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THE EFFECT OF CASH CROPPING ON FOOD CONSUMPTION ADEQUACY AMONG THE MERU OF NORTHERN TANZANIA

by

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CHAPTER I

INTRODUCTION

"Nutrition seems to mock the achievements of economic development" (Ohlin, 1977, p. 201).

A major disappointment of the past 30 years has been the slow progress achieved in combating world hunger and malnutrition. These same 30 years have seen a rapid increase in both the degree as well as the complexity of the economic relations which now integrate even the most isolated communities into the world economic order. Thus, many have been led to consider the relationship of nutrition to the general process of economic development and change.

At both the macro and micro-levels of analysis, there are those who argue that the stagnant or declining nutritional status of individuals, communities, and even nations can be directly linked to the consequences of market integration. In this essay, we will be examining through a review of the literature as well as a case study of a rural community in northern Tanzania one such accusation--the proposition that small farmers who chose to divert a proportion of their land and labor to production for market sales (and thus away from subsistence production) will be unable to maintain their previous levels of food consumption.

It is important to note early on that although in the literature food consumption levels and nutritional status are often used interchangeably this is by no means an accurate representation. Food consumption exerts a major influence on nutritional status, but, as will be outlined in more detail in Chapters II and III, so do a number of other factors. In the review of the literature, we will be examining studies which have looked at the influence of cash cropping on either food consumption or nutritional status or both. In the case study, however, we have information only with respect to food consumption levels.

Before moving on to a consideration of the topic at hand, it would be useful to briefly outline the arguments advanced at the macro-level which seek to link the market integration of regions to nutritional as well as other problems. Samir Amin (1976) and Arghiri Emmanuel (1972) contend that previously "undeveloped" areas have undergone a process of "underdevelopment" as a result of their integration into the world economic order. Amin and Emmanuel further believe that, given the structure of the world economic system, these areas or nations can only hope to achieve true "development" by instituting independent, self-reliant policies. Interdepencence in their view permits the rich to intensify their exploitation of the poor.

In very few instances have these macro-level critiques been incorporated into the work done at the village or community level by anthropologists and nutritionists who have generally paid scant attention to the wider political and economic environment. They instead confine their attention (and criticism) to the options and decisions open to the individual rural household. In this essay, we will, with but a few exceptions, restrict ourselves to a similar consideration of the subject matter.

Objectives

As mentioned above, the primary objective of this essay is the consideration of the hypothesis that cash cropping has a negative impact on food consumption. An adequate consideration of this first hypothesis leads the analyst to scrutinize the diametrically opposing viewpoint as well. This second viewpoint is based on the conviction that nutritional problems will be overcome within the general process of economic development and that market specialization and integration are essential factors in that development process.

The establishment of these two extreme hypotheses, these two "strawmen," will provide a framework within which a number of other objectives can be considered. In the order in which they are treated, they are:

(1) The clarification of the "role" of nutrition in economic development.

(2) The identification and evaluation of the broad range of factors beyond market integration which influence nutritional status.

(3) The identification of the mechanisms by which the spread of cash crops affects food consumption and an analysis of the empirical record in this area.

(4) The examination at the household level of the relationship between food consumption goals and other family goals.

Background to the Area

The Meru of Arusha District in northern Tanzania are a small group of Bantu-speaking mixed farmers (51,000 in 1967) who have inhabited Mount Meru for the last 300 years. They are unrelated to the Meru ethnic group on Mount Kenya but are closely related linguistically and culturally to the larger Chagga ethnic group (440,000 in 1967) which inhabits the neighboring ecologically similar Kilimanjaro area. Whereas the Chagga have been the subject of numerous studies, the Meru have attracted much less attention.[1/] Thus, in certain instances, Chagga references will be used to fill in gaps in the Meru information base. Also, in Chapter IV, extensive comparisons will be made between the analysis of the Meru data and Zalla's analysis (1979, 1981) of a nearly identical data set collected from a sample of Chagga farmers.

[1/] Puritt (1970) is the most complete work available in English.

The Meru and the Chagga are considered to be among the most economically advanced groups in modern day Tanzania. The Meru constitute but a small minority of the population of Arusha District so it is difficult using official data sources to separate out their socioeconomic characteristics from those of the less advanced Arusha and Masai ethnic groups. The available evidence does indicate that the Meru are better educated, live longer, and have higher incomes than the average rural Tanzanian (Egero and Henin, 1973). The education figures were confirmed by our sample results which indicate that whereas among the Meru 52 percent of adult males and 41 percent of adult females had attended school, at the national level a combined total of only 23 percent of adults had attended school (the survey figures are for 1974, the national figures for 1967). No secondary source material, either in terms of other food consumption surveys or clinical studies of actual nutritional status, is available for the Meru. Lindner (1974) and the Tanzania Nutrition Committee (1970) report, based on clinical studies, the fairly widespread existence of moderate protein calorie malnutrition in children among the Chagga in the neighboring Kilimanjaro District. Whether or not this is also true among the Meru is uncertain.

When the Meru arrived on Mount Meru 300 years ago, they first settled on the rich soils of the middle zone of the mountain extending from 4,000 to 6,000 feet in altitude. The area above this middle belt is cooler and drier while the area below is drier and has poorer soils. In this early period, the Meru depended upon a mixed economy of home gardens and livestock. In the early 1800s, bananas and finger millet were introduced and soon partially replaced beans as the primary dietary staples. Livestock, during this period, retained an important role in the farming system.

In the late nineteenth century, the first German colonialists arrived in the area bringing with them a crop which would have a major impact on the nature of the Meru economic system, coffee. At the outset, an attempt was made to restrict coffee production to expatriate farms, but this restriction proved difficult to enforce. Thus, the Meru farmer became integrated into the market system as a smallholder rather than as a laborer on expatriate farms. The major explosion in coffee production occurred in the mid-1950s after the Meru gained the right to process and market their own coffee production. In the decade from 1955 to 1965, the quantity of coffee marketed through the Arusha-Meru cooperative increased from 20 to 5,200 tons.

The spread of coffee has had a profound impact on Meru land use patterns. As a consequence of coffee's demanding climatic requirements, the crop can only be grown in the heavily populated middle belt of the mountain.[1/] As a result, food crops, with the

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[1/] Population densities of 1,000 to 1,500 persons per square mile were reported in the 1960s.

exception of bananas intercropped with coffee, are rarely found in this zone. Traditional intensive livestock enterprises have also declined due to the increasing difficulty farmers face in obtaining sufficient fodder. In response to the growing shortage of land in the middle belt, caused both by the spread of coffee as well as by the rapid population growth (3 percent per year), Meru farmers since the 1950s have been establishing fields (and sometimes households) in the less populated areas of the Eastern slopes and Southern plains. These new food crop fields consist principally of the traditional staple beans intercropped with the newest addition to the Meru farming system, maize. As we shall see in the diet summary in Chapter IV, maize has rapidly gained acceptance as a new staple crop.

Our 1974 survey of 65 randomly selected Meru households was conducted entirely in the heavily populated middle belt. From the nature of the crops reported, we can conclude that most of these households also farmed outside of the coffee zone. The 1974 survey matches up quite closely to the 1967 census with respect to certain basic information. Both report an average household size of around 5.5. The census estimated farm size at four to five acres per household while our survey placed it at four acres. The anthropologist, Puritt, also placed farm size in this range based on his field work. According to our survey, 1.4 acres or 35 percent of the total farm acreage was devoted to coffee production. We will have more to say about the nature of the cropping system in Chapter IV.

In terms of a farming calendar, the Meru recognize four distinct seasons. They are: a hot dry season (January to mid-March), a long rainy season (mid-March to May), a long cool dry season (June to October), and finally the short rainy season (November to December). This pattern of seasons allows for multiple plantings which permit the Meru to escape the type of seasonal nutritional stress found in areas where only a single crop is harvested.

If indeed the food intake survey or other sources do reveal food consumption or nutritional problems among the Meru, there would appear to be at least three competing explanations. The first would focus on the inability of the resource base to keep up with the demands of the rapidly growing population. The second would emphasize the role that poor health and food practices and traditions play in permitting malnutrition to continue to exist in areas where food supplies are adequate. The third explanation would revolve around the argument that the current Meru farming system based upon coffee, for one reason or another, does not provide the necessary levels of food consumption. The three explanations need not of course be mutually exclusive. Although we will examine all three, our main focus will be in testing the hypothesis which is contained in the third explanation. We will be seeking to discover if in fact cash cropping can be shown to have a negative impact on food consumption levels.

Plan of the Essay

Chapter II of this essay deals with three issues which lay a necessary foundation for the rest of the work undertaken. They are a description of the science of nutrition, a discussion of the role of nutrition in economic development, and the establishment of a general framework to look at nutritional issues in all of their complexity.

In Chapter III, case studies will be reviewed which link cash cropping to food consumption and nutritional status. A particular goal of that chapter will be to trace through three different mechanisms by which cash cropping may affect nutrition and examine the empirical record for each.

In Chapter IV, a detailed analysis of the 1974 Meru survey data will be carried out. This will consist of an analysis of the adequacy of the diet and a series of regression equations which attempt to explain the observed variation in the food consumption levels of Meru households. Also in this chapter, a regression equation will be developed to explain variation in household type and possessions and the results of this equation will be compared to the results of the food consumption equation. Finally, the summary, conclusions, and implications of the research will be presented in Chapter V.

CHAPTER II

NUTRITIONAL PERSPECTIVES

In each of the three sections of this chapter, a quick overview is given of a separate broad subject area. These overviews will lay the necessary foundation for the more detailed work which is undertaken in the review of the literature in Chapter III and the case study in Chapter IV. The first section examines what the science of nutrition consists of and what the principal nutritional problems in the developing nations are. In the second section, diametrically opposing views as to how nutritional matters should be incorporated into general development plans will be investigated and a more reasonable approach will be suggested. In the final section, a case will be made for examining nutritional problems in all of their complexity rather than focusing solely on one or two aspects.

The Science of Nutrition

In a certain sense, the science of nutrition can be split into two parts with the first part consisting of actual physical or technical relationships and the second part consisting of the economic, social, and cultural variables which influence the inputs into these technical relationships. In this essay, we are primarily concerned with the economic, social, and cultural variables, but in this section, we will briefly summarize the relevant information concerning the "hard" science aspect of nutrition.

In economics, we would term the subject matter of the hard science of nutrition as the study of input-output relationships. Just as the crop scientist studies the impact of sunlight, fertilizer, water, and other inputs on plant growth, so too should the nutritionist be able to study the factors which influence human growth and development. It turns out, however, that human beings are much more complex organisms than maize plants.

Traditionally, the quantity and quality of food, genetic requirements, and diseases were thought to be the principal influences on some measurable "output" termed nutritional status. More recently, there has been a growing awareness that a host of behavioral variables influence nutritional status as well. Thus, nutrition remains a young, highly complex science with as yet poorly defined input-output relationships. The "hard" facts about nutrition have changed in the past and will undoubtedly continue to do so in the future.

Most nutritional studies focus on children under the age of five since they are the most susceptible to death or long-term scarring resulting from nutritional deficiencies. In the literature, the two principal nutritional disorders which are cited as affecting the young in the Third World are kwashiorkor, a lack of protein, and marasmus, a lack of calories. In an earlier period, the "protein gap" was widely regarded as the most serious nutritional problem. Nutritionists, however, began to recognize that protein and energy shortages most commonly appear together. Thus, classic kwashiorkor and marasmus may properly be regarded as representing extremes along a spectrum of what is now termed "protein calorie malnutrition" (PCM).

In 1973, the FAO revised its proposed safe levels for nutrient consumption by reducing calorie levels slightly and suggested protein requirements massively by 50 percent. Shortly thereafter, Payne (1975) argued that if the principal source of calories in the diet contained at least 4 percent protein a diet which provided sufficient calories would also provide sufficient protein. Thus, except in areas where tubers and root crops dominate the diet, calories have now replaced proteins as the primary subject of concern.

Nutrition in Economic Development

Experts from assorted disciplines perceive nutritional problems in quite different ways. As a first stage in this discussion, we will lay out two extreme positions as to the proper perspective towards nutritional issues. After the weaknesses of these "strawmen" positions have been pointed out, a more balanced and useful perspective will be presented.

The "nutritionists" concentrate on the technical relationships outlined above as well as other issues such as the physical availability of food, food consumption patterns, and the beliefs and taboos which affect food consumption and distribution. They tend to neglect the whole range of economic factors which directly affect food consumption and also ignore the fact that households and governments pursue a plethora of other goals at the same time that they are pursuing nutrition and food consumption goals.

In terms of policy interventions, the nutritionists have been instrumental in supporting programs directed towards overcoming specific problems for targeted groups. These programs have often proven to be relatively ineffective due to high costs and inadequate administration and infrastructure. Moreover, the very process of targeting frequently leads the nutritionists to be more concerned with curing particular symptoms rather than attacking the root causes of the problems. The nutritionists have also been in the forefront of those opposed to many general development policies on the grounds that these policies will disrupt the existing socioeconomic system and thus may potentially pose a nutritional threat. Johnston (1979) criticizes this call for the preservation of idyllic, purely subsistence rural economies by arguing that from a national perspective the agricultural sector of a developing country must produce a surplus. In his view, the nutritionists have simply chosen to ignore a number of extremely important trade-offs.

The "economists" approach this subject area from a quite different perspective. They regard as given all of the subjects of interest to the nutritionists and prefer to concentrate their attention on those elements which their training prepares them to study. These are principally market-related activities having to do with incomes and prices. Some economists perceive development in dollar terms and thus argue that the maximization of GNP is the appropriate goal of the development process. With respect to nutrition, the strawman economist position would be that it is unnecessary to put any explicit emphasis on nutritional questions since they will be "best" handled in the normal course of development.

In reaction to this position, certain economists have mounted a challenge to the proposition that the inclusion of nutritional concerns will detract from the achievement of overall economic goals. In particular, they have sought to demonstrate that nutritional improvement and economic growth are complementary rather than conflicting goals. In their view, once the true relationship is known it will no longer be necessary to worry about the difficult trade-offs between these two goals.[1/] Pedro Belli (1971) presents one of the more well-known empirical attempts to demonstrate this point. He regressed per capita income on per capita production of protein and interpreted the results as showing cross-sectionally that "good" nutrition (high per capita protein production) has fuelled the engines of growth. The results of his regression analysis, however, do not indicate anything with respect to the direction of causality. Few would doubt that there is a strong correlation between protein production and income; many, however, have challenged the conclusions which Belli draws (W. T. Wilford et al., 1975). One wonders if those who try to make a strong economic case for nutrition do not run the risk of establishing nutrition in the class of fads such as community development and the Green Revolution which promise too much and then fail to deliver. Ohlin (1977, p. 221) notes with respect to nutrition programs, "Boredom will set in when the effort does not produce in five years what it is only legitimate to expect in twenty-five years."

A more sensible and workable approach would seem to be to establish improved nutrition and other quality of life measures as separate and somewhat independent goals of the development process. The Overseas Development Council has gone the farthest in this direction with the creation of its Physical Quality of Life Index (PQLI) which the Council proposes as a non-income measure of development. Others would argue that the explicit consideration of nutritional goals can be more effectively integrated into general economic development programs without going to the bother of creating yet another quotable index number.

[1/] See Basta and Churchill (1974) and Popkin (1978) for an examination of the linkage between nutrition and productivity.

