# MSU RURAL DEVELOPMENT SERIES

## WORKING PAPER

FOOD CONSUMPTION BEHAVIOR:
RURAL SIERRA LEONE AND
KANO STATE, NIGERIA

By

Victor E. Smith, John Strauss
William Whelan, David Trechter
and Peter Schmidt

Working Paper No. 24, 1982

**Department of Agricultural Economics**
**Michigan State University**
**East Lansing, Michigan 48824**

## MSU RURAL DEVELOPMENT WORKING PAPERS

Carl K. Eicher and Carl Liedholm Co-editors

The MSU Rural Development Working Papers series is designed to report the preliminary results of comparative studies of rural development in Africa, Latin America, Asia, and the Near East. The papers will report research findings on community development and rural development in historical perspective as well as studies of contemporary rural development programs. The series will include papers on a wide range of topics such as alternative rural development strategies; off-farm employment and small-scale industry; alternative farming systems; marketing problems of small farmers; agricultural extension; interrelationships between technology employment, and income distribution; and evaluation of rural development projects.

The papers are aimed at teachers, researchers, policy-makers, donor agencies, and rural development practitioners. Libraries, individuals, and institutions may obtain single copies of the MSU papers free of charge and may request their names by placed on a mailing list for periodic notification of published papers by writing to:

MSU Rural Development Working Papers
Department of Agricultural Economics
Michigan State University
East Lansing, Michigan 48824
U.S.A.

# FOOD CONSUMPTION BEHAVIOR: RURAL SIERRA LEONE AND KANO STATE, NIGERIA

By

Victor E. Smith**, John Strauss*, William Whelan*,
David Trechter*, and Peter Schmidt**

FINAL REPORT

CONSUMPTION EFFECTS OF ECONOMIC POLICY PROJECT
USAID CONTRACT NO. AID/DSAN-C-0008

Working Paper No. 24, MSU Rural Development Working Paper Series
Department of Agricultural Economics
Michigan State University

*Graduate Research Assistant, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan
**Professor, Department of Economics, Michigan State University, East Lansing, Michigan

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES





## PREFACE


The research here reported was done under a project entitled "Consumption Effects of Economic Policy," funded by the United States Agency for International Development. The project had two principal goals: (1) to develop effective methods for analyzing the effects of economic policies or events upon the food-consumption behavior of semi-subsistence households and (2) to obtain factual information about food consumption patterns and their determinants. The data were those collected in Sierra Leone in 1974-75 under the direction of Dr. Dunstan S.C. Spencer and Dr. Derek Byerlee (under the Rural Employment Research Project at Njala University College, Sierra Leone), plus those collected by Peter Matlon during the same period in three villages in Kano State, Nigeria.

Although neither set of data was collected specifically for the study of food consumption and nutrition, it was possible to derive from them a mass of information on these topics that was previously unavailable for these geographical locations. The data show clearly that semi-subsistence households respond to economic factors and that the methods we have employed can measure such responses.

During the course of this project many persons other than those listed as authors of the several project reports have aided us with their advice, interest and cooperation. Our major debt, of course, is to Dunstan Spencer, Derek Byerlee and Peter Matlon, whose data made the study possible and whose help in interpreting the data was invaluable. Among the many others to whom we are grateful we can mention only a few, but that number must include Norman Sheldon, Agricultural Development Officer, US AID; Nancy Minett, Assistant Country Director, CARE, Sierra Leone; Gladys Carrol, Nutritionist, Sierra Leone Ministry of Health; Ibi May-Parker, Bank of Sierra-Leone; Dr. Joseph Tommy and Mr. Tom Roberts, Department of Agricultural Economics and Extension, Njala University College; and Agnes Becker, graduate student from Sierra Leone. To these and many others we express our deep appreciation.



## INTRODUCTION

Malnutrition and the threat of malnutrition are continuing problems among those rural masses of the developing countries who depend upon their own production for large parts of the food they consume. A few years ago Reutlinger and Selowsky, estimating that by 1975 over a billion people would be receiving less than the recommended daily caloric intake, predicted that the problem was unlikely to disappear in the normal course of economic development [1976, pp. 4, 7, 30]. In West Africa at least the situation seems to have grown worse.

The problems of malnutrition are complicated by economic change -- the processes of economic development and the government policies adopted in support of that goal. There is widespread agreement that economic change has major effects upon nutritional levels in the populations affected, but little is known in detail about the responses of individual households to the changes that occur during development or about the effects on household nutrition of the adjustments in agricultural production that occur as the result of governmental policies with respect to price, market opportunities or technical change. Quantitative measures of the effects of such policies are desperately needed.

Some assert that households producing most of their own food are relatively immune to the effects of such policies, on the ground that their primary concern is with providing food for their households and that this is a matter related to physical and environmental opportunities, but little affected by market conditions. Others hold that many or most of the households that produce large parts of their own food have access to the market for at least some of the crops they produce or could produce and that responses to the market do indeed affect their consumption behavior. If subsistence and semi-subsistence households do respond to the market, we must have quantitative information about the nature of those responses, and about how their consumption decisions are affected by changes in the production patterns that may occur.

Such quantitative information as exists with respect to consumption responses to economic determinants concerns mostly either urban households or nations as a whole. Valuable as such information is, we must be more specific. We must have information that relates specifically to rural households and information that is disaggregated by income group or such other relevant classifications as region or type of production. We also need to know the effects of production for the market upon consumption behavior and nutritional levels. Examples are often cited in which the nutritional level of a particular locality is reduced when the farmers in these areas begin to shift from production for their own consumption to the production of cash crops. Others of course cite the remarkable advances in overall food availability that have occurred in areas where production for the market has largely replaced production for the consumption of the individual household. The issue is joined; for its solution we need more empirical evidence. For any consideration of agricultural policy and its nutritional consequences it is important that we be able to predict whether an increase in market orientation will improve or worsen the nutritional well-being of the rural population. Only then can such effects be taken into account in designing agricultural policy.

In response to these needs, the United States Agency for International Development funded this study of the economic determinants of consumption behavior. Using data collected during 1974-75 in Sierra Leone and in three villages in Kano State, Nigeria, we were to develop methods for obtaining quantitative estimates of the effects of income (expenditure) and prices upon the consumption decisions of rural households (and the nutrients available to them) so that it would be possible to predict the effects of economic policy on such households.

Various questions were raised about the feasibility of such a project. Is it possible to make an economic analysis of the consumption decisions of households engaged in subsistence and semi-subsistence agriculture? Do such households respond to economic incentives? Can the economist analyze their responses, given the fact that much of what they consume does not pass through the market? Microeconomics, after all, is a study of market processes. What can be done when the household produces its own food rather than buys it from the market?

