

1927

Kenya

No. 10173

C0533/567

SUBJECT

Mineral Content
of Natural Pastures

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M.O. 6120/26

Subsequent

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Mineral Content of Natural Pastures

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NOT TO BE TURNED INSIDE OUT

1. ——— Colonial Office ——— 24 Feb, 1927
 Reports by W. Orr and Mr. Richison on
 work in Kenya.
 (Copies taken from 25323, General)

Mr. Jeffries.

Draft herewith in accordance with
your directions on the Gen. Dept paper
wh. I have released to H. E. Dept.

S.K. 25/2/27.

CJD 25/2/27

AMC

No. 24 Gen. Conf (w/copy)

- 2 MAR 1927

Enclosures of

CONFIDENTIAL.

COPY NO. 17

J.R.(M.C.) - 33.

COMMISSION OF CIVIL RESEARCH.

SUB-COMMITTEE ON THE MINERAL CONTENT OF
NATURAL PASTURES.

INVESTIGATION IN KENYA ON NATIVE DIETETICS AND ANIMAL
HUSBANDRY.

Note by the Secretary.

The following papers are circulated herewith by direction of the Chairman:-

- (i) Copy of a letter dated March 17th, 1928 from Dr.J.B.Orr to the Chairman.
- (ii) Report on investigations on native Dietetics by the Director of Medical and Sanitary Services, Kenya.
- + (iii) Notes of a Meeting held at Government House, Nairobi on February 29th, 1928.
- (iv) Pasture investigations in Kenya; November, 1926 to February, 1928. Note by Dr.J.B.Orr.

These papers have also been circulated to the Sub-Committee on Dietetics.

(Signed) A.F.HEMMING.

Secretary to the Sub-Committee.

2, Whitehall Gardens, S.W.1.

8th May, 1928.

SUMMARY OF RESULTS:

PASTURE INVESTIGATION IN KENYA

November 1926 - February 1928

NOTE by DR. J.B. ORR.

The investigation was undertaken to determine whether the pasture in certain districts in Kenya was deficient in essential nutrients and if so, whether these deficiencies were the cause of malnutrition in cattle and sheep.

The work consisted of:-

- A. Analysis of samples of pasture from four districts;
- B. Feeding experiments with cattle and sheep, to test the effect of feeding of certain constituents which were thought might be deficient.

A. COMPOSITION OF PASTURES.

The following Table on Appendix I, shows the average composition of the pastures at Naivasha; Athi Plains; Molo; and Nakuru, and for comparison that of good British pastures.

It is seen that the Naivasha pastures are as rich in nitrogen, lime, phosphorus and potash, as good British pastures, though rather lower in sodium and chlorine. Those of Molo and Nakuru are markedly deficient in all the mineral constituents. Those of the Athi Plains are intermediate in value between Naivasha and Molo. The deficiency in phosphorus at Molo is very marked, and is comparable with that found in the phosphorus deficient areas of South Africa and Australia, where malnutrition due to this cause occurs.

Samples were collected at intervals throughout the year to determine the difference in analysis after rain and during drought.

The Tables, Appendix 2, show the effect of rainfall on a good area - Naivasha, and a poor area - Nakuru.

It will be seen that there is a great increase in both mineral and protein content following rain. The increase is most marked in the good pasture - Naivasha, which responds to rain both by increased rate of growth and by improvement in quality much more rapidly than the poorer pastures of Nakuru and Molo.

B. FEEDING TESTS.

Nakuru. The tests at Nakuru were carried out to throw light on the cause of the local disease known as "Nakurutitis". From the appearance of the animals and the results of work in New Zealand it was thought that deficiency of iron might be an important factor.

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Four groups each of 30 oxen were grazed on the affected area: the animals in one group were given a mixture of salt and iron oxide in equal proportions ad lib. Other two groups were given mineral mixtures with a lower amount of iron - 8 per cent and 1 per cent. The remaining group serving as control received nothing in addition to pasture.

The Table, Appendix 3, gives details of the average gain or loss in weights in the different groups for a period of ten months. The average gain or loss is as follows:-

	<u>Control.</u> lbs	<u>Low iron.</u> lbs	<u>Medium iron.</u> lbs	<u>High iron.</u> lbs
average gain or loss	- 35	- 11	+ 69	+ 136

It will be seen that the control of group receiving no mineral mixture lost weight whereas considerable gains were made in the group receiving salt and iron oxide. The other two groups were intermediate and roughly in proportion to the amount of iron oxide fed.

The control animals developed the typical signs of "Makurutitis", while all animals receiving salt and iron remained healthy and at this date, after the drought, are in marketable condition as slaughter or work animals.

A few animals suffering from the disease were treated by the administration of salt and iron with good results.

The Medical and the Veterinary Laboratories co-operated in the technical work involved in blood tests and post mortem examinations. The results of these examinations show that anaemia is a marked feature of the disease.

The result seems to indicate that whatever the cause of the condition may be, it can be prevented by the feeding of this mixture.

SHEEP FEEDING EXPERIMENTS.

These were carried out at Naivasha and Molo. Three groups of ewes with lambs were grazed together. One group received a mineral mixture, a second group a mineral and protein mixture, the third group which served as control received nothing in addition to pasture at Naivasha, but at Molo received rock salt ad lib. The figures for weights of fleeces and rate of growth of lambs are given on appendix 4.

The following figures give a summary of the results to date:-

Average gain in weight of Lambs:-

	<u>Control.</u> lbs.	<u>Control Minerals.</u> lbs.	<u>Control Minerals, protein.</u> lbs.
12 months - Molo	23.24	27.75	35.57
14 months - Naivasha	55.2	57.3	57.5

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The rate of growth of lambs is much greater - nearly double at Naivasha than at Molo. In the former district the addition of mineral and protein had little or no effect on the rate of growth, whereas at Molo the average rate of growth of the animals receiving the minerals was 19 per cent greater than the controls, those receiving protein in addition 53 per cent.

These results are in keeping with the analyses of the pastures which showed a marked deficiency at Molo but none at Naivasha.

The weights of the fleeces in the fed groups are about 10 per cent heavier in both Molo and Naivasha.

CALF REARING.

Molo and Naivasha.

Tests were carried out at Molo and Naivasha. At the latter centre no beneficial effect was obtained (up to one year) with feeding either minerals or protein. The animals in all the groups are in excellent condition.

At Molo the average increase to date was as follows:-

<u>Control.</u>	<u>Control Minerals.</u>	<u>Control Minerals, protein.</u>
256 lbs.	270 lbs.	319 lbs.

Figures are given in detail on appendix 5.

MILK COW EXPERIMENT.

The tests at Naivasha and Molo were undertaken to determine the effects of the feeding of minerals and protein. There were, however, such marked differences in the quality of cows that the data are useless. At Molo a second test was carried out with heifers, whose milk yield was recorded during a preliminary period before feeding of minerals or protein was begun and the animals then arranged in 3 comparable groups of 8 with the same average yield. Appendix 5 gives data for this test.

The following table shows difference in milk yield, that of the control group being expressed as 100:-

<u>Control</u>	<u>Control Mineral</u>	<u>Control Mineral, protein.</u>
100	133	135

The feeding of minerals to those cows seems to have a marked beneficial effect on the milk yield.

In addition to work on the main problem, viz. deficiencies in pasture, it was possible to carry out, without additional expense, feeding experiments with milk cows, pigs

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and poultry. The results on pigs were negative, due to the fact that animals experimented on had milk ad lib, therefore no addition tried had any beneficial effect. The results on poultry were definitely positive. The addition of a mineral mixture doubled the egg yield. The results on cows were also positive, showing that in certain cows at least the feeding of concentrates during the dry season enormously increased the milk yield.

	<u>Control.</u> lbs.	<u>Experiment.</u> lbs.
Preliminary period: Yield 1st month.	1329	1351
Experimental cows fed: Yield per month.	808	1659

These extra tests were of course not purely experimental work, but local demonstrations of the effect of proper feeding.

CONCLUSIONS.

It should be kept in view that these tests have run for only a short period and the results are therefore not to be regarded as conclusive. They seem to indicate, however, that in areas like Nakuru and Molo, where the pastures are deficient in minerals an increased rate of growth can be obtained in lambs and calves, an increased milk yield in cows, and that in both good and bad areas an increased weight of wool is obtained by the feeding of appropriate mineral mixtures.

They seem however to warrant the following conclusions:-

- (1) The disease "Nakurutitis" can be prevented by the feeding of an appropriate mineral mixture.
- (2) In deficient areas, the feeding of minerals is followed by increased rate of growth in lambs and calves and increased milk yield in cows.
- (3) The feeding of minerals increases the weight of the fleeces of the sheep in both good and bad areas.
- (4) Feeding of concentrates to some cows at least gives a markedly increased yield of milk.

Further experiments are required to determine the economic value (if any) of these results, and if they are found to be of practical value to ascertain the best combination and amount of supplements to feed to obtain the maximum result at the minimum cost.

ANNEX I.

TABLE A.

Composition of the Dry Matter of the Herbage.

	Naivasha Av. of 14 samples.	Doonholm (Athi-Plains) Av. of 7 samples.	Molo Av. of 16 samples.	Nakuru Av. of 23 samples.	British Pastures. Av. for Cultivated: pasture pasture. : eaten."
Dry Matter	100	100	100	100	100
Nitrogen.	1.952	1.50	0.950	0.89	2.52
Acid Sol-Ash	5.673	4.42	2.422	3.90	2.50
Lime (CaO)	0.935	0.64	0.484	0.40	3.85
Soda (Na ₂ O)	0.062	0.16	0.016	0.07	0.53
Potash (K ₂ O)	2.123	1.56	.779	1.72	0.57
Phosphoric Acid (P ₂ O ₅)	0.686	0.36	.0194	0.22	3.16
Chlorine.	0.389	0.47	.170	0.35	0.74
					0.94
					0.64

TABLE B.

Rainfall Effect - Naivasha Percentages expressed on Dry Matter.

