AGRICULTURAL SURVEY COMMITTEE.

NUTRITION REPORT No. 1—TESO.

An Investigation into Health and Agriculture in Teso, Uganda

BY

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PART I.

A. THE AGRICULTURAL SURVEY.

4. The same method of surveying was used in the two *atongoles*, the following particulars being obtained and recorded against individual taxpayers: areas under each crop with the rotation practiced, and the numbers of cattle, ploughs, wives, children, total consumers and working units. Comparative figures are given later for data concerning the two *atongoles*, Ajuluku and Opami, and differences noted in the results of the agricultural survey are discussed. At this stage, however, it is convenient to give particulars, especially about social life, which apply to the two areas and, indeed, to the greater part of Teso.

5. **The Atongole.**—This is the smallest administrative unit and is placed under a chief, actually a kind of headman, who receives a salary of Shs. 200 a year. Its constitution can be described neither as communal nor individualistic for it consists of several family groups, each of which represents the original Teso social unit, and the combination of these groups in an *atongole* is purely an artificial measure undertaken for administrative convenience. Within the family group mutual aid is often given, either by the supply of cattle to help pay a bride premium or fine, or by help with planting, weeding or harvesting; a meal with beer is the usual payment for this kind of work.

6. **Division of Labour.**—Men do most of the heavy work, such as clearing and tree-cutting when preparing new plots. The women help to sow, weed and harvest and, of course, prepare all the food; this last task takes several hours a day. Boys of seven and eight herd the cattle and goats and a year or two later begin learning other work with their fathers. Girls start to help their mothers at about six years of age and at about eight they begin carrying water, working a little in the fields and helping their mothers prepare the evening meal.

7. **Cattle.**—It must be emphasized that the chief function of cattle in Teso is that of capital; they are primarily regarded as so much wealth, to be hoarded when obtained and paid over only on very special occasions, for instance as a bride premium or fine. Even when the Etesot has earned a cash return for his cotton or groundnut crop his first purchase is always cattle and money spent on other goods is usually the fraction which remains over after this transaction, and which is insufficient to buy an additional beast. This fact in itself indicates the state of social development to which the Teso have so far attained, one that is essentially comparable with the life led by the Old Testament patriarchs. Apart from their function as capital and, of course, interest by their

natural increase, cattle have certain other uses: ploughing requires a number of bullocks and the milk of cows forms an addition to the diet. No effort is made, however, to obtain a good yield and the milk supply is a somewhat haphazard one; when cows are milked, usually in the kraal about noon, the milk is left to sour (probably by yeasts more than bacteria) and the curds and whey are consumed separately. Children herding cattle often drink fresh milk direct from the cow's udder. Cattle are almost never slaughtered for food.

Cattle are usually let out to graze at about eleven o'clock in the forenoon and watered once daily. Members of one grazing herd may belong to six or eight people and are collected from the kraals by the owner whose turn it is to look after the cattle for a week; the proportion of cattle owned by an individual does not alter his obligation in this respect. The cattle are all fed on the "*mutala*" (savannah) from April until October and for the rest of the year on the edges of the swamps. Ploughing cattle usually start work at seven in the morning and continue without food or water until noon.

8. **Cultivation.**—Of recent years hand cultivation has to a great extent given place to ploughing; ploughs and oxen are hired out by the wealthy individuals, a charge of Shs. 2 per day, or equivalent payment in kind, being levied. Hired labour, as distinct from mutual help within the family group, is unknown with the exception of a paid herdsman employed by Elangot of Opami.

9. **Food and Diet.**—Apart from the regular consumption of fish in Opami, this is the same in the two *atongoles*. The main meal is taken in the evening before sunset and often a small meal is taken about noon. The day is started with a drink of beer and a baked sweet potato or cassava root may be eaten in the fields during work. The staple food is wimbi (Finger Millet; *Eleusine coracana*) ground into meal which, when cooked, is called "atap". From August to December sweet potatoes are usually substituted for wimbi and from January to May flour is made from dried cassava or sweet potatoes and mixed with flour made from the stored wimbi; this, when cooked, is also called "atap". Mtama (Sorghum; Kaffir corn) meal is often mixed with millet meal. Generally speaking, the food closely resembles that consumed over large areas of Africa; a full description of this type of diet, with chemical and caloric details, has been published by Richards and Widdowson (1936).

The ripe fruit of Elamai (*Ximenia americana*) and the pods of Epiduru (*Tamarindus indica*) are often used to flavour the food, their juice being mixed with the water used in cooking "atap". If milk is obtainable, *i.e.*, among the wealthier families, the whey is used instead of water in cooking "atap" and the curds are mixed

with green food or other relishes. Groundnuts, sim-sim (sesame) and beans are eaten as relishes on most days and the oil of the Shea butter-nut may be used for cooking, if obtained in sufficient quantity. There are many wild vegetables, but the leaves and young stems of the following plants form the chief supply of green food: Ekoropot (*Asystacia shimperi*), Emalakanyi (*Hibiscus* sp. *Malvaceae*), groundnuts, cassava and *Vigna* spp. From January until May very few vegetables are eaten as the herbage dries up, but the present year (1936) was exceptional and a certain amount of green-stuff was available throughout the "dry season".

Meat is rarely eaten more than two or three times a year by the average person. It is "tabu" for women to eat chickens or eggs, but a man may eat four or five chickens a year as well as the addled eggs which a hen does not hatch out; fresh eggs are never eaten. A few duiker and oribi may be found in the *atongoles*, and other buck, together with an occasional hippopotamus, near the swamp in Opami. It is very seldom that these animals are hunted and their meat cannot be considered as an addition to the dietary.

If a little money is left over after taxes have been paid and other purchases made, salt is bought in small quantities from a trading centre, but most of this commodity is obtained by the poorer peasants by dissolving salts out of the ashes of Epungula (*Coreopsis ugandensis*), Echuga (*Leonolis meptifolia*), Elokile (*Sonchus bipontini*), Epopong (*Euphorbia candelabra*), Essege (*Pennesetum* sp.) and Eliloto (*Sesamum macranthum*).

10. **Beer.**—This is prepared from stored wimbi, which is allowed to germinate; mtama is also allowed to germinate separately and then a flour made from grinding these together is steeped in water for a fortnight. The mixture is then evaporated over a fire and the residue spread out to dry for one day. This residue is next placed in water and a small quantity of old beer (*i.e.*, a yeast culture) is added. In three days' time the new beer is ready for drinking, but to obtain the maximum intoxicating effect it must, of course, be kept a little longer; after five days it becomes bitter and is considered spoiled.