The data to be used were collected during year-long surveys of farm and non-farm production by rural households in Sierra Leone and in three villages of Kano State, Nigeria. Although expenditure data were collected, the emphasis was on household production activities. There was no original intention to study food consumption behavior. Is it possible to get useful information about the quantities of food consumed by individual households when the data were not collected originally with this intention, when they were based on recall periods of three or four days in length, and when they were based on studies of household expenditure and household production and sales, with no



direct observation of household consumption? Some students of food consumption and nutrition felt that results obtained in this way would be worthless.

These were also cross-section data, collected over a period of one year. Some economists asked whether it would be possible to obtain price elasticities from cross-section data. Or would there be so little price variation within the sample that useful relationships between prices and the quantities consumed could not be obtained?

What we found, for the rural households studied, was that consumption behavior was related to the market, that the survey methods used in collecting the production and expenditure data did provide useful and reasonably reliable information about consumption behavior, and that in these countries, where high transportation costs provided barriers to price equalization among markets, the cross-section data could be used to measure household consumption adjustments that were related to price variation. The evidence in support of these conclusions is contained in what follows and in the detailed reports dealing with particular parts of the study. In the first five chapters of this report we present results obtained from the Sierra Leone data; Chapter 6 summarizes the results obtained from the Kano State data.

CHAPTER I

# ESTIMATING FOOD CONSUMPTION

## The Nutritional Situation

The only recent study of nutritional conditions in Sierra Leone as a whole is the National Nutrition Survey, completed in 1978 by the Ministry of Health of Sierra Leone in cooperation with the University of California at Los Angeles. This study, directed toward determining the nutritional status of children under five, found the principal nutritional problems to be undernutrition and anemia, both more serious in rural than in urban areas.

In Sierra Leone as a whole, 30.5 percent of the young children were underweight (weighed less than 80 percent of the expected weight for a reference child of the same age). In rural Sierra Leone the percentage was 32.4. In the country as a whole, 24.2 percent of the young children were chronically undernourished (had attained less than 90 percent of the expected height of a reference child of the same age). In rural areas the percentage was 26.6 percent. Acute undernutrition (weighing less than 80 percent of the expected weight for a reference child of the same height) was less common, affecting only 3.0 percent of the children, but 9.3 percent of the children between 12 and 14 months of age. However, the survey was taken between November and March, when food is generally believed to be more plentiful than later, during the rainy season. [Sierra Leone, 1978, National Nutrition Survey, pp. xii-xiv, 40.]

Anemia was found in more than 50 percent of the children tested. By one measure, it occurred in 76.6 percent of the children in the Southern Province, in 57.2 percent of those in the Eastern Province and in 42.7 percent of those in the North. For the country as a whole, 73 percent of the cases of anemia were classified as mild, 26 percent as moderate, and 1 percent as severe. The type of anemia found indicated that iron deficiency was the major factor, but folate deficiency, although important, was much less so. Malaria was also a major factor, and hookworm infestation may have contributed. Anemia, like the various types of undernutrition, was more serious in rural than in urban areas. [Sierra Leone, 1978, National Nutrition Survey, pp. xxii, xxiv, 86-89.]

The National Nutrition Survey is the only recent study that is at all comprehensive. Kathryn Kolasa's report for this project, "The Nutritional Situation in Sierra Leone" [1979], is a thorough survey of information available in 1978 from all sources.

## Estimating the Quantities Consumed

To understand the nutritional problems of any country, it is necessary to know not only what people are consuming, but also what factors determine the quantities of foods consumed. Understanding the nutritional implications of any set of food consumption data requires that foods be defined in considerable detail. Dealing with broad groups of commodities like cereals, root crops, fruits or vegetables overlooks real nutritional differences that exist among the components of those groups. Dark green leaves (spinach, pigweed, sweet potato tops) are high in vitamin A, vitamin C and protein, but eggplant and dry onions are low in these vitamins. Mango and papayas are excellent sources of vitamin A; citrus fruits are not. Furthermore, the composition of broadly defined food groups may change greatly from one part of a country to another, so the same food group may have different nutritional significance in different areas. While it may be necessary to combine commodities for convenience in presentation or to reduce the number of variables to be dealt with, it is still important that the original materials be available in such detail that in selecting the grouping scheme one may see to it that the groups finally chosen are suitable for the types of nutritional problems that are of most concern. Moreover, converting physical quantities into their nutritional equivalents is best done by going back to the original commodity detail, especially where the composition of a particular food group changes appreciably from one area of the country to another.

We must also understand why people consume what they do, yet most surveys of food consumption collect little information (other than family size, income or geographical location) that is useful for explaining food consumption behavior. Some do not provide even that much, let alone information about prices, source of income, or other relevant variables. For a study that is ultimately concerned with the nutritional implications



of food consumption behavior, the essential requirements include data on the quantities of foods consumed (expenditure data alone will not suffice), a great deal of quantity detail, prices, income or expenditure information (or records of the quantities of the physical resources available), data on relevant household characteristics (size, composition by age and sex, ethnic group, location, and so forth), and, if we are dealing with subsistence or semi-subsistence households, comprehensive information about both the production and consumption side of household activities. For a study of rural households, consumption data must span the entire agricultural year, preferably from harvest to harvest, for strong seasonality in consumption is to be expected where households produce large quantities of their own food, and only a sampling procedure that collects information in all seasons of the year can be expected to lead to unbiased results. Furthermore, if a study of seasonal patterns in consumption is intended, reliable data on the quantities of foods and crops in storage is also needed: beginning and ending inventories, and amounts in storage at regular intervals during the year.

## Data Available

In 1974-75 the Rural Employment Research Project at Njala University College of the of University of Sierra Leone conducted a nationwide survey of rural household farm and nonfarm activities in Sierra Leone. The project was financed by the Rockefeller Foundation and by a contract, AID/cds 3625, between the United States Agency for International Development and Michigan State University. Through twice weekly interviews over a period of 12 to 14 months it collected detailed data concerning the whole range of farm and nonfarm production activities. Data on household expenditures were collected from half the households by interviews scheduled to occur twice during one week of each month. The sampling and interviewing procedures are described in Smith et al., 1979, Chapter 3 and Appendix 2.

The sample was stratified in such a way as to provide equal representation of all the major agro-climatic or resource regions, which we shall call ecological zones. Two parts of Sierra Leone were excluded: the Western Area because it is primarily urban and the northern part of the Eastern Province because the patterns of agricultural behavior there were likely to be affected by the presence of diamond mining. The remainder of the country was divided into eight zones, Numbers 1, 3, 5 and 7 of which constitute the Northern Province and Numbers 2, 4 and 8 of which correspond closely to the Soutern Province. (See Figure 1.) Zone Six represents roughly the southern two-thirds of the Eastern Province.

