra—

- (1.) High mortality in calves.
- (2.) Large proportion of “unthrifty” calves and lambs.
- (3.) Sterility among cows reported to be high.

(b.) Half-bred English stock, even though specially tended and fed, “very prone to non-parasitic skin diseases.” Calves and store cattle “do not thrive as they ought.”

(c.) Stock decrease in size in low-lying districts.

(d.) “A greater difficulty is being experienced in maintaining previous numbers of stock though there is no lack of grazing.”

(e.) All stock slow in reaching maturity and when full grown small in size.

(f.) Cases of goitre in young stock. Human goitre also seen.

(g.) Pica (mud eating) observed in cattle.

(h.) Opinion offered that above malnutrition largely due to “deficiency of carbonates and phosphates,” “salt” and in some areas iodine.

(31.) *Scyelles*.—(a.) No difficulty in raising cattle. No sign of malnutrition. Milk cows particularly strong and healthy.

(b.) No marked contagious disease among cattle.

(c.) Attention is called to the fact that these islands contain great quantities of guano. This is rich in essential mineral elements.

Australasia.

(32.) *New South Wales*.—(a.) Definite areas where osteomalacia occurs.

(b.) In these areas “pica” prevalent, the most marked craving being for bones.

(c.) In areas where osteomalacia occurs there is difficulty in maintaining previous numbers of stock on the same area.

(d.) The feeding of bone meal licks yields good results.

(33.) *Victoria*.—(a.) In some districts mineral deficiency very acute. Young cattle or sheep cannot be reared though mature sheep do well and wool of best quality.

(b.) After application to pasture of mineral fertilisers health of stock is benefited. Stock prefer pastures thus treated.

(c.) Soil has lower percentage of phosphate of lime than most European soils. English grasses grown in Victoria "poorer in phosphate of lime than the same grasses grown under average European conditions."

(d.) Investigations on effect of top-dressing with superphosphate are being conducted.

(34.) *South Australia*.—(a.) To the north of Adelaide, except in the hills, exceptionally healthy stock with large frames and strong constitutions.

(b.) To the south of Adelaide and in the hills animals lose in size and constitution, and are more readily subject to disease. Animals affected chiefly in the early growing stage. These "defects" attributed to lack of lime and phosphates.

(c.) "Pica" common throughout the State, especially where deficiency of lime and phosphorus in the soil.

(d.) Top-dressing with phosphatic fertilisers practised in recent years.

(e.) "Pica" tends to disappear where land has been treated with mineral fertilisers and sheep observed to "cling" to top-dressed areas, to the neglect of untreated areas.

(35.) *Western Australia*.—(a.) High death rate in sheep from "braxy-like" disease of unknown cause. Deaths commence after the first rains and cease with the onset of the dry summer.

(b.) "Pica" for bones in all uncultivated areas.

(c.) "Craving for sand" noted in newly-born calves in Perth district.

(d.) In area north of Perth difficulty in breeding horses, attributed to high lime content of soil.

(e.) Difficulty in breeding sheep in area south of Perth, apparently due to phosphorus deficiency.

(f.) Chemical analyses of pastures from (1) plots treated with "phosphatic artificial manures" and (2) untreated areas show that, after the application of the manures, the percentages of both phosphorus and lime in the pasture are increased.

(g.) Top-dressing with phosphorus manures prevents the eating of bones, and, if fed to pregnant cows, prevents calves eating sand.

(36.) *Tasmania*.—Signs of malnutrition are present to a varying degree in different districts. Special reference is made to rickets, osteomalacia, fragility of bones, "stiffness of hindquarters," swelling of joints, emaciation, "hidebound appearance" and to a condition resembling "bush-sickness" in New Zealand or "Nakurutis" in Kenya.

The cause of these pathological conditions is known to be deficiency of mineral elements in the pasture, especially calcium and phosphorus. "Excellent results" are obtained by feeding "Parrish's Chemical Food," bone meal, and mineral mixtures rich in calcium and phosphorus, and administration of these is recommended by the Agricultural Department. Investigations on soil deficiencies and on effects of feeding various mineral salts are being conducted.

(37.) *New Zealand*.—(a.) "Bush-sickness" occurs in North Island in volcanic district which grows "excellent pasture" (cocksfoot grass and clovers). In spite of the presence of abundant feed, ruminant stock will not live longer than a year—sheep little more than half this period. Area where this disease occurs estimated to be over a million acres in extent. Disease can be prevented or cured by feeding iron salts.