In summary, it would seem that both the exclusive dependence on direct targeted programs as well as the "benign neglect" approach of allowing nutritional problems to solve themselves leave much to be desired. Per Pinstrup-Andersen (1971) sums up the new consensus by arguing that while nutritional goals must be stated explicitly, "the overall problem of energy and protein deficiencies among large population segments can only be solved through the mainstream of social and economic development."

The Complexity of Nutritional Problems

The preceding section has examined the appropriate approach to be taken towards nutritional matters within the context of general economic development. In this section, we will be demontrating the need for a holistic approach to nutritional problems.

Pinstrup-Andersen (1981) provides a good starting point with his list of four major factors which influence the nutritional status of an individual. They are:

(1) Food availability;

(2) Ability of the household to obtain available food;

(3) Desire to obtain available food;

(4) Utilization of available food to meet nutritional needs.[1/]

The main point which he wishes to make is that a concentration on any one of these factors to the detriment of the others will probably not yield the desired results. Several examples will clarify why commonly proposed solutions to perceived problems often have little impact. Frequently, the physical availability of food is regarded as the primary problem when in fact it is what might be termed the "economic availability" of food which is the constraining element. Thus, an effective solution would require developing a means of getting food into the hands of the needy households. Free distribution, a reduction in prices, or an increase in incomes represent three possibilities. Even when the food reaches the household level, nutritional problems may persist as a result of the pattern of intra-household food distribution, food practices, or food beliefs. Changes in nutritional education and/or the sources of income might prove effective at this level.

As should be evident, the four factors which Pinstrup-Andersen outlines provide a useful and powerful tool in addressing the questions of how to best increase food consumption and improve nutritional status. We will be referring back to them in the chapters that follow.

Lance Taylor's (1977) flow diagram (Figure 1) of the linkages among agricultural, food processing, and nutritional variables represents another valuable aid in thinking through the complexity of the interrelationships of these variables. The diagram serves to

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[1/] In Appendix A, we reproduce his complete chart of factors affecting nutritional status.

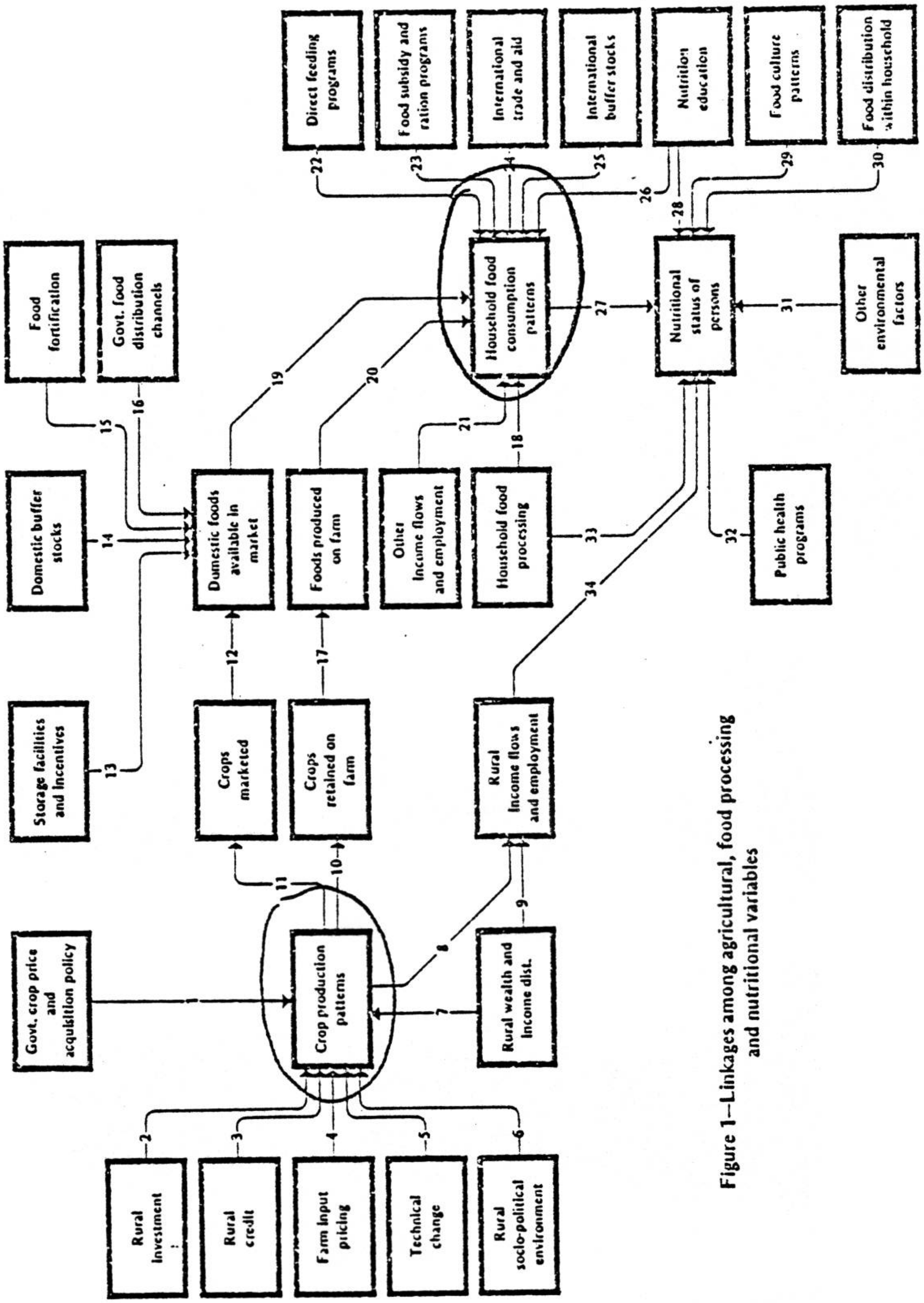

Figure 1—Linkages among agricultural, food processing and nutritional variables

Source: Taylor [1977], p. 30.

reemphasize the naivete of concentrating on only selected aspects of the problem without first developing an overall perspective. In terms of this essay, we are particularly interested in the number of intervening links between crop production patterns on the left-hand side of the diagram and household food consumption patterns on the right-hand side. Thus, the researcher who simply looks at family crop production patterns and decisions will be ill-prepared to analyze the reasons for inadequate food consumption levels and/or low nutritional status in particular households.

In examining Taylor's diagram, one can distinguish between policies and decisions taken outside the rural household (input prices, credit, international trade, etc.) and those taken within the household unit (production, consumption, and marketing decisions). Although in the following two chapters we will primarily concentrate on household level decisions, the environment within which households function cannot be ignored. Properly forewarned we can now proceed to the subject at hand.

CHAPTER III

THE EFFECT OF CASH CROPPING ON FOOD CONSUMPTION AND NUTRITIONAL STATUS

"... many traditional African diets provided an excellent and well-rounded regime, especially where there was no population pressure and no cash cropping" (Hughes and Hunter, 1970).

In this chapter, we will be reviewing a number of empirical studies which have examined the impact that an increase in the market orientation of production has had on food consumption levels and nutritional status.[1/] The holistic approach proposed by Pinstrup-Andersen and Taylor will be used in order to pinpoint the specific problem areas and thus escape the sweeping generalizations which, up until now, have hampered progress in achieving a better understanding of this still controversial subject. Cash cropping, once it is placed in the proper context, will be shown to be neither as evil nor as praise-worthy as the opposing sides have made it out to be.

Since the beginning of the colonial era, millions of formerly isolated producers have begun to enter into market exchange relationships. Although this integration was greatly favored by the colonial and later national governments, it would be unfair to regard this simply as a process intended to extract surplus from rural areas. While instances of coercion did occur, it should be recalled that most of these new market participants eagerly and freely embraced these new opportunities to fulfill family consumption goals.

While they have entered the market sphere of relations, most African smallholders still continue to produce an important percentage of their subsistence food needs. These "mixed" households have proven quite difficult to study. Referring back to our "strawmen" from the last chapter, the economists lack both the interest and the theoretical tools to handle the non-market-oriented activities and decisions while the nutritionists simplify their models by assuming that marketed production is exogenously determined. What is needed is a model which more accurately reflects the actual decision-making process which takes place within these households.

The first section of this chapter will deal with the techniques used to measure food consumption and nutritional status. This will be followed by a short section examining the impact of greater market integration on the mainly non-sedentary populations in the so-called marginal areas of Africa. In the main section of the chapter, the impact of cash

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[1/] We can measure market orientation in terms of either the percentage of total value of production sold or the percentage of labor time devoted to non-subsistence production.

cropping on food consumption and nutritional status will be considered in terms of three different mechanisms--the competition between cash and food crops, the differences between cash and kind income, and the implications that cash cropping has for the intra-family distribution of labor, income, and resources. This section will draw upon a number of case studies as well as the author's own field work in northern Cameroon.

Techniques for Measuring Food Consumption Levels and Nutritional Status

Much of the accepted wisdom as to the relationship between the orientation of production and nutrition comes from simple observations untainted by any actual measurements. Those who wish to test their hypotheses more rigorously generally use one of four methods:

(1) Food balance sheets;

(2) Food intake surveys;

(3) Anthropometric surveys;

(4) Clinical or biochemical surveys.

The first two methods are descriptive of dietary patterns and may or may not coincide with any manifestation of malnutrition. The latter two methods, in contrast, reflect the actual nutritional status.

Food balance sheets are calculated by regarding consumption as the residual after food production, purchases, sales, and storage losses have been accounted for. In most instances, food balance sheets have been utilized at aggregated levels such as regions or nations. As such, they do not consider the crucial issues of food distribution and actual food practices nor can they be used to examine the interrelationship between food consumption and socioeconomic variables at the household level. Michigan State's 1974-1975 African Rural Employment survey (Smith et al., 1981; Strauss et al., 1981) in rural Sierra Leone represents one instance in which food balance sheets were constructed at the household level. These disaggregated food balance sheets permit a much more complex analysis of the data.

Food intake surveys, in comparison to aggregate food balance sheets, are more expensive to undertake and more limited in their scope. They provide the researcher with a detailed description of the actual diet. Since these surveys are carried out at the household level, the data which are collected can be analyzed using analysis of variance or regression techniques if the necessary supporting data are gathered. Often, however, the data are tabulated and analyzed only at the aggregate level of the village or the region. Food intake surveys can be carried out at the individual level in order to make intra-family comparisons but this has not been done frequently due to measurement difficulties and high cost. We will have more to say about the actual data collection procedures used in food intake surveys in the latter part of this chapter as well as in Chapter IV when we discuss how the Meru food intake data were collected.

Of the remaining two techniques, anthropometrics are gaining favor as a rapid and inexpensive method of determining the nutritional status of a population which does not require a highly trained staff. Hitchings (1979) argues that the height for age statistic measures long-run nutritional problems ("stunting") while weight for age ("wasting") captures the effect of seasonality or other short-term factors. He further notes that since there is virtually a zero correlation between these two factors at a given point in time, the researcher is able to formulate a precise idea of the nature of the nutritional problems in a given area. Clinical studies, which for the time being are more expensive and complicated to carry out, provide the researcher with an even more detailed analysis of the actual problems.

Frequently, research efforts which have carried out both direct measurements of nutritional status as well as food intake studies for the identical sample populations have not found the results to be mutually reinforcing (see, for example, Keller et al., 1969). These divergences should sensitize the researcher to the variety of factors beyond food consumption which influence nutritional status and force him to search out the important factors for the particular case which he is studying. Trechter (1980) discovered that his anthropometric study of small children indicated that the children in a village in which food consumption was fairly high were relatively worse off than the children in a village with much lower per capita food consumption. He attributed the inferior nutritional status in the relatively richer village to differences in weaning practices.

The Market Integration of Populations in Marginal Areas

In the 1970s, certain so-called marginal areas of Africa gained the reputation in the world press of being unable to support their current population levels. In the minds of many observers, the Sahel region of West Africa brings forth an immediate association with drought and famine. Other observers, however, have noted that whereas droughts are a natural phenomena, famines are often man-made (Lofchie, 1975). These observers attribute the severity of the Sahelian famine not to the prolonged drought but rather to the recent integration of the Sahelian populations into a wider market system. According to this view, the emphasis on cash cropping and market-based pastoralism drew down traditional food reserves and left the population dependent and vulnerable during the years of the drought.

Lar Bondestan's (1975) study in Ethiopia of the encroachment of an irrigated sugarcane project onto the traditional dry season grazing grounds of the Afars recounts a similar tale although in this case it was the Afars' productive resources rather than the people themselves which were integrated into the market system. Although the subsequent dry weather was the proximate cause of the Afars' suffering, it would be short-sighted to blame their problems entirely on the climate. This particular case study directly poses the questions of who benefits and who bears the risk of development activities.

Louis Grivetti (1979) carried out a study in another marginal area in Africa, the Kalahari Desert, in order to demonstrate the continued viability of a traditional system. He argues that the Tswana have achieved notable success in nutritional matters due to their continued reliance on the "three-legged stool" of agriculture, pastoralism, and hunting and gathering. In bad years, when agriculture and pastoralism suffer, the Tswana are able to fall back on a reliance on over 250 wild plants as well as an extremely complex and well-adapted system of food preparation and preservation. Grivetti thus found that in the aftermath of a drought as severe and sustained as the Sahelian drought, the Tswana society was virtually unmarked by malnutrition. Grivetti cautions, however, that the future of the Tswana in the Kalahari may be less certain. As in other regions, contact with the outside world appears to be eroding the old ways. The disappearance of these tried and true methods may rob the Tswana society of its traditional resiliency. The issue which all three studies raise is whether or not the market system provides a security system for these people who live in areas destined to suffer periodic onslaughts at the hands of the environment. In the light of people's desires for new consumption opportunities as well as rapidly increasing population levels, it is unrealistic to strive solely to maintain the old ways. Attention must, however, be given to preserving or replacing the basic societal survival mechanisms if future nutritional disasters are to be avoided.

The Impact of Cash Cropping on Nutritional Status and Food Consumption Among Settled Agriculturalists[1]

In this section, we will be examining the impact of market orientation on food consumption and nutritional status in the more favorably endowed regions of the Third World. As a word of caution, we should note that there is a natural but dangerous tendency for the researcher who concentrates his efforts on examining the influence of a single factor to neglect giving adequate attention to other factors, and thus to formulate

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[1] Schofield (1979) presents summaries of most of the studies carried out in this area.

an unbalanced view of the importance of the various factors involved. Interregional studies which are commonly used to investigate the impact of cash cropping on food consumption and nutritional status demonstrate these potential problems quite clearly. Although a whole host of factors will vary from one region to another (climate, physical resources, food beliefs and practices, market availability of food, etc.), a researcher who is interested in cash cropping may credit a disproportionate amount of the differences he observes to that single factor. The utilization of the type of framework constructed by Taylor and Pinstrup-Andersen constitutes the best defense against this tendency.

The section will be organized around the use of the empirical studies to examine three basic questions:

(1) Do food and cash crops compete for farm resources and if they do what influence does this have on household nutritional status?

(2) Do semi-subsistence farmers treat cash and kind income differently and how does each become translated into food consumption?

(3) What effect does the market orientation of production have on the intra-family distribution of resources and ultimately on family food consumption?