Date of Collection.	March 6th Before rain.	March 23rd After rain.
Dry Matter.	100	100
Nitrogen	1.05	3.60
Acid Soluble Ash	2.70	8.76
Lime (CaO)	0.51	1.22
Soda (Na ₂ O)	0.03	0.08
Potash (K ₂ O)	0.70	4.17
Phosphoric Acid (P ₂ O ₅)	0.50	1.15
Chlorine (Cl)	0.24	0.62

TABLE C.

Rainfall and Maturity Effects - Nakuru.Percentages expressed on the Dry Matter.

Date of Collection.	January 7th		March 10th		April 16th		June 27th	
	100	Before rain.	100	After rain.	100	After rain.	100	Grass fully mature.
Dry Matter.								
Nitrogen	0.51		0.75		1.95		0.77	
Acid Soluble Ash	2.35		3.41		6.12		3.65	
Lime (CaO)	0.39		0.40		0.52		0.28	
Soda (Na ₂ O)	0.03		0.03		0.06		0.06	
Potash (K ₂ O)	0.97		1.14		3.25		1.96	
Phosphoric Acid (P ₂ O ₅)	0.17		0.15		0.41		0.19	
Chlorine (Cl)	0.26		0.27		0.85		0.15	

FEEDING EXPERIMENT.

"Nakuruitis".

(Weight in lbs.)

	Group I (Control)	Group II (Low Iron) Grade Oxen	Group III (Medium Iron)	Group IV. (High Iron)
Av. Wt. 16/11/36	707.5	774.3	753.8	764.3
Av. Wt. 3/10/37	724.5	769.3	827.7	952.2
Gain or Loss	- 38.6	- 5.0	+ 73.9	187.9
<u>Work Oxen.</u>				
Av. Wt. 16/11/36	616.4	592.7	580.7	558.1
Av. Wt. 3/10/37	592.6	552.7	615.3	633.5
Gain or Loss	- 23.8	- 11.0	34.6	75.4
<u>Native Oxen.</u>				
Av. Wt. 16/11/36	607.2	616.4	659.0	601.0
Av. Wt. 3/10/37	532.2	592.0	756.3	716.3
Gain or Loss	- 75.0	- 18.4	98.3	146.3

Iron Content of Mineral Mixtures.

0 1% 5% 50%

FEEDING EXPERIMENTSMOLO.

Average weight per lamb (lbs)

	Group 1 <u>Control</u> lbs.	Group 2 <u>Control Minerals.</u> lbs.	Group 3 <u>Control Minerals. protein.</u> lbs.
Average Wt. 16/2/27	35.0	35.2	35.1
Average Wt. 16/2/28	58.34	62.95	70.67
Gain (12 months)	23.34	27.75	35.57
Gain expressed as % of gain in Group 1	100	119	153

Fleece Weights (lbs)

	Group 1 <u>Control</u> lbs.	Group 2 <u>Control Minerals.</u> lbs.	Group 3 <u>Control Minerals. protein.</u> lbs.
From 16/2/27 - 19/5/27	1.58	1.74	1.81
From 19/5/27 - 1/12/27	2.72	2.83	3.19
Total	4.30	4.57	5.00
Average condition of wool (possible 8 pts)	4.32	6.24	6.43

NAIVASHA.

	Group 1 <u>Control.</u> lbs.	Group 2 <u>Control Minerals.</u> lbs.	Group 3 <u>Control Minerals. protein.</u> lbs.
Average Wt. Lambs			
" " 24/11/26	25.0	24.1	24.8
" " 7/ 2/26	80.2	81.4	82.8
Gain - 14 months	55.2	57.3	57.4

Fleece Weights (lbs)

	Group 1 <u>Control.</u> lbs.	Group 2 <u>Control Minerals.</u> lbs.	Group 3 <u>Control Minerals. protein.</u> lbs.
Lambs - From 24/11/26			
to 1/ 4/27	1.95	2.31	2.04
From 1/ 4/27			
to 11/10/27	3.68	4.21	4.06
Total	5.63	6.52	6.10
Ewes - From 1/ 4/27			
to 11/10/27	3.92	4.66	4.18

HEIFERS - 1ST LACTATION.MOLO.

	Group 1 (Basal)	Group 2 (Basal, Minerals)	Group 3 (Basal, Mineral, Protein).
	lbs.	lbs.	lbs.
Preliminary Period.			
Initial Yield (14 days)	2052	1939	1990
Yield till 31st Jan.	19464	25158	25540
Yield for Exp. period	17412	23217	23550
Taking Group 1 yield as 100 "	100	133.3	135.2

CALF FEEDING EXPERIMENT.Keringet.

	Group 1 (Control)	Group 2 (Control, Mineral)	Group 3 (Control, min- eral, protein)
	lbs.	lbs.	lbs.
Av. Initial Weight	104	100	107
Av. Weight after 13 months	360	370	426
Average Gain	256	270	319

Naivasha.

Av. Initial Weight	75.2	72.5	77.1
Av. Weight after 11 months	396	396.3	324
Average Gain	321	324	308

The Veterinary Department, between whom and the Medical Department there has been co-operation throughout the experiments, has detailed a helminthologist to investigate and compare the incidence of helminthic parasites in the different groups.

The data as regards the physical conditions of the Masai and Kikuyu natives are of great importance and interest. Although statistical analysis has not yet been effected there is little doubt that the Masai generally, more particularly the men, are in better nutritional condition than are the Kikuyu. The following table, kindly prepared by the Statistician to the Governors' Conference from the data collected, shows the figures obtained from a random sample of Masai and Kikuyu men between the ages of 18 and 50:-

No.	Age.	Height.	Weight.	Dynanometer.	Chest.
60 Kikuyu men	37	5ft. 4 ins.	109	56	31.6 ins.
100 Masai men	30	5ft. 6 ins.	128	73	33.1 ins.

It will be remembered that the Masai live largely on a diet of meat, milk and blood of which milk is an important constituent, while the Kikuyu are restricted very largely to a vegetable diet. Their important sources of calcium are what might be termed accessory factors. The mental condition of the two races corresponds to the general physical condition.

The figures regarding the incidence of disease tend to show that pulmonary disease is more common among the Kikuyu and that the ulcers so commonly found among that tribe are comparatively rare among the Masai. Common complaints among the Masai, especially among the older section of adults, are "rheumatism" and constipation. The latter is rare among the Kikuyu with whom a soft unformed stool is the rule.

Comment was made in the earliest report by Dr. Orr as to the better physical condition generally of the Kikuyu young women as compared with that of the young men. Evidence has recently been collected which tends to show that the girls and young women receive a diet richer in calcium than do the male members of the tribe. If this be confirmed by the chemical analyses the observed differences between young men and young women will form a natural demonstration comparable to the results being obtained by feeding calcium rich substances under experimental conditions to youths at the Gaol.

The results of both sides of the investigation are of great interest and importance. Observations appear to be falling into line and mutually confirming one another. It is interesting to note that the general trend of the results of the work on animals, with some aspects of which the Medical Department has been connected, is similar to that on native dietetics reported on above.

JOHN L. GILKS,

DIRECTOR OF MEDICAL & SANITARY SERVICES.

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were placed under his sole charge. Special arrangements for the feeding, addition of supplements to the diets and treatment of the cases were made. In addition to the chemical and clinical work which was required for the study of the ulcer cases and which was performed by Dr. Henderson himself, certain other investigations were necessary and were performed by the various members of the staff of the Medical Research Laboratory. These included bacteriological investigation of the ulcers, the Wassermann re-action of the cases and clinical laboratory work for the detection of protozoological or helminthological parasites. All the Laboratory work both by Dr. Henderson and others came under the direct charge of the Deputy Director of Laboratory Services, Dr. W.H. Kauntze.

The metabolic experiments indicate that the prisoners at the gaol are probably suffering from a deficiency in calcium. The majority of the cases, particularly the growing boys, showed either a definite negative balance in this connection or a very small positive one. The results coincided with the analyses of the diets, which showed a calcium content of roughly one-third of the generally accepted optimum, although they were satisfactory with regard to the other constituents and probably more satisfactory than the ordinary diet in a reserve.

The field investigations by Dr. Foster in the Kikuyu Reserve and such analyses as have so far been performed at the Rowett Institute tend to confirm these findings, while it is clear that resort has been made by the natives to sources of calcium which are not obtainable in their ordinary food-stuffs. The results of the metabolic experiments are contained in three papers which have been written conjointly by Dr. Henderson and Dr. Kelly; these, it is suggested, should be published at an early date. Considerable economic importance attaches to these results as it appears clear that the ordinary food-stuffs of the country are normally deficient in calcium and that some resort has to be made to an accessory supply of this mineral. It remained to be considered whether by the addition of some cheap form of calcium to the diet of the employed native outside his own reserve, physical improvement could be attained or, at any rate, a loss of physical efficiency prevented. The question of an addition to native diet generally will require to be considered when further information has been collected as regards the actual position in the reserves.

It was decided to perform a further metabolic experiment in the gaol to ascertain the effect of an addition of small quantities of

- (a) powdered chalk, and
- (b) powdered bone meal.

These substances were selected on account of their cheapness and from the fact that they could probably be added to the diet without causing any great disturbance either in the mind of a labourer or in the economy of the farm. The results to date tend to indicate that the addition of either of these substances is followed by a considerable retention of calcium in the growing boys on whom the experiment was conducted and who

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were previously on a very small positive balance.

During the course of the metabolic experiments an interesting and important point emerged. The addition of cod liver oil to one of the groups was not found to be followed by an increase in calcium retention in the absence of an additional supply of that mineral. Another group or an addition of a mineral mixture without cod liver oil was found to be retaining calcium. Both groups were exposed to similar conditions and amounts of sunlight.