11. **Fish.**—This is not obtained in Ajuluku but it forms a staple article of diet in Opami, where the Komolo swamp is easy of access. From December to April fish, either fresh or smoked, is eaten almost daily by practically all the inhabitants of Opami; from April to December it is eaten about twice a week. The species principally caught are Ekole (cat-fish; *Clarias*), Ibelengi (lung-fish; *Protopterus aethi-opicus*) and a small carp-like fish. There are five methods of fishing in general use—

(*a*) The fish are beaten into a narrow part of the waterway and conical traps made of sticks are thrust, apex upwards, into

the water. If fish are found to have been imprisoned in the traps they are removed by inserting the hand and arm through a hole near the apex. This is a "hit and miss" method.

(*b*) Similar traps, without the apical hole, are often placed side by side with their open bases in a semi-circle across the main waterway; the fish are driven by beaters into the concavity of this semi-circle and eventually find their way into the traps.

(*c*) During the dry season lung-fish are dug out with [illegible]es from the mud cells in which they aestivate.

(*d*) Fish-spearing is a method which calls for a [illegible]n amount of skill. A six-foot staff is shod with a spike [illegible]e butt end and has a socket at the other; into this socket a [illegible]rp hook, with a concavity of about 2 inches, is fitted. The fisherman takes the staff in his right hand and in the left holds a string which is attached to the hook, the stem of which is placed in the socket of the staff. The fish is first hooked and then, while the hook and fish are held by the string in the left hand, the staff is rapidly disengaged from the hook, reversed, and the fish is despatched by being speared with the spike at the butt end.

(*e*) Where small pools are known to contain fish, it is the practice to scoop out the greater part of the water and then to catch the fish in a basket shaped like a scoop and used like a drag-net.

12. **Money.**—The native's wants are, at present, easily satisfied and trade goods have little appeal for him. It must be remembered that the poorer family is essentially self-supporting—a kind of Swiss Family Robinson—grows its own food requirements, builds its own dwellings, collects its own firewood and water and asks for little or nothing in the way of clothes and other luxuries. Without money, which elsewhere is the universal ready means of exchange, there is no place for the specialist and it is hopeless to expect the peasant to become a whole-time carpenter, mason, butcher or tradesman. All that really concerns him is the collection of sufficient cash to pay his taxes and this is usually got by the sale of his cotton, groundnuts, sim-sim and, as a last resort, his cattle. Money is usually spent in the following way: first taxes; then, if crops have been good and a fair price has been obtained, the remaining money is invested in cattle or goats (real property!) and a little is left over for the hire of a plough, the purchase of a new hand-hoe blade, clothes for the family, salt and cigarettes. Rarely, when a cash crop has been grown to the virtual exclusion of food, wimbi may be bought from a neighbour. It will be realized that the Etesot is not yet "money-minded"; the importance of this observation will become apparent later when constructive suggestions are discussed

13. **Natural Vegeta[illegible]d Soil.**—

(*a*) Ajuluku.—[illegible]*ngole* contains half of the wet weather swamp which s[illegible]nds it on three sides. The remainder of the area, like the gr[illegible]er part of Kumi and Ngora counties, has very few trees, the principal varieties being Tamarind and species of *Ficus*; most of these have had their branches cut off to supply firewood and consequently give little shade or protection from the wind. Cape lilac is planted round most compounds to provide firewood and building poles. The chief grass found on resting land is *Chloris gayana* and one of the commonest weeds is a wild mint (*Ocimum menthaefolium*); both these plants are found on worn-out, sandy soils in other parts of Teso. It is noticeable that no Lusenke (*Imperata cylindrica*) and very little Hyparrhenia are to be found in this *atongole;* both grasses flourish in the more fertile parts of Teso and are taken by the natives as a standard of fertility.

(*b*) Opami.—This *atongole* is not uniform, one half resembling Ajuluku, the other being more fertile. In the part nearest Komolo there is a fairly thick "mutala scrub" and a tree stand of approximately six to the acre; where the land is resting there is a good grass cover of Hyparrhenia and Lusenke. In the part nearest Osuguro there is no "mutala scrub", a tree stand of only 2·4 to the acre, and thinner grass herbage with a larger proportion of *Chloris gayana.*

14. The chief economic and agricultural differences between the two *atongoles* are presented in table form (p. 7) for convenience in reference.

15. Three most important differences stand out in the table: crop rotation, density of population and the ratios of working units* to consumers and children. In each case the figure for Opami, though far from perfect, is nearer the ideal and one must conclude that in Ajuluku there is overcrowding, an excessive burden of non-producing consumers and an unsatisfactory method of crop rotation, probably due to the overcrowding, which is bound to result in the land being worked out more quickly than in Opami. Figures relating to the acreages of different crops and the composition of families are given in the appendices.

B. THE MEDICAL SURVEY.

16. (*i*) **Laboratory.**—An African laboratory orderly, with a nursing orderly who acted as interpreter, was stationed in Ajuluku for 25 days. During this time he toured the *atongole* and obtained specimens of blood and fæces from as many of the inhabitants as

* A working unit is taken as meaning one adult, or two children or old relations, each of whom is able to do half-a-day's work.

TABLE I.

Some Comparisons between Agricultural and Economic Conditions in Ajuluku and Opami.

	Ajuluku.	Opami.	Comments.
Area of the *atongole* (in acres) ..	3,188	5,500	
Uncultivable	577	67	
Available for cultivation ..	2,611	5,433	
Area under cultivation ..	959	958	
Area resting	1,652	4,475	
Proportion of resting to cultivated land	1·72 : 1	4·7 : 1	This section gives an indication of the relative overcrowding and over-cultivation in Ajuluku.
New land broken up	154	358	
Cultivation period in years ..	6	2·5	
Resting period in years ..	11	12·5	
Grazing—			
Acres per head of cattle ..	3·8	4·4	In Ajuluku dry weather grazing is partly outside the *atongole*.
Number of cattle	554	1,014	
Number of goats and sheep ..	271	241	
Herbage cover	poor	very fair	
Population—			
Tax-payers	203	199	
Wives able to work	217	249	
Old relations:			
Able to do ½ day's work ..	23	49	
Unable to work	27	4	
Children:			
Able to do ½ day's work ..	104	58	
Unable to work	136	140	
Total ..	710	699	
Units of work	483	501·5	
Ratio of units to consumers ..	1 : 1·47	1 : 1·39	These figures are important.
Ratio of units to children ..	1 : 0·49	1 : 0·39	
Density of population per square mile	143	82	These figures are important.

were willing to provide material; at the same time the nursing orderly gave injections to cases of yaws and medicine to other sick people, in an endeavour to gain their confidence. Teso such as these, who live in the traditional way, intensely dislike giving away blood or fæces, as they believe that witchcraft, of the type described by Frazer (1925) as "contagious magic", may be practiced on them. It says much for the tact and perseverance of the orderlies that 131 blood slides and 80 specimens of fæces were collected.