In looking at the first question, the influence of the production of cash and food crops on household nutritional status, many researchers jump directly into the analysis without first stepping back to consider the two important issues of whether a precise distinction can be drawn between these two categories of crops and whether in economic terms competition in fact exists between cash and food crops. We will briefly highlight these issues here and then refer back to them in the discussion of the specific empirical studies.

With respect to the supposed cash crop/food crop dichotomy, while it is apparent that some crops are grown solely to be marketed (coffee, cocoa, cotton), it should also be clear that any food crop can also be a cash crop if it is sold rather than consumed. The distinction between edible and nonedible cash crops is somewhat more useful but whether or not a particular crop is actually consumed in an area will depend on local food habits and traditions as well as on whether or not it is edible. In examining food crops, it is necessary to consider the harvest and storage characteristics of the crop since only crops which can be harvested throughout the year or stored for long periods can be depended upon for year-round subsistence. If large quantities of crops are grown which have concentrated harvest periods and limited storage potential, the farmer must enter the market place with them.

In considering the competition for resources between cash and food crops, it is necessary to examine the underlying production functions for the two sets of crops.[1/] If cash crop production functions are revealed to be either joint or noncompetitive with food crop production functions, there would be little basis for blaming insufficiencies in food crop production on the "interference" of cash crops.

Keeping these points in mind, we can begin to examine the empirical record. Julien Perisse's (1962) study of food consumption patterns in three ecological zones in Togo raises many of the important issues with respect to competition between food and cash crops. He found that the "rich" Southern zone in which cocoa and coffee are sole cropped and tubers form the mainstay of the diet displayed the most severe nutritional problems. Aman (1972) and Collis et al. (1962) also report nutritional problems in areas in which a substantial percentage of the land is devoted to perennial cash crops and tubers are the staple crop. If, as many observers argue, semi-subsistence farmers wish to maintain a certain degree of self-sufficiency in food (calorie) production, then a causal link may be formed between these two elements of the farming system since as more land and labor are devoted to cash crops farmers may elect to utilize their remaining land and labor in such a way as to maximize their production of calories. This would imply a shift towards the production of high yielding but nutritionally inferior root or tuber crops.

The conclusions which might be drawn from this scenario are that perennial cash crops are a dangerous element in a farming system and that their removal will lead to improvements in the quality and perhaps the quantity of the population's diet. There are, however, at least three assumptions which underlie the proposed scenario. If any or all of them do not hold, the conclusions will no longer seem reasonable.

The first assumption is that tubers or root crops are the dietary staple due to the necessity of fulfilling a desire for self-sufficiency rather than because they are the most profitable production alternative or because they best satisfy the taste or work preferences of the population. If the population chooses to consume and/or produce roots and tubers for any of these reasons, a decrease in perennial cash crop acreage may not result in the expected improvement in the quality of the diet. Under these circumstances, it would be more appropriate to depend upon a nutrition education program to change food habits. A second assumption is that the land transferred into the cash crops was previously used for subsistence food crops. If, however, this land had previously been planted in marketed food crops, there would be no need for the households to turn increasingly towards high yielding crops for subsistence needs. The third assumption is

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[1/] Leonard Joy (1964) gives a concise theoretical analysis of the competition between food and cash crops for land resources.

that the money income earned from the cash crops will, for some reason, be insufficient to replace the kind income which is foregone. This question will be treated in depth at a later point in the chapter. If these last two assumptions do not hold, it might be appropriate to look for some culprit aside from cash cropping (such as food practices or disease problems) as the cause(s) of observed nutritional problems.

Returning to Perisse's study, we find that he characterized the Northern zone as having a good staple crop, millet, but suffering substantial nutritional stress due to a prolonged dry season as well as an unfortunate tendency to sell peanuts in order to meet cash needs rather than retaining them as a source of protein. In our work in northern Cameroon (Lev, 1980), we similarly found that certain edible crops (white potatoes, sweet potatoes, and, to a lesser extent, peanuts) were viewed by the farmer as commercial rather than subsistence crops.

Perisse praised the farming system set up by the Cabre emigrants from the North in Central Togo as being the most viable from a nutritional standpoint. The two central elements of the system which he singled out were the maintenance of millet rather than tubers as the primary staple and the practice of intercropping cotton and cereals. It should be noted that cotton can be intercropped in time as well as in space with cereals since the residual cotton fertilizer as well as the advantages of following a rotation can greatly increase cereal crop yields in alternate years (Lev, 1981).

The overall conclusion to this question of competition for resources between cash and food crops should be that it is a far more complex subject than it is generally made out to be. In many instances, the supposed competition between the two types of crops is largely nonexistent.[1/] Even in the cases in which there is direct competition, a whole range of other factors must be considered before concluding that there is an impact on food consumption levels and ultimately on nutritional status.

Almost all critiques of cash cropping have focused on the issue of whether or not small farmers treat cash and kind income in the same fashion. In our interviewing in northern Cameroon, we found the sentiment expressed again and again that cash crops are fine for meeting certain needs but "they do not provide our food needs." The principal problems cited with respect to cash crop income are that it is lumpy and that for some reason it does not seem to store as well as cereals. Collis, Dema, and Omololu, in their study of Nigeria, came up with a telling description of communities heavily influenced by cash crops:

[1/] Such as between dry season sorghum and rainy season cotton in northern Cameroon.

> Economically, the most important finding for the country which came out of our survey concerns the cocoa villages. Cocoa is one of the best cash crops in the world, giving the highest cash yield for the smallest energy output. One might therefore expect the cocoa villagers to be well off, well fed, happy, and gay. We found exactly the reverse. The people were dull, apathetic, and unhappy. Their villages were run down, dirty, and delapidated and their children naked, pot-bellied, and sickly. The reason for this is that it is not enough to introduce a highly paying cash crop to an illiterate peasantry and expect them to profit by it. What happens is that it tends to kill their traditional life, merely putting money in their pockets for a short period in the year, during which time they enjoy themselves. When the money gets scarce, months before the next harvest, they find themselves short of everything. In a pure cocoa village, they have given up most of their land for cocoa and are no longer able to till the ground for food, for as the cocoa tree grows it so shades the soil under it that nothing else will live there. Hence, with their money running out, they can only buy the cheapest of food, e.g., cassava and yams. Also, the cocoa season is short and the cocoa farmer has very little to do for the remaining part of the year but sit around. Such idleness is not the refreshing rest that comes after labor, but sterile boredom in which man's mind and body degenerate, leaving him unhappy and discontented. The contrast between the people in a pure cocoa village and those in a mixed cropping village, for instance between Abebeyun (mixed cropping) and Igun (cocoa), can be seen immediately upon visiting the villages. In Abebeyun, the villagers run up the one full of interest, talk, and jokes and they are ready for help and advice and are very cooperative. At Igun, on the other hand, they are apathetic, complaining if asked questions, and appear devitalized and sick (pp. 223-224).[1/]

They continue by making two very important points. First, they contend that convincing farmers to adopt new farming practices (such as the cultivation of coffee or cocoa) is a task which is largely independent from teaching them how to manage cash incomes or how to properly look after family nutrition. Thus, a farmer or community could be extremely progressive in the sphere of agriculture and dangerously uninformed in nutritional matters. Secondly, they note that the very fact that farmers are receptive to agricultural changes can serve as a basis for optimism that if effective and meaningful nutritional practices are disseminated the rural population will respond willingly. In a later article, Collis and Jones (1968) indicated their belief that while income should be seen as the primary weapon in the fight against urban malnutrition, education is a more potent force in rural areas.

Thomas Marchune (1977) argued that more radical measures may be needed to counteract the adverse nutritional effects of cash cropping. He looked at the case of Jamaica where the government explicitly set out to disentangle itself from the world

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[1/] John Strauss, in commenting on an earlier draft of this paper, observed that critiques of this sort may be placing the entire burden for the decline on cocoa production when part of it may actually belong elsewhere, such as the lack of well-developed savings institutions to encourage interseasonal savings.

economy by aiding small subsistence farmers and thereby relocalizing the food supply and limiting the need for food imports. His research indicated that these new policies resulted in improvements in income distribution, equality, and the nutritional status of the young. He does not outline as carefully what was given up.

Two studies undertaken in Kenya, Hitchings (1979) and Keller, Muskat, and Valder (1969), dispute the finding that cash crop farmers have lower levels of food consumption and inferior nutritional status than non-cash crop farmers. Hitchings used bivariate analysis and compared the anthropometric measurements for children of growing and non-growing households for five different cash crops (coffee, tea, cotton, pyrethrum, and sugarcane). Only in the case of sugarcane does he find strong indications of nutritional dangers. Apparently young children fill up on the empty sugarcane calories and are unable to meet their other nutritional needs. Note that the problem there is with the consumed rather than the marketed portion of the crop. In other areas and with other cash crops, the differences between growers and non-growers are not significant. Given the rather simple level of his analysis, Hitchings perhaps goes beyond his findings when he seems to dismiss the likelihood of finding detrimental effects to cash crop cultivation.

The study by Keller et al. is one of the few to use regression analysis to test the relationship between a series of economic variables and two different dependent variables, one being anthropometric measurements and the other being the adequacy of the diet. The analysis suffers from the fact that, in an over-zealous effort to avoid multicollinearity, they estimate separate equations for each of the independent variables instead of estimating a single equation. The issues of multicollinearity and variable selection will be considered in Chapter IV. Keller et al. found caloric adequacy to be positively correlated to total cash income, income from the sale of agricultural products, land size, and expenditure for food and clothing. The height for weight index which they used displayed a significant positive correlation to the caloric adequacy of the diet, size of landholding, available cash, and income from sales of agricultural products but not with expenditures for food and clothing.

The analysis of data from Sierra Leone carried out at Michigan State University (Smith et al., 1981; Strauss et al., 1981) represents, in many respects, the most detailed examination of the impact of changes in production orientation on caloric availability at the household level. The authors argue convincingly that household food consumption decisions result from a unified decision-making process in which production, consumption, and market decisions all play a role. Using this more realistic modelling of household decision making, marketed surplus is an endogenous variable which is affected by a variety of exogenous variables. They thus find that the relationship between market surplus and caloric availability depends upon the source of the change in marketed surplus. As an example, for low expenditure households, an increase in oils and fats price results in increased marketed surplus and higher caloric availability, while an increase in the price of rice leads to decreased marketed surplus but also higher caloric availability. Smith et al. (1981, p. 21) conclude "No rule of thumb is an adequate basis for policy; we must examine each specific case in order to assess the probable outcomes."

In summary, we must acknowledge that the empirical studies already undertaken do not present an adequate basis for determining whether or not semi-subsistence farmers do treat cash and kind income differently. In practical terms, in order to calculate the net impact which a change from subsistence farming towards greater market sales has on food consumption, it is essential to have information on two transformation functions. The first involves the transformation of resources previously used for subsistence crops into cash crops and the second is the transformation of money income back into food consumption. Our estimation is that once kind income is more carefully valued by taking into account such factors as seasonal price variations, the cost of transport, and the risk of theft which accompanies cash incomes, a large part of the gap in the supposed treatment of the two different types of income may be bridged. Only further empirical work will indicate what, if any, differences in treatment remain.

The last question which will be considered in this section is the most difficult to research. It concerns the interaction between market orientation and intra-family distribution of resources and the ultimate impact this has on family food consumption and nutrition. The case studies from Latin America, Stravakis and Marshall (1978) and Gross and Underwood (1971), paint bleak pictures of the ultimate effect that particular cash crop production schemes have had on nutritional status. Stravakis and Marshall examined sugarcane production and recount a familiar tale of land shortages and the downgrading of the traditional diet. They also focused on the very important dichotomy between cash crops controlled by men and food crops which are left to the women. They argue that as more resources are devoted to the cash crops, the women are left without the means to adequately feed their families.

Gross and Underwood, in a combined study by an anthropologist and a nutritionist, looked at the impact of the introduction of sisal plantations on nutrition in northwestern Brazil. In one part of their study, they calculated detailed energy balance sheets (calories consumed and calories expended) for the individuals in two families. They observed that the strenuous work loads of the adult males could only be maintained by the skewing of intra-family food distribution towards these members. In the other part of the study, they compared the anthropometric measurements of the children of sisal workers and non-workers for a much larger sample and found the sisal workers' children to be significantly worse off. They thus argue that the next generation suffers the consequences of the current work patterns. Gross and Underwood are among the few authors to place their study in an "unequal exchange" context by charging that the sweat of the poor countries is being used to produce goods cheaply for the developed world.

In contrast to the two case studies above in which market integration has been cited as negatively influencing the household's ability to adequately feed itself, two further examples will be cited in order to demonstrate the variety of possible responses. Tripp (1979) reports in a case study in northern Ghana that women who gave up subsistence farming to undertake marketing activities improved the nutritional status of their children. We can hypothesize that the increase of income flowing to women more than offset the decrease in subsistence production. Puritt (1970) recounts another instance in which market integration need not have reduced food production or consumption. The Meru men, in the years preceding the introduction of coffee, did not participate in the agricultural activity.[1/] Thus, the introduction of coffee, which is chiefly tended by men, should not have greatly influenced the number of hours available for subsistence crop production[2/] (although it definitely did influence the quality and quantity of the land available).

The overall lesson of this chapter should be the importance of studying the exact mechanisms by which a change in the farming or economic system is thought to influence food consumption or nutritional status. Otherwise the analysis will remain at the level of generalizations and will not yield meaningful guidance for policy interventions.

[1/] He attributes this to the influence of the neighboring Masai and Arusha ethnic groups.

[2/] The main difference would come from the increased travel time to the new more distant fields.

CHAPTER IV

THE EFFECT OF CASH CROPPING ON FOOD CONSUMPTION AMONG THE MERU IN THE ARUSHA DISTRICT OF TANZANIA[1/]

In this chapter, we will be analyzing the results of a combined food intake and socioeconomic survey conducted among the Meru of Arusha District in 1974. The first section of the chapter will describe the Meru diet and will examine its overall sufficiency in terms of the quantity and quality of the nutrients provided. In the following section, ordinary least squares equations (OLS) will be derived in order to analyze at the household level the factors which account for variation in the nutrient adequacy ratios for calories and essential amino acids (hereafter known as NAR_c and NAR_a, respectively).[2/] In the third section, the "wealth index," an independent variable in the earlier equations, will become the dependent variable in a new OLS equation. The comparison between the results of this equation and the earlier NAR equations will highlight the conflicting nature of household consumption goals. Finally, there will be a brief discussion of the appropriateness of using a simultaneous equation system rather than single OLS equations in order to capture the household decision-making process in all of its complexity.

The Survey

Interviews focusing on contemporary food consumption patterns and socioeconomic characteristics of 65 randomly selected Meru households were carried out by a team of local enumerators during the first three months of 1974. The food consumption data are based on a single-visit 24-hour recall of food consumed the previous day. By way of comparison, Trechter (Cameroon) collected consumption data for four consecutive days, Perisse (Togo) carried out interviews for six consecutive days at three different times during the year, while Collis et al. (Nigeria) collected data for seven consecutive days four times during a calendar year. The most serious weakness of the single-day procedure is the inability to average out a portion of the random fluctuation of daily household food

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1/ This chapter contains a partial equilibrium analysis at the household level. The implications of general equilibrium analysis are briefly considered in Chapter V.

