



Publication series "Afrika-Studien" edited by Ifo-Institut für Wirtschaftsforschung e. V., München, in connexion with

Prof. Dr. PETER VON BLANCKENBURG, Berlin

Prof. Dr. HEINRICH KRAUT, Dortmund

Prof. Dr. OTTO NEULOH, Saarbrücken

Prof. Dr. Dr. h. c. RUDOLF STUCKEN, Erlangen

Prof. Dr. HANS WILBRANDT, Göttingen

Prof. Dr. EMIL WOERMANN, Göttingen

Editors in Chief:

Dr. phil. WILHELM MARQUARDT, München

Afrika-Studienstelle im Ifo-Institut

Prof. Dr. HANS RUTHENBERG, Stuttgart-Hohenheim,

Institut für Ausländische Landwirtschaft

Lit.112

Investigations into Health and Nutrition in East Africa

with 132 tables and 70 figures

By

H. KRAUT / H.-D. CREMER (Eds.)

with contributions of

M. G. ATTEMS

H. KASPER

W. KELLER

R. KORTE

Y. KREYSLER

E. MUSKAT

W. POEPLAU

H. J. SCHAEFER

C. SCHLAGE

P. THEERMANN

W. VALDER



WELTFORUM VERLAG · MÜNCHEN

Contents

| | |
|--|-----|
| IV. The Nutritional and Health Status of the People Living on the Mwea-Tebere Irrigation Settlement | 267 |
| 1. Background Information | 271 |
| a) The History of the Scheme | 271 |
| b) Population and Land Distribution | 271 |
| c) The Income of the Tenants | 272 |
| d) Housing | 273 |
| 2. Vital and Health Statistics including Incidence Studies of Intestinal Parasites and Malaria | 273 |
| a) Health Facilities | 273 |
| b) Intestinal Parasites | 274 |
| c) Malaria | 278 |
| d) Malnutrition | 279 |
| 3. The Questionnaire Survey | 280 |
| a) Family Statistics | 281 |
| b) Agriculture and Economy | 283 |
| c) Eating Habits and Child-Care | 286 |
| d) Attitudes and Medical Consciousness | 288 |
| 4. Food Consumption Survey | 289 |
| a) Selection of the Sample | 289 |
| b) Meals | 293 |
| c) Quantitative Consumption | 294 |
| d) Frequency of Foodstuffs Eaten | 294 |
| e) Caloric Contribution of Foodstuffs Consumed | 295 |
| f) Seasonal Changes of the Diet | 296 |
| g) The Diet of the Scheme Area in Comparison to the Non-Scheme Area | 296 |
| h) Prices of Commonly Eaten Foodstuffs | 297 |
| i) Adequacy of the Diet | 298 |
| 5. Anthropometric Measurements | 305 |
| 6. Clinical Assessment of Nutritional Status | 312 |
| 7. Biochemical Assessment of Nutritional Status | 316 |
| a) Estimations in Blood | 316 |
| b) The Assessment of Urinary Compounds | 322 |
| 8. The Progress of the Mwea-Tebere Irrigation Scheme | 325 |
| a) The Establishment of the Scheme as a Means for Improving the Situation of the Landless Population | 325 |
| b) The Situation of the Scheme Area in Comparison to Conditions in the Nyeri District | 326 |
| 9. Recommendations | 327 |
| 10. Summary | 330 |
| References | 331 |
| Acknowledgements | 334 |

Tables

| | |
|---|-----|
| 1. Tenant Statistics by Length of Tenure | 272 |
| 2. Relative Distribution of Tenants Falling into Various Classes of Net-income | 273 |
| 3. Results of Routine Bilharzia Surveys in Schools, 1966 | 276 |
| 4. Results of the Bilharzia Survey Conducted as Part of the Nutrition Survey | 277 |
| 5. Results of Snail Counts, November 1966 | 278 |
| 6. The Incidence of Malnutrition in the Scheme and the Non-Scheme Areas | 280 |
| 7. Deaths Occurring at Different Ages (Scheme Area) | 283 |
| 8. Deaths Occurring at Different Ages (Non-Scheme Area) | 283 |
| 9. Population Structure of Kirogo and Mahigaine | 290 |
| 10. Other Sociological Data Concerning Kirogo and Mahigaine | 291 |
| 11. Approximate Percentage of Tenants Coming from Different Areas | 292 |
| 12. The Age Groups of the Sample and their Representation in Proportion to the Total Population (Villages Combined) | 292 |
| 13. Quantitative Consumption of Foodstuffs (raw), July 1966 | 294 |
| 14. Frequency Distribution of Foodstuffs Consumed (July 1966) | 295 |
| 15. The Relative Caloric Contribution of Foodstuffs to the Diet | 295 |
| 16. Relative Frequency of Foodstuffs Consumed | 297 |
| 17. The Most Commonly Used Foodstuffs and their Approximate Prices in the Area of the Mwea-Tebere Irrigation Scheme | 297 |
| 18. Evaluation of Chest-headcircumference Ratios | 309 |
| 19. Summary of Anthropometric Findings | 310 |
| 20. Findings of Clinical Investigations | 313 |
| 21. Hemoglobin Levels Observed | 316 |
| 22. The Frequency of Anaemia in Different Age Groups | 317 |
| 23. P.C.V. Values Observed | 317 |
| 24. M.C.H.C. Values Observed | 317 |
| 25. Values of Total Serum Protein Observed | 318 |
| 26. Vitamin A Levels Observed in Different Age Groups | 322 |
| 27. Ratios of Urinary Compounds Observed | 324 |

Figures

| | |
|--|-----|
| 1. Total Number of Bloodslides Examined at Kimbimbi Health Centre | 279 |
| 2. Size of Family by Length of Tenure | 282 |
| 3. Number of Households Falling into Different Groups of Caloric Adequacy | 299 |
| 4. Number of Households Falling into Different Groups of Vitamin A Adequacy | 302 |
| 5. Number of Households Falling into Different Groups of Riboflavin Adequacy | 303 |
| 6. Number of Households Falling into Different Groups of Vitamin C Adequacy | 304 |
| 7. Weights in the Male Population up to 18 Years of Age | 306 |
| 8. Weights in the Female Population up to 18 Years of Age | 306 |
| 9. Heights in the Male Population up to 18 Years of Age | 307 |
| 10. Heights in the Female Population up to 18 Years of Age | 308 |
| 11. Tricepskinfolds in the Male Population up to 18 Years of Age | 310 |

c) Eating Habits and Child-Care

Scheme area

A dietary survey, as it will be described in chapter 4 (Food Consumption Survey) can only give information on the food consumed over a very limited period. Therefore, some questions concerning the consumption of foods were included in the questionnaire to investigate seasonal differences.