(b.) In certain other districts malnutrition of bones noted. In these districts "pica" occurs. The malnutrition can be prevented by feeding phosphate of iron or applying phosphates to the soil.

(c.) In certain parts sheep "cannot be kept up to standard without frequent introduction of new blood."

(d.) Analyses of the soil have shown that there is a deficiency of phosphorus and "enormous quantities of phosphates are being imported."

(38.) *Fiji Islands*.—(a.) Osteoporosis occurs in horses.

(b.) Low milk yield and general unthriftiness observed in cattle.

(c.) Pica for bones and salt noted.

America.

(39.) *Canada*.—(a.) Goitre in sheep and hairlessness in pigs occur in many districts and cause considerable losses. They are believed to be due to deficiency of iodine. Feeding iodine gives good results.

(b.) In the maritime provinces there has been a depletion of the soil resulting in deficiency of minerals, especially calcium in the pastures.

(c.) Feeding mineral mixtures gives "remarkable results."

(d.) Lime improves the yield of pastures, but there is nothing to show that it improves the feeding value.

(40.) *Honduras*.—(a.) "Pica" noted during the dry season and also after the first showers, when the cattle usually suffer from dysentery.

(b.) Low milk yield attributed to poor pastures.

(c.) Sterility high—attributed to inbreeding.

(40a.) *British Guiana*.—(a.) Milk yield of cows is low.

(b.) "Light bone below the knee and hocks are accepted creole characteristics."

(c.) There is a "fairly heavy death rate amongst sheep."

(d.) The above conditions are attributed to deficiency of calcium and phosphorus and the administration of bone meal has lately been recommended.

(e.) Further research work on the composition of pastures on modern lines is contemplated.

(f.) The Report from British Guiana is accompanied by a Memorandum by the late Sir John Harrison, C.M.G., on the composition of local soils. The Memorandum stresses the importance of soil analysis of virgin tropical soils for reliable indication as to their value for European agricultural purposes.

(41.) *Falkland Islands*.—(a.) High mortality in lambs, deterioration in stock and decreased carrying capacity of pastures have become serious economic factors during the last few years.

(b.) Report of Mr. Hugh Munro of the New Zealand Department of Agriculture shows that there is "pica" in both cattle and sheep, steady decrease in size of mature animals unless maintained by importing breeding stock, and heavy mortality among young sheep. It is suggested that these signs of malnutrition are due to "exhaustion" of pastures.

(c.) Report by Dr. J. B. Orr on "Analyses of Soils and Pastures" indicates that calcium is most probably the limiting factor in the pasture.

Asia.

(42.) *India*.—(a.) First crosses of native cattle with Ayrshire or Holstein bulls are successful, but more susceptible to the many diseases affecting cattle in India. Second and third crosses have proved a failure; they lack constitution and stamina, and are much inferior to the first cross both in draught and milking qualities.

(b.) No very pronounced decrease in fertility is taking place, but the percentage of barren cows is considerably higher in India than in the West.

(c.) Cattle have deteriorated.

(d.) It is stated that there are no data to show that any malnutrition which occurs is due to deficiency of minerals in the soil. In some areas the pasture is of a relatively inferior quality, but its limited quantity is a far more important factor. Attention is called to the increasing pressure of the increasing population of both stock and human beings upon the acreage of the country.

(43.) *Ceylon*.—(a.) Considerable difficulty in keeping and breeding imported cattle and sheep of European type.

(b.) Generally speaking, parturition difficulties are uncommon in Ceylon, especially amongst cattle of the "Zebu" variety. Difficulties are markedly more common amongst imported cows of European origin. Small calves and cases of retained placenta are common.

- (e.) For dairying purposes fresh animals must be imported constantly.
- (d.) "The progeny of imported stock and cross-bred stock decrease in size and ultimately, if they survive, come down to the small size of the native cattle."
- (e.) Cattle show "a strong desire for salt."
- (f.) Imported race horses are liable to develop osteoporosis.
- (g.) The administration of bone meal, calcium, potassium, magnesium salts and lime water has a considerable effect in prevention, but cure of developed cases is unsatisfactory.
- (h.) Calcium and phosphorus are believed to be generally deficient in pastures.
- (44.) *Cyprus*.—(a.) Young stock develop slowly. This applies also to imported stock kept under favourable conditions.
- (b.) Stiffness and lameness occurs in oxen, believed to be analogous to styfsiekte, a disease caused by mineral deficiency.
- (c.) Pica common, most marked in imported breeds.
- (d.) Analysis of soil shows deficiency of calcium and phosphorus.
- (45.) *Palestine*.—(a.) Local stock stunted and slow growing.
- (b.) There are sporadic cases of rickets, osteoporosis and pica, generally confined to imported or graded stock.
- (c.) Preliminary analyses show phosphorus content of pastures to be very low compared with those of England and Germany.