For the purpose of estimating quantities of food consumed the fact that the data were collected as part of a larger survey of household production activities created problems as well as opportunities. Because food consumption was not the central focus of the investigation, there was not the same emphasis on precision with respect to expenditure and food production data that there was with respect to the major farming activities (rice production, in particular). A study designed solely to obtain food consumption information for use in estimating household nutrient intake might have used shorter recall periods, for instance, or provided for weighing the quantities of food consumed.

## Making the Estimates

The food consumed by rural households in Sierra Leone is either purchased from the market or produced by the household itself.[1] We used household expenditure data to estimate the quantities of foods purchased from the market and production and sales data to estimate the quantities of foods available for home consumption. The latter was done by the disappearance method. From the quantity harvested we subtracted the quantities sold, used for seed (in the case of rice only)[2], paid out as wages in kind for hired labor, or used for processing. The remainder was adjusted for losses in storage. Although we shall often speak of our estimates as quantities of food consumed, it is evident from the method of estimation that they are in fact simply quantities of food available for consumption. Details of the procedure are presented in Smith et al., 1979, pp. 33-35. Similar estimates of the quantities of food available for consumption by rural households in three villages in Kano State, Nigeria, are described in Smith, et al., 1982. See also Chapter 6 of the present report.

[1] Food may also be obtained in kind in the form of gifts and loans or loan repayments, but we do not attempt to adjust for this component.

[2] None was used as animal feed.



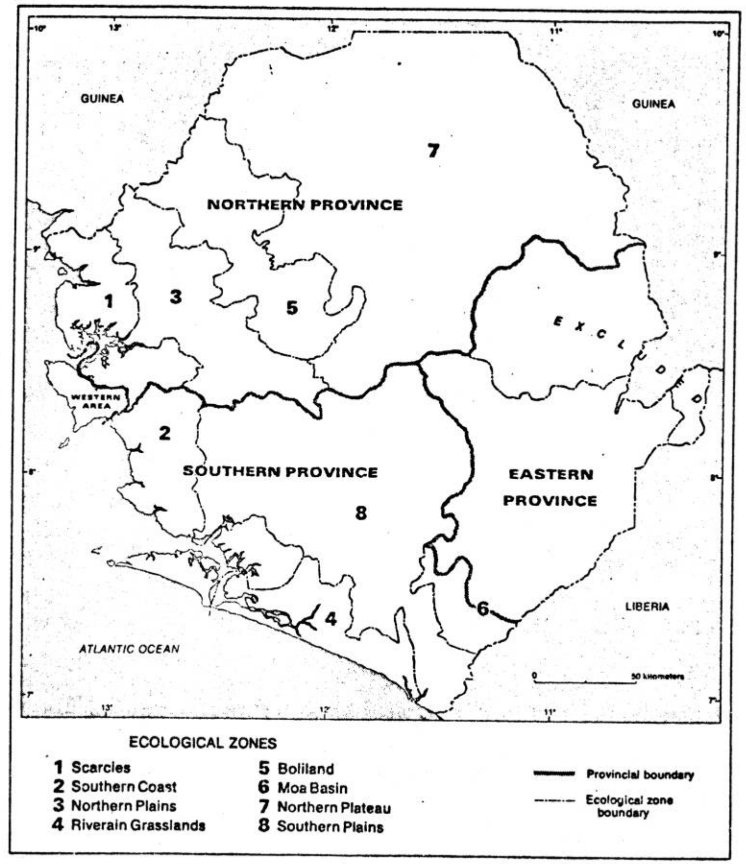


Figure 1

Sierra Leone: Ecological Zones

# CHAPTER II

## FOOD CONSUMPTION PATTERNS - RURAL SIERRA LEONE

Detailed quantitative information about the entire range of household food consumption is rare in Sierra Leone. These estimates, based on data from the comprehensive 1974-75 survey of rural production and expenditure done by the Rural Employment Research Project at Njala University College, fill an important gap.

The data in this chapter describe the sample rather than the total rural population of the areas sampled. The sample was stratified by resource region, to give good representation of the range of production activities carried on in rural Sierra Leone. It was planned to contain representatives of each important type of farming, but not to be proportional to the frequency of occurrence of each type of farming or to the number of people in each resource region. Population estimates of the quantities consumed per capita will be presented later in this report (in Chapter 5).

The 1974-75 survey was planned to provide a sample of 500 households. Because of enumerator failure or dishonesty, missed interviews and gaps or inaccuracies in the data, the number of households included in the final production sample was only 328. As the expenditure survey was conducted for only half of the households in the production sample, the number of households available for use in a consumption study was necessarily much smaller. Actually only 140 households (at some later stages of the work, 138) were suitable for our use. In this situation the question immediately arises whether the sample of 140 households constitutes a representative sampling from the total production sample. This question was examined at length in Chapter 2 of Smith, et al., 1980, with the result that the consumption sample was found to be reasonably representative of the larger sample from which it was drawn. Estimates of the distribution of the values of sample characteristics are of course less reliable than estimates of their means.

### Annual Consumption Levels

Table 2.1 shows the quantities available for consumption of each of 26 different foods or groups of foods. These 26 constitute the whole diet. They represent groupings of consumption estimates for 100 different foods. (The detailed estimates were reported in Smith et al., 1980, pp. 27-30, and -- an earlier version -- in Smith et al., 1979, pp. 38-41.) Table 2.1 records

TABLE 2.1

MEAN ANNUAL CONSUMPTION, ALL HOUSEHOLDS IN SAMPLE, BY COMMODITY GROUP--RURAL SIERRA LEONE
(Kilograms)

| Commodity Group | Quantity per Household | Quantity per Capita | Quantity per Consumer Equivalent |
|---|---|---|---|
| Clean rice | 612 | 93 | 126 |
| Other cereals | 116 | 18 | 24 |
| Cassava | 343 | 52 | 71 |
| Cassava products | 34 | 5 | 7 |
| Yams | 4 | 1 | 1 |
| Other root crops | 4 | 1 | 1 |
| Palm oil | 83 | 13 | 17 |
| Palm kernel oil | 1 | 0 | 0 |
| Other oils and fats | 9 | 1 | 2 |
| Groundnuts | 68 | 10 | 14 |
| Other legumes | 24 | 4 | 5 |
| Fish: saltwater, fresh or frozen | 114 | 17 | 23 |
| Fish: saltwater, dried | 140 | 21 | 29 |
| Other fish | 16 | 2 | 3 |
| Game | 8 | 1 | 2 |
| Other meat | 8 | 1 | 2 |
| Other animal products | 2 | 0 | 0 |
| Vegetables | 81 | 12 | 17 |
| Citrus fruits | 17 | 3 | 3 |
| Banana, plantain and avocado | 0 | 0 | 0 |
| Other fruits | 15 | 2 | 3 |
| Sugar | 3 | 0 | 1 |
| Salt and other condiments | 15 | 2 | 3 |
| Kolanut | 10 | 2 | 2 |
| Beverages, non-alcoholic | 6 | 1 | 1 |
| Beverages, alcoholic | 118 | 18 | 24 |
| Meals | -35[a] | -5[a] | -6[a] |

[a]Meals measured in numbers. A negative entry means meals paid out.



quantities per household, per capita and per adult male consumer equivalent, averaged over all households in the sample. Equivalent data for consuming households only will be found in Smith et al., 1980, p. 33.