The families on the Scheme usually have 2 or 3 meals per day. They eat only 8 chickens a year and about 6 pounds of other meat each month. More than 50% of the persons questioned said that they prefer sugar cane as a snack. Only 13% ate fruits; the rest preferred sweets or gave no answer.

The families were also asked what they had eaten on the day prior to the investigation. The results will be discussed together with the dietary findings in chapter 4.

Breastfeeding is usually continued for a long period. 12% fed their children up to 6 months, 46% up to 12 months, 31% up to 18 months and the remaining 11% up to the end of the second year.

56% fed the children with animal milk in addition to the breast milk. The quantities given are, however, suspected to be very small. 30% stopped breastfeeding suddenly, while the remaining 70% weaned their children gradually. 6% used physical separation as a method of weaning, 14% applied a bitter substance, like chillies, to the breasts, 10% left their children to cry until hungry, and 70% weaned their children gradually by introducing other food in addition to the breastmilk.

In 20% of the cases, the first food supplements were introduced about the third month after birth. 74% added extra food between 4 and 6 months. 6% added extra food to the child's diet during the second half of the first year.

Most of the foods were rather poor in quality, however. 86% fed their children potatoes, bananas, rice or any other soft, predominantly starchy food. Only 1% gave their children beans. 13% said to add animal products like meat, eggs or milk to the child's diet.

The food is usually fed to the child in such a way that there is a great possibility of infection. 64% used a spoon for feeding. 25% gave the food by hand, 9% after chewing the food, and the remaining 2% used a cup.

The full family diet was given to the child in 22% of the families by the end of the first year. 54% introduced the full diet during the second year and 24% during the third year of life.

The question, whether special food was given in addition to the family diet, showed that 16% gave no additional special food, 67% added starchy foods, 14% added animal products and only 3% vegetables. In 75% of the households, the children apparently had the first choice at a meal. In 16% the

father, while the mother had the first choice in only 2%. In 7% no person was especially favoured.

The feeding of school children constitutes another grave problem. 59% of the children have no breakfast before they leave for school early in the morning. 27% have breakfast regularly and 14% occasionally. Those children living close to the school usually go home for lunch, the others stay at school during the lunch hours. 27% of the children take no food to school nor go home to eat their lunch.

Non-Scheme area

The situation in Kiarukungu and Kangai is similar to conditions on the Settlement. The number of meals eaten ranged from 1 to 3. 13% had only one meal, 59% two meals and 28% had three meals. The families eat about two chickens per year and 2 pounds of other meat each month. Sugar cane is eaten as frequently as on the Scheme. Fruits were not so readily available.

Breastfeeding was not continued as long as in Mwea-Tebere. 38% stopped breastfeeding after 6 months, 35% after 12 months and 20% after 18 months. The remaining 7% weaned their children after 24 months. Only 38% added other milk to the breastfed milk. 18% weaned their children suddenly and 82% gradually.

Only 3% used physical separation as a method for weaning. 4% applied bitter substances to their breasts. 14% left their child to cry until hungry. 79% gradually introduced other foods. In 22% of the households the first food supplements were introduced when the child was about 3 months old, 67% added food between 4 and 6 months and 11% not later than the end of the first year. The foods introduced were in 90% of the cases starchy and were mixed with beans in 11%. None of the mothers added animal protein to the child's diet. 38% fed their children by means of a spoon, 15% used a cup, 2% a bottle, 33% used their hands and 12% chewed the food before they gave it to the baby.

The full family diet was given to the child in 32% of the cases before the end of the first year of life, in 42% during the second year, and in 26% not later than the end of the third year.

As special foods given in addition to the family diet, 42% considered starchy foods, 10% vegetables, while the remaining families did not give any extra food to their children.

In 71% the children had the first choice at any meal. In 6% the mother and in 23% the father.

68% of the children had no breakfast before going to school, while 32% had their breakfast regularly. The vast majority ate no lunch at home nor took food to school.

d) Attitudes and Medical Consciousness

Scheme area

Radios, bicycles and household equipment, like tables and chairs, are good indicators of the social and economic status of a family.

16% of the families in Mwea-Tebere owned a radio. This figure agrees with the economic status of the people. 65% owned a bicycle, and 71% possessed tables and chairs. This indicated that articles of luxury were as frequently found in the homes as the basic household equipment, which was more important for proper housekeeping.

The question "if you had more money what would you spend it on?" was answered by expressing the desire to buy a farm in 82% of the cases. Others wanted to buy agricultural machines, a car, more education, a wife, or a tea shop.

12% of the tenants wanted to have up to 5 children. 46% up to 10 children, and the rest wanted more than 10 or "as many as possible". The reasons for so many children: "I can afford their education", "some might die", or "to help me". 61% were in favour of family planning, 27% were against it for personal or religious reasons and 12% had never heard of it. A number of questions were asked in order to test the people's medical knowledge and their attitude towards health in general.

If a member of the household became slightly ill, the person would get traditional medicine in 13% of the cases. 84% would get modern medicine or be sent to the health centre, while the rest would remain untreated. Medicine is bought in 36% of the cases in one of the local shops or obtained from the nearest hospital or dispensary. Very few persons would get it from a witchdoctor. "Many people say a person can become bewitched, what could be done to cure this person?" This question provoked interesting answers. Only 13% would take this patient to a witchdoctor, while all the others would go to a dispensary or a hospital.

The drugs taken more frequently were "Aspro", "Aspirin", "Melabon" or other harmless analgesics in 73% of the cases. Only 27% made use of antimalarial drugs. No tablets against intestinal infection (parasites) were taken.

The cause of kwashiorkor was believed to be bad food by 21%, not enough food by 22%, not enough meat and eggs by 8%, and no milk or vegetables by 8%. 41% could not answer the question. Diarrhoea was thought to be caused by bad food by 25%, by dirty water by 37%, and by 5% by dirt. 33% did not know the reason. 57% of the people believed that hard work was the cause of chest trouble, 14% mentioned cold as a reason, and 29% did not give an answer. 65% of the sample considered vaccination useful for their children, 20% thought it was harmful, while 15% had not heard of it.

The last child was born in 63% of the families at home. Only 37% were born

at a health centre or a hospital. When the child was born at home the chord of the new-born baby was usually dressed with a piece of cloth, saliva and ashes, powder, or remained undressed.

Non-Scheme area

Due to their lower economic status, only 2% of the non-Scheme population had a radio, 15% had a bicycle and 14% had table and chairs.

As many as 66% wanted to buy a farm, and surprisingly enough 11% wished to buy a car if they had more money. Otherwise, the answers were the same as in Mwea-Tebere.

The desire for children was less outspoken. 20% wanted up to 5 children; 52% wanted up to ten; and the rest wanted more than 10, or as many as possible. The explanations for this desire were very similar to those mentioned above. Only 28% appreciated the idea of family planning; 40% rejected it; and as many as 33% did not know what it was.