17. A single examination of a thick blood film and of a fresh stool smear constituted the laboratory examination. The Medical Officer was present on the first day and helped to work over a part of the *atongole*, taking with him various chiefs and, of course, the orderlies. Subsequently samples of the material collected and reported on by the laboratory orderly were re-examined by the Medical Officer in order to insure that the resul shown were, as

was actually found to be the case, accurate. The thick blood films were collected by day and stained by the Azur II—Eosin method; stools were examined fresh in normal saline. Owing to exigencies of staff posting it was not possible to perform a laboratory survey of Opami.

18. (*ii*) **Examination of Individuals.**—In Ajuluku as many of the inhabitants were examined as could be persuaded to present themselves, 362 individuals in all. It became apparent, however, that bachelors and childless married couples were of little value in the assessment of nutritional disturbances, as the signs of these appear far more promptly in children, so in Opami only those families were examined in which there were children under the age of puberty. These comprised 257 individuals. It will be realized that in this type of field-work elaborate examinations are impossible, if only for the reason that such procedures would frighten away the majority of cases; statistics of height and weight, too, would have been of great interest, but unfortunately the ages of all but the infants are unknown and guess-work or the equally fallible attempt to assess age by dentition could scarcely be expected to yield reliable results. It will be seen that ages of children are given in some of the tables; these ages must be accepted with caution, but they have not been used as data where any conclusions depend on a precise statement of age. The following standards were adopted in estimating the health of individuals:—

19. (*a*) Dietetic Deficiencies:—*Vitamin A Deficiency.*—Xerophthalmia and phrynoderma (Loewenthal, 1933 and 1935*b*); a general dryness of the skin, though probably due largely to this deficiency, was not counted for statistical purposes. One case of night-blindness was discovered in Ajuluku, the patient herself complaining of this symptom. Tests for its presence in others were not performed, for the reasons given in the second reference quoted above (p. 409). Criteria for the assessment of other vitamin deficiencies were not formulated, as no cases were seen.

Dental Caries.—Caries of one tooth was not counted, as this might well happen after accidental fracture of a tooth. Caries of more than one tooth was noted when occurring in children and young males who had lived all their life in the family group, but not in married females, who usually come from other communities and whose malnutrition during childhood cannot, therefore, be attributed to conditions obtaining in the *atongole* under survey.

Leg Ulcer.—In accordance with the opinion of numerous writers from different parts of Africa (*e.g.*, McCulloch, 1928; Loewenthal, 1932-3; Orr and Gilks, 1931; Dalrymple, 1928), tropical ulcer was assumed to be of dietetic origin and its occurrence, or the pres e of large scars due to previous ulceration, was noted where

seen. Ulcers obviously due to yaws or ecthyma were not included in the same part of the statistics. The same provision with regard to age and sex was made as in the case of dental caries.

20. (*b*) Spleen Rate.—All individuals except infants were examined for splenic enlargement while standing. The results were tabulated as:—no enlargement; one, two or three finger enlargement (1F, 2F, 3F) and enlargement greater than three fingers (++). The splenic index was calculated separately, on a rough estimate of age, in those below 2 years, between 2 and 10 years, and over 10 years of age.

21. (*c*) Effects of Yaws.—In addition to the primary sore and secondary eruptions, the following manifestations of yaws were encountered: atrophy and pigment disturbance of the hands and feet (*Ebikata*, Luganda); tertiary lesions of the sole (*Nungu*, Luganda); thickening and forward bowing of the *tibiae;* juxta-articular nodes and diffuse ganglion of the hand and wrist.

22. (*d*) Other Diseases.—Notes were made of the occurrence of scabies, ecthyma, leprosy, syphilis and severe degrees of anæmia, judged clinically, but it was not possible to confirm this last manifestation by examination of the blood, nor to correlate it with the laboratory findings. The cases of trachoma noted were all in an advanced stage, the routine eversion of the upper eyelid necessary to establish early infection being a measure which was greatly resented by those who had consented to be examined.

23. (*iii*) **Assessment of a Health Index.**—It was obvious that, for statistical purposes, a numerical value corresponding with the health of the individuals must be assigned to each family. For this calculation only manifestations attributable to malnutrition were selected and these comprised:—

(*a*) Leg ulcer, not due to yaws or ecthyma, in children and young males.

(*b*) Phrynoderma.

(*c*) Xerophthalmia.

(*d*) Night-blindness (one case).

(*e*) Caries of more than one tooth in children and young males.

(*f*) Anæmia. The reason for the inclusion of this condition will be discussed later.

It will be seen that, with the exception of night-blindness, an individual might show a maximum of five manifestations possibly attributable to dietary deficiency. The family health was, therefore, assessed according to the following formula:—

$$1 + \left(\frac{\text{number of manifestations}}{\text{number of members of the family} \times 5} \times 100.\right)$$

For example, a family of four in which one child was found with phrynoderma and dental caries, and another with anæmia, shows three manifestations and its health index will be:—

$$\text{H.I.} = 1 + \left(\frac{3}{4 \times 5} \times 100\right) = 1 + \frac{300}{20} = 16.$$

A healthy family of four will have the basic health index of 1:—

$$\text{H.I.} = 1 + \left(\frac{0}{4 \times 5} \times 100\right) = 1 + 0 = 1.$$

It is essential to add 1 to the index obtained by the expression $\left(\frac{a}{b \times 5} \times 100\right)$, otherwise a health index of 0 is obtained in healthy families and the expression Σ (xy), used later in the correlations, could not be employed without losing many data, for a health index of 0 multiplied by any other variable obviously gives a product of 0 and thus all variations shown by this second variable are lost.

PART II.

RESULTS.

24. **A. Laboratory.**—The figures obtained from the Ajuluku population are given in Appendix I. The high rate of blood slides positive for malaria parasites at all ages is interesting, as is also the observation that quartan malaria in adults was found more than twice as frequently as all other species, and was present in 30 per cent. of all blood slides examined.

25. **B. Medical.**—Table II gives the number of cases of various diseases found in the two *atongoles*, with their percentage of the total population examined.

TABLE II.

	Ajuluku.		Opami.	
Number examined	362	Percentage	257	Percentage
Phrynoderma	39	10·8	16	6·2
Xerophthalmia	6	1·7	1	0·4
Night-blindness	1	0·3	0	—
Dental caries	21	5·8	20	7·8
Leg ulcer or scar	17	4·7	1	0·4
Active yaws	4	1·1	2	0·8
Old yaws	14	3·9	15	5·8
Advanced trachoma	6	1·7	6	2·3
Leprosy	0	—	1	0·4
Syphilis (secondary and tertiary) ..	2	0·6	0	—
Elephantiasis	1	0·3	0	—
Scabies	38	10·5	7	2·7
Ecthyma	3	0·8	2	0·8
Splenic enlargement	84	23·4	109	42·4
Severe anæmia	7	1·9	19	7·4
Total of individuals with one or more of the above diseases ..	117	32·3	72	28·0

A full consideration of the relative incidence of various diseases attributable to dietary deficiency is given in a subsequent section (paragraphs 34—36), but a few comments on the above table may be made here.