The most important foods were rice, palm oil, dried fish and cassava; every household consumed rice, nearly every household consumed dried fish and palm oil, and eighty-two percent of the households consumed cassava. Annual rice consumption per household, 612 kg per year, was equivalent to .56 lb or 924 calories per person per day. This is consistent with Central Statistics Office estimates of rural rice consumption in 1969/70 of .56 and .53 pounds per day [Sierra Leone, Central Statistics Office, 1972, pp. 45, 48, 51]. For more detailed analysis of household consumption figures see Smith et al., 1979, pages 37-45.

The total calories available from the whole diet amounted to an average for the sample of 2109 per capita per day [Strauss et al., 1981b, pp. 67-69]. This may be compared to FAO estimates (for 1972-74 and 1975-77) of 2090 calories per capita per day for the country as a whole. [United Nations, Food and Agriculture Organization, 1980, p. A.41.]

## Factors Affecting Consumption

Working Papers 7 and 12 [Smith et al., 1979, 1980] contain the details of tabular analyses made in a preliminary examination of non-price factors that affect household food consumption in rural Sierra Leone. There is also a discussion [pp. 72-74 of Smith et al., 1980] of factors associated with being a non-consuming household. Tabular analysis is easy and inexpensive, but its effectiveness is severily limited when used with a sample as small as ours (140 cases). Perhaps its most important advantage is that the results are easily understood. One can see the magnitudes involved (how much rice is consumed by the average household in a given classification), observe the relationships that exist between the dependent variable and independent variables taken singly or jointly, and judge for himself their strength and consistency. Tabulation and cross-tabulation provide realistic and intimate knowledge of the data--knowledge not easily obtained in other ways. In addition, tabular analysis is not restricted by prior decisions about the form of the function that relates the dependent variable to the independent variables. The form revealed by the data will be whatever the data require -- a real advantage indeed.

While the results of tabulation analysis appear straightforward and easily interpreted, they may also be deceptive. Where only a small number of cross-tabulations is possible important changes in omitted independent variables may occur for which the tabular analysis cannot control. When looking at cross-tabulations it is easy to see what is not there. An independent variable may appear to be related to the dependent variable when in fact the true relationship is with still another variable closely correlated with the one that happened to be used in the tabulation. It is also easy to fail to see something that is there. A variable that has significant influence, given the levels of the other relevant variables, may appear unrelated to the dependent variable because changes in other independent variables have masked the influence of the variable under examination. For discussion of other disadvantages of the tabular method, see pp. 75-78 in Smith et al., 1980.

In the tabular analysis the dependent variable was consumption per adult male consumer equivalent. As household size and composition clearly have considerable effects upon consumption levels, it is necessary to adjust for these before attempting to detect the influence of other variables. However, dividing the quantity consumed by the number of consumer equivalents does not entirely remove the influence of household size and composition. The relationship need not be linear. For rice, cassava and palm oil, consumption per consumer equivalent fell as the number of consumer equivalents rose. (The economist would say there were "economies of scale"; the nutritionist would say people were less well fed.) This was not the case for groundnuts. While larger households tend to have larger incomes, on balance their members do not appear to eat as well as the members of households with fewer consumer equivalents. [See Table 5.7, Smith et al., 1979.]

In addition, the consumer equivalent unit is inherently an arbitrary measure of household size and composition. As we shall see when we look at the results of the regression analysis, different components of the household affect consumption in different ways for any particular commodity and the relationship between household size and composition and the quantities consumed differs among commodities as well as among household members. An alternative way of accounting for household size and household composition is to use the dependency ratio as an independent variable. This also is an inherently arbitrary measure, which did not prove to be useful in most of the regression analyses. The usual hypothesis, that high dependency ratios are associated with low consumption per consumer equivalent, was supported for a number of foods [Table 5.6 of Smith et al., 1979] but only for cassava and palm oil among the six important foods treated in Smith et al., 1980 [pp. 43-66]. Plausible as this relationship may seem it cannot be



relied upon generally.

In general, the tabular analysis showed that consumption rises with income per consumer equivalent, except for alcoholic beverages (and for cassava in the North), but the relationship is not consistent among subgroups of households. In both the Northern and Southern regions, cassava consumption falls off somewhat in the highest income group. The consumption of alcoholic beverages shows no clear relationship with income.

The regional variable is important: households in the Southern region consume large quantities of cassava; those in the South and East use large quantities of palm oil. Northern households consume small amounts of cassava and palm oil but large amounts of vegetables and alcoholic beverages. In the East the consumption of rice, other cereals and cassava is low but these households are large consumers of citrus fruit and kola nut as well as of palm oil. Ethnic origins also make a difference: Limba households are high consumers of alcoholic beverages[1] and cereals other than rice, while Mende households are high consumers of cassava and palm oil.[2]

Nutritionists and others often argue that the level of nutrition of households producing large parts of their own food declines as those households begin to produce more largely for the market. In order to discover whether such was the case in Sierra Leone, we looked at the relationship between quantities of food consumed per consumer equivalent and each of three variables that might be regarded as proxies for dependence upon the market. A related hypothesis, that upland rice production is more conducive to good levels of nutrition than other types of rice production, was also examined.

To deal with these hypotheses thoroughly it would be necessary to examine the relationship between the independent variable and some measure of the total nutrition provided by the diet. This would be possible, by converting quantities of food consumed into their nutritional equivalents, as we do at a later stage with respect to calories, but at this point we look at only individual components of the diet.

From the tabular analyses we find that market orientation (the percentage of the value of total farm and nonfarm output that is sold on the market) has

[1]All Limba households are in the North, which must partially explain the high alcoholic beverage consumption in that region.

[2]In the South, which is a high consuming region for these two foods, almost all the households are Mende. In the East, however, although all the households were Mende, cassava consumption was low.

no clear effect on consumption per consumer equivalent for rice, palm oil or groundnuts, but that consumption of "other cereals", cassava and alcoholic beverages tends to fall as market orientation rises. Of course a decline in the quantity of cassava consumed may represent an improvement in the diet if it is replaced by energy sources that provide larger quantities of protein. However, palm wine, which constitutes well over 90 percent of the alcoholic beverages consumed, is an important source of calories for some households. Moreover the apparent negative relationship between alcoholic beverage consumption and market orientation may appear only because the Limba, who consume large quantities of palm wine, are less oriented toward the market than are members of the other ethnic groups.