In case a person became slightly ill, 12% would be given traditional medicine, 73% modern medicine and 15% would not be given any treatment at all. 17% would buy the medicine required at a shop, 68% would collect their drugs at the health centre or dispensary. In 16% of the cases, a bewitched person would be taken to a witchdoctor. 79% would go to a hospital or dispensary. Some families thought that nothing could be done about it, or denied the possibility that a person could be bewitched.

Commonly taken drugs were analgesics in 56% of the households. Only 10% took antimalarial tablets. All others did not use tablets regularly.

21% believed bad food to be the cause of kwashiorkor. The majority could not give any explanation as to the cause. 16% thought bad food was responsible for diarrhoea. The same number considered dirty water responsible while 68% could not give any reason.

40% thought hard work to be the cause of chest trouble. 4% thought it was the cold. 56% could not answer the question. 42% considered vaccination good for their children; 15% did not like it; and 43% did not know what it was. In 68% of the families the last child of the family was born at home. Only 14% were born at a health centre or hospital. The rest either had no children or went to relatives for the birth of their children.

4. Food Consumption Survey

a) Selection of the Sample

Two villages of the Tebere Block, Mahigaine and Kirogo, were chosen for the nutrition survey. The Mwea and Thiba section could not be considered, be-

Table 9. Population Structure of Kirogo and Mahigaine

| Age group | Mahigaine Total population: 1,030 | | | Kirogo Total Population: 523 | | | Villages combined Total Population: 1,553 | | |
|-------------|--------------------------------------|----------|-------------------------------|---------------------------------|----------|-------------------------------|--|----------|-------------------------------|
| | Male % | Female % | Sex Ratio M/F ^a | Male % | Female % | Sex Ratio M/F ^a | Male % | Female % | Sex Ratio M/F ^a |
| 0-11 months | 0.78 | 1.36 | 2.14 | 0.96 | 1.53 | 2.49 | 0.84 | 1.42 | 2.25 |
| 1-4 years | 11.07 | 11.65 | 22.72 | 11.86 | 9.37 | 21.22 | 11.33 | 10.88 | 22.21 |
| 5-9 years | 8.54 | 8.84 | 17.38 | 7.65 | 8.41 | 16.06 | 8.24 | 8.69 | 16.93 |
| 10-14 years | 5.63 | 3.50 | 9.13 | 3.44 | 4.59 | 8.03 | 4.89 | 3.86 | 8.76 |
| 15-19 years | 4.76 | 4.08 | 8.84 | 4.78 | 5.17 | 9.94 | 4.77 | 4.44 | 9.21 |
| 20-29 years | 5.24 | 9.32 | 14.56 | 5.74 | 9.56 | 15.30 | 5.41 | 9.40 | 14.81 |
| 30-39 years | 6.31 | 5.24 | 11.55 | 5.54 | 5.54 | 11.09 | 6.05 | 5.34 | 11.40 |
| 40-49 years | 3.30 | 3.79 | 7.09 | 3.82 | 3.63 | 7.46 | 3.48 | 3.73 | 7.24 |
| 50-59 years | 1.94 | 1.65 | 3.59 | 3.06 | 1.91 | 4.97 | 2.32 | 1.74 | 4.06 |
| 60 and more | 1.07 | 1.94 | 3.01 | 1.15 | 2.29 | 3.44 | 1.10 | 2.06 | 3.15 |

^a M/F = male/female

cause a survey in those areas presented unmanageable transport problems. Mahigaine and Kirogo were believed to be representative of large parts of the Scheme which were not too inaccessible by transport, yet not too near to Kimbimbi and the main road along which other surveys had been carried out recently. The frequency of surveys reduces the willingness of the population to cooperate. Moreover, the old villages were chosen in order to obtain a sample of people who had eight or more years to establish themselves in those originally entirely unaccustomed new surroundings. Before the actual investigations were started, a meeting with the villagers was held to explain the aim of the survey and to ask for their co-operation. A more detailed census followed in both villages. The results of this census are compiled in table 9 and 10.

Table 10. Other Sociological Data Concerning Kirogo and Mahigaine

| | Mahigaine | Kirogo | Villages combined |
|--------------------------|-----------|--------|-------------------|
| Total No. of tenants | 109 | 64 | 173 |
| Average age of tenants | 41.4 | 44.5 | 42.6 |
| Average No. of wives | 1.5 | 1.4 | 1.5 |
| Average age of wives | 32.3 | 31.6 | 32.0 |
| Average family size | 8.2 | 7.7 | 8.0 |
| No. of unmarried tenants | 1 | 4 | 5 |

Along with the census, general information was also collected. The average income of the tenants in 1966 in Mahigaine amounted to 2,467 shs. In Kirogo the average was 3,165 shs. The mean income of both villages combined was 2,722 shs. The difference between the villages appeared to be surprisingly high. A possible explanation could be the different origin of the tenants (see table 11). Kiambu, Muranga and Nyeri are relatively advanced areas. Cattle is raised in both villages. A total of 464 animals were counted. The villagers are normally not permitted to raise cattle in the Scheme-area. The management considers badly watched cattle to be responsible for the destruction of furrows, drains, and fields. Both villages have a small butcher shop, where about 10 cattle are offered for sale each month at an average price of 1.40 shs per pound. Both butchers claim to have great difficulty selling this amount. A small grocery store sells a few items which are required for the household. Only a very limited supply of fruits and vegetables are available. Milk is almost never on sale.

The sample was drawn systematically from the census list of tenants in Mahigaine and Kirogo. Tenants with no families or small ones were not surveyed (one wife and no children). The number of households is equal to the number of wives cooking separately for their own children. Thus, 12 families, equivalent to 15 households, were selected in Mahigaine and 11 families with the

Table 11. *Approximate Percentage of Tenants Coming from Different Areas*

| Mahigaine | Kirogo |
|---------------|-------------|
| 75% Kirinyaga | 50% Kiambu |
| 12% Muranga | 25% Muranga |
| 13% Kiambu | 25% Nyeri |

Table 12. *The Age Groups of the Sample and their Representation in Proportion to the Total Population (Villages Combined)*

| Age groups | Male | | Female | |
|---------------|------|------|--------|------|
| | No. | % | No. | % |
| 0-11 months | 6 | 46.1 | 2 | 9.1 |
| 1- 4 years | 47 | 26.7 | 51 | 30.2 |
| 5- 9 years | 19 | 14.8 | 21 | 15.1 |
| 10-14 years | 14 | 18.4 | 9 | 15.0 |
| 15-19 years | 8 | 10.8 | 10 | 14.5 |
| 20-29 years | 7 | 8.3 | 18 | 12.3 |
| 30-39 years | 10 | 10.6 | 6 | 7.2 |
| 40-49 years | 3 | 5.6 | 9 | 15.5 |
| 50-59 years | 6 | 16.7 | 4 | 14.8 |
| 60 and more | 1 | 5.9 | - | - |
| Total | 121 | 15.7 | 130 | 16.2 |
| Overall total | 251 | | 16.1% | |

same number of households were selected in Kirogo. The representation of each age group is given in table 12 in absolute numbers and in percentages of the total village population in each age group.