26. The impression given by the subjects examined is that very few approach normal physique. Impressions are, of course, notoriously fallible and can be no more than impressions in the absence of accurate records of height and weight. It is, nevertheless, noteworthy that during his survey of Opami the Medical Officer made a note against one of the families to the effect that the four elder wives were the only plump and really healthy-looking women he had so far seen. Observers who live in Teso are apt to think of the local peasant as a thin, spindle-shanked individual with a very dark, dull skin and a somewhat listless mentality. The family referred to above (that of Elangot, No. 40) presented a singular contrast; all seemed to be more normally proportioned, all had shining, unwrinkled skins and all seemed happy and alert. Subsequently, when the agricultural figures were scrutinized, it was found that Elangot was by far the wealthiest individual in the *atongole;* he has 9 wives, over 200 head of cattle and he grows enormous crops. So abnormal, in fact, are his circumstances that his family had to be omitted from the statistical calculations given later, in order to avoid distortion. If Elangot's family is taken as representing optimum health it follows that no other family in either *atongole* can be considered as reaching the desired standard and that even those termed "healthy" (*i.e.*, H.I. = 1) are, in fact, below the degree of fitness which it is possible to attain. The mental alertness noted in Elangot's family might be taken as a warning against conclusions based on intelligence tests carried out amongst less fortunately situated Africans.

27. **Leg Ulcer.**—Only one case of this condition was found in the whole of Opami *atongole*; it does not figure in the correlations worked out later, as it was present in a young unmarried man and, as previously explained, only families with children were considered for the purpose of statistics dealing with nutrition and disease. It is noteworthy that the individual with leg ulcer was one of the very few inhabitants of Opami who never eat fish.

28. **Vitamin Deficiencies.**—As will be seen from Table II Vitamin A deficiency is of frequent occurrence; this bears out the results of a previous investigation by one of the writers (L.J.A.L.). Had abnormal dryness of the skin, without the papular eruption called phrynoderma, been taken as a criterion of Vitamin A deficiency—and modern opinion would support this procedure—the incidence of the deficiency would have been well over 50 per cent. in both *atongoles*.

No cases of beri-beri, pellagra or scurvy were seen and this is attributed to the custom prevalent among old and young of drinking native beer. In one family (Oriang, No. 71 Opami), three out of five children suffered from severe anæmia, and of these three, two also had pronounced œdema. This isolated instance was not considered sufficiently convincing to adduce food deficiency as a cause.

29. **Dental Caries.**—No significant difference can be found between the incidence of this condition in the two *atongoles*, nor were cases of dental caries especially frequent in those families whose members showed Vitamin A deficiency, leg ulcer or anæmia.

30. **Anæmia.**—Only severe degrees were noted, that is in those cases where there was marked blanching of the mucous membranes. Where noted, anæmia was taken as a factor in evaluating the health index, but it has not been treated later as a separate group, as has been done in the cases of Vitamin A deficiency, dental caries and leg ulcer. There are two reasons for this omission: first, degrees of anæmia merge insensibly one into the other and in the absence of accurate blood estimations the personal factor in the decision as to whether a given case is to be called anæmic or not is too potent a source of error; secondly, anæmia, though often nutritional, may just as well be due to hookworm infestation or severe malaria. Severe anæmia was not found to occur more frequently in families suffering from other manifestations of food deficiency.

31. **Spleen Rates.**—The results of spleen examinations in the two *atongoles* are summarized below—

TABLE III.

SPLEEN RATES IN AJULUKU AND OPAMI.

AJULUKU.

Age.	No enlargement.	1F.	2F.	3F.	++	Total cases.
Below 2 ..	5	0	5	3	3	16
2—10 ..	44	22	15	7	2	90
Over 10 ..	229	7	8	4	8	256

Splenic Index: 2—10 = 51%
over 10 = 10 %
under 2 = 11 out of 16.

OPAMI.

Age.	No enlargement.	1F.	2F.	3F.	++	Total cases.
Below 2 ..	2	7	3	5	3	20
2—10 ..	27	26	21	17	4	95
Over 10 ..	119	10	6	5	2	142

Splenic Index: 2—10 = 72%
over 10 = 16%
under 2 = 18 out of 20.

It will be seen that both areas are hyper-endemic, basing the estimation on children between 2 and 10 years. Opami has a significantly higher spleen-rate and this may be attributable to the adjacent swamps. The advantage of having a good fish supply in the vicinity thus entails a corresponding disadvantage in malarial hyper-endemicity.

32. Scabies is a very common complaint and seems to have a similar incidence at all ages. It was interesting to note that it is often a hut disease and that where only certain members of a family are affected it is usually found that these occupy one hut, while other members of the family occupying other huts in the same compound may remain uninfected.

33. **Yaws and Syphilis.**—The figures given in Table II may be taken as a fair guide to the comparative incidence of these diseases in most parts of Teso. Ajuluku is ten miles from Ngora township where trade, Mission enterprise and cotton ginning have been responsible for an influx of natives from other districts, and it is probable that the two cases seen in Ajuluku were infected by prostitutes in the bazaars or cotton markets. Opami is less in contact with civilization and resembles the remoter parts of Teso, where a case of syphilis is a clinical curiosity.

PART III.

THE RELATION OF HEALTH TO AGRICULTURE.

34. The two parts of each survey were purposely done separately, in order that the results of medical examinations should not be biassed unconsciously by preconceived ideas. It was only when figures had been worked out separately for health and for agricultural data that an attempt was made to find significant correlations. As previously mentioned, the family of Elangot had to be taken out of the Opami figures, for his means were so abnormal as to distort the means for the rest of the *atongole*. This left 55 families in each *atongole*. The first table in this part of the investigation shows the incidence of the various nutritional diseases by families:—

TABLE IV.

DISTRIBUTION AND ASSOCIATION OF NUTRITIONAL DISEASES.

	Ajuluku.		Opami.	
Number of families	55	Percentage	55	Percentage
Showing Vitamin A deficiency ..	21	38·2	11	20
Showing dental caries	13	23·6	13	23·6
Showing leg ulcer	11	20·0	0	—

In Ajuluku—

Of 21 families with Vitamin A deficiency—
8 show dental caries.
5 show leg ulcer.
2 of the above 13 show dental caries + leg ulcer.

Of 13 families with dental caries—
8 show Vitamin A deficiency.
4 show leg ulcers.
2 of the above 12 show Vitamin A deficiency + leg ulcers.

Of 11 families with leg ulcer—
5 show Vitamin A deficiency.
4 show dental caries.
2 of the above 9 show Vitamin A deficiency + dental caries.