The investigation into the aetiology of ulcers has so far produced little in the way of positive evidence of any special deficiency. It is clear however from data which have been collected that syphilis, yaws or malaria are not the casual factors. There was found to be distinct delay in the sugar tolerance curve but this was not confined to individuals suffering from ulcers. A similar observation was made in India in connection with cereal-eating people. The percentage calcium content of the blood in ulcer cases varied between wide limits; the average, however, was not definitely less than in non-ulcer cases. The blood phosphorous was definitely higher than normal. The exact significance of the last two observations is not understood, it is evident however that there is disturbance of the calcium and phosphorous metabolism associated in some way with a disturbance of sugar metabolism as evidenced by the delay in the sugar curve. There was an increase of the lymphocyte count. Apart from these observations little information was gained beyond the fact that the subjects were all in a state of malnutrition as shown by the co-incident healing of ulcers and improvement in the general condition.

During the course both of the metabolic investigations and those on ulcers it was apparent that the factor of helminthic infestation was one that could not be ignored and was one that might possibly have a considerable influence on metabolism generally and particularly of calcium.

An independent investigation conducted at the same time showed that an infestation by taenia of growing boys produced very considerable effects on the general nutritional condition. Information is being sought with regard to the effect on adults. The possible effect of helminthic infestation is obviously of such importance that the part played in the nutritional problem must be cleared up before any definite conclusions can be drawn. It is proposed immediately to undertake a metabolic investigation at the gaol on prisoners infested with intestinal worms.

In connection with the possible influence exercised by helminthic infestation on the nutritional condition a particular point has arisen on several occasions. It has been suggested, and a certain amount of evidence has been brought forward in support, that helminthic infestation itself is largely influenced by the nutritional condition. An endeavour is being made to ascertain evidence in support or otherwise of this theory. In this connection the feeding experiments at Molo at present being conducted on sheep may throw considerable light. In these experiments groups of sheep are being grazed together on the same pasture, some receiving supplementary feeding in order to balance up deficiencies.

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With regard to the completion of the investigation, the work with animals is clear and straightforward, the results are in accordance with those which have already been obtained in Britain, South Africa, Australia and New Zealand, and the main requirement is to demonstrate on a larger scale the application of the information gained. The programme for the immediate future is attached.

With regard to the medical work, I have arranged with the Director of Medical and Sanitary Services here that Doctor Foster and Doctor Henderson should continue the investigation along the lines indicated in the medical report attached until the late autumn of the present year, when they will have completed two years work. They should then be brought back to the Rowett Institute where the mass of data will be analysed and put into a form in which it can be considered by the dietetics sub-committee of the Civil Research Committee. When that committee has considered the information collected, the question of the desirability of continuing the work, the lines along which it should be continued, and the means of having it carried out, could then profitably be considered.

In conclusion I should like to state that the whole investigation has been carried out without any hitch or friction, the permanent officials here have co-operated, especially in the native dietetics investigation, so heartily that it is difficult in many instances to determine what part of the work was done by the workers sent out and what part was done by the officials here.

The success of this long range research in which the scientific aspect of the investigation is controlled by the committee in London is worthy of note in view of the attempts being made by the various committees in which you are interested to organize Empire research on the lines of having existing scientific information applied quickly to economic or health problems.

Yours faithfully,

J.B. ORR.

REPORT ON INVESTIGATIONS ON NATIVE
DIETETICS BY THE DIRECTOR OF MEDICAL
AND SANITARY SERVICES, KENYA.

The visit to Kenya of Dr. J.B.Orr afforded an unique opportunity for a discussion of the investigations on native dietics which are being carried out by the workers sent out by the Sub-Committee of the Civil Research Committee and by the Officers of the Kenya Medical Service. Certain other investigations having a bearing on the general problem were included. The discussion was of exceptional interest and of great value to all. As a result, it was considered desirable that a report giving a general idea of the progress made should be drawn up for the information of the Chairman of the Sub-Committee by the Director of Medical and Sanitary Services who has been in close touch with all the different aspects of the investigations.

It will be remembered that two Officers were appointed from England, one for field work and the collection of information regarding dietary habits and customs and their correlation with disease among the Masai and Kikuyu races, and the second for investigations on the aetiology of the ulcers which are so commonly met with among the natives.

The basic reason of the ulcer investigation was that it was considered that the large incidence of ulcers might be a result of some dietary deficiency. The collection of information relating to the dietaries of Masai and Kikuyu was decided upon on account of the wide variation met with in these two tribes, the first living almost entirely on animal products and the second on cereals.

One of the conditions attached to the investigation was that two Officers should be supplied by the Government of Kenya for work on the general problem. The Kenya Government agreed and also expressed its willingness to defray the local expenditure in connection with travelling, housing, etc., of the Officers appointed in London.

Dr. J.M. Henderson was selected for the ulcer investigation and Dr. J.W.Foster for the field work. The last named was employed for three months prior to sailing in an examination of the literature in order to obtain information as to dietary habits among uncivilised races which might indicate that special measures had been evolved in order to cope with deficiencies in the mineral constituents of the diet. Dr. Henderson arrived in Kenya on 11th November, 1926, and Dr. Foster on 19th February, 1927.

Necessary re-arrangements in the Medical Laboratory at Nairobi had been effected prior to Dr. Henderson's arrival, in order to accommodate the extra worker. In addition, plans had already been got out for the performance by the Kenya Bio-Chemist, Dr. F.C. Kelly, of metabolic experiments to be carried out on a large scale at the Nairobi Prison. With every assistance from the Prison Authorities special arrangements were made for the cooking and distribution of food to the groups of prisoners selected. On the retirement of Dr. Kelly the work was taken over

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by Dr. D. Harvey. The collection of material and the administration of selected additions to the diets of the subjects employed was the direct responsibility of Sub-Assistant Surgeon Nazir Chand of the Kenya Service without whose help the experiments could not have been the success that they were. The results of the experiments will afterwards be described.

On the arrival of Dr. Foster, Dr. J.C. Callanan of the Kenya Service was detailed to accompany him to the Kikuyu Reserve and to be in charge of the party. The general plan of the field investigation was discussed in Nairobi and a form for the recording of physical measurements of individuals was devised and adopted; it has since not been found to require modification.

The field investigation in the Kikuyu Reserve occupied four months during which time 6,349 individuals were examined and their physical measurements recorded while a large number of specimens of food-stuffs was obtained and despatched to Nairobi whence after preparation in the Laboratory they were forwarded for analysis at the Rowett Research Institute. The investigation in the Kikuyu Reserve was not entirely unaccompanied by restlessness and uneasiness on the part of the natives but the amount of information which was gathered and the amount of material collected reflects great credit on both the Officers concerned.

Although the collection of information, foodstuffs and specimens of salt licks and mineral springs in the Kikuyu Reserve was not completed it was decided in July that this should be deferred for a time in order to take advantage of the weather conditions to proceed to the Masai Reserve for the collection of physical statistics of the population and information as to dietary habits. It has to be remembered that during the months of March to July the rainy season renders communication almost impossible. Owing to the scattered nature of the population of 45,000 in an area of 14,700 square miles, combined with the difficulty and cost of transport it was decided that one Officer only should undertake the work in this District. Dr. Foster accordingly proceeded by himself.

The work, difficult and arduous as it would be under normal conditions, has been rendered still more so from the fact that owing to the drought which has obtained during the year the population has migrated and is still migrating in a continual search for water and for grazing for the herds. Moreover the whole mental attitude of the Masai has been one of anxiety as to where the necessary facilities might be obtained and little interest could be aroused in anything else. In spite of the difficulties enumerated a large amount of most useful work has been done, but it became evident at the beginning of February that the expenditure of time and money among the Masai was not being attended by results which could warrant its continuance under existing conditions. Dr. Foster accordingly left the Masai Reserve and returned to Kikuyu where he resumed the collection of specimens of food-stuffs, salt licks and mineral springs.

On arrival in Nairobi Dr. Henderson, by arrangement with Dr. Massey, the Senior Medical Officer, was allotted beds in the Native Hospital and such ulcer cases as were required

Copy of a letter dated March 17th 1928.

from Dr. J.D.Orr to the Chairman.

Nairobi, Kenya.

14th March, 1928.

Dear Major Elliot,

The following report is sent to you as Chairman of the various committees interested in the Kenya investigations, for your personal information. It has been drawn up so hurriedly that it is not fit to be submitted as an official report.

I visited the various centres where work is being done and have had repeated discussions with the workers sent out and the permanent officials interested in the investigation.

At the request of the Governor a Conference was held to consider the results of the work. Those present were the Colonial Secretary, the Director of Medical and Sanitary Services, the Acting Director of Agriculture, the Director of the Veterinary Research Department, and the Settlers on whose estates the feeding experiments with animals are being done.

A report of the animal work was drawn up for the Conference; a copy is attached. The report on the medical work was made orally. A copy of the minutes is enclosed. A detailed account of the medical work is being drawn up by the Director of Medical and Sanitary Services, who has been in close touch with the work, and will accompany this report.

The main points of the reports are:-

Animals: the feeding tests at Naivasha are negative; the tests at the other centres are definitely positive. This is in accordance with what would be expected from the analytic data from the pastures.

Native Diabetics: the field survey shows a marked difference in the diets of the Kikuyu and the Masai, and a difference in the physique and kind of diseases prevalent in the respective tribes.

The Laboratory and clinical work has yielded interesting results, the practical significance of which for preventative medicine is in some cases not yet clear.

The opinion of the Conference seemed to be that the results of the work on animals is of considerable economic importance, and that on native diabetics of potential value in connection with the prevention of disease and the improvement of the physique of the natives.

It was unanimously agreed that the work should be continued and if possible extended especially along the lines of the practical application of the knowledge being accumulated. It may be expected that the Kenya Government will make a request for the work to be developed under the continued general guidance and direction of the present technical committees appointed by the Civil Research Council, and will offer the continued co-operation of the local officials, increased local facilities and a grant of money to enable the work to be extended.

SUMMARY OF RESULTS:

PASTURE INVESTIGATION IN KENYA

November 1926 - February 1928

NOTE by DR. J.B. ORR.

The investigation was undertaken to determine whether the pasture in certain districts in Kenya was deficient in essential nutrients and if so, whether these deficiencies were the cause of malnutrition in cattle and sheep.