The methods which were used to calculate food consumption were largely based on the FAO (1962).

For the calculation of the calorie, protein, carbohydrate, mineral and vitamin contents of the foods consumed a food composition table was drawn up taking values from different sources (PLATT, 1962 and INCAP-ICNND, 1961). For the calculation of the aminoacid composition of foods tables compiled by FAO (1963), SOUCI, KRAUT, FACHMANN (1962) and BOWES, CHURCH (1962) were used. The adequacy of the diet was assessed by comparing the nutritive value of foods consumed during the survey period with the nutritional requirements of the consumption group.

For the calculation of calorie requirements, recommended dietary allowances as given by FAO (1962), FAO (1957) and WHO (1965) were used. Fat and carbohydrate requirements were taken from NICHOLLS, SINCLAIRE, and JELLIFE (1961). Protein requirements were adopted from WHO (1956), MILLER and PAYNE (1961), and PLATT, MILLER and PAYNE (1961). For calcium the recommended allowances of WHO (1962) formed the basis

for calculations. Iron, vitamin A, and vitamin C requirements were calculated using the dietary allowances of the National Research Council (1958). For the calculations of Thiamine, Niacin and Riboflavin adequacy data given by FAO (1962) were used.

b) Meals

The villagers normally had 3 meals per day. The breakfast very often consisted solely of tea and sugar or cocoa with sugar and sometimes milk. Sometimes a mixture of maize flour, *uji*, and leftovers from the previous day were eaten. School children leaving for school early often missed their breakfast. (The habits of school children were discussed in a previous chapter.) Lunch and dinner were similar in their composition. Maize and some kind of legumes formed the main foodstuffs. Small portions of rice and other cereals were also eaten. Children up to 4 or 5 years of age were given rice and English potatoes frequently. These were considered adequately soft for the young children. Although available in every household, rice was disliked by the tenants. The reason for this dislike stems from the fact that after a meal of rice (boiled in water), the feeling of hunger quickly returns. The heavy mixture of maize and beans, on the other hand, is digested slowly. When legumes and maize were not so abundantly available, the consumption of rice increased despite the tenants dislike for it. To improve the taste of leftover food, it was sometimes prepared with small amounts of cheap vegetable oil and a few onions. Seasoning like chillies, pepper or curry was used only very rarely at meals. Even the consumption of salt, although not accurately recorded, appeared to be low. The tenants have little knowledge of ways to improve the palatability of their monotonous meals. The consumption of animal protein was negligible in most of the households. Some did not eat any at all. Meat was eaten only on special occasions such as a feast when guests were present. Children therefore did not benefit from the meat-protein. Milk, in a few cases, was purchased for young children. Green vegetables were scarcely available in the area and were therefore rarely prepared by the housewives. Maize and beans were boiled for 2 to 3 or even 4 hours. Vegetables, when available, were also cooked this long. They undoubtedly suffered a severe loss in vitamins. Fruits were usually consumed between meals as snacks and were probably not recorded in each case. The resulting error should, however, be small. The only fruits offered in the small markets of the villages were bananas and small green oranges.

The consumption of local beer appeared to be considerable, especially in Mahigaine. The relatively short distance to Kimbimbi with its numerous pubs plus the tenants' pockets full of money from the last pay-out, may have encouraged its consumption. Some tenants were hardly found sober on any of the days of the survey. It can be suspected, however, that seasonal differ-

ences play a role and probably make the picture more sympathetic throughout the year.

c) Quantitative Consumption

To show the quantitative distribution of foodstuffs consumed during the survey, table 13 shows the absolute amounts in kg consumed by the families included in the sample.

Table 13. *Quantitative Consumption of Foodstuffs (Raw)*
(July 1966)

| | |
|------------------------------------|---------|
| Maize and maize products | 408 kg |
| Rice | 85 kg |
| Millet | 31 kg |
| Beans | 181 kg |
| Lentils | 13 kg |
| Pigeon peas | 27 kg |
| Cow peas | 10 kg |
| Potatoes | 42 kg |
| Arrowroot | 4 kg |
| Bananas | 22 kg |
| Sugar | 14 kg |
| Fruit | 6 kg |
| Green vegetables | 15 kg |
| Onions | 1 kg |
| Fat | 2 kg |
| Meat | 5 kg |
| Milk | 21 ltr. |

This table reflects the monotony of the diet in which cereals and legumes prevail, while animal protein forms only a very small part.

d) Frequency of Foodstuffs Eaten

A total of 202 full days were surveyed. The frequency distribution of the different foodstuffs eaten on different days is given in table 14. This table also indicates that very few foodstuffs were eaten regularly e.g. maize and legumes. Other high protein and vitamin rich foods show a very uneven distribution over the period of the survey. This indicates the imbalance of the diet. While animal protein may be abundant on one day, it is entirely missing on others. This impairs aminoacid utilization. An even distribution of essential foodstuffs is the characteristic of a balanced diet with optimal utilization. The correlation of the frequency distribution (in table 14) with the absolute amounts of foodstuffs consumed (in table 13) was calculated according to SPEARMAN. The rank correlation coefficient R was 0.566 with a significance

Table 14. *Frequency Distribution of Foodstuffs Consumed (July 1966)*

| | |
|------------------------------------|----------|
| Maize and maize products | 194 days |
| Rice | 62 days |
| Millet | 37 days |
| Sorghum | 8 days |
| Beans | 149 days |
| Lentils | 16 days |
| Peas | 39 days |
| Potatoes | 40 days |
| Arrowroot | 1 days |
| Bananas | 23 days |
| Sugar | 115 days |
| Bread | 2 days |
| Fruit | 4 days |
| Green Vegetables | 31 days |
| Onions | 39 days |
| Fat | 59 days |
| Eggs | 1 day |
| Meat | 3 days |
| Milk | 47 days |

at the 5% level. This correlation will justify a method applied later to investigate the seasonal differences in the diet (see page 296 and also CHASSY, 1967).

e) Caloric Contribution of Foodstuffs Consumed

The best way to ascertain the contribution of certain foods to the diet is to calculate their relative contribution to the total intake of calories. This avoids misleadingly high percentages for foods with a high water content, e.g. milk (see table 15).