If we measure production for the market by the percentage of the value of total output that comes from activities usually engaged in to obtain money income (PCTOUT), two more instances support the general hypothesis that an increase in market activities is associated with lower consumption per consumer equivalent. Rice is one such case (but among the Temne the relationship is the opposite) and cassava is the other. With palm oil consumption the relationship is reversed: low participation in this group of activities (one of which, to be sure, is the production of palm products) is associated with low consumption of palm oil. For the other foods studied in Smith et al., 1980, no clear relationship can be seen between involvement in these kinds of activities and consumption levels per consumer equivalent.

The hypothesis that households producing large shares of their own consumption consume more than other households is supported by the data in three out of the four instances studied: for cassava, palm oil and groundnuts. The exception is rice, for which no clear pattern was established -- but rice is the most important single food consumed in Sierra Leone.

One hypothesis remains: that the quality of the diet improves as households devote larger percentages of their labor to the production of upland rice, because upland rice, unlike other types, is grown with a mixture of other crops. The percentage of labor devoted to upland rice production is positively associated with the consumption of cassava, commonly grown in such mixed plantings. Likewise a low percentage of labor devoted to upland rice is associated with low palm oil consumption. Yet between the two groups of households that most emphasize upland rice these relationships are unclear or even reversed. The production of upland rice has no clear relationship to the consumption of cereals other than rice, groundnuts or alcoholic beverages.



In summary, the hypothesis that production for the market has an adverse effect on the diet finds some support in the data, but more often is not confirmed. Still there are enough instances in which the consumption of a specific food falls as one or the other measure of production for the market rises to remind us that the economist cannot safely ignore the possibility that greater dependence on the market may have adverse effects. More detail on all of these matters may be found in Smith et al., 1979, 1980.

# CHAPTER III

## SINGLE-EQUATION REGRESSIONS - RURAL SIERRA LEONE

### The Semi-Subsistence Household

A major objective of this study was to develop methods for obtaining expenditure (or income) elasticities for low-income rural households that produce much of their own food. Among the problems peculiar to such households is the fact that the food the household consumes does not pass through a market, so food consumption decisions are related to production decisions more directly and perhaps in a different way than would be the case if the only link was the amount of income generated by productive activities. If a major fraction of the food consumed does not pass through the market, the economist cannot assume that data concerning quantities bought and sold in the market will represent accurately the total consumption response to price variation. Moreover, he will have no market prices that apply specifically to the food produced by the household for its own consumption. In addition, there is a problem that confronts all demand analysis, but may be particularly important if the estimates of food consumption behavior are ultimately intended for use in evaluating nutrient availability. This is the fact that strong interrelationships exist among consumption decisions for different kinds of foods.

For the many rural households in developing countries that sell part of their total output on the market, the fact that much of the food consumed does not pass through the market is less serious than many economists have thought in the past. For one thing, there are local markets in which rural households trade with each other; our data for Sierra Leone reveal these to be considerably more significant than may previously have been thought. For another thing, the fact that goods consumed for one's own production do not pass through the market cannot be taken to imply that they are unaffected by market forces. In this work we take account of those forces by valuing all foods consumed within the household at their opportunity costs, defined as follows: For foods obtained from the market, clearly the opportunity cost is the price at which the food was purchased. Foods consumed from home production have an opportunity cost equal to the farm gate sales price at which they could have been sold had they not been consumed. Even if none of the food is in fact sold by a given household we assume that the opportunity exists and that the price received by other households selling that food is the best available measure of that opportunity. In addition to measuring the opportunity cost of consumption from home production this method of valuing home produced food solves the problem of measuring both the value of total consumption and total expenditure (or income) for semi-subsistence households.

Both market and sales prices are calculated as average prices for the ecological zone. If we were to use the prices actually paid by the individual households, this would introduce a large random component, heavily affected by errors of measurement and reporting. Furthermore, the average price for the zone can reasonably be regarded as exogenous, but the prices paid by individual households would be at least partially endogenous, as they would be partially determined within the consumption decision-making process. (See Smith et al., 1981a, pp. 17-18.) Thus we are operating with a conceptual model of the rural household in which the household faces two sets of prices, one for the foods obtained from the market and another one (generally lower) for the foods that it provides for itself from its own production. Costs of handling and marketing prevent these two prices from being brought to equality by competition, just as transportation cost and barriers to the free flow of information prevent prices from being brought to equality among the different ecological zones. It is these price variations from zone to zone that make it possible to determine price elasticities even though we are using cross-section data.

For the purposes of our analysis we combine market and sales prices into a weighted average where the weights in each zone are the shares of the total value of the $i^{th}$ food consumed in that zone that come from the market and from home production. The weights vary from zone to zone as the proportions of food obtained from the market and from home production change. [Smith et al., 1981a, pp. 18-19.]

The fact that these households produce large quantities of their own food means that production and consumption decisions are interrelated. Traditional analysis that views consumption decisions as allocation of a given income among goods purchased from the market is not adequate for semi-subsistence households. Production decisions do, of course, affect consumption through the effect they have on income. This is normally taken account of when setting up a household-firm model, but the relationship may be different in form than that which is customarily assumed. Production decisions may also affect consumption by their effect on the form in which income is produced. A household that produces part of its income in the form of palm oil or groundnuts has access to a larger share of its palm oil or groundnut consumption at the low farm-gate sales price than



does a household that produces the same total income in other ways. With the single-equation regressions we are able to examine the hypothesis that consumption levels for particular commodities are affected by the form of household income as well as its level.

In developing a method for analyzing the food consumption choices of semi-subsistence households, one of our goals was to find a method that would be effective, relatively inexpensive, and simple enough to be carried out in a country that did not have elaborate computer facilities. Such a method would, of course, be the single-equation regression estimation that we are discussing in this chapter. Another objective was to see what might be accomplished with the most powerful methods currently available to the econometrician. The results of that work will be described in Chapter IV. With single equation regressions we can measure the quantitative relations that exist between household food consumption and household expenditure levels, food and non-food prices, household characteristics, the form in which income is received, and the degree of market orientation, among other relevant variables. We cannot, however, take full account of the fact that food consumption decisions are interdependent, in particular that the disturbances are correlated across equations. Taking account of these facts requires systems estimation, which will be employed in Chapter 4.

## The Equations

As the dependent variable we used the annual quantity of a specific food consumed (available for consumption) by the household. The predicting equation is homogeneous of zero degree in prices and incomes. The independent variables enter arithmetically rather than logarithmically, so demand elasticities can vary with income.