The work consisted of:-

- A. Analysis of samples of pasture from four districts;
- B. Feeding experiments with cattle and sheep, to test the effect of feeding of certain constituents which were thought might be deficient.

A. COMPOSITION OF PASTURES.

The following Table on Appendix I, shows the average composition of the pastures at Naivasha; Athi Plains; Molo; and Nakuru, and for comparison that of good British pastures.

It is seen that the Naivasha pastures are as rich in nitrogen, lime, phosphorus and potash, as good British pastures, though rather lower in sodium and chlorine. Those of Molo and Nakuru are markedly deficient in all the mineral constituents. Those of the Athi Plains are intermediate in value between Naivasha and Molo. The deficiency in phosphorus at Molo is very marked, and is comparable with that found in the phosphorus deficient areas of South Africa and Australia, where malnutrition due to this cause occurs.

Samples were collected at intervals throughout the year to determine the difference in analysis after rain and during drought.

The Tables, Appendix 2, show the effect of rainfall on a good area - Naivasha, and a poor area - Nakuru.

It will be seen that there is a great increase in both mineral and protein content following rain. The increase is most marked in the good pasture - Naivasha, which responds to rain both by increased rate of growth and by improvement in quality much more rapidly than the poorer pastures of Nakuru and Molo.

B. FEEDING TESTS.

Nakuru. The tests at Nakuru were carried out to throw light on the cause of the local disease known as "Nakuruitis". From the appearance of the animals and the results of work in New Zealand it was thought that deficiency of iron might be an important factor.

Four groups each of 30 oxen were grazed on the affected area: the animals in one group were given a mixture of salt and iron oxide in equal proportions ad lib. Other two groups were given mineral mixtures with a lower amount of iron - 8 per cent and 1 per cent. The remaining group serving as control received nothing in addition to pasture.

The Table, Appendix 3, gives details of the average gain or loss in weights in the different groups for a period of ten months. The average gain or loss is as follows:-

	<u>Control.</u> lbs	<u>Low iron.</u> lbs	<u>Medium iron.</u> lbs	<u>High iron.</u> lbs
Average gain or loss	- 35	- 11	+ 69	+ 136

It will be seen that the control of group receiving no mineral mixture lost weight whereas considerable gains were made in the group receiving salt and iron oxide. The other two groups were intermediate and roughly in proportion to the amount of iron oxide fed.

The control animals developed the typical signs of "Akurutis", while all animals receiving salt and iron remained healthy and at this date, after the drought, are in marketable condition as slaughter or work animals.

A few animals suffering from the disease were treated by the administration of salt and iron with good results.

The Medical and the Veterinary Laboratories co-operated in the technical work involved in blood tests and post mortem examinations. The results of these examinations show that anaemia is a marked feature of the disease.

The result seems to indicate that whatever the cause of the condition may be, it can be prevented by the feeding of this mixture.

SHEEP FEEDING EXPERIMENTS.

These were carried out at Naivasha and Molo. Three groups of ewes with lambs were grazed together. One group received a mineral mixture, a second group a mineral and protein mixture, the third group which served as control received nothing in addition to pasture at Naivasha, but at Molo received rock salt ad lib. The figures for weights of fleeces and rate of growth of lambs are given on appendix 4.

The following figures give a summary of the results to date:-

Average gain in weight of Lambs:-

	<u>Control.</u> lbs.	<u>Control Minerals.</u> lbs.	<u>Control Minerals, protein.</u> lbs.
12 months - Molo	23.24	27.75	35.57
14 months - Naivasha	55.2	57.3	57.5

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The rate of growth of lambs is much greater - nearly double at Naivasha than at Molo. In the former district the addition of mineral and protein had little or no effect on the rate of growth, whereas at Molo the average rate of growth of the animals receiving the minerals was 19 per cent greater than the controls, those receiving protein in addition 53 per cent.

These results are in keeping with the analyses of the pastures which showed a marked deficiency at Molo but none at Naivasha.

The weights of the fleeces in the fed groups are about 10 per cent heavier in both Molo and Naivasha.

CALF REARING.

Molo and Naivasha.

Tests were carried out at Molo and Naivasha. At the latter centre no beneficial effect was obtained (up to one year) with feeding either minerals or protein. The animals in all the groups are in excellent condition.

At Molo the average increase to date was as follows:-

<u>Control</u>	<u>Control Minerals.</u>	<u>Control Minerals, protein.</u>
256 lbs.	270 lbs.	319 lbs.

Figures are given in detail on appendix 5.

MILK COW EXPERIMENT.

The tests at Naivasha and Molo were undertaken to determine the effects of the feeding of minerals and protein. There were, however, such marked differences in the quality of cows that the data are useless. At Molo a second test was carried out with heifers, whose milk yield was recorded during a preliminary period before feeding of minerals or protein was begun and the animals then arranged in 3 comparable groups of 8 with the same average yield. Appendix 5 gives data for this test.

The following table shows difference in milk yield, that of the control group being expressed as 100:-

<u>Control</u>	<u>Control Mineral</u>	<u>Control Mineral, protein.</u>
100	133	135

The feeding of minerals to those cows seems to have a marked beneficial effect on the milk yield.

In addition to work on the main problem, viz. deficiencies in pasture, it was possible to carry out, without additional expense, feeding experiments with milk cows, pigs

and poultry. The results on pigs were negative, due to the fact that animals experimented on had milk ad lib, therefore no addition tried had any beneficial effect. The results on poultry were definitely positive. The addition of a mineral mixture doubled the egg yield. The results on cows were also positive, showing that in certain cows at least the feeding of concentrates during the dry season enormously increased the milk yield.

	<u>Control.</u> lbs.	<u>Experiment.</u> lbs.
Preliminary period:		
Yield 1st month.	1329	1351
Experimental cows fed:		
Yield per month.	808	1659

These extra tests were of course not purely experimental work, but local demonstrations of the effect of proper feeding.

CONCLUSIONS.

It should be kept in view that these tests have run for only a short period and the results are therefore not to be regarded as conclusive. They seem to indicate, however, that in areas like Nakuru and Molo, where the pastures are deficient in minerals an increased rate of growth can be obtained in lambs and calves, an increased milk yield in cows, and that in both good and bad areas an increased weight of wool is obtained by the feeding of appropriate mineral mixtures.

They seem however to warrant the following conclusions:-

(1) The disease "Nakurutitis" can be prevented by the feeding of an appropriate mineral mixture.

(2) In deficient areas, the feeding of minerals is followed by increased rate of growth in lambs and calves and increased milk yield in cows.

(3) The feeding of minerals increases the weight of the fleeces of the sheep in both good and bad areas.

(4) Feeding of concentrates to some cows at least gives a markedly increased yield of milk.

Further experiments are required to determine the economic value (if any) of these results, and if they are found to be of practical value to ascertain the best combination and amount of supplements to feed to obtain the maximum result at the minimum cost.

APPENDIX I.

TABLE A.

Composition of the Dry Matter of the Herbage.

	Naivasha Av. of 14 samples.	Doonholm (Athi-Plains) Av. of 7 samples.	Melo Av. of 18 samples.	Nayuru Av. of 23 samples.	British Pastures. Av. for "AV. for Hill Cultivated: pasture" all pasture. : "eaten."
Dry Matter	100	100	100	100	100
Nitrogen	1.952	1.50	0.960	0.99	2.82
Acid Sol-Ash	5.625	4.42	2.423	3.90	5.50
CaO	0.955	0.64	0.484	0.40	6.64
MgO	0.062	0.16	0.016	0.07	1.00
K ₂ O	2.123	1.55	.779	1.72	0.85
Phosphoric Acid (P ₂ O ₅)	0.686	0.36	.0184	0.32	0.27
Organic	0.389	0.47	.170	0.35	3.15
					0.74
					0.94
					0.64

TABLE B.

Rainfall Effect - Naivasha Percentages expressed on Dry Matter.

	Date of Collection.	
	March 6th Before rain.	March 23rd After rain.
Dry Matter.	100	100
Nitrogen	1.05	3.60
Acid Soluble Ash	2.70	8.76
Lime (CaO)	0.51	1.82
Soda (Na ₂ O)	0.33	0.08
Potash (K ₂ O)	0.70	4.17
Phosphoric Acid(P ₂ O ₅)	0.50	1.15
Chlorine (Cl)	0.24	0.62

APPENDIX 2.

TABLE C.

Rainfall and Maturity Effects - Nakuru.

Percentages expressed on the Dry Matter.

Date of Collection.	January 7th		March 10th		April 16th		June 27th	
	100	Before rain.	100	After rain.	100	After rain.	100	Grass fully mature.
Nitrogen	100	0.51	100	0.75	100	1.95	100	0.77
Acid Soluble Ash		2.35		3.41		6.12		3.65
Lime (CaO)		0.59		0.40		0.52		0.28
Soda (Na ₂ CO ₃)		0.03		0.03		0.06		0.05
Potash (K ₂ O)		0.97		1.14		3.25		1.96
Phosphoric Acid (P ₂ O ₅)		0.17		0.15		0.41		0.19
Chlorine (Cl)		0.26		0.27		0.85		0.13

FEEDING EXPERIMENT."Nakurutia".

(Weight in lbs.)

	Group I (Control)	Group II (Low Iron) <u>Grain Oxen</u>	Group III (Medium Iron)	Group IV. (High Iron)
Av. wt. 12/11/26	737.1	774.3	753.6	764.3
Av. wt. 2/10/27	724.5	759.3	827.7	952.2
Gain or Loss	- 36.6	- 5.0	+ 73.9	187.9
		<u>Work Oxen.</u>		
Av. wt. 12/21/26	616.4	593.7	580.7	558.1
Av. wt. 3/10/27	597.6	563.7	615.3	633.5
Gain or Loss	- 12.8	- 11.0	34.6	75.4
		<u>Native Oxen.</u>		
Av. wt. 12/11/26	607.5	616.4	654.0	601.0
Av. wt. 3/10/27	582.2	598.0	756.3	716.3
Gain or Loss	- 55.0	- 18.4	99.3	143.3

Iron Content of Mineral Mixtures.