Table 15. *The Relative Caloric Contribution of Foodstuffs to the Diet*

| | |
|--------------------------------|-------|
| Maize | 57,3% |
| Rice | 9,4% |
| Other cereals | 3,1% |
| Legumes | 24,5% |
| Potatoes | 1,2% |
| Fruit and vegetables | 0,3% |
| Bananas | 0,8% |
| Animal products | 0,8% |
| Fat | 0,5% |
| Sugar | 1,8% |
| Other | 0,3% |

The table shows clearly that the diet consisted nearly entirely of maize, legumes and a little rice.

f) Seasonal Changes of the Diet

In order to demonstrate seasonal differences, the frequency distribution of foodstuffs eaten is listed in table 16 for the survey in Tebere (July 1966) and in the whole Scheme, and Kangai and Kiarukungu, surveyed in March 1967 (the latter two being based on the questionnaire survey). Since differences in the dietary pattern were very slight in the different families of the Scheme, it was possible to compare the food consumption of two not quite identical samples.

The table shows a clear reduction in the consumption of maize and beans while more rice was eaten at the end of the dry season in March. This is in comparison to the consumption in July 1966 (shortly before and during the new harvest). The differences in meat consumption are meaningless because the absolute amounts eaten are so small. Even an increase of 500% would not meet the requirements. The same applies to other foodstuffs that are consumed in very low quantities. The lower consumption of milk was probably due to the fact that less milk was available after the very long dry season. The increased consumption of onions and vegetable oil is in agreement with the fact that the number of families eating rice is increasing. These are used to improve the taste of the otherwise disliked diet. Sugar was less frequently consumed in March. This may have been due to the fact that no money was left to buy foodstuffs which are a luxury.

g) The Diet of the Scheme Area in Comparison to the Non-Scheme Area

The dietary pattern of the population in Kangai and Kiarukungu resembles the frequency distribution of foods eaten in July 1966 in Tebere. Differences naturally exist in the consumption of rice as this crop is not grown in this area. Millet was apparently preferred. Less animal protein was consumed. But many more green vegetables were eaten. The low consumption of sugar is due to the lower economic status of the population. In general, the differences in food are surprisingly small in comparison to the vast differences in income.

The frequency distribution is more a measure of quality than of quantity. These findings do not exclude the occurrence of calorie deficiency which in Mwea-Tebere is well compensated for by the increased consumption of rice. This, however, reduces the quality of the protein eaten. On a diet consisting mainly of rice, the recommended NDpCals%³ may still be met for adults, but it is definitely deficient for children. The NDpCals% were found to be too low for this age group already on the diet eaten in July 1966 (see page 300).

³ NDpCals% = Net Dietary protein Calories %.

Table 16. *Relative Frequency of Foodstuffs Consumed*

| | Scheme area | | Non-Scheme area |
|--------------------------|-------------|----------|-----------------|
| | July 66 | March 67 | March 67 |
| Maize and maize products | 96 | 60 | 94 |
| Rice | 30 | 74 | 5 |
| Millet | 18 | 7 | 23 |
| Sorghum | 4 | 3 | — |
| Beans | 74 | 55 | 52 |
| Lentils | 8 | 2 | — |
| Peas | 19 | 3 | 2 |
| Potatoes | 20 | 20 | — |
| Arrowroot | 1 | 12 | 3 |
| Bananas | 11 | 11 | 3 |
| Sugar | 74 | 16 | 7 |
| Bread | 1 | 3 | — |
| Fruits | 2 | 1 | 1 |
| Green vegetables | 12 | 28 | 53 |
| Onions | 19 | 55 | 18 |
| Fat | 29 | 55 | 30 |
| Eggs | 1 | 2 | — |
| Meat | 2 | 11 | 1 |
| Milk | 23 | 12 | 5 |

h) Prices of Commonly Eaten Foodstuffs

To indicate the costs of the most commonly eaten foodstuffs, a list of prices is given in table 17 (Prices adopted from a study by MORIS, 1966, with his kind permission).

Table 17. *The Most Commonly Used Foodstuffs and their Approximate Prices in the Area of the Mwea-Tebere Irrigation Scheme*

| | |
|-------------------------------|-----------|
| Maize, 200 lb. | 40,00 shs |
| Maize flour, 200 lb. | 50,00 shs |
| Beans, 200 lb. | 60,00 shs |
| Peas, 200 lb. | 47,00 shs |
| Millet, 200 lb. | 25,00 shs |
| Sorghum flour, 1 tin (40 lb.) | 8,00 shs |
| Arrowroot, 1 | 0,50 shs |
| Beef, 1 lb. | 1,40 shs |
| Egg, 1 | 0,15 shs |
| Milk, 1 pint | 0,50 shs |
| Sugar, 1 lb. | 0,70 shs |
| Potatoes, 4 lb. | 1,20 shs |
| Cabbage, 1 lb. | 0,20 shs |
| Bananas, 3 | 0,15 shs |
| Onions, 1 lb. | 0,50 shs |
| Fat, 1 lb. | 3,50 shs |

These prices are of course subject to seasonal changes. When this list of prices is used to calculate the expenses of a family for the whole year, assuming that nearly all foodstuffs except for rice have to be bought, then just over 500 shs are spent per annum per family. This was almost exactly the amount determined by the questionnaire survey (see page 285).

i) Adequacy of the Diet

Calories

The requirements were compared with the actual caloric intake. The intake was calculated per person per day by dividing the total calories calculated from the food composition tables by the number of consumption units. The requirements amounted to 2,058 cal while the actual intake surpassed this amount by more than 500 cal. It reached a mean value of 2,604 cal per person per day. Expressed in percent, this means that the caloric adequacy was 127% i.e. in most of the families a good deal above the recommended allowances. Assuming the correctness of the FAO recommendations and looking at the anthropometric data which will be discussed later (see chapter 5), it is believed that these data are too high and do not reflect the true situation. There may be many sources of error. Seasonal changes in food consumption are very likely. The rather high calorie consumption could be explained by the fact that the survey was conducted only a few weeks after the pay-out and at the beginning of the new harvest. Another error probably lies in adopting the values of food composition tables. The water contents of legumes and beans may vary considerably with environmental humidity and temperature. Difficulties occur also in estimating the definite amount of food consumed on the first or the last survey day. The composition of the leftovers could not always be determined accurately. But the values should not deviate more than 5 to 10% from the actual intake. It cannot be determined which of the three factors contributed most to the high intake. The findings do not indicate that the caloric intake is optimal, especially when the adequacy is less during other seasons of the year.