In Opami—

Of 13 families with dental caries—
6 show Vitamin A deficiency.

Of 11 families with Vitamin A deficiency—
6 show dental caries.

35. The next table shows the comparison between individual nutritional diseases in the families of the two *atongoles*, with the significance of their differences:—

TABLE V.

Disease.	Ajuluku.	Opami.	t*	Significance P.
Vitamin A deficiency ..	38·2%	20·0%	1·897	<·10 but >·05
Dental caries	23·6%	23·6%	—	Nil
Leg ulcer or scar	20·0%	0	—	Highly significant

Now it will be noted that whereas the incidence of Vitamin A deficiency in Opami is lower than in Ajuluku (although not quite statistically significant), not a single case of leg ulcer has occurred among the families examined in the former *atongole*. The only *absolute* difference between the economics of Ajuluku and Opami is the entire absence of fish from the dietary in the former place; on the other hand, Table I shows certain important *quantitative* variations and it may eventually be feasible to find out whether the absence of tropical ulcer in Opami is referable to the consumption of fish, while the relatively large amount of Vitamin A deficiency in Ajuluku is due to overcrowding, with consequent exhaustion of the land, and an excessive burden of non-producing consumers.

36. **Method of Assessing Health and Economics.**—The health index has already been explained (paragraph 23) and its value for the various groups of families is shown in Table VI (page 15).

The 55 families in each *atongole* had the following particulars noted: Health Index (A), number of Units (B), number of Consumers (C), number of Children (H), food crop acreage in thousands of

* *Vide* Table IV in Reference 5.

The means are shown in Table VII, together with the figures for Elangot's family in Opami in order to demonstrate the necessity of omitting this from the statistics.

TABLE VI.

Health Indices of Various Groups of Families in Ajuluku and Opami.

	Ajuluku.		Opami.	
	Number.	H.I.	Number.	H.I.
All families	55	7·05	55	5·25
Healthy families	19	1·00	28	1·00
Vitamin A families	21	12·48	11	11·91
Caries families	13	11·92	13	13·08
Ulcer families	11	13·36	0	—
Vitamin A + ulcer	3	21·67	0	—
Vitamin A + caries	6	14·00	6	17·00
Ulcer + caries	2	12·50	0	—
Vitamin A + ulcer + caries ..	2	16·50	0	—

TABLE VII.

Health and Agricultural Data: Means and Elangot.

	H.I. A	Units. B	Consumers. C	Children. H	Food. D	Cash. E	Cows. F
Ajuluku Mean ..	7·05	3·24	5·44	2·13	17·53	21·22	3·75
Opami Mean ..	5·25	2·91	5·22	2·25	15·71	15·91	3·95
Elangot	1·00	13·00	15·00	1·00	150·00	75·00	119·00

37. The next step is to find out the correlation coefficients for the various factors given above, and to assess their significance; the correlations and partial correlations were obtained by the method given by Fisher (1932; sections 31 and 32) and the significance estimated by using Table V.A. A comparison of the results from each *atongole* is given in Table VIII (page 16).

In addition, there were, of course, highly significant correlations between the numbers of consumers, units and children, and between food crops, money crops and cows.

38. **Comments on Table VIII.** (*a*) Ajuluku.—Although no direct correlation of any significance is obtained between A and any of the other factors, the partial correlations are of great interest. Thus, considering the correlations $r_{AB.C}$, $r_{AC.B}$ and $r_{AF.BC}$, it is found that working units increase the health of the family, an increase of consumers decreases the health of the family, and when the effect of units and consumers has been taken out health improves

* Cows only, and not bulls or bullocks, were used in these calculations, as milk is the only important food produced by them (*vide* paragraph 7). It is generally found that the owner of numerous cows also possesses bulls and bullocks in proportion.

Correlation Coefficients (r_{AB}, etc.).

r.	Ajuluku coefficient.	Significance P.	Opami coefficient.	Significance P.
AB	— ·0683	nil	+ ·0542	nil
AC	+ ·1670	nil	+ ·1317	nil
AD	— ·1582	nil	— ·0582	nil
AE	— ·1893	nil	— ·1796	nil
AF	— ·2230	nil	— ·0498	nil
AH	+ ·2072	nil	+ ·1524	nil
AH_2	—	—	+ ·1768	nil
AB.C	— ·2735	= ·05	—	—
AC.B	+ ·3105	< ·05	+ ·1152	nil
AF.C	— ·3585	< ·01	—	—
AF.BC	— ·3720	< ·01	—	—
AC.BH	+ ·5516	< ·01	+ ·1834	nil
AC.E	+ ·2906	< ·05	+ ·1777	nil
AD.C	— ·2453	nil	—	—
AE.C	— ·3026	< ·05	—	—
CD	+ ·3877	< ·01	+ ·2433	nil
CE	+ ·4578	< ·01	+ ·2168	nil
CF	+ ·4989	< ·01	+ ·3110	< ·05

with the number of cows*. The most significant correlation is obtained for $r_{AC.BH}$, that is, health diminishes with an increase in consumers when the effect of units and children is taken out.

(*b*) Opami.—There is no significant correlation or partial correlation between health and any of the other variables, B, C, etc.; in other words there must be one or more additional factors whose effect is strong enough to mask those already taken into consideration; these factors are assumed to be the consumption of fish in Opami and the differences pointed out in the discussion on Table I. Some importance may be attached to the correlations r_{AH} and $r_{AH}{}^2$, for although neither are significant the latter is tending towards significance and suggests that an increase of children is an additional burden on the health of the family in Opami, as in Ajuluku.

39. **Regression Formulae.** (*a*) Ajuluku.—By the method described by Fisher (*loc. cit.*, section 29) three regression formulae were obtained which fitted the families, collectively, fairly well. These formulae are:—

I. $A = 13{\cdot}12 - 9{\cdot}9508B + 4{\cdot}7712C + 0{\cdot}03964D + 0{\cdot}05342E - 0{\cdot}4353F.$

II. $A = 4{\cdot}84 - 2{\cdot}2535B + 2{\cdot}0260C - 0{\cdot}4027F.$

III. $A = 5{\cdot}34 - 2{\cdot}4680B + 1{\cdot}7191C + 0{\cdot}8523H - 0{\cdot}3854F.$

It will be noted that working units and cows are the only factors which improve health (*i.e.*, lower the health index).

The 55 families examined in Ajuluku were next divided into three groups, healthy, medial and unhealthy, according to the

* A negative correlation, of course, shows an increase of health as the health index *increases* with *ill-health*.

findings of the Medical Officer's survey; their actual H.I. is compared with the H.I. obtained from the three regression formulae in the next table:—

TABLE IX.

ACTUAL AND CALCULATED H.I. IN THREE GROUPS IN AJULUKU.