0	1%	5%	50%
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23.

FEEDING EXPERIMENTSMOLO.

Average weight per lamb (lbs)

	Group I <u>Control</u> lbs.	Group 2 <u>Control</u> <u>Minerals.</u> lbs.	Group 3 <u>Control, Minerals</u> <u>protein.</u> lbs.
Average Wt. 16/2/27	35.0	35.2	35.1
Average Wt. 16/2/28	58.34	62.95	70.67
Gain (12 months)	23.34	27.75	35.57
Gain expressed as % of gain in Group 1	100	119	153

Fleece Weights (lbs)

	Group I	Group 2	Group 3
From 16/2/27 - 19/5/27	1.58	1.74	1.81
From 19/5/27 - 1/12/27	2.72	2.83	3.19
Total	4.30	4.57	5.00
Average condition of wool (possible 8 pts)	4.32	6.24	6.43

NAIVASHA.

	Group I <u>Control.</u> lbs.	Group 2 <u>Control</u> <u>Minerals.</u> lbs.	Group 3 <u>Control, Minerals</u> <u>protein.</u> lbs.
Average Wt. Lambs			
" " 24/11/26	25.0	24.1	24.8
" " 7/ 2/28	80.2	81.4	82.2
Gain - 14 months	55.2	57.3	57.4

Fleece Weights (lbs)

	Group I	Group 2	Group 3
Lambs - From 24/11/26			
to 1/ 4/27	1.95	2.31	2.04
From 1/ 4/27			
to 11/10/27	3.66	4.21	4.06
Total	5.63	6.52	6.10
Ewes - From 1/ 4/27			
to 11/10/27	3.92	4.66	4.18

HEIFERS - 1ST LACTATION.MOLO.

	Group 1 (Basal)	Group 2 (Basal, Minerals)	Group 3 (Basal, Mineral, Protein),
	lbs.	lbs.	lbs.
Preliminary Period.			
Initial Yield (14 days)	2052	1939	1990
Yield till 31st Jan.	19464	25158	25540
Yield for Exp. period	17412	23217	23550
Taking Group 1 yield as 100 .	100	133.3	135.2

CALF FEEDING EXPERIMENT.Keringet.

	Group 1 (Control)	Group 2 (Control, Mineral)	Group 3 (Control, min- eral, protein)
	lbs.	lbs.	lbs.
Av. Initial Weight	104	100	107
Av. Weight after 13 months	360	370	426
Average Gain	256	270	319

Naivasha.

Av. Initial Weight	75.2	72.5	77.1
Av. Weight after 11 months	396	396.3	324
Average Gain	321	324	308

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C.R.(D) 21.

COMMITTEE OF CIVIL RESEARCH.

SUB-COMMITTEE ON DIETETICS.

PROGRESS REPORT BY DIRECTOR OF THE INVESTIGATIONS.

The investigation into native dietetics in Kenya has been carried out according to a two-year scheme of work recommended by this Sub-Committee. The two-year period is nearing an end and it appears desirable to review the position in the light of the progress made. The following reports have already been submitted:

- (1) Interim Progress Report C.R.(D) 12.
- (2) Report of Sub-Committee C.R.(C) 21.
- (3) Report by Director of Medical Services, Kenya, C.R.(D) 16.

It is unnecessary to repeat in detail the information already given in the above reports. The following notes summarise the position.

Field Work: A survey has been made of the dietary habits, of the physical condition, and incidence of disease among the Kikuyu, a tribe who are almost entirely vegetarian, and the Masai, a tribe whose food consists almost exclusively of meat, blood and milk. A preliminary review of the information collected shows that there are marked differences in the physical condition and in the diseases prevalent in the two tribes. Before a full report on this part of the work can be drawn up, however, a mass of detailed information including measurements of about 10,000 natives, analytical data of about 100 samples of native foodstuffs and salt licks, has yet to be examined more thoroughly and in some cases, subjected to statistical analyses.

Clinical and Laboratory Work:

(a) Ulcers: It has been shown that there is no correlation between the incidence of ulcers and that of syphilis, yaws or malaria. This negative result has cleared up a point which has been in dispute for some time, but on which there existed no data from which conclusions could be drawn.

The examination of blood of natives of the tribe (the Kikuyu) among which ulcers are prevalent, has shown that it differs from that of Europeans in Kenya in the following respects:- The calcium content is lower, phosphate content is higher, there is a lag in the return to normal level of blood sugar after glucose ingestion, although no sugar can be detected in the urine.

A differential blood count shows a higher lymphocyte and a lower polymorph count than in the case of Europeans. In ulcer cases these deviations from the European standard tend to be exaggerated except in the case of calcium which is not lower in ulcer than in non-ulcer cases.

(b) Treatment of Ulcers: The effects of various dietary factors have been tested on the rate of healing in ulcers. The only general conclusion which can be drawn is that the ulcer tends to heal in proportion to the improvement in the state of nutrition of the patient.

(c) Balance Experiments with Natives: Examination of the diets fed in hospitals and prisons showed that compared with European diets they were very low in certain mineral elements, especially in calcium. The addition of calcium in the form of calcium carbonate or ordinary bone meal fed to natives on these diets led to a marked increase in the amount of calcium retained. This was especially marked in young subjects who were still growing.

As in the case of the field work a great deal of data has been collected which has not yet been adequately studied.

Literature: A review of the literature of iodine has been completed. On the recommendation of this Sub-Committee, the review is being dealt with by the Nutrition Committee of the Medical Research Council.

Need for Systematic Examination of Information Accumulated.

So far the two workers in Kenya have been engaged in the accumulation of information including experimental data. It is suggested that some time should now be devoted to the systematic examination of the accumulated data. It would be most convenient if Drs. Henderson and Foster were brought back to this country for a period of two or three months for the purpose of having a full report on the work written up. If this were done in this country, they would be able to work in periodic consultation with members of the Sub-Committee, who would be able to give guidance in interpreting the data and in drawing conclusions. This seems desirable in view of the fact that some of the conclusions reached may be of practical importance in connection with preventive medicine amongst the natives in Africa.

This work in Kenya has been running in close association with the permanent officials there and under the personal local supervision of Dr. Gilks. It would be possible therefore, to arrange for some of the work, especially certain feeding experiments which are running, to be carried on by the permanent officials, although Drs. Henderson and Foster were not in Kenya.

(Sd.) J.B. ORR.

Rowett Research Institute,
Aberdeen.
6th September, 1928.

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COPY NO. 19

COMMITTEE OF CIVIL RESEARCH.

SUB-COMMITTEE ON THE MINERAL CONTENT OF
NATURAL PASTURES.

Progress Report by Dr. Orr.

Research work has now been going on for two years under the general supervision of this Sub-Committee, and it seems desirable at this stage to review the position and in the light of the further information which has been obtained, to consider the lines along which it would be most profitable to pursue the investigation. Since the Committee was formed, investigations on similar lines have been undertaken in other parts of the Empire. These should be considered in discussing the development of the research.

The following is a brief account of what has been done.

Collection of Existing Information: A Questionnaire (see C.R.(C)-6) accompanied by a memorandum stating the problem, was issued to all the Governments within the British Empire. The replies to the Questionnaire showed that pathological conditions which are probably attributable to deficiencies in the pasture, were prevalent in nearly all parts of the Empire where there were large pastoral areas.

A worker was devoted to a search of the literature and summaries of all the available papers bearing on the subject have been made.

The information obtained in the replies to the Questionnaire and in the search of the literature has been

written up, and in accordance with the recommendations of this Sub-Committee, the review is at present being circulated to all the research workers or officials within the Empire who are known to be interested in the subject, with a request that they will assist by correcting, supplementing, or offering any suggestions, especially with reference to their own Dominion or Colony which they consider will be of use in making the review more accurate and complete.

There is reason to believe that this collection of information which includes a bibliography of the literature will be of considerable value to the increasing number of officials and research workers throughout the Empire who are now studying this problem.

Experimental Work: The main experimental work was carried out in Kenya Colony. Some control tests were, however, carried out in Scotland. Two Interim Progress Reports have been submitted. The main results are as follows :-

(1) The chemical composition of the pastures from different areas in Kenya and collected at different seasons corresponds with the known nutritive value of the pastures in these areas and at those seasons. Malnutrition is most prevalent in the areas where deficiencies are most marked.

(2) The administration to the grazing animals of inorganic salts rich in the elements believed to be deficient in the pastures has been followed by beneficial effects in two areas where the pastures were deficient. In a third area where the results of analyses showed no deficiency, no effect on rate of growth or health was obtained.

(3) In other tests where, in addition to minerals, a small amount of protein, in which the pastures were poor and a trace of cod liver oil was fed, the beneficial effect especially with regard to rate of growth in lambs was more

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marked than when a mineral mixture only was administered.

These results obtained in Kenya correspond closely with those being obtained in other parts of the Empire where comparable tests are being done. The results on "Nakurutitis" correspond closely with the results obtained in New Zealand in connection with "Bush-Sickness", which is probably the same deficiency disease, and the increase in milk yield - about 30 per cent - as a result of feeding inorganic salts to milk cows in a deficient area in a short test is very similar to that obtained by Theiler and his co-workers in South Africa through feeding bone meal under similar conditions.

(4) In Scotland where feeding tests were carried out with sheep on the lines of paragraph 3 above, the results varied in different districts. In the Western Highlands where the herbage is very deficient, especially in calcium, and where the mortality amongst sheep is high, the condition of the ewes improved, the size of the lambs increased, the fleeces were heavier and there was a decrease in mortality.

In these areas it is considered to be impossible to winter growing sheep. At two of the experimental centres small groups of about twenty sheep of this type were successfully wintered.

In these tests the amount of the material fed varied from half an ounce to an ounce per ewe per day. The material fed consisted to the extent of over 50 per cent of inorganic salts. There is no evidence to show to what extent the beneficial results are due to inorganic salts and to what extent to organic substances.

In other areas in the South of Scotland where the pasture is richer, and also in a test on a hill near the Rowett Institute where the animals had access to a small area of comparatively good pasture, little or no difference was obtained between the experimental and control groups.