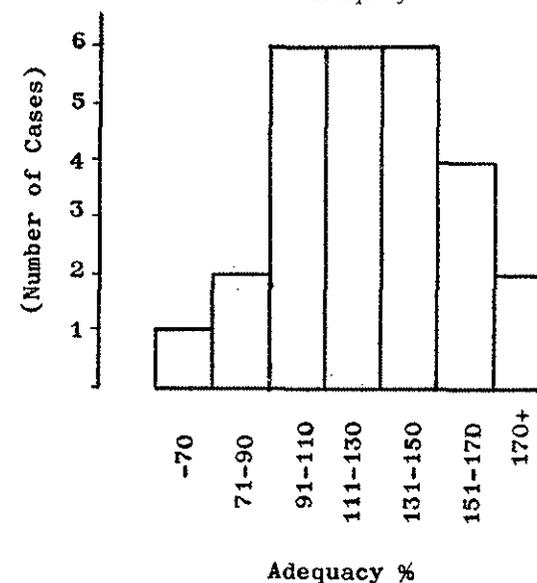
The values of adequacy range from 62% to 190%. This suggests, although the mean caloric intake is above the recommended allowances, that the differences between the various families were vast and a number of them had an inadequate consumption, at least for short periods of time.

The frequency distribution of families falling into different classes of caloric adequacy is shown in the graph below (Figure 3).

Fats

Fats contributed about 9% to the total caloric intake. This, of course, varied from family to family. It ranged from 7.2% to 11.2%. Since hardly any

Figure 3. Number of Households (Cases) Falling into Different Groups of Caloric Adequacy



fat was added to the meals, most of the fats were derived from the natural contents of maize, beans, and rice. Maize contributed approximately three times the amount of beans or rice per weight unit. Since these oils contain a high percentage of EFA⁴ the problem is rather one of quantity than quality. Vitamin D deficiency is not a serious problem in tropical countries, and very little is known about the requirements of vitamin E. The low fat intake certainly impairs the absorption of vitamin A. Since the food containing a high degree of carbohydrates and proteins is very bulky it can hardly meet the caloric requirements because the feeling of satiation comes before the intake is adequate. This applies especially to small children fed on a predominantly carbohydrate diet. Adults complained about rice as a staple food mainly because they felt hungry a short time after eating a meal of rice. This was due to the low content of fat. It should also be noted that fat can greatly improve the palatability of a diet.

Carbohydrates

The mean caloric percentage of carbohydrates found during the survey was 76.6% with values ranging from 73.0% to 88.2%. These findings correspond reasonably well with the recommended carbohydrate intake. As most of the carbohydrates are derived from cereals and legumes, a certain amount of

⁴ EFA = essential fatty acids.

indigestible carbohydrates such as cellulose (listed in the food composition table as "fibre") plays a role and contributes to making the food bulky.

Protein

The meals consumed during the period of the survey contained an average of 14.7% of protein calories. The maximum and minimum values were 17.5% and 12.4%. The average protein score amounted to 61.8%. The sulfur containing aminoacids were limiting in 22 cases. Tryptophan was limited in the remaining five families. The lowest score was 53.9%, and the highest was 72.2%. The amount of reference protein required per person per day averaged 22.7 g. The amount actually consumed was calculated to be 95.1 g. This value was corrected for protein quality by multiplication with the protein score, and then reduced by 20% to allow for a margin of safety. The adequacy of protein intake was thus calculated to be 209%, ranging from 122% to as high as 327%. These values were too high to be considered as an indication of the true nutritional status of the population and contradictory to findings that will be discussed later.

The disagreement of this high adequacy with other findings which clearly indicates a lack of protein, may be due to many factors:

- The relatively high calorie intake entails a high protein intake.
- There may have been an error in the calculation of the chemical score. The score was calculated on a weekly basis. The artificial assumption was made that all protein from different sources was available at the same time.
- The high concentration of protein derived from legumes may impair utilization (FAO, 1964).
- The presence of intestinal parasites reduces the utilization of protein.
- Infections in general produce an increased need for proteins.

Much better values were obtained when using the method of MILLER and PAYNE (1961). The Net Dietary Protein Calorie percentages averaged 7.48%, ranging from 6.11 to 8.96%. These values consider more the protein concentration in a diet.

The average NDp Cals % value of 7.48 does not meet the requirements of children up to three years of age, adolescents, and lactating and pregnant mothers. This means that the requirements of a large part of the population are not covered.

Taking into account that the NDp Cals % may drop by 50% during infections, it becomes obvious that the diet consumed by the population on the Mwea-Tebere Irrigation Scheme is marginal and that any stress situation may upset the balance.

At the same time, it becomes clear that a vegetarian diet is unable to meet the requirements of all age groups. The ratio of legumes to maize comes

very close to the recommended 30:70 ratio which is considered optimal when only maize and beans are consumed. Regardless of the quantity of protein consumed, a score of less than 60 does not allow an adequate intake for children between the ages of 1 and 3 due to the limited intake capacity at this age. Out of the 28 households examined, 9 ate a diet containing protein with a score below 60.

Calcium

Calculations revealed an average requirement of 525 mg per person per day while the intake was only 321 mg equalling an adequacy of only 62%. The highest value was found to be 101%, the lowest 38%. As there is so far no convincing evidence that in the absence of nutritional disorders an intake of calcium even below 300 mg is harmful, there is no immediate need to encourage the consumption of more calcium in the diet. A general improvement in the variety of the foodstuffs eaten will automatically increase the calcium intake.

Iron

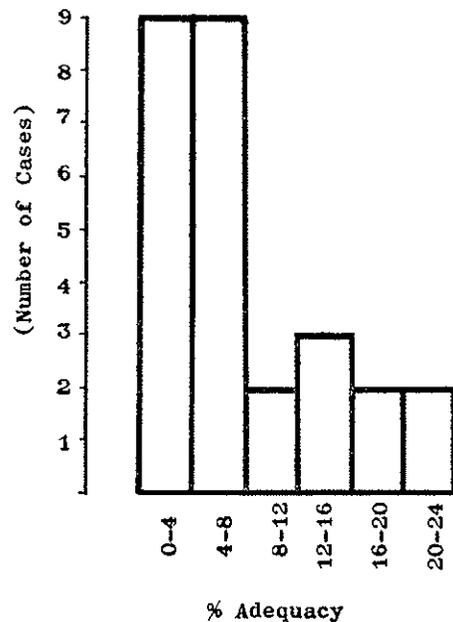
Using the above mentioned recommended dietary allowances, an average of 10.6 mg iron was required per person per day. The actual intake exceeded this value and amounted to 27.5 mg, giving an average adequacy of 264%. Highest and lowest values observed were 410% and 163%. It can, therefore, be assumed that iron is in good supply in the diet although it has to be kept in mind that intestinal parasites cause a constant loss of blood through which also iron is lost that needs to be replaced.

Vitamin A

The supply of vitamin A in the diet was found to be extremely poor. The average amount required was 3,900 I.U. while the actual amount consumed was found to be only 308 I.U., ranging from 28 I.U. to 991 I.U. This gives an average adequacy of 8.1% with a range from 24.1% to 0.8% as compared with the recommended allowances. Figure No. 4 gives the frequency distribution of vitamin adequacy. A considerable number of the families consumed hardly any vitamin A at all. Few families improved their vitamin intake by single meals rich in vegetables and fruits. Only very few families consumed vitamin rich foods regularly.