2/ These ratios are calculated as Nutrients Consumed divided by Nutrients Required for each individual household.

consumption.[1/] It should also be recognized that Trechter noted the presence of local market days so he will be able to include a binary market day variable in his analysis, while both Collis and Perisse established long enough data collection periods in order to observe whole market cycles. Finally, the Perisse and Collis surveys were specifically set up to take seasonal variation into account. Having listed these three shortcomings of the overall survey design, we can proceed to analyze the survey results.

In the Meru survey, the enumerators asked for all foods prepared or consumed by the household on the day preceding the interview. Reh (1962) reports from her work in Central America that the recall technique will yield somewhat higher estimates than will a procedure based on actual measurements. The enumerators recorded quantities in local measures and these were later converted to standard measures using average values from a separate sample of local measure/food item combinations. Standard measures were then converted to calories, protein, and amino acids using food composition tables from several sources (Latham, 1964; FAO, 1970, 1972; Marealle, 1974; USDA, 1960). Appendix Table B.1 itemizes the actual composition used for each food item found in the survey.

Table 1 summarizes the sources of calories and proteins in an average Meru household by food category as well as the amount coming from the household's own production and the time of day the nutrients were consumed. It must be re-emphasized that these figures should be interpreted as characterizing the Meru diet only for the survey period (the dry season from January to March) and not for the year as a whole.

In total, 36 percent of the calories come from maize, 30 percent from bananas, 7 percent from meat, and 6 percent each from beans and milk. The principal sources of protein are maize (36 percent), meat (20 percent), beans (15 percent), and bananas and milk (11 percent each). The survey results confirm Puritt's observation (1970) that fish, eggs, and poultry are virtually absent from the Meru diet due to food taboo restrictions. As a reference point, the diversity of the Meru diet may be compared to the much more monotonous diets reported by Trechter (1981) in northern Cameroon where between 61 percent and 82 percent of the total calories in the diet came from the staple food,

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[1/] John Strauss' comments on this matter are helpful: "There may be a statistical problem due to calorie data being based on one day's information. Suppose it is average daily intake for a household which is related to the independent variables. Suppose further that measured daily intake is systematically above or below the daily average. Then that systematic error term is incorporated in the OLS error term, which no longer has mean zero. Hence coefficient estimates are biased. If the systematic error has the same mean for every household, then the situation is not so bleak. Since we have a constant term, the non-zero mean of the error term will be added on to our estimated constant. In other words, the constant term will be a biased estimate of the true constant term, but all other coefficients will remain unbiased, as will the estimate of the standard error of the equation."

Table 1

Sources of Energy and Protein in the Average Household Diet Among the Meru by Food Category, Origin and Time of Day Consumed, 1974

Food Category	Kilocalorie		Percent of Total	Grams of Protein		Percent of Total
	Own Produce	Total	Calories	Own Produce	Total	Protein
Bananas	4,198	4,454	29.6	39	42	10.3
Other Root and Tubers		212	1.4	--	4	1.0
Maize	3,183	5,476	36.4	87	146	35.7
Other Cereals	--	221	1.5	--	5	1.2
Nuts and Legumes	570	958	6.4	37	62	15.2
Fruits	0	0	0	0	0	0
Vegetables	64	154	1.0	0	10	2.4
Meat	0	1,067	7	0	80	19.6
Milk	684	956	6.4	33	46	11.2
Oils and Fats	--	691	4.6	--	--	0
Sugar and Sweets	--	393	2.6	--	--	0
Other	--	79	0.5	--	3	0.7
Banana-Millet Beer	--	392	2.5	--	10	2.4
Totals	8,980	15,052	100.0	208	409	99.7
Time Eaten						
Morning		1,060	7.0	--	26	6.3
Afternoon		6,423	42.7	--	179	43.8
Evening		6,199	41.1	--	165	40.3
Snacks		1,369	9.1	--	40	9.7
Totals		15,052	99.9		409	100.1

sorghum. Within an historical perspective, we see that finger millet, at one time a staple, has virtually disappeared, and milk and bean consumptions are substantially less important than published reports indicate that they were in the last century. Bananas, which are intercropped with coffee, and the latest major addition to the diet, maize, currently account for the bulk of the calories consumed.

Although the Meru are well known as cash crop farmers, it is significant to note that 60 percent of all calories and 51 percent of all proteins consumed come from home production. The greater dependence on the market for proteins is not surprising since "luxury" foods such as meat are commonly purchased. The overall picture which forms is that of a population which continues to produce a high proportion of its subsistence needs but supplements its diet with substantial market purchases.

Adequacy of the Diet

Requirements for calories, protein, and amino acids were based on those suggested by FAO/WHO (1973) with adjustments for the lighter stature of East Africans (-15 percent) and for the very active work load of women (+17 percent) between the ages of 13 and 59. Age-specific amino acid requirements were calculated by interpolating between the requirements per gram of protein for the four different age groups listed in Appendix Table B.2. The actual age- and sex-specific requirements used in this analysis are detailed in Appendix Tables B.3 and B.4.

Although we will also examine the adequacy of the diet in terms of protein and essential amino acids, we will concentrate most of our attention, for a number of reasons, on the caloric adequacy of the diet. The first reason is that while people consume energy in order to satisfy specific cravings, this is apparently not the case with respect to protein (FAO, 1973). Thus, while on a day-to-day basis people attempt to maintain stable caloric consumption, they may save up or purchase proteins for special occasions. Secondly, the assumption that intra-family distribution of nutrients is on the basis of individual requirements may be less valid for proteins than for calories. Finally, given the makeup of the Meru diet, protein would not appear to be a limiting factor if calorie needs are met.

Before calculating the overall adequacy of the diet, it was first necessary to exclude the observations for one enumerator who was revealed in simple comparisons to be far above the mean food consumption figures. In the regression analysis which follows, these observations were retained and a dummy variable for this enumerator was inserted in the regression equations.[1/] The overall ratios for the percentage fulfillment of requirements

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[1/] The specification of the dummy variable is based upon the assumption that the enumerator overestimated the total nutrients consumed by a constant percentage, thereby shifting the NARs up by a constant amount.

were 1.27 for calories (NAR_c), 2.40 for protein (NAR_p), and 3.05 for amino acids (NAR_a). Zalla's figures using the larger Chagga sample were about 10 percent lower at 1.19, 2.21, and 2.70, respectively. Among the Meru, 27 percent of all households consumed less than 100 percent of the daily caloric requirement on the day previous to their interview and 16 percent and 12 percent, respectively, were below daily protein and amino acid requirements. Among the Chagga, these percentages were 39 percent, 13 percent, and 9 percent, respectively.

It should be recalled that below recommended consumption levels for a given household on a given day do not place that household in the at risk category since daily consumption varies and genetic requirements may differ from the standards used. One-shot interviews obviously cannot identify consistent tendencies of particular families to consume below standards (which may or may not be a problem for the particular family). They can only be used globally to indicate potential problem areas.

Although our confidence in the results is somewhat tempered by the weaknesses in the survey design outlined above, we can still arrive at the conclusion that the Meru are generally well-nourished in terms of both the quality and quantity of food consumed. Furthermore, the survey results indicate that due to the nature of the diet calories rather than proteins would appear to be the more limiting factor. Finally, it should be recalled that adequate food consumption is more or less a necessary rather than a sufficient condition for good nutritional status. As we saw in Taylor's flow diagram, there are a whole host of other factors (disease, poor food habits, etc.) which could lead to nutritional problems.

Factors Explaining Adequacy of Calorie and Protein Consumption

In this section, we will use ordinary least squares (OLS) equations to identify the factors which explain variations in the NAR for calories and for the limiting amino acid for the individual household diets.[1/] Following Zalla (1981), we use the NAR for the limiting amino acid rather than for protein because it is a better least common denominator of metabolizable protein.

As a first step, it is possible to specify a number of variables which will affect a household's ability to attain adequate levels of food consumption. They are categorized and listed below.

[1/] Since both the farming system and the methods of analysis are very similar between this study and Zalla's study (1979, 1981), frequent comparisons will be made to his results.

Variables which influence primarily nutrient supply:

1. Household income--positive
2. Farm size--positive
3. Resources in specific crop and livestock activities
   --uncertain with respect to cash crops and products
   --positive with respect to food crops and products
4. Rainfall and irrigation water--positive
5. Temperature--varied
6. Sunlight--positive
7. Soil fertility--positive
8. Topography--varied
9. Time of the year--varied
10. Livestock holdings--positive
11. Proportion of consumption from own production--probably positive
12. Farmer receptivity to technical change--positive
13. Age of head of household--uncertain
14. Number of children under the age of five--negative
15. Market accessibility--positive
16. Level of market food prices--negative

Variables which influlence primarily nutrient requirements:

1. Household size--negative
2. Age-sex composition of household--varied
3. Nutrients consumed by guests--unknown
4. Biological stress--negative
5. Genetic deviation from mean requirements--neutral

Variables which influence primarily diet composition:

1. Education of adults in household--positive
2. Household's level of nutritional education--positive
3. Beliefs and taboos--unknown
4. Relative price of foodstuffs--varied

Not all of the necessary information was gathered during the survey interview. Information with respect to the amount and the intra-family distribution of income represents the most important missing chunk of data. This type of data, since it is both controversial and complex, is extremely difficult to collect using a single-interview format. Zalla (1979), working with the very similar Chagga data set, proposed using an ordinal measure of wealth based upon household type and possession of certain household items[1/] as a proxy for income. Although this variable is included in the regression equations presented here, it will not be taken to represent income but rather will be seen as a measure of material possessions. The lack of accurate income information will considerably restrict the scope of the analysis which can be carried out. In terms of the three issues which were focused on in the review of the literature chapter, it can quickly be seen that we will be unable to directly contrast the uses of cash and kind income since we do not have information about either. Similarly, the data are not available to examine the impact of different intra-family distributions of income and resources on food consumption. Thus, we will devote most of our attention to the supposed competition for resources between cash and food crops and the ultimate influence that this has on food consumption levels. Due to the interrelationship of these three issues, as well as our small sample size, our findings should be interpreted as pointing in certain directions rather than as definitive results.

Other gaps in the available data include market-related information, a measure of household nutritional knowledge, and a measure of biological stress as well as deviations from mean genetic requirements at the household level. The absence of this information will increase the amount of unexplained variation. There are also certain difficulties in working with the crop-related data collected in the survey but we will postpone our discussion of these issues until a later section.

Description of the Variables

NAR_c	= the nutrient adequacy ratio for calories	The ratio of calories consumed by the household to calories required, multiplied by 100
NAR_a	= the nutrient adequacy ratio for essential amino acids	The ratio of the amount of the limiting amino acid supplied by the diet to the amount required by the household, multiplied by 100
X_1	= altitude	This set of variables acts as a proxy for rainfall, sunlight, temperature, and soil fertility which vary by altitude and bearing with respect to the summit
X_2	= bearing	
X_3	= $X_1 \cdot X_2$ (altitude x bearing)	
X_4	= age of head of household	The age of the head of the household with a second-degree term

[1/] Household type is based on type of roof, floor, wall, and paint. The possession index is a Guttman scale consisting of seven elements--blanket, chair, table, lantern, iron bed, foam mattress, and couch.

X_5	$= X_4^2$	
X_6	= caloric requirement of guests	The sum of age-sex specific calorie requirements of guests eating at meals covered in the survey
X_7	= protein requirements of guests	The sum of the age-sex specific protein requirements for guests eating meals covered in the survey
X_8	= education of the wife of the head of the household	Number of years of education of the wife of the head of the household
X_9	= "wealth"	This is an ordinal scale ranging from 1-20 with 50 percent of the value of the scale reflecting household possessions. The possession portion of the scale was developed using a Guttman scale
X_{10}	= employment	This is a dummy variable with a value of one if the head of household has permanent employment
X_{11}	$= X_8 \cdot X_9$ (wealth x education of wife)	An interaction term between wealth and the education of the wife
X_{12}	= progressiveness index	An ordinal index ranging from 1-23 based on cultural practices for maize, coffee, and livestock
X_{13}	= Calorie Subsistence Ratio	The proportion of calories coming from household production
X_{14}	= Protein Subsistence Ratio	The proportion of protein coming from household production
X_{15}	$= \frac{\text{Coffee Acreage}}{\text{HH calorie requirement}}$	The weighted coffee acreage (see text) divided by the household's calorie requirement, all multiplied by 1,000
X_{16}	$= \frac{\text{Staple Acreage}}{\text{HH calorie requirement}}$	The sum of the weighted bean and maize acreage (see text) divided by the household's calorie requirement, all multiplied by 1,000
X_{17}	= Enumerator #10	A dummy variable equal to one when enumerator #10, a timid interviewer, collected the data (see footnote, page 26)

In regression analysis, the process of formulating the equations is often as instructive as the results which are derived. The researcher must thoroughly understand what each variable represents before including it in the model. In this instance where sample size limited the number of independent variables which could be included in the model, it was also essential to know the influence of the excluded variables.

Since, in most cases, the functional forms of the independent variables were not established by any theory, all of the independent variables were graphed against the two dependent variables. Among the variables in the final equations, only the age of the head of household variable revealed a relationship which clearly required something other than a linear form. The age variable was thus included as a second-degree polynomial while all of the other variables retained a simple linear form.

Overall Results

The results of the OLS equations for the NAR_c and the NAR_a as well as the necessary summary statistics are contained in Tables 2-4. As expected, the calorie equation produced a higher R^2 (.74) than did the amino acid equation (.66). Both equations explained a substantial amount of the variation in their dependent variable. In the final equations reported here, variables were left in if they were needed to test specific hypotheses irrespective of their significance levels. The discussion which follows distinguishes among three sets of variables. The first set consists of variables primarily included in order to reduce unexplained variation but which are also useful in establishing whether or not the researcher understands the overall system he is studying. The second consists of the non-agriculturally related variables which are central to the issues being examined or have possible policy implications. The third set is composed of the agricultural variables which are central to our main area of interest which is the impact of cash cropping on food consumption levels.

Variables Included to Reduce the Unexplained Variation

Included in this category are the dummy variable for enumerator #10 as well as the variables for altitude, bearing, age, and guest consumption. Of these variables, only the age variable is somewhat difficult to interpret.

The age of the head of household variable, which is highly significant in both equations (.000 level in the calorie equation and at the .003 level in the amino acid equation), consists of a negative linear term and a positive squared term. At the mean of all variables if the age variable is increased by one standard deviation (18.1 years), the net impact on the NAR_c is a decrease of almost 23 units or 17 percent. This reflects a greater impact for a one standard deviation change than for any other variable in that equation.