### Functional Form

All the single-equation estimates derive from the following model:

$$q_i = f(y, p, h, v, r), \quad (1)$$

where $q_i$, the annual quantity of the $i^{th}$ food available for consumption by the household, is a function of y (household expenditure), p (a vector of prices), h (a vector of household characteristics), v (a vector of variables identifying certain types of production activities, and r (a vector of variables describing the relationship of the household to the market). Because the function is linear in h, v, and r, these operate as shift variables, adjusting the average predicted relationships between quantity and the price and expenditure variables for the shifts in the utility function associated with the household characteristics variables (h), or for the differences in production or market opportunities (or choices), that are reflected in the v and the r variables. Stated algebraically:

$$q_i = \sum_j a_j(p_j/p_i) + b_1(y/p_i) + b_2(y/p_i)^2 + \sum_k c_k h_k + \sum_m d_m v_m + \sum_n e_n r_n \ , \qquad (2)$$

where $q_i$ is the quantity of the $i^{th}$ food consumed by the household, $p_i$ and $p_j$ are the respective prices of the $i^{th}$ and $j^{th}$ foods, y is the total expenditure variable for the household, the $h_k$, $v_m$, and $r_n$ are the elements of the vectors h, v, and r, and the $a_j$, $b_1$, $b_2$, $c_k$, $d_m$, and $e_n$ are the regression coefficients.[1] Doubling each price and expenditure variable has no effect on the quantity consumed. Isolating the term in the relative price of the $i^{th}$ food leads to (3):

$$q_i = a_i + \sum_{j \neq i} a_j(p_j/p_i) + b_1(y/p_i) + b_2(y/p_i)^2 + \sum_k c_k h_k + \sum_m d_m v_m + \sum_n e_n r_n \ . \qquad (3)$$

As the relative price of the $i^{th}$ food is always unity $(p_i/p_i = 1)$, its regression coefficient, $a_i$, appears as the constant term in (3), and the own-price variable does not appear explicitly as an independent variable. Its influence on quantity operates through all the relative price and expenditure variables, as well as the constant term.

If we drop the terms in v and r, (3) becomes a conventional demand regression for a household that receives all its income in money and buys all its goods in the market. Its selection of goods depends upon market prices and the amount of income, but not upon the form in which income is received or how it is produced. To test the hypothesis that the form or source of income matters we include the terms in v and r. If the hypothesis is correct a least squares demand regression that ignores the form or source of income yields biased coefficients[2] whenever the regression is fitted to data from households that produce significant portions of their own food.

---

[1]The regression coefficients are specific for the $i^{th}$ food; they change from food to food.

[2]Because relevant variables have been omitted from the regression.



Equation (3), useful as a test of the hypothesis that production characteristics or decisions affect consumption choices, is not a demand regression in the sense of a structural regression that reveals only the responses that occur on the demand side of the household's calculations. It is a behavioral regression, which predicts the net effect on consumption of both production and consumption responses to the situation faced by the household. A change in a price variable affects both production and consumption decisions; what these regressions show is the net effect on consumption of both sets of decisions. This is what is required by the student of food consumption and nutritional well-being.

In addition to the quantity regressions presented here we calculated share regressions where the dependent variable was $(p_i q_i) \div y$, and quantity regressions for certain groups of households. [See Smith et al., 1981a, Chapters 5 and 6].

<u>Elasticities</u>

The expenditure and price elasticities from these equations vary with expenditure as well as with prices and, in the case of the own-price elasticity, with variables other than price and expenditure. The own-price elasticity, given for the $i^{th}$ food, is:

$$\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i} = -1 + [a_i - b_2(y/p_i)^2 + g]/q_i, \text{ where } g = \sum_k c_k h_k + \sum_m d_m v_m + \sum_n e_n r_n .^{1} \qquad (4)$$

The own-price elasticity will be independent of total expenditure and equal to -1 if $a_i$, $b_2$, and g are equal to zero. The own-price elasticity will be independent of expenditure, but not necessarily equal to -1, if $b_1$ and $b_2$ are equal to zero, for in that case the income term in the enumerator of the second term of the expression will have a value of zero and the $q_i$ in the denominator will itself be independent of income. The value of the constant term in the regression for equation (3), $a_i$, is important in determining the value of the own-price elasticity, but neither its magnitude nor its sign is related in a simple way to that own-price elasticity.

---

[1]From (3), we have $\frac{\partial q_i}{\partial p_i} = \frac{-1}{p_i}[\sum_{j \neq i} a_j \frac{p_j}{p_i} + b_1 \frac{y}{p_i} + 2b_2(y/p_i)^2] =$

$-\frac{1}{p_i}[q_i - a_i + b_2(y/p_i)^2 - g]$. Hence $\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i} = -[\frac{q_i - a_i + b_2(y/p_i)^2 - g}{q_i}] =$

$-1 + [\frac{a_i - b_2(y/p_i)^2 + g}{q_i}]$ .

The cross-price elasticities are:

$$\frac{\partial q_i}{\partial p_j}\frac{p_j}{q_i} = \frac{a_j}{p_i}\frac{p_j}{q_i} = \frac{a_j}{q_i}\frac{p_j}{p_i} . \quad (5)$$

They vary with total expenditure whenever $q_i$ does (when $b_1$ and $b_2$ are not equal to zero).

The income (expenditure) elasticity for the $i^{th}$ food is:

$$\frac{\partial q_i}{\partial y}\frac{y}{q_i} = [b_1 + 2b_2(y/p_i)]\frac{y}{p_i q_i} . \quad (6)$$

It too is a function of income unless $b_1$ and $b_2$ both equal zero or $p_i q_i$ is equal to $ky^2$ for constant $p_i$.

A representative elasticity with respect to the other variables is given by $\frac{\partial q_i}{\partial h_k}\frac{h_k}{q_i} = c_k \frac{h_k}{q_i}$ . This is also a function of income whenever $q_i$ varies with income.

## The Variables

### The Dependent Variable

In the tabulation analysis, quantities "consumed" were simply the sums of purchased quantities plus those available from home production. In the case of alcoholic beverages, however, treating a kilogram of palm wine, low in alcoholic content, as equivalent to one of omole (native gin) was not the best procedure. (It gave us a good measure of the total water consumed in these forms, however.)

In the regression analysis, the quantity consumed by each household is represented by an adjusted kilogram figure which takes into account the fact that market and home produced goods have different properties just as do onions and tomatoes or the components of any group of foods. For each food, the adjusted consumption quantity (q) was calculated as follows for each household:

$$q = \frac{q_h \cdot p_h}{p_a} + \frac{q_m \cdot p_m}{p_a},$$

where $q_h$ and $q_m$, respectively, are the quantities the household produced at home and purchased from the market, $p_h$ and $p_m$ are the average home and market prices for those foods in the ecological zone where the household is located, and $p_a$ is a weighted average of $p_h$ and $p_m$. This definition of quantity consumed



is consistent with theory, for $q \cdot p_a$ equals the expenditure on the food being considered.