Short period surveys indicate that a low vitamin A intake does not necessarily correlate deficiency. The requirements are usually only met in well to do societies (OOMEN, McLAREN, ESCAPINI, 1964). In most of the tropical countries these standards are far beyond the scope of possibilities. At the same time, very often no conclusive clinical signs of vitamin A deficiency

Figure 4. Number of Households (Cases) Falling into Different Groups of Vitamin A Adequacy



are found (see page 314). It must be assumed that the consumption figures are not altogether accurate because they omit unknown sources of pro-vitamin A. During short seasons of the year, fruits and vegetables are frequently consumed. This tends to replenish the temporarily exhausted stores of iron in the liver and to help prevent severe vitamin A deficiency.

Thiamine

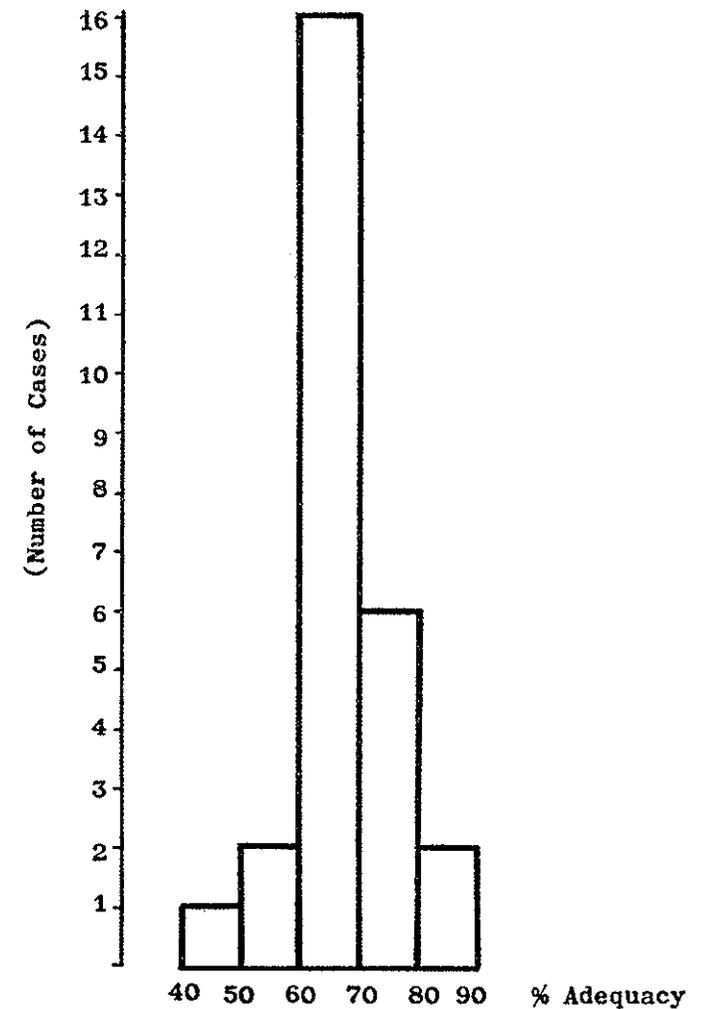
Since the rice was generally home pounded in the surveyed villages, the vitamin content was hardly diminished. The actual vitamin intake in nearly all families was well above the recommended allowances. An average of 1.3 mg per person per day was required and 2.7 mg was consumed equalling 210% of adequacy ranging from 106% to 290%.

Even though losses may occur during food preparation, it can be assumed that thiamine is not deficient in the diet.

Riboflavin

1.6 mg were required per person per day. But only 1.0 mg was consumed giving a mean adequacy of 67.0%. The values ranged from 49.2% to 86.1% (see also figure 5).

Figure 5. Number of Households (Cases) Falling into Different Groups of Riboflavin Adequacy



This clearly indicates that most of the households have an intake well below the recommended allowances due to the low consumption of milk and milk products, green vegetables, meat, fish, and eggs. Riboflavin certainly needs closer attention when aiming at a balanced diet for the population.

Niacin

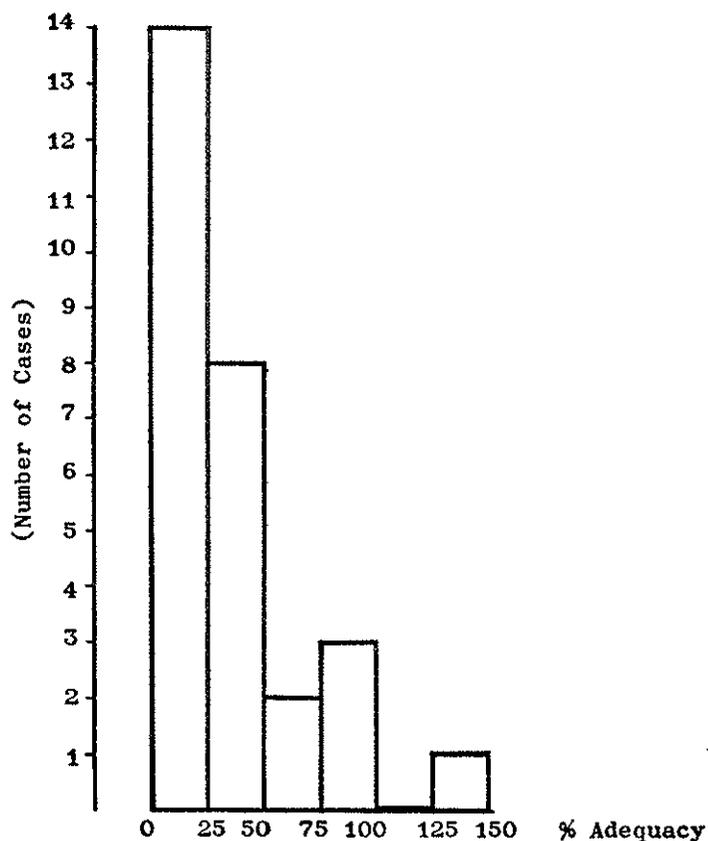
The average requirement was calculated to be 12.8 mg per person per day. The intake exceeded this value and amounted to 15.5 mg. This amount

provided a mean adequacy of 119%. Values ranged from 100% to 181%. It can be assumed that requirements were generally met and Niacin deficiency constituted no major problem.

Vitamin C

The average amount required per day was found to be 65 mg. Only 21 mg were consumed averaging 32.6% of adequacy with a range from 0% to 146% (see also figure 6).