Table 2

Regression Coefficients and Significance Levels for Variables Explaining Variation in the NAR for Calories and Essential Amino Acids

Variable		Model					
		Calorie			Amino Acid		
Func. Form	Description	Estimated Coefficient	Standard Error	Sign. of F Ratio	Estimated Coefficient	Standard Error	Sign. of F Ratio
NAR_c	Calorie NAR	N.A.[a]	(29.1)[b]	.000	--	--	--
NAR_c	Amino Acid NAR	--	-- --	--	N.A.	(111)[b]	.000
X_1	Altitude	-.585	(.250)	.025	-2.65	(.96)	.009
X_2	Bearing	-17.0	(8.1)	.043	-84.6	(31.)	.010
X_3	$X_1 \cdot X_2$	$.37/10^2$	$(.17/10^2)$	.032	$.18/10^1$	$(.64/10^2)$	.008
X_4	Age of Household Head	-6.84	(1.37)	.000	-16.93	(5.37)	.003
X_5	X_4^2	$.60/10^1$	$(.11/10^1)$	.000	.167	$(.45/10^1)$	.001
X_6	Calorie Requirement of Guests	$.48/10^2$	$(.20/10^2)$	.024	N.A.	--	--
X_7	Protein Requirement of Guests	N.A.	--	--	.469	(.307)	.136
X_8	Education of Wife of Head of Household	-11.45	(5.21)	.034	-53.18	(20.35)	.013
X_9	Wealth	-6.97	(1.54)	.000	-22.53	(6.09)	.001
X_{10}	Employment (Dummy)	-7.76	(13.72)	.575	-6.19	(55.22)	.911
X_{11}	$X_8 \cdot X_9$	1.24	(.42)	.005	5.54	(1.64)	.002
X_{12}	Progressiveness Index	5.26	(1.75)	.005	22.32	(6.72)	.002
X_{13}	Calorie Subsistence Ratio	23.34	(15.16)	.132	N.A.	--	--
X_{14}	Protein Subsistence Ratio	N.A.			-105.04	(58.04)	.079

Table 2 (continued)

Variable		Model					
		Calorie			Amino Acid		
Func. Form	Description	Estimated Coefficient	Standard Error	Sign. of F Ratio	Estimated Coefficient	Standard Error	Sign. of F Ratio
X_{15}	Coffee Acreage / HH Caloric Req.	92.93	(40.38)	.027	135.19	(157.07)	.395
X_{16}	Staple Acreage / HH Caloric Req.	2.30	(12.27)	.853	-8.51	(48.41)	.861
X_{17}	Enumerator #10 Dummy	63.00	(19.69)	.003	241.88	(75.46)	.003
Constant		2932	(1208)		13168	4623	

[a]Not applicable.

[b]Standard deviation of regression equation.

Table 3

Mean and Standard Deviation for Variables Explaining Variation in the NAR for Calories and Essential Amino Acids

Variable	Description	Mean	Standard Deviation
NAR_c	Calorie NAR	132	48.4
NAR_a	Amino Acid NAR	321	161
X_1	Altitude	4,683	435
X_2	Bearing	154	10
X_3	$X_1 \cdot X_2$	721,952	84,395
X_4	Age of Head of Household	46.6	18.1
X_5	X_4^2	2,496	2,038
X_6	Cal. Req. of Guests	1,460	2,403
X_7	Prot. Req. of Guests	39.8	63.5
X_8	Education of Wife of Head of Household	2.1	2.5
x_9	Wealth	10.3	4.4
X_{10}	Employment Dummy	.26	.44
X_{11}	$X_8 \cdot X_9$	26.2	33.8
X_{12}	Progressiveness Index	11.1	3.1
X_{13}	Calorie Subsistence Ratio	.56	.31
X_{14}	Protein Subsistence Ratio	.51	.33
X_{15}	$\frac{\text{Coffee Acreage}}{\text{HH Calorie Requirement}}$	.13	.14
X_{16}	$\frac{\text{Staple Acreage}}{\text{HH Calorie Requirement}}$	.37	.50
X_{17}	Enumerator #10 Dummy	.07	.26

Table 4

Summary Statistics for Calories and Essential Amino Acid Regression Equations

Statistic/Description	Model	
	Calorie	Essential Amino Acid
R^2	.742	.661
Adjusted R^2	.638	.520
Regression Degrees of Freedom	15	15
Residual Degrees of Freedom	37	36
Regression Mean Square	6,021	58,413
Residual Mean Square	847	12,458
F Ratio	7.11	4.69
Significance of F Ratio	.000	.000

In the calorie model, an increase of one year in the age of the head of the household continues to have a negative effect on the dependent variable until the head of the household reaches the age of 60. From that point on, the net impact of a year's change in age is positive. In the amino acid equation, this change or "turning point" comes a bit earlier at age 50.

The theory is not firm here but our expectation before running the model was the opposite of what was found. We expected that as young farmers became more settled they would be better able to provide food for their families. Then, as old age approached (depending upon the structure of the household), the expectation was that food consumption adequacy ratios would fall. A scenario which could explain the results found here is that young farmers face a situation in which there are many dependents and few workers, while old farmers can profit from the assistance of their children who have succeeded in finding a good position.

Zalla did not find the age variable to be significant in his equations using the Chagga data. This calls into question the validity of the observed relationship for the Meru beyond our small sample. It also reduces our overall acceptance of the equations since the age variable contributes a great deal to the high R^2s.

Both of the guest consumption variables have positive coefficients with the guest calorie variable being substantially more significant (.024 significance level versus .136 significance level), a finding which is confirmed by Zalla. These variables indicate that when guests are present more food is prepared. We do not know who profits from the additional food--the guests, the family, or both.

It should be noted that household size (as well as the age-sex composition of the household) only enters the regression equations as the denominator of the two normalized acreage variables. In theoretical terms, one might expect household size to have an impact on nutritional sufficiency independent of its effect on the relative abundancy of land. Both equations were tried with the household nutrient requirements as a separate independent variable. In the calorie equation, the variable had the wrong sign (positive rather than negative) but was not significant at the 70 percent level while in the amino acid equation the variable was negative and highly significant. The inclusion of this variable did not increase the R^2 of either equation markedly, and in both equations there was clearly multicollinearity between it and the two normalized acreage variables. Therefore, the decision was taken to exclude the nutrient requirement variable from the final versions of the two equations.

Non-Agricultural Variables

In this section, we will be examining three variables which are of greater interest in our discussion. These are the variables for the "wealth" index, the education of the wife,[1/] and the employment of the head of the household. At first glance, one is surprised to find that all three have negative coefficients in the regression equations. The employment variable can be quickly dismissed since in both equations its standard error exceeds its coefficient estimate. One hypothesis for this low level of significance would be that there are two distinct categories of people who hold full-time jobs and when we lump them together we lose the characteristics of each.

In examining the other two variables, it should be noted first that the equations also include an interaction term between the education of the wife variable and the "wealth" index. When these equations are run without the interaction term, the two variables become less significant and the R^2s of the equation drop substantially (.08 for the calorie equation and .06 for the amino acid equation). When we include the interaction term in our calculations of the net impact, we find that the negative coefficient of the wealth variable is partially offset while, at the mean, the negative coefficient of the education variable is more than offset.

Table 5 details the net effect that a one standard deviation change in a given independent variable has on the two dependent variables if all other independent variables are held constant at their mean values.[2/] The education variable is revealed here to have a very minor positive impact on the equation. At the low levels of education found in the area (the mean value for women is 2.1 years), it is probably that few food consumption and nutritional matters are covered.

The large negative net impact of the wealth variable (significant at the .000 level in the NAR_c and .001 in the NAR_a) is more striking. A one standard deviation change in the wealth index results in 16 percent reduction in the NAR_c and a 15 percent reduction in the NAR_a. The literature does make frequent references to the possibility that material wealth and low levels of food consumption may co-exist. The following quote from Collis et al. (1962) is but one example:

> The material items which are much rated by practical economists are not reliable criteria for judging living standards in our African communities since some of the worst conditions of nutrition and sanitation may be seen in families with large buildings, several wives and many children, extensive cash crop areas, and a heavy consumption of imported goods. (p. 143)

[1/] In a test run, variables for the education levels of both the husband and the wife were included but neither was significant due to high multicollinearity. Subsequently, only the education of wife variable was retained.

[2/] These comparisons should not be pressed too far since some of the variables are cardinal and others are ordinal.

Table 5

The Net Impact of a One Standard Deviation Increase of a Given Variable on the NAR for Calories and Amino Acids[1]

Variable				Calorie			Amino Acid		
Description		Mean	Standard Deviation	Esti. Coeff.	Change in NAR_c	% Change in NAR_c	Esti. Coeff.	Change in NAR_a	% Change in NAR_a
X_8	Education of Wife[2]	2.1	2.5	-11.45	3.28	2.5	-53.18	9.21	3.0
X_9	Wealth[2]	10.3	4.4	-6.97	-21.3	-16.1	-22.53	-48.0	-14.9
X_{12}	Progressiveness Index	11.1	3.1	5.26	16.3	12.4	22.32	69.2	21.5
X_{13}	Calorie Subsistence Ratio	.56	.31	23.34	7.2	5.5	N.A.	--	--
X_{14}	Protein Subsistence Ratio	.51	.33	N.A.	N.A.	N.A.	-105.04	-34.65	-10.8
X_{15}	Coffee Acreage	.13	.14	92.93	13.0	9.8	135.19[3]	18.2	5.8
X_{16}	Staple Acreage	.37	.50	2.3[4]	N.A.	N.A.	-8.51[4]	--	--

[1]All other variables are maintained at their mean values (no implied interactions are taken into account).

[2]Takes into account the change in the interaction term as well.

[3]Coefficient is only significant at the .40 level.

[4]Not analyzed due to low significance level of coefficient.

If we would decide to continue to regard the wealth index as a proxy for income, we could proceed to test the hypothesis that cash and kind incomes have different impacts on food consumption levels. Given the large negative coefficient of the wealth term, this would lead to a strong condemnation of the influence of market integration on the ability of households to attain adequate food.

We do not have, however, any verification that this index does act as a proxy for money income.[1/] Zalla's results are not instructive since the variable had a very low level of significance in his equations. In reflecting on what the index is made up of, it would seem that instead of serving as a proxy for income the index could more properly be seen as competing use of family resources. Using this interpretation within the context of regression analysis, the negative coefficient of the variable begins to make a bit more sense. The coefficient suggests that, with all resources being equal, the households which spend the most on material goods will have the fewest resources left over for meeting food consumption needs.

Throughout the rest of the essay, we will interpret the "wealth" index as an alternative form of consumption.[2/] In a later section, an OLS equation will be derived with the wealth index as the dependent variable and the results will be compared and contrasted to the regression analysis presented in this section.

Agricultural Production Variables

The remaining variables reflect in one respect or another the influence of the agricultural production system on food consumption levels. Since our main concern will be with the crop acreage variables, we will first consider the other variables in the equation.

The progressiveness index which is highly significant in both equations measures, with an ordinal scale, the farmer's willingness to adopt new production techniques for maize, coffee, and livestock. As such, it should partially reflect the total production data which was not collected. As can be seen in Table 5, the progressiveness index has the strongest influence of any variable on the NAR_a (21.5 percent) and is second only to the wealth index in influencing the NAR_c (16.3 percent). A "progressive" farmer, it should be recalled, would be expected to have higher cash and kind incomes so this variable does not help us to distinguish between cash and subsistence farming.

[1/]Note that in the literature few claim that money income itself actually has a negative influence on food consumption. They argue instead that once the kind income which is given up is accounted for the net impact is negative.

[2/]From here on, we will drop the quotation marks in the text.

The subsistence ratios focus in on the question of the interrelationship between market orientation (for purchases) and food consumption adequacy. We find a very interesting contrast between the two equations. Whereas the calorie subsistence ratio exerts a positive influence on the NAR_c, the protein subsistence ratio has a negative coefficient and is highly significant in the amino acid equation. Zalla finds the identical relationships in looking at the very similar Chagga farming system. One interpretation would be that this reflects the dominant role of the coffee/banana intercrop in the two farming systems with the bananas providing subsistence calories while coffee provides income used to purchase protein. Thus, a household's "nutritional strategy" could be based on the subsistence production of calories and market dependence for proteins.

The crop acreage variables are central to the examination of the question of whether or not the marginal allocation of resources between cropping activities influences food consumption adequacy. As mentioned in Chapter 1, the reported (but unmeasured) farm size for survey farmers was four acres. Since the Meru system is characterized by extensive intercropping, the total reported crop acreage is much higher at 6.5 acres.

According to the survey, over 85 percent of the acreage of each of the five major crops was intercropped. The total acreage for the individual crops is given below:

	Acres
Coffee	1.41
Bananas	1.60
Maize	1.69
Beans	1.53
Millet	.28

A clear distinction can be made between two types of cropland. The first is the "Kihamba" land around the homesteads which is devoted to coffee and bananas. The second type is "Kisbamba" land located outside of the middle zone of the mountain which is generally planted in a maize/bean mixture.

Beyond determining whether the acreage was sole cropped or intercropped, no data was collected with respect to the intensity of land use (plants per acre by crop) or the total yields realized. In order to give more precision to the crop acreage data, it was decided to introduce a weighting system which would distinguish between sole cropped and intercropped acreage. The following set of weights, based upon studies in the area (Coulson, 1972; Sykes, 1959; Wallace, 1968) as well as knowledge of similar systems in other parts of Africa, was established for the intercrops: coffee (.75), bananas (.50), maize (.8), beans (.8), and millet (.8). The new weighted average crop acreage was calculated to be 4.8 acres. As will be seen shortly, this weighting system did not clear up all the problems it was intended to.

In beginning the analysis, an initial attempt was made to introduce each of the four major crop acreages as a separate independent variable. The high simple correlation between the maize and bean acreage (.90) caused the classic signs of multicollinearity to appear in the regression equation as neither variable was significant. Multicollinearity is a sample characteristic which prevents the researcher from distinguishing what the independent effects of particular variables are.

The interaction between the coffee and banana variables was somewhat different. When either coffee or bananas were in the regression equation, each had a positive coefficient and was highly significant. When both variables were in the equation, coffee became more positive and remained significant while bananas took on a negative coefficient and fell to the .25 significance level. A search of the relevant statistical literature revealed that the opposing signs of two closely related variables could be related to the statistical phenomenon of "tipping" in which one variable displays a highly positive coefficient and the other variable counterbalances it by taking on a negative coefficient (Gordon, 1967). If, within the sample population, the two variables are so closely related that it is impossible to identify their independent influences, the researcher must sum their coefficients and interpret that sum as the net impact for that group of variables.

Thus, on the basis of the high correlation between maize and bean acreage and between coffee and banana acreage, it quickly became evident that no more than two crop acreage variables could be included in the regression equations.[1/] In fact, the crop acreage data presented a second problem beyond multicollinearity which prevented introducing separate variables for each crop. The weighting scheme for the intercropped acreage was based upon average rates of intercropping. Within individual fields, the intercropping (and thus the production) varied a good deal around this average, but we did not have specific data on that variation. As one example, in the early years of the coffee cycle, the farmer would harvest more bananas and less coffee than he would later in the cycle. In trying to separate these crops at the household level, we would be implying a greater precision in the data than actually existed. While the multicollinearity problem could be handled by, among other things, increasing the number of observations, this second problem could only be dealt with by increasing the detail rather than the quantity of the data.

[1/] Gordon (1967) makes the interesting point that researchers often include many variables in their area of interest and only a few variables in other areas, thus causing the variables of interest to have relatively lower significance levels.

The final decision was to introduce two crop acreage variables into the regression equation with one being the sum of the weighted maize and bean acreage and the other being the weighted coffee acreage[1/] with the understanding that this second variable represented bananas as well.[2/] At this point, the reader might protest that we have defined away the one variable which is central to our entire analysis of the impact of cash cropping on food consumption levels. A bit of reflection reveals that the pure cash crop variable which the reader is looking for does not in fact exist in the Meru farming system. Since a Meru farmer who grows an acre of coffee also grows an acre of bananas, it can be argued that no independent effect of coffee production can be analyzed.[3/] This represents one of the most important lessons learned from the case study.