For a food group such as fruits or "other legumes," the procedure was the same, replacing $q_h \cdot p_h$ by $\sum_i q_{hi} \cdot p_{hi}$ and $q_m \cdot p_m$ by $\Sigma\, q_{mi} \cdot p_{mi}$, and summing over the i foods in the group, with $p_a$ being the average price for the group of foods.

### Independent Variables

In principle, the number of variables that affect decisions about the quantities of foods to be consumed is limited only by the curiosity of the investigator. In practice, considerations of feasibility arise--we ask ourselves how much time and money are really worth spending on experimentation with variables that have some plausible connection with the consumption decision. In this case, we set an upper limit of 27 (the maximum number that could be handled by the computer program we planned to use) upon the number of independent variables to be made available for use in any one of the quantity equations. The variables fell into three classes: price and expenditure, household characteristics, and those relating to the source of income.

If a household must allocate a fixed monetary income among many consumption goods, economic theory concludes that income (or total expenditure) and the prices of all goods are relevant variables. We include total expenditure and its square plus the prices of rice, cassava, palm oil, dried fish, and non-food goods as variables available to each of the food consumption regressions. The list includes the prices of the four most important widely-consumed foods in rural Sierra Leone. In addition, each food consumption regression includes as an available independent variable the price of that specific food (the own-price variable) and the prices of such other foods as one would expect to be rather closely related in consumption to the dependent variable. The most frequently used of these additional prices is the price of groundnuts, but the prices of fresh fish and of "other cereals" also appear in a number of equations.

The variables relating to household characteristics--size, composition, ethnic group, and region--identify influences that may affect the utility function of the household. Variables relating to size and composition represent household members' physiological needs for food and the effects of any consumption preferences (food or non-food) that may differ by age and sex among the subgroups that comprise the household. These variables also represent the amount and type of labor available within the household.

Ethnic group and region represent differences in customs and taste, differences in ecological characteristics, or differences in the economic opportunities available (including access to the market, to saltwater or freshwater fishing locations, and so forth). The entire set of household characteristics variables was included in the available set for each of the quantity regression equations.

As we have already indicated, students of food consumption behavior often argue that the quantity and quality of food that a household consumes is affected by the source of household income as well as by its amount. The economist, in contrast, often argues that if the time and effort spent in earning the income is held fixed, only the amount of income affects the consumption decisions made at any given set of relative prices. A partial explanation of these different points of view lies in the fact that non-economists examining food consumption behavior frequently do not make adequate observations of incomes and relative prices, and that economists tend to arrive at their conclusions by using a theory that assumes perfectly competitive markets, a clear distinction between production and consumption decisions, and a household that can be thought of as an integrated decision-making unit.

As we have said before, the decision to consume food produced at home is likely to be affected by both the production and the consumption opportunities available. Furthermore, the kind of production chosen (for market or for home consumption) may alter the locus of consumption decisions within the household and thus the nature of those decisions. To test the hypothesis that the source or form of income has an effect on food consumption choices, we include several variables relating to source of income.

In general, these variables fall into two categories: (1) production characteristics--the type of production activity, and (2) market orientation--the extent to which (a) crops are produced for the money income they provide, or (b) the household relies upon the market as a source of food. Three variables identify the extent to which a household engages in certain activities often chosen primarily, if not exclusively, as sources of money income. Each measures the share of the value of total output plus labor sold out that is obtained from a single activity: (1) SHOOPT--the production of



onions, peppers, and tomatoes (if on a large scale, this output is normally intended for sale in urban markets); (2) SHOCC--the production of cocoa or coffee; and (3) SHOLSO--labor sold out for use by other households. These three variables do not comprise all activities engaged in primarily for money income, but they are examples that allow us to examine the hypothesis of interest. They are included in the available set for each food consumption regression.

In two regressions, those for cassava and for palm oil, we also use a more inclusive variable, which is SHOSS--the share of the value of output plus labor sold out which is derived from the three specific sources identified above plus the production of palm oil products and/or any non-farm activity, including fishing. Both the production of oil palm products and fishing are activities that may or may not be primarily devoted to the provision of money income, but when either of these comprises an unusually large fraction of the value of the output of the household, we may reasonably conclude that money income was an important objective.

SHLUR--the share of household labor that is devoted to the production of upland rice--characterizes the type of farming activity from a different point of view. This variable is of interest because intercropping is commonly associated with the production of upland rice. Again, we have experimented with the variable only in the equations for cassava and for palm oil.

The previous five variables distinguish among households in terms of potentially relevant characteristics of their cropping patterns. The first four identify households that apparently have a particular interest in the production of money income, but they do not necessarily identify all such households. A measure of market orientation that applies to all households, but gives no specific information with respect to type of activity, is MKTOR--the total value of sales as a percentage of the value of total output, including the output from non-farm activities. Income from labor sold out or from trading activity is not included in either the numerator or the denominator of this fraction.

The last variable, the share of the household consumption of a given food commodity that the household itself produces, approaches market dependence from a different point of view. In this case, we measure the extent to which the household is free of dependence upon the market in obtaining the food it consumes. Chapter 2 of Smith et al., 1981, discusses the variables in more detail.

Permitting 27 variables to be available for use in a given commodity regression may be regarded as testing the hypothesis that each variable affects the quantity of food consumed. The test is not as sharp as one would like because in some cases several variables are alternative measures of the same underlying factor. In these cases, the data will determine which of the alternative measures are the more useful as predictors of food consumption.

Multicollinearity

Variables were selected for possible use in each equation on theoretical grounds, as explained above. It turned out, however, that for each commodity at least one variable was an almost exact linear combination of other variables in the set--the multiple correlation ($R^2$) between this variable and that combination exceeded 0.9999. In this situation, at least one variable had to be deleted if the necessary matrix inversion operation were to be carried out satisfactorily.

The variables most commonly identified as being substantially linear combinations of the other variables were Region 1, Region 2, and the prices of palm oil, non-food, and cassava. Some of the multicollinearity exists because food prices are calculated for areas which are subdivisions of the regions. There can be at most eight different values for a single price variable, one for each ecological zone. Each region consists of a set of these zones, so it is not surprising that some combination of one of the price variables should exist that could replace the regional variable. If a regional variable is omitted in this situation, whatever influence the regional variable might have had can be picked up by an appropriate combination of variables that was not deleted. Similarly, if the palm oil price is deleted, the regional and other variables may pick up part of its influence.