Figure 6. Number of Households (Cases) Falling into Different Groups of Vitamin C Adequacy



This shows the inadequacy in the diet of vitamin C. In most of the households the vitamin C distribution is very similar to the vitamin A adequacy. Both vitamins are derived from fruits and vegetable leaves. The low ade-

quacy in the diet does not necessarily entail symptoms of scurvy. Fruits eaten at other times of the year help to meet vitamin requirements. It takes about 18 months to exhaust body stores. On the other hand, special investigations on volunteers have shown that 10 mg were sufficient to protect them from scurvy. In another group 10 mg was enough to heal the clinical signs of deficiency (Medical Research Council, 1953).

Although recommended allowances appear to exceed the minimum requirements many times, the complex function of vitamin C in the intermediate metabolism may necessitate an extra amount especially in situations of stress due to disease, unusual exposure or activities.

Vitamin C deficiency is not a severe deficiency on the Irrigation Scheme, and it will automatically be improved by a general improvement in the diet eaten.

5. Anthropometric Measurements

In addition to the families included in the sample for the food consumption survey (see chapter 4), a group of 31 children in Kirogo, and 29 in Mahigaine were examined. All mothers of children aged 1-3 years were asked to volunteer to have their children examined. This group was selected in order to get more representative information on this nutritionally vulnerable group.

158 other school children were selected mainly of the ages 8-12 years. They came from the schools in the Tebere area, Kimbimbi, Mathangauta, Kirogo, Murubara, and Gathigiriri. From several reports of MUNOZ (1963), it appeared that the 7-9 age group was nutritionally very vulnerable. Therefore, special attention was given to these young pupils by extending the investigations into this age group as well.

School children are generally not accepted as representative samples for the whole community. The Mwea-Tebere Settlement, however, with its relatively good economic conditions, shows a high percentage of children attending the primary schools. This justifies the assumption that the pupils do not only represent the better part of the population. The same extended sample was also examined for clinical and biochemical data (see chapters 6 and 7).

It is a well established fact that the constitution of the body and health are related to each other and are both influenced by the nutritional status of an individual. Any deviation from the norms will generally have an adverse effect on life expectancy.

Body measurements can therefore be considered a valuable means of obtaining information on the nutritional status when compared with standard values. As no special Kikuyu standard has ever been established,

water supply will be of greater benefit to the population. These projects may be costly in the initial stages but would be well worth the effort.

10. Summary

The population of the Mwea-Tebere Irrigation Settlement represents a relatively high income group. Information on the nutritional status and the public health, agricultural, socio-economic, and cultural conditions were collected. They indicated how well the Settlement had developed economically.

A sample of families and school children was selected for the survey. Their consumption of food during a period of 7 days was measured. Anthropometric, clinical, biochemical, and socio-economic data were also collected. Investigations of intestinal infection proved the high rate of morbidity among the population. While ascariasis constitutes the main problem in children of 1 to 4 years of age, bilharziasis is a major concern in children of school age.

A questionnaire survey provided data for a comparison with the situation of the poor population in the immediate surroundings of the Scheme. It demonstrated that wrong attitudes and beliefs concerning child care and medical consciousness were the same in this area and the Scheme area. Signs of wealth and luxury like radios however were confined to the Scheme area. Before a tenant in Mwea-Tebere would improve the poor conditions of hygiene in his hut, he would prefer to build a new one. The people generally prefer quantity to quality.

The same attitude is found with respect to the diet of the population. The caloric requirements appear to be met in nearly all households. This must be considered a consequence of better economic conditions. The quality of the food consumed, however, shows little difference from that of the surrounding areas and seems to be even inferior to the diet of the population in the district where people have a similarly good annual income. Especially the quality of the protein needs improvement. There is a critical need for better protein in the diets of pregnant and lactating mothers. The intake of vitamins is low due to the extremely low consumption of animal products and fresh green or yellow vegetables.

The study of seasonal changes suggests that the quality of the diet is lowest toward the end of the dry season and during the rainy season. While the diet was found to be marginal during the period of the survey in July, it is undoubtedly deficient in nearly all nutrients for most age groups during the rainy season, and at the end of the dry season. This is also when the money of the last pay-out is spent. This is of special importance as nearly

all foodstuffs have to be bought. There is not enough red soil available to provide the tenants with the necessary crops to feed their families.

The incidence of protein-calorie malnutrition was high. This was also indicated by a high incidence of clinical signs related to protein nutrition. Many other lesions, which indicate various vitamin deficiencies, were observed. The findings concerning riboflavin and vitamin A deficiency were also in agreement with nutrition surveys conducted in other parts of Kenya. Anthropometric data clearly indicate a deviation towards lower values. Measurements related to protein nutrition were affected most of all.

The data of the biochemical assessment of the nutritional status indicated that a sufficient amount of protein was consumed. The dietary anthropometric and clinical data also indicated that a sufficient quantity of protein was consumed. The quality of the diets was, however, obviously unsatisfactory. A moderate degree of iron deficiency was suggested by reduced hemoglobin levels.

The survey clearly indicates that at least in this settlement the improvement of the economic status does not necessarily mean an improvement in the general health or nutritional status. These have apparently not kept pace with the rapid economic development of the Scheme. At the same time, economic progress is impaired by the poor nutritional state of parts of the population. Finally, various measures to improve the situation on the Mwea-Tebere Irrigation Scheme are recommended.

References

- ALBRITTON, E. C. (1952): Standard values in blood. Philadelphia.
- ARENS, L. and BROCK, J. F. (1954): Some of the aspects of the serum protein pattern of Africans. *S. Afr. J. Clin. Sci.* Vol. 5, No. 1.
- BENTON, D. A. (1956): *Arch. Biochem.* 60.
- BERGLUND, F. and SÖRBO, B.: Turbidimetric analysis of inorganic sulfate in serum, plasma and urine. *Scand. J. Clin. Lab. Invest.* 12, 1960.
- BOHDAL, M., GIBBS, N. E., SIMMONS, W. K. (1969): WHO Nutrition Team in Kenya, Nairobi. Nutrition Survey and Campaign against Malnutrition in Kenya (1964-1968).
- BOWES and CHURCH (1962): Food values of portions commonly used, 9th edition, J. B. LIPPINCOTT, Comp., Philadelphia and Montreal.
- Ciba Foundation Study Group (1965): Diet and bodily constitution. London, Churchill.
- CHASSY, P. J., VAN VEEN, A. G. and YOUNG, F. W.: The application of social science research methods to the study of food habits and food consumption in an industrializing area. *Am. J. Nutr.* 20, 1.
- CRAVIOTO, J. and ROBLES, B. (1963): The influence of protein-calorie malnutrition on psychological test behavior. In: Symposium of the Swedish Nutrition Foundation, Mild-moderate forms of protein calorie malnutrition. Uppsala.