Following the procedure used by Keller et al. (1969), the crop acreage variables were put on a per family size basis by dividing through by the family caloric requirements (and then multiplying by 1,000). This yielded variables which much more accurately reflected the family's relative resource base. The other variables in the two equations were not normalized in this fashion because they can not be expressed in a per family size basis in the same fashion.

In the equations presented in Table 2, two variables, one for coffee and the other for staple crops, are listed. In the process of formulating the final equations, considerable time was spent examining the interactions which take place among a set of three crop variables measuring the percentage of weighted crop acreage devoted to coffee. The impact of including the various possible combinations of these variables on the coefficient estimates and significance levels as well as on the overall accuracy of the equations is detailed in Table 6.

When either staple or coffee is in the equations alone, they each take on higher coefficients and are more significant than when they are both in the equations. It is clear, however, that the coefficient associated with coffee is always much greater (six times or more) and has a higher level of significance than the coefficient of the staple crop variable. Part of this undoubtedly reflects differences between the number of hours

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[1/] Although for consistency sake it might appear logical to include the sum of the weighted coffee and banana acreage as the second acreage variable, this was deemed inappropriate since bananas were also grown (either sole cropped or intercropped with maize) outside of the coffee belt.

[2/] As a note, at least one study in the area (Wallace, 1968) indicates that the total value of the bananas which came off an intercrop acre exceeds the total value of the coffee.

[3/] This is perhaps too strong a statement. If we had very detailed production data, we could in fact identify the separate influences of coffee and bananas as a function of planting densities or yields.

Table 6

The Effect of Different Combinations of the Three Crop Acreage Variables on the Equation for the NAR_c

Variables in Equation	$\bar{R}^2$	F Ratio	Variable								
			Coffee Acreage			Staple Acreage			Percent Coffee		
			Est. Coef.	Std. Error	Sig. of F Ratio	Est. Coef.	Std. Error	Sig. of F Ratio	Est. Coef.	Std. Error	Sig. of F Ratio
Coffee Alone	.647	7.81	96.50	(35.16)	.009	N.A.[1]	N.A.	N.A.	N.A.	N.A.	N.A.
Staple Alone	.597	6.50	N.A.	N.A.	N.A.	15.60	(11.41)	.179	N.A.	N.A.	N.A.
Coffee-Staple	.638	7.11	92.93	(40.38)	.027	2.29	(12.26)	.853	N.A.	N.A.	N.A.
Coffee-Staple--% Coffee	.628	6.49	101.97	(63.52)	.147	.083	(17.20)	.996	-10.52	(56.54)	.853
Coffee-% Coffee	.638	7.12	102.20	(41.56)	.019	N.A.	N.A.	N.A.	-10.71	(40.30)	.792
Staple-% Coffee	.612	6.48	N.A.	N.A.	N.A.	20.75	(11.65)	.083	58.90	(37.19)	.122
% Coffee Alone	.590	6.35	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	40.46	(36.73)	.278

[1]Not applicable.

of labor put in as well as the quality of the land used. Nonetheless, the indication given here is that growing coffee (and bananas) on the more fertile land makes sense from the perspective of maximizing food consumption.[1/] Referring back to Table 5, we see that the coffee acreage variable has a substantial positive impact on the NAR_c and a lesser but still positive one on the NAR_a. We definitely do not find the negative influence on food consumption levels which in some of the literature is ascribed to perennial cash crops.

While the percentage of acreage devoted to coffee has an intuitive appeal as a variable which measures the relative emphasis that a farmer gives to cash cropping, it is another variable which appears to represent more than it does. We still do not have the data to separate coffee from bananas so this variable merely represents the proportion of the farmer's acreage which is in the middle belt. The variable is left out of the final equations based on its low level of significance and its less than clearcut interpretation.

In summary, our results indicate that the intercropping of coffee and bananas among the Meru is a viable use of land from the perspective of the achievement of household food consumption goals. These results should not be interpreted as suggesting that coffee or another cash crop grown elsewhere could not have a net negative impact. It is essential in each instance to investigate the entire farming and economic systems and see how they fit together. All that we can say is that the Meru appear to have found a method of including a perennial cash crop in their farming system without unduly sacrificing their sources of food.

"Wealth" Index Equation

As outlined above, the wealth index is seen as an alternative use of family resources. A household's position on this index reflects its decision to consume the goods which make up the index, not merely its level of income. The realization that rural households have multiple consumption possibilities implies that the previously estimated equations contain at least two endogenous variables. Since the right-hand side endogenous variable, "wealth," would be correlated to the error term, the equations as a whole would suffer from simultaneous equation bias (Gujarti, 1978). Thus, we have two further tasks. The first is to investigate the manner in which food consumption goals may conflict with family goals for the consumption of other goods. The second is the suggestion of a more appropriate statistical model for investigating these issues.

[1/] Puritt (1970) argues that the lumpy coffee income is frittered away on alcohol and other non-essentials. Although this may be true, it would be at least partially offset by the stable in-kind banana income.

In order to address the first task, an OLS equation was estimated using the wealth index as the dependent variable. In contrast to the two nutrient adequacy ratios, the wealth index used here is measured in absolute terms rather than relative to some per capita standard.[1] Thus, it is seen as a function of total family surplus rather than per capita surplus. This difference greatly influences the nature of the variables which enter into the wealth equation.

The variables for altitude, bearing, the progressiveness index, the age of the head of household, the education of the wife, and the dummy variable for employment were entered in the same form as they were in the food consumption models. These variables were joined by the following new variables:

X_{20}	= Education of Head of Household	The number of years of education of the head of the household.
X_{21}	= Highest Level of Education for Family Member if not living at Home	This is a very rough attempt to find a variable which can act as a proxy for remittances from well-educated members.[2]
X_{22}	= Cattle group	This is an ordinal measure of four cattle groups ranging from no cattle to grade cattle. It is entered here as a proxy for value of cattle holdings.
X_{23}	= Coffee acreage	The absolute acreage rather than the acreage divided by nutritional requirements is used here since we are interested in the absolute amount of surplus earned.
X_{24}	= Total calories	Total calories consumed divided by 1,000.
X_{25}	= Working members	All family members over the age of five.
X_{26}	= Percentage in food crops	Food crops/total crop acreage.

In Tables 7-9, the results of this regression as well as the necessary summary statistics are shown. In Table 10, the net effect of a one standard deviation change in a given variable (with all other variables maintained at the mean) is calculated.

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[1] This is based on the assumption that the African head of household has some interest in increasing his own stock of goods rather than the family's per capita stock of goods.

[2] Note that we have no actual data on remittances. For simplicity's sake, we will refer to this variable as remittances from here on.

Table 7

Regression Coefficients and Significance Levels for Variables Explaining Variation in the "Wealth" Index

Variable and Functional Form	Description	Estimated Coefficient	Standard Error	Significance Level
X_9	"Wealth"	-	-	-
X_{10}	Employment	.980	1.341	.469
X_1	Altitude	.0026	.0014	.063
X_2	Bearing	.027	.045	.545
X_{12}	Progressiveness	.202	.171	.243
X_4	Age of HOH	-.255	.176	.156
X_5	X_4^2	.0027	.0014	.074
X_{20}	Education of HOH	.377	.184	.047
X_8	Education of Spouse	.490	.271	.078
X_{21}	"Remittances"	.266	.117	.028
X_{22}	Cattle Group	1.851	.531	.001
X_{23}	Coffee Acreage	.924	.628	.149
X_{24}	Total Calories	-.205	.078	.012
X_{25}	Working Members	.759	.277	.009
X_{26}	Percentage in Food Crops	-5.687	2.12	.011

Table 8

Mean and Standard Deviation for Variables Explaining Variation in the "Wealth" Index

Variable	Description	Mean	Standard Deviation
X_9	"Wealth"	10.04	4.43
X_{10}	Employment	.25	.44
X_1	Altitude	4,669.16	432.95
X_2	Bearing	154.49	10.52
X_{12}	Progressiveness	10.92	3.08
X_4	Age of HOH	47.43	18.43
X_5	X_4^2	2,583.39	2,086.33
X_{20}	Education of HOH	3.21	3.27
X_8	Education of Spouse	2.05	2.48
X_{21}	"Remittances"	2.56	4.51
X_{22}	Cattle Group	1.36	1.07
X_{23}	Coffee Acreage	1.07	.80
X_{24}	Total Calories	14.75	7.17
X_{25}	Working Members	4.54	2.42
X_{26}	Percentage in Food Crops	.7402	.209

Table 9

Summary Statistics for
Wealth Index Equation

Statistic/Description	
R^2	.659
Adjusted R^2	.540
Regression Degrees of Freedom	14
Residual Degrees of Freedom	40
Regression Mean Square	49.90
Residual Mean Square	9.02
F Ratio	5.53
Significance of F Ratio	.000

Table 10

The Net Impact of a One Standard Deviation Increase of a Given Variable on the "Wealth" Index[1]

Variable	Mean	Standard Deviation	Estimated Coefficient	Change in Wealth Index	% Change in Wealth Index
Progressiveness	10.92	3.08	.202	0.62	6.2
Education of Wife	2.05	2.48	.377	1.21	12.1
Education of HOH	3.21	3.27	.490	1.21	12.1
"Remittances"	2.56	4.51	.266	1.20	12.0
Cattle Group	1.36	1.07	1.85	1.98	19.7
Coffee Acreage	1.07	.80	.924	0.72	7.2
Total Calories	14.75	7.17	-.205	-1.47	-14.7
Working Members	4.54	2.52	.759	1.91	19.1
Percent Food Crops	0.74	.21	-5.69	-1.19	-11.9

[1] All other variables are maintained at their mean values (no implied interactions are taken into account).

Three of the new variables, those for the education of the household head as well as the proxy variables for remittances and the value of cattle holdings, were included in test runs of the food consumption equations but none were found to have significant coefficients. In terms of the two education variables, it is interesting to note that both are significant and are strongly positive in this equation whereas in the previous equations education had a mixed effect. The two proxy variables represent lumpy sources of income which apparently are translated more easily into material goods than into food.

The progressiveness index has the same sign as in the previous equations which indicates that advanced farming techniques increase family surplus and thus favor all types of consumption. The variable representing family members over the age of five is notable since Zalla found in his equations for the Chagga that family size was negatively correlated with the NARs.[1/] Here we see quite clearly the difference between levels of absolute family surplus and levels of per capita surplus.

While the negative coefficient for the variable representing percentage in food crops is as expected, the negative coefficient on total calories consumed is somewhat surprising. It would seem logical that in terms of a long-run strategy a family would seek to feed itself adequately in the present in order to attain "wealth" in the future. One can, however, construct other scenarios. Particular farmers may formulate a strategy based upon having large families and establishing <u>some</u> of their children in favorable positions (probably outside the rural economy). The age at which the polynomial variable for the age of the head of the house begins to exert a positive influence, 50 years old, agrees with this analysis since that is approximately the point at which the children could be expected to begin sending remittances.

The main point which should be retained from this comparison is the high degree of dissimilarity between the factors which influence the NARs and the wealth index. The wealth index is influenced by absolute amounts of resources and by lumpy sources of income while the NARs are influenced by per capita resources and, one would guess, by continuous sources of income.

Simultaneous Equations Model

If, as we are led to believe, there is more than one endogenous variable in each of these equations, it would be appropriate to use a simultaneous equation technique to estimate the equations. The advantage of a simultaneous equation system is that the estimates derived are, unlike OLS estimates, asymptotically consistent.

[1/] Remember that in this essay family size was only included in the NAR equations as the denominator of the acreage variables.

In two-stage least squares (2SLS), one proceeds by first regressing the right-hand side endogenous variables on all of the exogenous variables in the system. This yields estimates of the endogenous variables which are no longer correlated with the error term. In the second stage, the endogenous variables are replaced by their estimates and each structural equation is estimated again by OLS.

A two-equation 2SLS model was run with the NAR_c and the wealth index specified as the only two endogenous variables in the system. All of the coefficient estimates in the two equations retained the same signs and roughly the same levels of significance. The coefficient of the wealth variable should show the greatest change as its negative coefficient increased by about 50 percent in the 2SLS system of equations. As the reader will recall, our original expectation was that this variable would be positive so the use of 2SLS has not cleared up that problem.

There are a number of reasons why the use of this simple 2SLS approach does not seem to be satisfactory. First, while we have focused on the NARs and the "wealth" index as endogenous variables, a number of other variables in the equations could also be conceived of as endogenous. We would have to formulate a structural equation for each of these variables and would not have all of the necessary data. Secondly, the small sample properties of 2SLS are not well-known. Although the coefficient estimates are asymptotically consistent, they also tend to be less efficient than the OLS estimates. Finally, Gujarti (1978) notes that in cases in which the reduced form equations for the right-hand side endogenous variables yield low R^2s it is not advisable to use 2SLS since nothing is gained by replacing a variable which is correlated with the error term by a variable which contains a high degree of unexplained variation. Although the equations derived here have fairly high R^2s, a large proportion of the variation in all three equations is explained by the age of head of household variable which we suspect might represent a characteristic of the sample rather than the population.

Thus, although we feel that it is important to recognize that a number of types of decisions are being made simultaneously with the food consumption decisions, we cannot push our analysis very far in that direction. A more complete data set would be needed to investigate the broad range of household production and consumption decisions.

CHAPTER V

SUMMARY AND CONCLUSIONS

We began this essay with the specific task of investigating the influence of cash cropping on the adequacy of household food consumption levels. As a first step in confronting this issue, we argued that it was necessary to pull back and formulate an overall view both of the role of nutrition in economic development and of the whole network of factors which influence food consumption and nutritional status. The contributions of Pinstrup-Andersen and Taylor were particularly helpful in forming this overall perspective.

In Chapter III, the opposite tact was adopted. Whereas in the previus chapter an attempt was made to place the discussion on a more general level than is normally carried out, in Chapter III our goal was to use the available case studies to push the discussion down to a more specific and precise level. In particular, three mechanisms by which cash cropping might influence food consumption were identified. They are:

(1) The competition between cash and food crops

(2) The impact of moving from kind to cash income

(3) The influence of changes in the intra-family distribution of income, resources, and labor

Even within these categories no hard and fast rules were found. Sometimes food and cash crops compete for resources and other times they do not. Sometimes, in fact, there is no clear distinction between a food crop and a cash crop. Similarly, cash income may or may not be translated back into food and the impact that cash cropping has on the intra-family distribution of income and resources could ultimately back on food consumption levels will vary from community to community. The most serious nutritional problems were associated with sole cropped perennial cash crops which are controlled by men and which provide a lumpy source of income. One must, however, analyze the important characteristics of each specific case before reaching any overall conclusion as to the influence of cash cropping. The modelling of the farm household decision process carried out by Smith and Strauss at Michigan State University would appear to be the most promising manner of sorting through the complexities of a given case.

Having developed this general background, the next step was to examine the particular case study of the Meru ethnic group in northern Tanzania. The Meru diet was found to be largely sufficient in both the quality and quantity of nutrients provided. Single-equation regression models were estimated in an attempt to discover the influence of a variety of socioeconomic factors on the nutrient adequacy ratios (NAR) for calories and amino acids at the household level. The lack of appropriate data prevented us from examining through regression analysis the influence that both the type as well as the intra-family distribution of income have on family food consumption levels.