	Healthy group.	Medial group.	Unhealthy group.
Number of families	19	26	10
Actual H.I. (Means)	1	7·23	18·10
H.I. from Formula I	5·43	7·28	9·81
H.I. from Formula II	5·98	6·97	9·37
H.I. from Formula III	5·52	7·24	9·60

COMMENT—

(i) Formula I gives the closest fit for the extreme groups and Formula III for the medial families, although Formula I is remarkably close.

(ii) It is obvious that the relationship between the Health Index and the other variables is approximately linear in the medial group, but is not linear in the extremes.

40. The same formulae were next applied to the families with leg ulcer, caries and Vitamin A deficiency, with the following results:—

TABLE X.

ACTUAL AND CALCULATED H.I. IN AJULUKU FAMILIES SHOWING NUTRITIONAL DISEASES.

	Ulcer families.	Caries families.	Vit. A deficient families.
Number of families	11	13	21
Actual H.I.	13·36	11·92	12·48
H.I. from Formula I	12·97	9·32	7·54
H.I. from Formula II	9·57	7·84	8·21
H.I. from Formula III	9·94	8·22	8·52

COMMENT—

Formula I gives the closest fit for ulcer and caries, but the worst for Vitamin A deficiency, for which Formula III gives the best fit. It seems possible that the relatively greater importance of cows in Formula III may be responsible for this.

41. Testing the significance of the three formulae by the method of "analysis of variance", it is found that the variance due to the multiple regression exceeds the variance due to random errors 8·16 times in the case of Formula I, 4·81 times in the case of Formula II, and 3·98 times in the case of Formula III. Entering the table of z with the requisite degrees of freedom, it is found that Formula I is the most significant ($P << \cdot 01$). This is only to be expected, as it gives the closest fit over the majority of cases tested (*vide* Fisher, *loc. cit.*; Chaps. VII and VIII).

42. (*b*) OPAMI.—No formula could be obtained, based on all 55 families. In view of Table VIII (comparison of r's) it is obviously not permissible to apply Ajuluku formulae to Opami. Actually, when the best Ajuluku formula (I) is applied to the 55 Opami families, unexplained errors are found to exceed variance taken out by the partial regression coefficients, *i.e.*, there is no significance.

PART IV.

CONCLUSIONS REGARDING NUTRITION.

43. The first, and most obvious observation is that nutritional disease is more prevalent in Ajuluku than in Opami, and that it might be possible to improve dietary and agricultural conditions in Ajuluku by imitating the conditions obtaining in Opami. The comparison of significance between correlation coefficients in Ajuluku and Opami suggests that fish in the diet is one of the main causes of superior health (probably referable mainly to the absence of ulcer) in the latter area. In this connection the reader is referred to the most recent work on this problem at present available, that of Brown (1935) and Clements (1934). The latter investigator, using statistical methods, found that tropical ulcer was confined chiefly to natives who lived on a high carbohydrate, low protein diet and that the addition of fish had a most beneficial effect on health in this respect. Hence the addition of animal food seems desirable in the more vegetarian parts of Teso, and probably of other districts.

44. The only feasible method of procuring this is to encourage the slaughter and consumption of bullocks. There are in Teso at least 60,000 non-working male cattle after optimum ploughing requirements have been fulfilled (allowing 4 oxen to each of 14,000 ploughs for between 25 and 30 acres per plough). The great difficulty which will be encountered in introducing this revolutionary project lies in the native's idea that his cattle are his capital (*cf.* the derivation of the English word "pecuniary" from *pecus*, a herd of cattle, Lat.). They are used almost exclusively as bride premium; the word "dowry" so often used implies that the woman's family contributes wealth and this is the converse of what actually occurs. In practice the bridegroom's family group pays upwards of five head of cattle to the bride's family group and this premium is in effect an insurance for the good behaviour of both parties. From this point of view money is a less desirable method of paying the premium as it is more negotiable and the insured parties are less efficiently protected. Where money is taking the place of cattle it is found that abuses and litigation are far more liable to ensue and that the basis of community life is upset.

45. The underlying principle in the above transaction is the exchange of a working and breeding unit for more or less frozen capital for, even if cows can produce some natural increase, most bullocks represent only idle wealth. If radical changes are to be brought about the first step must be to substitute cash premiums for cattle premiums; to overcome the disadvantages connected with this step, it is suggested that these should be deposited with the Native Administration, whose function it would be to act as trustee. These premiums can earn interest on deposit and both parties are still insured, while disputes are still settled by the Native Administration as heretofore, but with the difference that capital and interest are in safe hands for eventual return if called upon. In this way the cash capital represents the original cattle premium and the cash interest represents the natural increase of the cattle. An additional degree of insurance is obtained by avoiding possible loss from cattle disease and theft; the former is an ever-present risk.

46. The second suggestion is that greater facilities be given for the slaughter of cattle in country districts. This may be done in one of two ways: either a class of professional butchers must be encouraged to grow up, men who have the capital to buy bullocks and are content with a reasonable profit when they slaughter and sell meat in selected centres; or else facilities may be given to the peasant to slaughter his own cattle and sell their meat at selected and controlled centres. It is hardly necessary to add that an infant trade of this kind must not be hampered at the outset by unnecessary taxation. Without exception the Teso are fond of meat and, in fact, suffer from definite "meat hunger" in the same way as other African tribes which are vegetarian from necessity; no fears need be entertained that meat offered for sale in small quantities in rural districts will not be bought with avidity.

47. Until, however, these upheavals in the normal life of the Teso can be brought about it is worth while trying to decide what other improvements can be introduced, and for this purpose a study of the correlation coefficients for Ajuluku must be repeated. The importance of working units, consumers and children in relation to health suggests that overcrowding is one of the main causes of nutritional disorder. Apart from impossible remedies such as birth-control, wholesale forced movements of population, and infanticide as practiced empirically by many primitive tribes in crowded or inhospitable areas, only one reasonable course suggests itself: the production of a limited area must be increased. Briefly, this will have to be done by soil conservation and improved crop rotation, as well as by making more use of the cow population in the production of milk (*vide* significance of $r_{AF.\,BC}$). The experienced economist will have realized that an early step must be the continued

attempt to make the Teso "money-minded", for without this no far-reaching programme can be devised; but it must be remembered that, all factors being taken into consideration as in Formula I, an increase in cash crops decreases health. The reason for this is not clear at present. One immediate consequence of an increased circulation of money will undoubtedly be an increased consumption of meat. This conclusion is based on experience gained in other parts of Uganda, where the natives have become "money-minded" (*see* paragraph 46).