Work in Other Parts of the Empire. In New Zealand in addition to the work on "bush-sickness", work is being begun on the following lines:

A general survey of the mineral content of pastures is being made.

The cause of malnutrition in sheep occurring in a certain area and believed to be due to calcium deficiency is being investigated. The condition of malnutrition presents certain similarities to those found in sheep in the West of Scotland.

Arrangements are being made for an iodine survey to be carried out jointly by the Medical and Agricultural Departments.

In Australia fundamental work is being done on the effect of deficiencies in the soil on the rate of transpiration of pasture plants. It has been found that the amount of moisture used by the plant is about 30 per cent greater on a soil deficient in phosphorus than in the case of the same soil with phosphates added to it. This is in line with observations made in Kenya on the difference between the nutritive value of pastures in drought on rich and on poor soils.

Other work in Australia includes a systematic investigation on the mineral content of different species of pasture plants, and an investigation on the incidence of goitre and its relation to iodine supply.

It is probable that feeding experiments on the lines carried out in South and East Africa and in the West Coast of Scotland will also be undertaken in the immediate future.

In South Africa the work begun by Sir Arnold Theiler is being continued. Probably the most interesting result which has not yet been published is that the deterioration of improved breeds which takes place in phosphorus deficient areas is prevented by feeding inorganic phosphates.

In Canada the administration of iodine to all kinds of stock has been found to be followed by beneficial results. No systematic work on pastures on the above lines has, however, been undertaken.

In Ceylon work during the past year has shown that a disease in horses known as "Big Head" is prevented by feeding calcium salts and it is suggested that the poor condition of the cattle there may be due to the same deficiency.

To complete this brief review, reference must be made to the important work on pastures being done at both Cambridge and Aberystwyth. This work has a certain bearing on the problem being studied. At Cambridge it has been shown that according to its chemical composition young pasture should have a very high nutritive value. This has been confirmed by digestibility and feeding tests. Experiments on the conservation of pasture at this stage of growth are being carried out. At Aberystwyth the work of the plant breeders has led them to consider the chemical composition of pasture plants, and the results of the investigations there are beginning to throw further light on the special problem being investigated by this Committee. This brief reference to the work at Cambridge and Aberystwyth is not to be regarded as a report on the work, it is inserted here merely

to remind the Sub-Committee of these important allied lines of investigation related to pastures.

Nature of Further Work Required: Some of the results obtained suggest that under certain conditions the feeding to animals of small amounts of substances deficient in the pastures on which they are grazing has a beneficial effect out of all proportion to the cost of the material fed. These results appear to be of practical value and should be further exploited. A series of three-year tests should be undertaken in both Kenya and Scotland to demonstrate the effects more fully, especially the effects on the second generation.

The observations made suggest that in certain areas in Scotland where there is a high mortality in the sheep, the feeding of these substances reduces the death rate. This result, if confirmed, is of great importance. These tests afford valuable facilities for the study of the influence of nutrition on susceptibility to certain diseases. Information on this subject in which physiologists, bacteriologists and clinicians would co-operate appears to be warranted.

The results of two tests suggest the possibility of wintering sheep at small cost in areas where under present conditions wintering is impossible. Wintering of sheep is a serious economic problem in Scotland as large numbers from the West have to be wintered every year in other parts of the country at a cost of from 10/- to 15/- per head. A series of tests should be carried out to determine whether these animals could not be wintered at home if supplied with comparatively small amounts of the right kinds of nutrients.

In the South of Scotland where there is a certain amount of malnutrition in sheep, though less marked than that in the Western Highlands, the feeding of substances rich in calcium, phosphorus, sodium chloride, animal protein and cod liver oil, has not had any definite

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result. It is just possible that in these areas there may be deficiencies of substances which are required only in traces, e.g. iodine, manganese and copper. Such information as is available with regard to the effects of deficiencies of these, should be collected and samples of pasture which have been collected from different areas in the course of this investigation should be analysed to determine what amount of these substances are present.

Organisation of Further Work: Sufficient analytical data have been obtained on the pastures in Kenya to form a basis for the further feeding tests which are required. The comparatively small amount of additional chemical work which may be necessary could be done in the laboratory at Nairobi. At a recent meeting of the Director of this research and the officials in Kenya it was agreed that the Kenya Government should make an extension to the laboratory in Nairobi to make provision for chemical work required in connection with both the animal and human nutritional work being done in the Colony.

Certain problems in connection with the growth and mineral content of pastures in drought conditions should be investigated. Fundamental work on this subject is being done at the Waite Institute in Australia, which has a grant for pasture research from the Empire Marketing Board. It would be convenient to base any Kenya work of this nature on the Waite Institute as there is a closer similarity between the climate and soil conditions in Australia and Kenya, than between those in Kenya and in Scotland.

If these arrangements were made the expenditure on the Kenya work which would fall to be charged against the grant made by the Empire Marketing Board for work under the supervision of this Sub-Committee, would be limited to that involved in practical field work. This would leave about the half of the present grant to be expended on the other lines of research indicated above, which should be carried out more economically in Scotland.

To enable the work to be done in Scotland, it would be necessary to take a lease of a small sheep farm in an area in the West Highlands where there is a high mortality amongst the sheep. All the experimental work which is at present scattered at a number of centres throughout the West Highlands, could then be centred at this farm where the workers would have complete control of the animals and of the management of the farm.

If a systematic attack were to be made upon the problem of the influence of diet on the susceptibility to disease in sheep, it would be necessary to secure the co-operation of bacteriologists and clinicians. The Animal Diseases Research Association for Scotland will probably be willing to co-operate in this work. It is hoped also that as the subject is of great importance in human medicine, the Medical Research Council might agree to be associated with in the investigation and to give assistance and guidance.

Concurrently with the experimental work, a review of the literature should be made to bring together all the information bearing on (a) the influence of nutrition on the incidence of disease and (b) the role of traces of substances such as zinc, manganese and copper in nutrition.

The close contact which has been maintained between this work on low grade pastures and the work at Cambridge on good pastures would be continued, and the contact between the Scottish work and that at Aberystwyth which has been made during the past year, would be developed.

The present grant from the Empire Marketing Board, if continued, would be sufficient to carry through the above scheme of work.

(sd.) J.B. ORR.

Rowett Research Institute,
Aberdeen.
1st September, 1928.

CONFIDENTIAL.

COPY NO. 18

C.R.(M.C.) - 33.

COMMITTEE OF CIVIL RESEARCH.

SUB-COMMITTEE ON THE MINERAL CONTENT OF
NATURAL PASTURES.

INVESTIGATION IN KENYA ON NATIVE DIETETICS AND ANIMAL
HUSBANDRY.

Note by the Secretary.

The following papers are circulated herewith by direction of the Chairman:-

- (i) Copy of a letter dated March 17th, 1928 from Dr. J. B. Orr to the Chairman.
- (ii) Report on investigations on native Dietetics by the Director of Medical and Sanitary Services, Kenya.
- (iii) Notes of a Meeting held at Government House, Nairobi on February 29th, 1928.
- (iv) Pasture investigations in Kenya; November, 1926 to February, 1928. Note by Dr. J. B. Orr.

These papers have also been circulated to the Sub-Committee on Dietetics.

(Signed) A. F. HEMMING.

Secretary to the Sub-Committee.

2, Whitehall Gardens, S.W.1.

8th May, 1928.

Enclosure No. (1)

Copy of a letter dated March 17th 1928.

from Dr. J.B.Orr to the Chairman.

Nairobi, Kenya.

14th March, 1928.

Dear Major Elliot,

The following report is sent to you as Chairman of the various committees interested in the Kenya investigations, for your personal information. It has been drawn up so hurriedly that it is not fit to be submitted as an official report.

I visited the various centres where work is being done and have had repeated discussions with the workers sent out and the permanent officials interested in the investigation.

At the request of the Governor a Conference was held to consider the results of the work. Those present were the Colonial Secretary, the Director of Medical and Sanitary Services, the Acting Director of Agriculture, the Director of the Veterinary Research Department, and the Settlers on whose estates the feeding experiments with animals are being done.

A report of the animal work was drawn up for the Conference; a copy is attached. The report on the medical work was made orally. A copy of the minutes is enclosed. A detailed account of the medical work is being drawn up by the Director of Medical and Sanitary Services, who has been in close touch with the work, and will accompany this report.

The main points of the reports are:-

Animals: the feeding tests at Naivasha are negative; the tests at the other centres are definitely positive. This is in accordance with what would be expected from the analytic data from the pastures.

Native Diets: the field survey shows a marked difference in the diets of the Kikuyu and the Masai, and a difference in the physique and kind of diseases prevalent in the respective tribes.

The laboratory and clinical work has yielded interesting results, the practical significance of which for preventative medicine is in some cases not yet clear.

The opinion of the Conference seemed to be that the results of the work on animals is of considerable economic importance, and that on native dietetics of potential value in connection with the prevention of disease and the improvement of the physique of the natives.

It was unanimously agreed that the work should be continued and if possible extended especially along the lines of the practical application of the knowledge being accumulated. It may be expected that the Kenya Government will make a request for the work to be developed under the continued general guidance and direction of the present technical committees appointed by the Civil Research Council, and will offer the continued co-operation of the local officials, increased local facilities and a grant of money to enable the work to be extended.

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With regard to the completion of the investigation, the work with animals is clear and straightforward, the results are in accordance with those which have already been obtained in Britain, South Africa, Australia and New Zealand, and the main requirement is to demonstrate on a larger scale the application of the information gained. The programme for the immediate future is attached.

With regard to the medical work, I have arranged with the Director of Medical and Sanitary Services here that Doctor Foster and Doctor Henderson should continue the investigation along the lines indicated in the medical report attached until the late autumn of the present year, when they will have completed two years work. They should then be brought back to the Rowett Institute where the mass of data will be analysed and put into a form in which it can be considered by the dietetics sub-committee of the Civil Research Committee. When that committee has considered the information collected, the question of the desirability of continuing the work, the lines along which it should be continued, and the means of having it carried out, could then profitably be considered.