Europe.

- (46.) *Ireland*.—Application of lime to certain natural pastures alters the botanical composition of the pastures and makes them more valuable.
- (47.) *Great Britain*.—A survey of the natural pastures in various parts of Great Britain seems to show that there is a correlation between the nutritive value of the pasture and its mineral content (see 65, 66, 67; 68, 69, 70).
- (47A.) There is nothing of special interest with regard to mineral deficiencies in pastures or malnutrition which can be attributed to this cause in the replies from Nigeria, The Sudan, Newfoundland, St. Lucia, St. Vincent, Gambia, Jamaica, Malta, Trinidad, Windward Islands, Malay States, Bahamas, Barbados, Leeward Islands, Mauritius and Hong Kong.

List of Publications referred to in Replies.

- (48.) Phosphorus in the Live-Stock Industry (Union of South Africa), Dept. of Agri., Reprint No. 18, 1924.
- (49.) Osteomalacia in Cattle: Henry, "Agri. Gazette," N.S.W., p. 885, 1912.
- (50.) Two Factors in Disease Prevention: Henry & Henry, "Agri. Gazette," N.S.W., p. 337, 1923.
- (51.) Some Granite Soils: Jensen, "Agri. Gazette," N.S.W., p. 1085, 1909.
- (52.) Mortality amongst Cattle in the Bega District: Henry, "Veterinary Journal," N.S.W., p. 62, 1915.
- (53.) The Influence of the Mineral Constituents of Food on Animal Health: Henry, "Agri. Gazette," N.S.W., p. 888, 1925.
- (54.) Soils: Jensen, "Agri. Gazette," N.S.W., p. 95, 1910.
- (55.) Notes on Osteomalacia, Dept. of Agri., N.S.W., "Science Bulletin" No. 12.
- (56.) The Biochemical Significance of Phosphorus: Kincaid, Proc. Roy. Soc., Victoria, 23 (N.S.), Pt. 11, 1911.
- (57.) Bulletin on Pasture Top-Dressing, Victoria.
- (58.) Imports of Phosphate to New Zealand, J. Dept. of Agri., 1925.
- (59.) Report on Investigation into the Conditions and Practice of Sheep Farming in the Falkland Islands: Munro, Dept. of Agri., New Zealand, 1924.

- (60.) Analyses of Indian Grasses : Sen, "Pusa Bulletin," 1917.
- (61.) Phosphorus Deficiency in Bihar : Davis, "Agri. J. of India," XXII, p. 77.
- (62.) Principal Fodders in the Central Provinces and Berar : "Agri. J. of India," 1920.
- (63.) Die Insel Cypern (Unger and Kotschy, 1865).
- (64.) On Pining, Vinquish or Daising in Sheep : McGowan, "Scot. J. of Agri.," Vol. V, p. 274, 1922.
- (65.) The Mineral Content of Pastures : Elliot, Orr and Wood, "Scot. J. of Agri.," Vol. VIII, p. 349, 1925.
- (66.) Investigation on the Mineral Content of Pasture Grass and its Effect on Herbivora : Elliot, "J. of Agri. Sci.," Vol. XVI, p. 59, 1925.
- (67.) Report on the Effect of the Addition of Mineral Salts to the Ration of Sheep : Elliot and Crichton, "J. of Agri. Sci.," Vol. XVI, p. 65, 1925.
- (68.) Report on the Chemical Analyses of Samples of Pasture from Various Areas in the British Isles : Godden, "J. of Agri. Sci.," Vol. XVI, p. 78, 1925.
- (69.) Report on the Seasonal Variations in the Mineral Content of Pastures : Cruickshank, "J. of Agri. Sci.," Vol. XVI, p. 89, 1925.
- (70.) Report on the Effect of Fertilisers on the Mineral Content of Pastures : Godden, "J. of Agri. Sci.," Vol. XVI, p. 98, 1925.

2, Whitehall Gardens, S.W. 1,
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