48. The close fit given by Formula I to the families containing cases of leg ulcer (Table X) deserves special mention. Firstly, this constitutes an additional proof, if one were needed, that leg ulcer—or at least that form known as "tropical phagedenic ulcer"—is partly or wholly of dietetic origin. Secondly, it will be observed that the essential distinction between Formula I and the other regression formulae lies in the relatively greater weight given to the effect of working units and their relation to consumers; this suggests that leg ulcer should be more prevalent in big families where children are relatively preponderant, and an examination of the figures in Table XI actually bears out this forecast.

TABLE XI.

WORKING UNITS, CONSUMERS, CHILDREN AND COWS OF VARIOUS GROUPS OF FAMILIES IN AJULUKU AND OPAMI.

	Units. B	Consumers. C	Children. H	Cows. F
Ajuluku (Mean)	3·24	5·44	2·13	3·75
Ajuluku (Ulcer Group)	3·18	6·45	2·91	2·91
Ajuluku (Vitamin A Group) ..	3·43	5·86	2·71	1·90
Ajuluku (Caries Group)	3·42	6·46	2·92	5·92
Opami (Mean)	2·91	5·22	2·25	3·95
Opami (Vitamin A Group) ..	2·86	5·91	3·09	3·91
Opami (Caries Group)	3·04	5·38	2·15	5·00

It will be seen in the above table that the Vitamin A deficiency group in Opami shows far worse unit : consumers and unit : children ratios than does the Vitamin A deficiency group in Ajuluku. This probably has some slight connection with the greater number of cows owned by the Opami group, but the principal conclusion to be drawn is the following: that under Opami conditions a far worse unit : consumer ratio is necessary before the signs of Vitamin A deficiency appear. To sum up in other words, where a community is living under Ajuluku conditions—overcrowded, on land which is being exhausted, and with practically no animal food in the diet—a much smaller upset of the unit : consumer or unit : children ratio produces leg ulcer and Vitamin A deficiency than is the case in Opami.

49. Dental caries offers a curious problem. In Ajuluku the ratios of units : children and units : consumers in the caries group fall between those of the ulcer and Vitamin A deficiency groups, but in Opami they are actually slightly better than the mean, while in both *atongoles* the number of cows in the caries group is well above the mean for the whole *atongole*. When it is remembered that, both in Opami and Ajuluku, families with dental caries numbered 13 out of 55 and that there was no significant difference in incidence in the cases noted in Tables II and V, it is permissible to doubt whether nutrition alone plays an important part in the aetiology of this condition in the area under survey. An investigation into the incidence of dental caries in families living under widely different conditions of diet and environment certainly seems to be indicated.

PART V.

SUGGESTIONS FOR FURTHER INVESTIGATIONS.

50. It will have been noted that some of the conclusions rest on assumptions which, though reasonable enough, have not yet been proved statistically; especially is this the case in adducing fish-diet and density of population as factors intimately related with nutritional health. To ascertain the real effect of these variables it will be necessary to select two more *atongoles* in each of which one of the following combinations occurs: (*a*) No overcrowding, with no fish in the diet; (*b*) Overcrowding, with fish in the diet. By comparison of the results obtained in these latter *atongoles* with those already set out in this paper it should be possible to assess the precise effect of both these variables, *i.e.*, addition of fish to the diet and density of population.

51. Both Ajuluku and Opami will have to be the subjects of one or more further surveys, in order to determine the effect, if any, of the following factors on nutritional health: a pronounced dry season, a failed cash crop, failed food crops and the relative acreage of individual food crops, *e.g.*, millet, sweet potatoes, cassava, etc.

52. It seems that the time is now ripe for accurate analyses of the available plant nutrients of the soils and a chemical analysis of the food plants in various parts of the district; along with these examinations an attempt should, of course, be made to estimate the vitamin contents of fresh, stored and cooked foods. An investigation into the relative fertility of the soils in each surveyed *atongole* should also be made, and for the results to be of any value the effect of climatic differences must be eliminated. In order to do this it would appear feasible to take composite samples of soil from each *atongole* and conduct replicated pot experiments at, for example, Serere Experiment Station. Analyses of cows' milk,

fresh and soured, should also be made during the different seasons and compared over areas of varying soil fertility.

53. Following the analyses suggested above, it should be possible to decide whether a given food crop should be encouraged or discouraged throughout the district. Even with the knowledge at present available one is permitted to doubt whether it is wise to plant large areas of cassava as a famine reserve; cassava is known to be a poor food and its replacement by alternative famine reserve crops should be considered. The policy of collecting famine reserves of wimbi and allowing it to remain stored for several years should also be re-examined from the nutritional point of view.

54. This survey must be regarded as an essay in co-operation between two departments, namely Agricultural and Medical. It is suggested that more comprehensive results would be obtained by a full team of workers from all the departments concerned in the problems to be solved—Administration, Veterinary, Forestry and Education, in addition to those mentioned above. A standing committee could be formed by the various officers in the district; its functions would be the examination of evidence collected by its members (acting as a team), the co-ordination of field-work and the framing of policy based on the results obtained.

PART VI.

SUMMARY.

55. (*a*) A combined agricultural and health survey of two small administrative units (*atongoles*) in Teso has been made.

(*b*) In one of the *atongoles*, that with the denser population and negligible consumption of food of animal origin, significant correlations were obtained between nutritional health and certain agricultural and economic factors.

(*c*) In the other area, where the population is less dense and where fish is eaten frequently, these correlations were not obtained and it is, therefore, believed that overcrowding combined with a purely vegetarian diet have an adverse effect on the nutritional health of a community.

(*d*) Suggestions are made for immediate [illegible] remote possibilities of improving the nutritional heal[illegible] native communities living under the conditions describe[illegible]

(*e*) Figures are given for the incidence of [illegible] non-nutritional diseases among the inhabitants of these *atongoles*, and also for the types of crop grown with the rotations practised.

References.