In conclusion I should like to state that the whole investigation has been carried out without any hitch or friction, the permanent officials here have co-operated, especially in the native dietetics investigation, so heartily that it is difficult in many instances to determine what part of the work was done by the workers sent out and what part was done by the officials here.

The success of this long range research in which the scientific aspect of the investigation is controlled by the committee in London is worthy of note in view of the attempts being made by the various committees in which you are interested to organize Empire research on the lines of having existing scientific information applied quickly to economic or health problems.

Yours faithfully,

J.B. ORR.

REPORT ON INVESTIGATIONS ON NATIVE
DIETICS BY THE DIRECTOR OF MEDICAL
AND SANITARY SERVICES, KENYA.

The visit to Kenya of Dr. J.B.Crr afforded an unique opportunity for a discussion of the investigations on native dietics which are being carried out by the workers sent out by the Sub-Committee of the Civil Research Committee and by the Officers of the Kenya Medical Service. Certain other investigations having a bearing on the general problem were included. The discussion was of exceptional interest and of great value to all. As a result, it was considered desirable that a report giving a general idea of the progress made should be drawn up for the information of the Chairman of the Sub-Committee by the Director of Medical and Sanitary Services who has been in close touch with all the different aspects of the investigations.

It will be remembered that two Officers were appointed from England, one for field work and the collection of information regarding dietary habits and customs and their correlation with disease among the Masai and Kikuyu races, and the second for investigations on the aetiology of the ulcers which are so commonly met with among the natives.

The basic reason of the ulcer investigation was that it was considered that the large incidence of ulcers might be a result of some dietary deficiency. The collection of information relating to the dietaries of Masai and Kikuyu was decided upon on account of the wide variation met with in these two tribes, the first living almost entirely on animal products and the second on cereals.

One of the conditions attached to the investigation was that two Officers should be supplied by the Government of Kenya for work on the general problem. The Kenya Government agreed and also expressed its willingness to defray the local expenditure in connection with travelling, housing, etc., of the Officers appointed in London.

Dr. J.M. Henderson was selected for the ulcer investigation and Dr. J.W.Foster for the field work. The last named was employed for three months prior to sailing in an examination of the literature in order to obtain information as to dietary habits among uncivilised races which might indicate that special measures had been evolved in order to cope with deficiencies in the mineral constituents of the diet. Dr. Henderson arrived in Kenya on 11th November, 1926, and Dr. Foster on 19th February, 1927.

Necessary re-arrangements in the Medical Laboratory at Nairobi had been effected prior to Dr. Henderson's arrival, in order to accommodate the extra worker. In addition, plans had already been got out for the performance by the Kenya Bio-Chemist, Dr. F.C. Kelly, of metabolic experiments to be carried out on a large scale at the Nairobi Prison. With every assistance from the Prison Authorities special arrangements were made for the cooking and distribution of food to the groups of prisoners selected. On the retirement of Dr. Kelly the work was taken over

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by Dr. D. Harvey. The collection of material and the administration of selected additions to the diets of the subjects employed was the direct responsibility of Sub-Assistant Surgeon Mazir Chand of the Kenya Service without whose help the experiments could not have been the success that they were. The results of the experiments will afterwards be described.

On the arrival of Dr. Foster, Dr. J.C. Callanan of the Kenya Service was detailed to accompany him to the Kikuyu Reserve and to be in charge of the party. The general plan of the field investigation was discussed in Nairobi and a form for the recording of physical measurements of individuals was devised and adopted; it has since not been found to require modification.

The field investigation in the Kikuyu Reserve occupied four months during which time 6,349 individuals were examined and their physical measurements recorded while a large number of specimens of food-stuffs was obtained and despatched to Nairobi whence after preparation in the Laboratory they were forwarded for analysis at the Rowett Research Institute. The investigation in the Kikuyu Reserve was not entirely unaccompanied by restlessness and uneasiness on the part of the natives but the amount of information which was gathered and the amount of material collected reflects great credit on both the officers concerned.

Although the collection of information, foodstuffs and specimens of salt licks and mineral springs in the Kikuyu Reserve was not completed it was decided in July that this should be deferred for a time in order to take advantage of the weather conditions to proceed to the Masai Reserve for the collection of physical statistics of the population and information as to dietary habits. It has to be remembered that during the months of March to July the rainy season renders communication almost impossible. Owing to the scattered nature of the population of 45,000 in an area of 24,700 square miles, combined with the difficulty and cost of transport it was decided that one Officer only should undertake the work in this District. Dr. Foster accordingly proceeded by himself.

The work, difficult and arduous as it would be under normal conditions, has been rendered still more so from the fact that owing to the drought which has obtained during the year the population has migrated and is still migrating in a continual search for water and for grazing for the herds. Moreover the whole mental attitude of the Masai has been one of anxiety as to where the necessary facilities might be obtained and little interest could be aroused in anything else. In spite of the difficulties enumerated a large amount of most useful work has been done, but it became evident at the beginning of February that the expenditure of time and money among the Masai was not being attended by results which could warrant its continuance under existing conditions. Dr. Foster accordingly left the Masai Reserve and returned to Kikuyu where he resumed the collection of specimens of food-stuffs, salt licks and mineral springs.

On arrival in Nairobi Dr. Henderson, by arrangement with Dr. Massey, the Senior Medical Officer, was allotted beds in the Native Hospital and such ulcer cases as were required

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were placed under his sole charge. Special arrangements for the feeding, addition of supplements to the diets and treatment of the cases were made. In addition to the chemical and clinical work which was required for the study of the ulcer cases and which was performed by Dr. Henderson himself, certain other investigations were necessary and were performed by the various members of the staff of the Medical Research Laboratory. These included bacteriological investigation of the ulcers, the Wassermann re-action of the cases and clinical laboratory work for the detection of protozoological or helminthological parasites. All the laboratory work both by Dr. Henderson and others came under the direct charge of the Deputy Director of Laboratory Services, Dr. W.H. Kauntze.

The metabolic experiments indicate that the prisoners at the gaol are probably suffering from a deficiency in calcium. The majority of the cases, particularly the growing boys, showed either a definite negative balance in this connection or a very small positive one. The results coincided with the analyses of the diets, which showed a calcium content of roughly one-third of the generally accepted optimum, although they were satisfactory with regard to the other constituents and probably more satisfactory than the ordinary diet in a reserve.

The field investigations by Dr. Foster in the Kikuyu Reserve and such analyses as have so far been performed at the Rowett Institute tend to confirm these findings, while it is clear that resort has been made by the natives to sources of calcium which are not obtainable in their ordinary food-stuffs. The results of the metabolic experiments are contained in three papers which have been written conjointly by Dr. Henderson and Dr. Kelly; these, it is suggested, should be published at an early date. Considerable economic importance attaches to these results as it appears clear that the ordinary food-stuffs of the country are normally deficient in calcium and that some resort has to be made to an accessory supply of this mineral. It remained to be considered whether by the addition of some cheap form of calcium to the diet of the employed native outside his own reserve, physical improvement could be attained or, at any rate, a loss of physical efficiency prevented. The question of an addition to native diet generally will require to be considered when further information has been collected as regards the actual position in the reserves.

It was decided to perform a further metabolic experiment in the gaol to ascertain the effect of an addition of small quantities of

- (a) powdered chalk, and
- (b) powdered bone meal.

These substances were selected on account of their cheapness and from the fact that they could probably be added to the diet without causing any great disturbance either in the mind of a labourer or in the economy of the farm. The results to date tend to indicate that the addition of either of these substances is followed by a considerable retention of calcium in the growing boys on whom the experiment was conducted and who

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were previously on a very small positive balance.

During the course of the metabolic experiments an interesting and important point emerged. The addition of cod liver oil to one of the groups was not found to be followed by an increase in calcium retention in the absence of an additional supply of that mineral. Another group or an addition of a mineral mixture without cod liver oil was found to be retaining calcium. Both groups were exposed to similar conditions and amounts of sunlight.

The investigation into the aetiology of ulcers has so far produced little in the way of positive evidence of any special deficiency. It is clear however from data which have been collected that syphilis, yaws or malaria are not the casual factors. There was found to be distinct delay in the sugar tolerance curve but this was not confined to individuals suffering from ulcers. A similar observation was made in India in connection with cereal-eating people. The percentage calcium content of the blood in ulcer cases varied between wide limits: the average, however, was not definitely less than in non-ulcer cases. The blood phosphorous was definitely higher than normal. The exact significance of the last two observations is not understood, it is evident however that there is disturbance of the calcium and phosphorous metabolism associated in some way with a disturbance of sugar metabolism as evidenced by the delay in the sugar curve. There was an increase of the lymphocyte count. Apart from these observations little information was gained beyond the fact that the subjects were all in a state of malnutrition as shown by the co-incident healing of ulcers and improvement in the general condition.

During the course both of the metabolic investigations and those on ulcers it was apparent that the factor of helminthic infestation was one that could not be ignored and was one that might possibly have a considerable influence on metabolism generally and particularly of calcium.

An independent investigation conducted at the same time showed that an infestation by taenia of growing rats produced very considerable effects on the general nutritional condition. Information is being sought with regard to the effect on adults. The possible effect of helminthic infestation is obviously of such importance that the part played in the nutritional problem must be cleared up before any definite conclusions can be drawn. It is proposed immediately to undertake a metabolic investigation at the goal on prisoners infested with intestinal worms.

In connection with the possible influence exercised by helminthic infestation on the nutritional condition a particular point has arisen on several occasions. It has been suggested, and a certain amount of evidence has been brought forward in support, that helminthic infestation itself is largely influenced by the nutritional condition. An endeavour is being made to ascertain evidence in support or otherwise of this theory. In this connection the feeding experiments at Holo at present being conducted on sheep may throw considerable light. In these experiments groups of sheep are being grazed together on the same pasture, some receiving supplementary feeding in order to balance up deficiencies.