Thus, in the regression analysis, we focused on what is in some respects the more general question of whether and how cash and food crops compete and what is the eventual impact on food consumption levels.[1/] Our most important conclusion in this section was that no pure cash crop exists in the Meru farming system since coffee is inevitably intercropped with bananas. Our regression analysis indicates that this intercrop has a positive influence on the nutrient adequacy ratios and quite probably represents the best use of those land resources.[2/] We also found indicators that Meru households follow a strategy of relying more heavily on subsistence production for calories and turn to markets for the purchase of proteins.

A second major finding was the apparent competition between food consumption goals and material good consumption goals for family resources. In order to examine the conflicting nature of these goals, a separate single-equation regression model was estimated with the wealth index as the dependent variable. The results of this equation were then compared to the earlier regression results in order to contrast the factors which influence different types of consumption. It was noted that whereas food consumption levels are determined relative to family nutritional requirements, wealth is simply calculated on a per family basis. Thus, maximization with respect to food consumption involves seeking a per capita maximum while maximization with respect to wealth requires seeking an overall family maximum.

In comparing the equations, absolute resources (land, number of workers) were found to be important influences on levels of wealth while relative resources (land per capita) were influential in the food consumption equations. Whereas lumpy forms of income such as remittances and cattle ownership influenced wealth, they appeared to have little impact on the NAR equations.

[1/] We did not have price data available which would have allowed us to duplicate Smith and Strauss' efforts to look at the causes of changes in cash cropping.

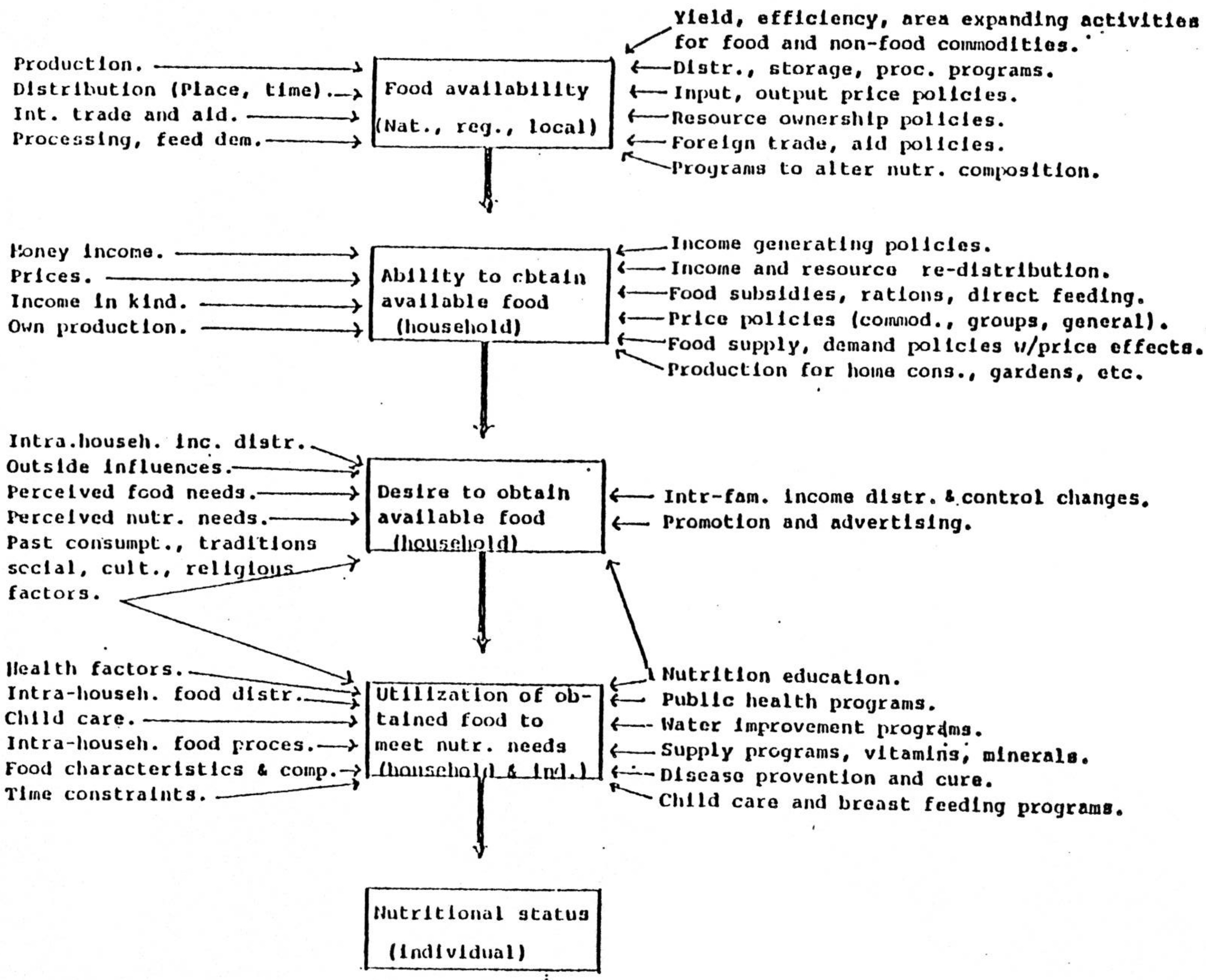
[2/] John Strauss noted in comments on an earlier draft that the regression results are for a partial equilibrium analysis. He thus observed that in full equilibrium if households switched land from maize-beans to coffee-bananas the market supply and demand curves for maize-beans may be shifting upwards. Thus, while at the partial equilibrium level, consumption of maize-beans probably rises due to the income effect of the rising price of coffee, when prices of maize-beans are allowed to rise, in a general equilibrium framework, the ultimate consumption of maize-beans may not rise.

Finally, while the education variables clearly exerted a major positive influence on the wealth index, they had little effect in the NAR equations. We interpreted this to indicate that food and nutrition subjects are not treated to any great depth in formal education. More research is needed on the cost effectiveness of increased investments in nutritional education programs.

Overall, in this essay, we made progress in demonstrating the weaknesses of the simplistic arguments which continue to abound in the discussions of the relative merits of cash cropping. We did so in part by coming to a better understanding of how the Meru economic system functions at the household level. The whole area of examining the effects of different cropping patterns and sources of income on household food consumption levels on a nutritional status should continue to be a research priority in the Third World. We cannot hope to discover quick, easy, and universal solutions to these difficult issues. Our increased understanding can, however, improve the quality of the policy interventions which are proposed and enacted.

APPENDIX

Figure A. Factors affecting the nutritional status.



Source: Pinstrup-Andersen (1981), p. 8.

TABLE B-1

ENERGY, PROTEIN AND AMINO-ACID CONTENT OF FOODS
CONSUMED IN KILIMANJARO PER 100 GRAMS
EDIBLE PORTION

Food Item	Frequency[a]	Edible Port.[b]	KCAL[c]	Grams[d]	NCF[e]	Grams[e]	Iso-leucine	Leucine	Lysine	Meth.-Cystine	Phenyl.-Tyro.	Threo.	Trypto-phan	Valine	Totals: Essent. Amino Acids	Totals: All Amino Acids
							Mgs. of Amino Acids Per Gram of Nitrogen[f]									
I. Cereals & Cereal Products																
Maize																
Grain		100	362	9.5	6.25	1.52	230	783	167	217	544	225	44	303	2513	6093
Cracked		100	362	9.5	6.25	1.52	230	783	167	217	544	225	44	303	2513	6093
Flour (96% extraction)		100	362	9.5	6.25	1.52	230	783	167	217	544	225	44	303	2513	6093
Sembe (60% extraction)		100	354	8.0	6.25	1.28	230	783	167	217	544	225	44	303	2513	6093
Millet (Finger)																
Grain		100	328	7.5	6.25	1.20	275	594	181	357	550	263	91	413	2724	6213
Flour		100	328	7.5	6.25	1.20	275	594	181	357	550	263	91	413	2724	6213
Rice																
Grain (highly milled)		100	352	7.0	5.95	1.18	262	514	226	229	503	207	84	361	2306	6007
Flour		100	352	7.0	5.95	1.18	262	514	226	229	503	207	84	361	2306	6007
Wheat																
Grain		100	332	12.7	5.83	2.19	204	417	179	253	469	183	68	276	2049	6033
Flour		100	364	11.0	5.70	1.93	228	440	130	250	449	168	67	258	1990	6216
Bread (white)		100	249	7.1	5.70	1.25	228	440	130	250	449	168	67	258	1990	6216
Chipati		100	249	7.1	5.70	1.25	228	440	130	250	449	168	67	258	1990	6216
Maandazi		100	400	4.0	5.70	.70	228	440	130	250	449	168	67	258	1990	6216
Hafu-Keki		100	249	7.1	5.70	1.25	228	440	130	250	449	168	67	258	1990	6216
II. Nuts & Legumes																
Beans																
Kidney		100	336	21.7	6.25	3.47	262	476	450	119	484	248	63	287	2389	5662
Mung		100	341	23.5	6.25	3.76	223	441	504	77	462	209	50	258	2225	5320
Nuts																
Coconut		65	375	4.0	5.30	.75	244	419	220	196	450	212	68	339	2148	5918
Peanuts		100	549	23.2	5.46	4.24	211	400	221	150	555	163	65	261	2026	5807
Peas																
Cowpeas		100	342	23.1	6.25	3.70	239	440	427	141	486	225	68	283	2309	5632
Dried Peas		100	339	22.3	6.25	3.56	267	425	470	127	458	254	56	294	2351	5806
Pigeon Peas		100	345	19.5	6.25	3.12	194	394	481	93	643	182	35	225	2247	5527

TABLE B-1 (CONTINUED)
ENERGY, PROTEIN AND AMINO-ACID CONTENT OF FOODS
CONSUMED IN KILOMANJARO PER 100 GRAMS
EDIBLE PORTION

							Mgs. of Amino Acids Per Gram of Nitrogen[f]								Totals	
Food Item	Frequency[a]	Edible Port.[b]	KCAL[c]	Grs.[d]	NCF[e]	Grs.[e]	Iso-leucine	Leucine	Lysine	Meth.-Cystine	Phenyl.-Tyro.	Threo.	Trypto-phan	Valine	Essent. Amino Acids	All Amino Acids
III. Starchy Fruits, Roots and Tubers																
Bananas																
Cooking Varieties		--[g]	128	1.2	6.25	.19	181	294	256	294	407	213	74	250	1968	5175
Sweet		--[g]	111	1.2	6.25	.19	181	294	256	294	407	213	74	250	1968	5175
Dried		100	298	3.2	6.25	.51	181	294	256	294	407	213	74	250	1968	5175
Flour		100	342	3.5	6.25	.56	181	294	256	294	407	213	74	250	1968	5175
Cassava																
Roots		85	153	.7	6.25	.11	175	247	259	170	256	165	72	209	1553	4554
Flour		100	342	1.5	6.25	.24	175	247	259	170	256	165	72	209	1553	4554
Cassava & Maize Flour[h]		100	356	6.9	6.25	1.10	226	745	173	214	524	221	46	296	2445	5985
Cocoyam (Taro)		85	113	2.0	6.25	.32	219	460	241	247	542	257	88	382	2436	5987
Potatoes																
Irish		85	75	2.0	6.25	.32	236	377	299	118	422	235	103	292	2082	4910
Sweet		85	114	1.5	6.25	.24	230	340	214	175	387	236	107	283	1972	4735
Yam Species		85	104	2.0	6.25	.32	234	404	256	172	501	225	80	291	2163	5291
IV. Fruits																
Avacado		70	165	1.5	6.25	.24	213	344	269	229[i]	363	181	68	288	1955	5200[j]
Guava[k]		100	58	1.0	0	0	0	0	0	0	0	0	0	0	0	0
Lemon[k]		77	36	.7	0	0	0	0	0	0	0	0	0	0	0	0
Lime[k]		77	32	.6	0	0	0	0	0	0	0	0	0	0	0	0
Mango[k]		66	63	.5	0	0	0	0	0	0	0	0	0	0	0	0
Orange[k]		75[l]	53	.8	6.25	.13	180	170	330	169	360	94	44	240	1587	5281
Papaya[k]		--	39	.6	0	0	0	0	0	0	0	0	0	0	0	0
Pineapple[k]		70	57	.4	0	0	0	0	0	0	0	0	0	0	0	0
Soursop[k]		72	60	1.5	0	0	0	0	0	0	0	0	0	0	0	0
Tomato		100	20	1.0	6.25	.16	112	169	175	74	193	138	52	131	1044	5042
V. Vegetables																
Cabbage Species		100	26	1.7	6.25	.27	193	331	194	135	304	235	66	263	1721	4451
Cassava Leaves		100	91	7.0	6.25	1.12	303	536	390	175	590	292	91	358	2734	5756
Carrots		100	33	1.0	6.25	.16	186	276	242	140	311	181	44	278	1658	4830
Egg Plant		90	32	1.0	6.25	.16	270	380	330	104	500	230	64	320	2198	5298

TABLE B-1 (CONTINUED)
ENERGY, PROTEIN AND AMINO-ACID CONTENT OF FOODS
CONSUMED IN KILOMANJARO PER 100 GRAMS
EDIBLE PORTION

Food Item	Frequency[a]	% Edible Port.[b]	KCAL[c]	Grams[d]	NCF[e]	Grams[e]	Iso-leucine	Leucine	Lysine	Meth.-Cystine	Phenyl.-Tyro.	Threo.	Trypto-phan	Valine	Essent. Amino Acids	All Amino Acids
							Mgs. of Amino Acids Per Gram of Nitrogen[f]								Totals	
Lettuce		100	20	1.2	6.25	.19	238	394	238	196[i]	488	256	50	338	2198	5000[j]
Mchicha (Amaranthus Species)		100	48	5.0	6.25	.80	294	485	316	230	577	266	77	346	2591	5615
Maize (Green)		33	152	5.0	6.25	.80	230	783	167	217	544	225	44	303	2513	6093
Onion		100	48	1.5	6.25	.24	93	169	288	130[i]	350[m]	93	93	138	1354	4800[j]
Spinach		100	26	2.1	6.25	.34	303	594	454	234	698	332	97	380	3092	6322
Squash		75	36	1.0	6.25	.16	231	325	270	95[i]	344[m]	169	70	300	1804	4800[j]
VI. Milk & Dairy Products																
Cows Milk (fresh & fermented)																
Pasteurized Whole		100	61	3.3	6.38	.52	399	782	450	211	820	278	91	463	3494	6698
Raw Whole		100	79	3.8	6.38	.60	295	596	487	208	633	278	88	362	2947	6463
Goat Milk		100	85	3.4	6.38	.53	328	589	327	147[i]	437	274	75	404	2581	5500[j]
Whole Milk Powder		100	500	25.5	6.38	4.00	330	619	453	220	614	263	89	402	2990	6607
Skimmed Milk Powder		100	357	36.0	6.38	5.64	330	619	453	220	614	263	89	402	2990	6607
Infants Milk Powder		100	500	25.5	6.38	4.00	330	619	453	220	614	263	89	402	2990	6607
Condensed Milk		100	208	8.4	6.38	1.32	437	660	436	172[n]	628	302	83	407	3125	6500[j]
Hen's Egg		100	158	12.4	6.25	1.98	393	551	436	362	618	320	93	428	3201	6446
VII. Meat & Meat Products																
Beef																
Mixed		78	232	17.5	6.25	2.80	302	502	601	228	521	272	81	321	2829	6475
Steak		100	232	17.5	6.25	2.80	302	502	601	228	521	272	81	321	2829	6475
Liver		100	136	20.0	6.25	3.20	297	543	454	212	446	250	86	398	2686	6126
Blood		100	92	21.1	6.25	3.38	70	782	568	156	694	319	79	539	3207	6439
Goat																
Mixed[o]		80	145	16.0	6.25	2.56	311	481	510	233	456	293	79	316	2679	6088
Chicken		67[p]	180	19.0	6.25	3.04	334	460	497	239	459	248	64	318	2619	5689
VIII. Fish																
Fresh		100	103	18.8	6.25	3.01	299	480	569	253	474	286	70	382	2813	6093
Smoked		100	317	37.9	6.25	5.76	325	506	575	267	444	311	66	363	2857	6278
Dagaa		100	319	43.5	6.25	6.96	325	506	575	267	444	311	66	363	2857	6278