1. *Africa* (1936). Editorial, IX, 147.
2. *Brown, A. A. F.* (1935). The Ulcer Syndrome in Tropical Africa. Jl. Trop. Med. and Hyg., XXXVIII, 157 *et seq.*
3. *Clements, F. W.* (1934). The Relation of Diet to Tropical Ulcer: A Preminary Report. Med. Jl. Australia, April 21, p. 520.
4. *Dalrymple, J.* (1928). Tropical Ulcer and Dietary. W. Afr. Med. Jl., II, 133.
5. *Fisher, R. A.* (1932). Statistical Methods for Research Workers. 4th Ed., Edinburgh and London.
6. *Frazer, J. G.* (1925). The Golden Bough. Abridged Ed., p. 37, London.
7. *Hooper, R. C. D.* and *Loewenthal, L. J. A.* (1936). A Survey of Health Work in Teso, Uganda. Ann. Trop. Med. and Parasit., XXX, 17.
8. *Loewenthal, L. J. A.* (1932). Tropical Ulcer as a Deficiency Disease. Lancet, CCXXIII, 889.
9. *Id.* (1932–3). Calcium Treatment in Tropical Ulcer. East Afr. Med. Jl., IX, 136.
10. *Id.* (1933). A new Cutaneous Manifestation in the Syndrome of Vitamin A deficiency. Arch. Derm. and Syph., XXVIII, 700.
11. *Id.* (1935*a*). An Inquiry into Vitamin A deficiency among the Population of Teso, Uganda. Ann. Trop. Med. and Parasit., XXIX, 349.
12. *Id.* (1935*b*). The Manifestations of Vitamin A deficiency in Man. *Ibid.*, 407.
13. *McCulloch, W. E.* (1928). Ulcers in Northern Nigeria—A Review and a Theory. W. Afr. Med. Jl., II, 96.
14. *Orr, J. B.* and *Gilks, J. L.* Studies of Nutrition. The Physique and Health of two African Tribes. Med. Res. Council Spec. Report, 155.
15. *Richards, A. I.* and *Widdowson, E. M.* (1936). A Dietary Study in North-Eastern Rhodesia. Africa, IX, 166.
16. *Thomas, H. B.* and *Scott, R.* (1935). Uganda. pp. 96, 97. London.

Appendix I.

Laboratory Investigations—Ajuluku.

(One examination only).

BLOOD.

	Quartan.	Subtertian Malaria.	Malaria Parasites. (Unspecified).	Negative.	Total.	Blood Slides. Positive.
Adults ..	30	12	2	57	101	44%
Percentage ..	30	12	2	56	100	
Children ..	10	11	2	7	30	75%
Percentage ..	33	35	7	25	100	
A. C. ..	40	23	4	64	131	51%
Percentage ..	31	17	3	49	100	

STOOLS.

	Ancylostoma.	E. coli.	Flagellates.	Negative.	Total.
Adults ..	31	(3)	(5)	39	70
Children ..	5	—	—	5	10
Total ..	36	(3)	(5)	44	80
Percentage ..	45	(4)	(6)	55	100

Note.—The figures shown in brackets refer to organisms found in stools which showed ancylostome infection also.

Appendix II.

Analysis of Agricultural Economic Data—Ajuluku.

	Groups.	Size of Sample.	Units for work.	Average acres per Taxpayer in each group.	Acreage cultivated per Unit.	Acres food crops per Unit.	Cotton cultivated per:— Taxpayer.	Cotton cultivated per:— Unit.	No. of Ploughs.	Ploughs per Unit.
A.	Bachelors	26	26	2·98	2·98	1·48	1·50	1·50	—	—
B.	Bachelors supporting an old relation ..	10	12½	3·49	2·79	1·75	1·31	1·04	1	·08
C.	Man and 1 wife	130	296	5·71	2·51	1·55	2·19	0·96	25	·08
D.	Man and 2 wives	29	107½	9·30	2·51	1·45	3·98	1·07	11	·10
E.	Man and 3 wives	5	22	14·30	3·25	1·85	6·18	1·40	5	·23
F.	Man and 4 wives	2	12	19·17	3·19	1·85	8·07	1·34	2	·17
G.	Man and 5 wives	1	7	20·77	2·97	2·14	5·83	0·83	1	·14
H.	1 Widow with 2 children ..	1	1	—	1·66	1·14	—	0·52	—	—

Appendix III.

Analysis of Agricultural Economic Data—Opami.

	Groups.	Size of Sample.	Units for work.	Average acres per Taxpayer in each group.	Acreage cultivated per Unit.	Acres food crops per Unit.	Cotton cultivated per:— Taxpayer.	Cotton cultivated per:— Unit.	No. of Ploughs.	Ploughs per Unit.
A.	Bachelors	29	29	2·69	2·69	1·73	0·96	0·96	0	0
B.	Bachelors supporting an old relative ..	8	12	3·24	2·16	1·39	1·15	0·77	0	0
C.	Man and 1 wife	103	234	4·97	2·06	1·46	1·36	0·60	11	0·047
D.	Man and 2 wives	45	150	7·23	2·06	1·52	1·80	0·54	14	0·093
E.	Man and 3 wives	10	44	10·88	2·47	1·86	2·78	0·62	7	0·16
F.	Man and 4 wives	2	10	18·18	3·67	2·88	3·78	0·76	2	0·20
G.	Man and 5 wives	1	6½	14·33	2·21	1·68	3·40	0·52	1	0·15
H.	Man and 9 wives and 1 daughter-in-law	1	13	65·69	5·05	3·64	18·36	1·41	2	0·15
I.	2 Widows	2	3 (1 daughter 17 years)	—	3·96	2·75	—	1·11	0	0

Appendix IV.

RELATIVE AREAS OF VARIOUS CROPS CULTIVATED BY PLOUGH AND BY HAND IN AJULUKU. ACRES.

Crop.	Total Area of each crop ploughed.	Total Area of each crop hand-cultivated.	Total Area both types of cultivation.	Mean Area.	Mean plot size for whole of Teso District.
Finger Millet (Wimbi) ..	267·50	14·20	281·70	0·89	0·65
Cotton	500·00	5·90	505·90	0·99	0·79
Groundnuts	155·20	16·30	171·50	0·50	0·41
Sweet Potatoes ..	77·10	16·05	93·15	0·21	0·22
Cassava (Muhogo) ..	59·50	4·40	63·90	0·30	0·25
Sorghum (Mtama) ..	122·70	5·20	127·90	0·87	0·51
Vigna (Kunde) ..	6·60	0·67	7·27	0·99	0·48
Maize	—	0·22	0·22	—	0·12
Sim-Sim	0·02	0·05	0·07	—	0·48
TOTAL ..	1,188·62	62·99	1,250·61	—	—

Appendix V.

RELATIVE AREAS OF VARIOUS CROPS CULTIVATED BY PLOUGH AND BY HAND IN OPAMI. ACRES.

Crop.	Total Area of each crop ploughed.	Total Area of each crop hand-cultivated.	Total Area both types of cultivation.	Mean Area.	Mean Plot size for whole of Teso District.
Finger Millet (Wimbi) ..	263·30	129·40	392·70	1·06	0·65
Cotton	303·30	14·10	317·40	1·13	0·79
Groundnuts	58·20	29·40	87·60	0·41	0·41
Sweet Potatoes ..	18·30	45·90	64·20	0·23	0·22
Cassava (Muhogo) ..	44·20	57·00	101·20	0·50	0·25
Sorghum (Mtama) ..	53·60	33·20	86·80	0·57	0·51
Vigna (Kunde) ..	6·10	0·29	6·39	0·22	0·48
Maize	1·10	2·40	3·50	0·08	0·12
Sim-Sim	110·40	16·70	127·10	0·62	0·48
Rice	0·93	—	0·93	—	—
TOTAL ..	859·43	328·39	1,187·82	—	—