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The Veterinary Department, between whom and the Medical Department there has been co-operation throughout the experiments, has detailed a helminthologist to investigate and compare the incidence of helminthic parasites in the different groups.

The data as regards the physical conditions of the Masai and Kikuyu natives are of great importance and interest. Although statistical analysis has not yet been effected there is little doubt that the Masai generally, more particularly the men, are in better nutritional condition than are the Kikuyu. The following table, kindly prepared by the Statistician to the Governors' Conference from the data collected, shows the figures obtained from a random sample of Masai and Kikuyu men between the ages of 18 and 30:-

No.	Age.	Height.	Weight.	Dynamometer.	Chest.
30 Kikuyu men	37	5ft. 4 ins.	109	56	31.6 ins.
100 Masai men	30	5ft. 6 ins.	128	73	33.1 ins.

It will be remembered that the Masai live largely on a diet of meat, milk and blood of which milk is an important constituent, while the Kikuyu are restricted very largely to a vegetable diet. Their important sources of calcium are what might be termed necessary factors. The mental condition of the two races corresponds to the general physical condition.

The figures regarding the incidence of disease tend to show that pulmonary disease is more common among the Kikuyu and that the ulcers so commonly found among that tribe are comparatively rare among the Masai. Common complaints among the Masai, especially among the older section of adults, are "rheumatism" and constipation. The latter is rare among the Kikuyu with whom a soft unferred stool is the rule.

Comment was made in the earliest report by Dr. Orr as to the better physical condition generally of the Kikuyu young women as compared with that of the young men. Evidence has recently been collected which tends to show that the girls and young women receive a diet richer in calcium than do the male members of the tribe. If this be confirmed by the chemical analyses the observed differences between young men and young women will form a natural demonstration comparable to the results being obtained by feeding calcium rich substances under experimental conditions to youths at the Gaol.

The results of both sides of the investigation are of great interest and importance. Observations appear to be falling into line and mutually confirming one another. It is interesting to note that the general trend of the results of the work on animals, with some aspects of which the Medical Department has been connected, is similar to that on native dietetics reported on above.

JOHN L. GILKS,

DIRECTOR OF MEDICAL & SANITARY SERVICES.

X10173/27 Kenya

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Mr. Haslerigg. 25/2/27.

Mr.

Mr. Jeffries. 25/2/27

Mr. E. J. Harding.

Sir C. Strachey.

Sir J. Shuckburgh.

Sir G. Grindle.

Sir C. Davis.

Sir S. Wilson.

Mr. Ormsby-Gore.

Earl of Clarendon.

Mr. Amery.

25 FEB
D. L. Church

Feb, 1927.

2 MAR 1927

Sir,

DRAFT.

Kenya.

Conf.

O.A.G.

(No. 6 on 6120/26)

with ref. to my conf. despatch

of the 26th of August last relative to the arrangements made for research workers to visit Kenya

in connection with the investigations (which are being made in regard to) the mineral content of natural pastures, I have the

honour to transmit to you, for

From Dr. Orr 12th Jan., 1927. your info., the accompanying

Report of Mr. Crichton. 11th Jan., 1927. on the subject
(all on this) Copy of a report by Mr. Arthur Crichton, M.A., B.Sc., together with a copy of a covering letter from Dr. Orr.

(Signed) L. S. AMERY.

REPORT FROM DR J.B. ORR.

The Rowett Research Institute
Bucksburch, Aberdeen.

12th January, 1927.

Major W.E. Elliot, M.P.
Scottish Office,
London, S.W.1.

Sir,

Investigation on Pastures
Report by Mr. Arthur Crichton, M.A., B.Sc. (Agri).

Mr. Arthur Crichton was sent out from this Institute to Kenya in August last to make the necessary local arrangements for the field work to be carried out there in connection with the above investigation.

He was instructed to visit Palestine on the return journey to meet the Director of Agriculture and the officials of Tel-Aviv Station and discuss with them the advisability of having an investigation on the mineral content of pastures carried out in Palestine.

The report from Mr. Crichton shows that it has been found possible to get the field work in Kenya begun in accordance with the scheme approved. The complete programme is now in operation and the first monthly reports for the various centres, together with the first samples have already arrived. This is eminently satisfactory as it was considered ~~probable~~ that local difficulties would render some parts of the scheme impracticable.

The report on Palestine seems to indicate that the problem of the mineral content of pastures there is overshadowed by the wider problem of the provision of a sufficient supply of food for cattle during the dry season

copy to Gen. Kemp - 2

season. Hence the research work required for Palestine is at the present stage at least, somewhat different from that being done in Kenya. It is evident, however, that the practical problems of animal nutrition in Palestine are urgent, and that in the interests of the country, all available information should be brought to bear upon their solution.

Cyprus seems to present a definite problem on the mineral content of pastures. Provisional preliminary arrangements for carrying out an investigation were discussed at an interview with Mr. Roe of Cyprus.

Copies of Mr. Crichton's reports are herewith submitted for your information.

I am, etc.

(Sgd) J.B. ORR
DIRECTOR.

REPORT OF MR. ARTHUR CRICHTON ON VISIT TO KENYA. 53

The Rowett Research Institute
Bucksburn,
Aberdeen

11th January, 1927.

The Director,
The Rowett Research Institute,
Bucksburn,
Aberdeen.

Sir,

I beg to submit therewith a report on my visit to Kenya Colony with the object of organising feeding experiments in connection with the mineral content of natural pastures.

Accompanied by H. Gunn, M.A., B.Sc., B.Sc. (Agri) Hons, the officer in local charge of the experiments in Kenya, I left London on August 29th 1926, and disembarked at Mombasa on September 28th. I remained in the Colony until November 13th 1926. The other three workers, R.W. Farquhar B.Sc. (Agri), J. Anderson and A. Tosh sailed from Southampton on September 17th 1926 and reported to me at Nairobi on October 19th 1926.

Twenty five tons of special foodstuffs were shipped from London and distributed to the various experimental centres. Considerable difficulty was experienced in clearing this material at Mombasa and delay in transporting up country. In this, as in other matters of transport, in the provision of apparatus and Government dips, etc., in help in the movement of stock and in making the path smooth in many other ways, I received invaluable assistance from the Director of Agriculture, The Hon. Alex Holm, and his staff. Local difficulties which for some time appeared to be insuperable were finally overcome by means of the energetic co-operation

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cooperation of the Staff of the Department of Agriculture
of the Kenya Government.

It was found possible to arrange all the experiments on the approved scheme with which I was supplied. Approximately one thousand animals will be used in these tests to begin with. A detailed summary of the experiments is appended herewith.

Three tours of the experimental centres were made by me and before leaving I was satisfied that the tests were either actually begun or ready to start.

Arrangements were made for each worker to submit a monthly report. The first reports have now arrived, from which it appears that the work is proceeding satisfactorily.

Satisfactory arrangements were made for the collection of the necessary samples of pasture for analysis from the different areas. The first of these is expected to arrive at any time.

A sketch map is also attached showing the location of the experimental centres.

(Sgd) Arthur Crichton
Head of Animal Husbandry Dept.

x Not yet forwarded.

ENCLOSURE TO MR. CRICHTON'S REPORT. 55
MINERAL CONTENT OF NATURAL PASTURES IN KENYA.
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SUMMARY OF FEEDING EXPERIMENTS BEING
CARRIED OUT ON BEHALF OF THE ABOVE BOARD
BY THE ROWETT RESEARCH INSTITUTE.

Officer in charge in Kenya H. Gunn, M.A., B.Sc., B.Sc. (Agric)
Hons.

A. Place - The farm of J.K. Watson, Esq., Doonholm, Nairobi
Officer in charge - J. Anderson.

(1) Cow Experiment - 48 Grade Ayrshire cows divided
in three groups.

Group 1	{ Control - Basel Ration	"	"	+	Minerals
" 2	{ Experiment	"	"	+	"
" 3	{ Experiment	"	"	+	Protein

Records to be kept of milk production, health
and fertility.

(2) Calf Experiment - Heifer calves from the cows on
experiment (1) above, divided into 3 similar
groups. Records to be kept of health and rate of
growth.

B. Place - The Government Farm at Manora, Naivasha.
Animals and Labour supplied by Rt. Hon. Lord Delamere.
Officer in charge H. Gunn, M.A., B.Sc., B.Sc. (Agric) Hons.

(1) Cow Experiment - 45 Grade shorthorn cows divided
into 3 groups. etc. as in (A) (1)

(2) Calf Experiment - As in A (2)

(3) Sheep Experiment - 150 Grade Merino ewes with
single ewe lambs divided into 3 groups

Group 1	{ Control - Basel Ration (Pasture)	"	"	+	Minerals
" 2	{ Experiment	"	"	+	"
" 3	{ Experiment	"	"	+	Protein

Records to be kept of health and fertility
of the ewes; health, rate of growth and subsequent
fertility of the lambs.

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END

C

Place - Nakuru township land

Animals supplied as follows: 84 oxen by W.J. Dawson, Esq,
Mjore.
40 grade Shorthorn steers by Rt. Hon
Lord Delamere.

Officer in charge - A. Tosh.

(1) Bullock experiment - 84 oxen and 40 grade Shorthorn
steers divided into 4 groups.

Group 1	(Control)	-	Basel Ration	(Pasture)	
"	2	(Experiment)	do.	+ Minerals A	
"	3	do	do.	+ Minerals B	
"	4	do	do	+ Minerals C.	

D.

Place - The farm of Powysland Ltd. at Keringet, Molo

Officer in charge R.W. Farquhar, B.Sc. (Agric)

(1) Cow Experiment - 60 grade Shorthorn Cows divided
into 3 groups, etc. as in A (1)

(2) Calf experiment - As in A (2)

(3) Sheep experiment - As in B (3)

(4) Pig Experimental - 12 gilts divided into 2 groups

Group 1	-	Basel ration
"	2	do. + minerals

Records to be kept of health and fertility of
gilts and health and rate of growth and subsequent
fertility of their progeny.

NAIROBI, KENYA COLONY

7th November, 1926.

RECORDS SECTION