TABLE B-1 (CONTINUED)
ENERGY, PROTEIN AND AMINO-ACID CONTENT OF FOODS
CONSUMED IN KILIMANJARO PER 100 GRAMS
EDIBLE PORTION

							Mg. of Amino Acids Per Gram of Nitrogen[f]								Totals	
Food Item	Frequency[a]	Edible Port.[b]	KCAL[c]	Grams[d]	NCF[e]	Grams[e]	Iso-leucine	Leucine	Lysine	Meth.-Cystine	Phenyl.-Tyro.	Threo.	Trypto-phan	Valine	Essent. Amino Acids	All Amino Acids
IX. Fats & Oils																
Animal Fat		100	890	0	0	0	0	0	0	0	0	0	0	0	0	0
Butter[q]		100	745	.5	6.38	.08	295	596	487	208	633	278	88	362	2947	6463
Ghee		100	828	0	0	0	0	0	0	0	0	0	0	0	0	0
Margarine		100	765	0	0	0	0	0	0	0	0	0	0	0	0	0
Peanut Oil		100	900	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Oils		100	900	0	0	0	0	0	0	0	0	0	0	0	0	0
X. Alcoholic Beverages, Sweets & Miscellaneous Products																
Beer																
Banana/Millet[r]		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bottled[k]		100	35	.3	0	0	0	0	0	0	0	0	0	0	0	0
Honey[k]		100	.55	.2	0	0	0	0	0	0	0	0	0	0	0	0
Sweets																
Honey[k]		100	311	.4	0	0	0	0	0	0	0	0	0	0	0	0
Jam		100	275	0	0	0	0	0	0	0	0	0	0	0	0	0
Soft Drinks		100	48	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar		100	400	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar Cane[k]		100[s]	62	.6	0	0	0	0	0	0	0	0	0	0	0	0
Samosa[t]		100	498	7.3	6.25	1.17	274	478	422	236	494	233	76	297	2510	6376
Tomato Paste		100	30	0	0	0	0	0	0	0	0	0	0	0	0	0
Tomato Powder[u]		100	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FOOTNOTES TO TABLE B-1

a) Number of times a household reported food item eaten.

b) Information on edible portion was either taken from Latham [1965] or was actually sampled and measured.

c) Values for kilo calories (KCAL) were taken from Latham [1965], FAO [1968, 1972] and USDA [1960]. Most entries came from the first two sources.

d) Protein content was taken from Latham [1965], FAO [1968, 1970, 1972] and USDA [1960]. Most entries came from Latham [1965] and FAO [1970].

e) Nitrogen conversion factors (NCF) and grams of nitrogen were taken from FAO [1970]. Where food items were not contained in this reference, conversion factors were assumed to be the same as the primary item from which they were derived or a similar item. In these cases grams of nitrogen were calculated from protein content using the appropriate NCF.

f) Taken from FAO [1970].

g) The edible portion of different varieties of bananas varies considerably and depends on maturity as well as variety. Only the edible portion of the local measure for each variety and maturity was measured in the field samples and was then converted directly from local measure to grams.

h) Assuming 2/3 maize and 1/3 cassava by weight.

i) Assuming contains 3/4 as much cystine as methionine. Cystine was not measured.

j) Estimated.

k) Amino acid figures were not available. We have assumed no amino acids are supplied by this item.

l) Measured net of waste and converted directly from local measure to grams.

m) Assuming contains 2/3 as much tyrosine as phenylalanine. Tyrosine was not measured.

n) Value for cystine not available. Assumed to be the same as for sterilized milk.

o) Amino acid content assumed to be the same as mutton. Actual figures not available.

p) As a percent of live weight.

q) Amino acid content assumed to be the same as milk.

r) Grossly underreported and not included in computation of food consumption.

s) Only juice content measured.

t) Assuming 25% beef, 25% wheat flour, 25% fat and 25% water and vegetables by weight.

u) Food composition unknown. Assumed to have no nutritive value.

Table B-2 MILLIGRAMS OF AMINO ACIDS REQUIRED PER GRAM OF PROTEIN WHEN PROTEIN IS SUPPLIED IN AN AMOUNT TO MEET THE REQUIREMENT

Essential Amino Acid	Age Group				WHO/FAO Provisional Scoring Pattern[b]
	Infant[a]	2-5[a]	10-12[b]	Adult[b]	
Isoleucine	46	40	37	18	40
Leucine	93	70	56	25	70
Lysine	66	57	75	22	55
Methionine/ Cystine	42	42	34	24	35
Plenylalanine/ Tyrosine	86	77	34	25	60
Threonine	43	40	44	13	40
Tryptophan	17	10	4.6	6.5	10
Valine	55	50	41	18	50
TOTAL	448	386	325.6	151.5	360

[a]Taken from Hegsted [1973], p. 289. Excludes requirement for Histidine.

[b]Taken from FAO/WHO [1973], pp. 55, 57.

TABLE G-3a

AGE SPECIFIC WEIGHTS, ENERGY REQUIREMENTS, SAFE LEVEL OF PROTEIN INTAKE UTILIZED FOR MALES,[a] IN COMPUTING HOUSEHOLD REQUIREMENTS

A	B	C	D	E	F	G	H
Age (Years)	Reference Weight (Kgs.)	Energy per Kg. per Day (kcal)[e]	Calculated Caloric (kcal) Requirement (BXC)	Caloric Requirement Utilized (kcal)	Safe Level of Protein Intake per Kg. per Day (Grams)[f]	Calculated Protein Requirement in Grams (BXF)	Protein Requirement Utilized (Grams/day)
.01-.99	7.3	112	818	820	1.74	12.7	13
1	11.4	103	1174	1180	1.27	14.5	15
2	13.6	100	1360	1360	1.19	16.2	17
3	15.6	100	1560	1560	1.12	17.5	18
4	17.4	99	1723	1720	1.06	18.4	19
5	20.7	91	1883	1880	1.01	20.9	21
6	23.2	87	2018	2020	.98	22.7	23
7	25.9	83	2150	2150	.92	23.8	24
8	28.6	79	2259	2260	.87	24.9	25
9	31.3	76	2379	2380	.85	26.6	27
10	33.9	74	2509	2500	.82	27.8	28
11	36.7	71	2606	2610	.81	29.7	30
12	40.2	67	2693	2690	.78	31.4	32
13	42.8[b]	61	2610	2610	.77	33.0	33
14	45.5[b]	56	2548	2550	.72	32.8	33
15	48.1[c]	53	2549	2550	.67	32.2	33
16	51.3[c]	51	2616	2620	.64	32.8	33
17	53.0[c]	50	2650	2650	.61	32.3	33
18	54.1[c]	49	2651	2650	.59[b]	31.9	32
19	55.0[d]	47	2585	2590	.57	31.4	32
20-39	55.0[d]	46	2530	2530	.57	31.4	32
40-49	55.0[d]	44	2420	2420	.57	31.4	32
50-59	55.0[d]	41	2255	2260	.57	31.4	32
60-69	55.0[d]	37	2035	2040	.57	31.4	32
70+	55.0[d]	32	1760	1760	.57	31.4	32

[a]Assuming moderately active level of activity.

[b]Interpolated.

[c]85% of reference weights as defined by FAO/WHO (FAO, 1973, Table 7).

[d]Average weight for East African adults as indicated by Latham [1965]. This is 85% of the FAO/WHO reference weights [FAO, 1973].

[e]Taken from FAO [1973], Tables 5, 6 and 7.

[f]Taken from FAO [1973] Table 23.

TABLE B-3b

AGE SPECIFIC WEIGHTS, ENERGY REQUIREMENTS AND SAFE LEVEL OF PROTEIN INTAKE UTILIZED FOR FEMALES[a] IN COMPUTING HOUSEHOLD REQUIREMENTS

A	B	C	D	E	F	G	H
Age (Years)	Reference Weight (Kgs.)	Energy per Kg. per Day (Kcal)[e]	Calculated Caloric (Kcal) Requirement (BXC)	Caloric Requirement Utilized (Kcal)	Safe Level of Protein Intake per Kg per Day[f] (Grams)	Calculated Protein Requirement in grams (B x F)	Protein Requirement Utilized (Grams/day)
.01-.99	7.3	112	818	820	1.74	12.7	13
1	11.1	106	1177	1180	1.27	14.1	14
2	13.4	100	1340	1340	1.19	15.9	16
3	15.4	99	1524	1530	1.12	17.2	18
4	17.5	96	1680	1680	1.06	18.6	19
5	20.0	90	1800	1800	1.01	20.2	21
6	22.4	85	1904	1900	.98	22.0	22
7	25.0	80	2000	2000	.92	23.0	23
8	27.6	76	2098	2100	.87	24.0	24
9	30.4	73	2219	2220	.85	25.8	26
10	33.8	68	2298	2300	.81	27.4	28
11	37.7	62	2337	2340	.76	28.7	29
12	42.4	57	2417	2420	.74	31.4	32
13	43.1[b]	61	2629	2630	.68	29.3	30
14	43.8[b]	59	2584	2580	.62	27.2	28
15	44.5[c]	56	2492	2490	.59	26.3	27
16	45.6[c]	53	2417	2420	.58	26.4	27
17	46.1[c]	50	2305	2310	.57	26.3	27
18	46.4[c]	49	2274	2270	.55[b]	25.5	26
19	47.0[d]	47	2209	2210	.52	24.4	25
20-39	47.0[d]	47	2209	2210	.52	24.4	25
40-49	47.0[d]	45	2115	2120	.52	24.4	25
50-59	47.0[d]	36	1692	1700	.52	24.4	25
60-69	47.0[d]	32	1504	1500	.52	24.4	25
70+	47.0[d]	28	1316	1320	.52	24.4	25

[a]Assuming moderate level of activity for ages 1-12 and 50 and above and very active level of activity for ages 13-49.

[b]Interpolated.

[c]85% of reference weights as defined by FAO/WHO (FAO, 1973, Table 7).

[d]Average weight of East African adults as indicated by Latham [1965]. This is 85% of the FAO/WHO reference weights [FAO, 1973].

[e]Taken from FAO [1973], Tables 5, 6 and 7 with 17% increase for ages 13-49 to reflect activity level (p. 83).

[f]Taken from FAO [1973], Table 23.

TABLE B-4a

AGE SPECIFIC AMINO ACID REQUIREMENTS UTILIZED FOR MALES IN COMPUTING HOUSEHOLD REQUIREMENTS

Age (Years)	Miligrams of Amino Acids Required[a]								Total Essential Amino Acids
	Isoleucine	Leucine	Lysine	Methionine-Cystine	Phenylalanine Tyrosine	Threonine	Tryptophan	Valine	
.01-.99	598	1209	858	546	1118	559	221	715	5824
1	645	1223	923	630	1223	623	203	738	6258
2	680	1190	969	714	1309	680	170	850	6562
3	720	1260	1026	756	1386	720	180	900	6948
4	760	1330	1083	798	1463	760	190	950	7334
5	842	1470	1197	882	1617	840	210	1050	8108
6	906	1546	1394	929	1573	933	205	1108	8599
7	931	1546	1541	931	1435	998	188	1114	8684
8	955	1540	1695	930	1280	1060	169	1115	8744
9	1015	1528	1928	961	1150	1166	153	1156	9117
10	1036	1568	2100	952	952	1232	129	1148	9117
11	1110	1680	2250	1020	1020	1320	138	1230	9768
12	1184	1792	2400	1088	1088	1408	147	1312	10419
13	1131	1702	2225	1075	1080	1306	161	1245	9925
14	1042	1556	1975	1028	1037	1160	170	1136	9104
15	950	1410	1725	979	994	1014	179	1028	8279
16	861	1264	1475	933	952	868	187	920	7460
17	772	1117	1226	886	909	721	196	811	6638
18	662	942	946	813	841	558	199	681	5642
19	576	800	704	768	800	416	208	576	4848
20-39	576	800	704	768	800	416	208	576	4848
40-49	576	800	704	768	800	416	208	576	4848
50-59	576	800	704	768	800	416	208	576	4848
60-69	576	800	704	768	800	416	208	576	4848
70+	576	800	704	768	800	416	208	576	4848

[a] When protein is consumed at safe levels. Values are calculated by multiplying values in column H by the values in Table B-3. Requirements per gram of protein for ages 1, 6-9 and 11-18 are interpolated from Table B-3 and then multiplied by column H.

TABLE 8-48

AGE SPECIFIC AMINO ACID REQUIREMENTS UTILIZED FOR FEMALES IN COMPUTING HOUSEHOLD REQUIREMENTS

Age (Years)	Miligrams of Amino Acids Required[a]								Total Essential Amino Acids
	Isoleucine	Leucine	Lysine	Methionine-Cystine	Phenylalanine Tyrosine	Threonine	Tryptophan	Valine	
.01-.99	598	1209	858	546	1118	559	221	715	5824
1	502	1141	861	588	1141	581	129	735	5838
2	540	1120	912	672	1232	640	160	800	6176
3	720	1260	1026	756	1386	720	180	900	6948
4	760	1330	1083	798	1463	760	190	950	7334
5	842	1470	1197	882	1617	840	210	1050	8108
6	867	1478	1333	889	1505	898	196	1060	8226
7	892	1481	1477	892	1375	957	180	1067	8321
8	917	1478	1627	893	1229	1018	162	1070	8394
9	978	1529	1856	926	1108	1123	148	1113	8781
10	1036	1568	2100	952	952	1232	129	1148	9117
11	1073	1624	2175	986	986	1276	133	1189	9442
12	1184	1792	2400	1088	1088	1408	147	1312	10419
13	1029	1547	2023	1067	981	1187	146	1131	9111
14	884	1320	1676	934	880	984	144	964	7786
15	779	1153	1412	801	810	829	146	841	6771
16	706	1034	1207	763	779	710	153	752	6104
17	633	914	1003	725	744	590	161	664	5434
18	539	765	769	661	683	453	162	553	4585
19	450	625	550	600	625	325	163	450	3738
20-39	450	625	550	600	625	325	163	450	3788
40-49	450	625	550	600	625	325	163	450	3788
50-59	450	625	550	600	625	325	163	450	3788
60-69	450	625	550	600	625	325	163	450	3788
70+	450	625	550	600	625	325	163	450	3788

[a]When protein is consumed at safe levels. Values are calculated by multiplying values in column H by the values in Table 8-3. Requirements per gram of protein for ages 1, 6-9 and 11-18 are interpolated from Table 8-3 and then multiplied by column H.

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