## The Regressions

We calculated single-equation regressions with quantity consumed as the dependent variable for 14 individual foods (counting fresh fish and dried fish as two of them) and six groups of foods [Smith et al., 1981a, Chapter 4]. The six groups plus the single foods not already in any group comprise almost the whole of the diet in rural Sierra Leone. The regressions were calculated for a sample of 138 households (900 persons).[1] They were fitted to the data for

[1]Two households included in our tabular analysis [Smith et al., 1980] were excluded because data were not available on their non-food expenditures.



consuming households only.[1]

In general, the results are reasonably good. The values of $\bar{R}^2$, the proportion of the variation in the dependent variable accounted for by the influence of the independent variables, adjusted for degrees of freedom, range as high as .76, with most values between .30 and .50. Most regression coefficients have plausible signs, although the number of negative signs on price coefficients (indicating that complementarity exists) is larger than one would expect from households that purchase all their food. When a food is produced at home, however, a coefficient that would indicate complementarity in demand if these were structural demand regressions may reflect either a demand-side or a supply-side relationship. These may be opposite in nature and in effect.

Examination of the residuals shows that heteroskedasticity exists which could be reduced, at least for rice, fish, cassava and palm oil, by using weighted regressions, weighting the data for each household by $1/\hat{q}_i$, where $\hat{q}_i$ is the predicted consumption of the $i^{th}$ food for that household. Because of the time and budget constraints under which the research was done we did not calculate these weighted regressions. We suggest, however, that they should be fitted if the single-equation estimates are to be used as a basis for policy decisions. We suggest also that in principle not all commodity regressions need be alike in this respect; the best weighting for one commodity may not be best for another.

Table 3.1 gives the regression equations for three of the most important foods plus sorghum and groundnuts. Table 3.2 identifies the variables. Among other things it lists the commodities and groups of commodities for which prices were calculated. The variables describing household characteristics are primarily concerned with the size and composition of the household. In addition the households are identified by ethnic group and region, and by the number of wives and age of the household head.

[1]In addition to these quantity regressions we fitted share regressions (using as the dependent variable the share of total expenditure spent on the food). [Smith et al., 1981a, Chapter 5.] We also fitted quantity regressions to groups of households, classifying the households by region and by expenditure group [ibid., Chapter 6].

The share regressions were calculated primarily as exploratory work in preparation for systems estimation of the household-firm model. Because the results of fitting the quantity regressions by groups of households were quite erratic from group to group and the fits were often very poor, we regard the coefficients from the grouped regressions as unreliable. Our sample was too small to make fitting the regressions to subgroups of the sample a desirable procedure.

TABLE 3.1

THE REGRESSIONS

| Commodity and Mean Consumption of Consuming Households (Kilograms) | Number of Consuming Households | $\bar{R}^2$ | Constant Term | Independent Variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Expenditure | | Prices | | | | | | | |
| | | | | TEXP | $(TEXP)^2$ | PRB | PCA | PPO | PDF | PNF | PGN | POC | Other |
| (1) Rice 589 | 138 | .599 | -268.7 (-1.86) | .259 (5.24) | -.176E-4 (-3.02) | a | 436.0 (1.04) | -108.3 (-1.93) | 204.2 (3.43) | | | | |
| (2) Sorghum 60 | 90 | .355 | 115.6 (2.40) | .253E-1 (1.81) | | 202.2 (2.10) | -496.4 (-2.32) | b | | -126.7 (-2.66) | | c | PSG a |
| (3) Cassava 394 | 114 | .529 | -374.6 (-1.72) | .155E-2 (0.11) | -.136E-6 (-0.51) | -99.6 (-4.02) | a | | -51.6 (-1.95) | | 122.2 (6.62) | 26.0 (4.59) | |
| (4) Palm Oil 85 | 133 | .481 | -74.7 (-1.38) | .196 (6.52) | -.328E-4 (-4.75) | | | a | 105.5 (2.11) | -269.1 (-4.31) | 200.4 (2.33) | | |
| (5) Groundnut[d] 81 | 103 | .406 | -235.2 (-3.35) | | .782E-6 (0.85) | | 241.2 (1.35) | b | -96.7 (-2.47) | 90.5 (2.09) | a | c | PFF e |

NOTE: Each expenditure and price variable has been divided by the price of the dependent variable.

The t-ratio for each regression coefficient is given in parentheses. The probability of obtaining by chance a t-ratio that lies outside $\pm$ 1.697 from a regression with 30 degrees of freedom is only 1 in 10.

An entry such as -.176E-4 is to be read as $-.176 \times 10^{-4}$; -.253E-1 = $.253 \times 10^{-1}$, etc. See TEXP and $(TEXP)^2$.

[a] No entry is possible in this cell because it is the own-price cell. The own-price variable, $p_i/p_i$, always has a value of one. The constant term of the regression is the coefficient of the own-price variable; but the significance of the constant term does not indicate the level of significance of that variable.

[b] This variable was deleted from the available set because it was almost an exact linear combination of the remaining variables in the set.

[c] Not included in the available set.

[d] One household has much influence on the estimates of these coefficients.

[e] Variable available but not included in the regression selected.



TABLE 3.1--Continued

| Commodity | Independent Variables | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Household Characteristics | | | | | | | | | | | | | Production and Market Factors | | | | | |
| | SIZE | INF | YCH | CH | MAD | FAD | DEPR | WIV | AGEHD | LIMB | TEMN | REG1 | REG2 | SHOCC | SHOLSO | SHOSS | SHLUR | MKTOR | SHCPH |
| (1) Rice | . | 69.6 (2.97) | -33.5 (-1.51) | 54.3 (1.87) | | | | 59.5 (1.87) | | -473.4 (-3.68) | -301.9 (-2.89) | b | 741.4 (7.03) | | | c | c | | |
| (2) Sorghum | 48.7 (3.38) | -44.7 (-2.31) | -38.9 (-2.05) | -67.1 (-3.02) | -45.9 (-1.99) | | | 29.4 (1.41) | | 312.0 (3.44) | 232.5 (3.94) | b | b | | | c | c | -3.5 (-4.03) | |
| (3) Cassava | 35.6 (2.18) | | -62.9 (-1.46) | | | | 82.8 (1.23) | | | | | b | b | | -5.6 (-1.33) | 7.4 (2.47) | 5.9 (3.45) | -7.2 (-2.15) | -2.0 (-1.91) |
| (4) Palm Oil | -6.6 (-1.49) | 25.8 (2.78) | | | | 35.0 (3.03) | | -32.9 (-2.97) | 2.03 (3.50) | | | b | b | -1.6 (-2.01) | | 1.5 (3.74) | | | .8 (3.78) |
| (5) Groundnut[d] | -49.7 (-2.73) | 53.3 (2.68) | 42.5 (2.42) | 57.6 (2.51) | 67.4 (3.37) | 66.1 (2.75) | | 26.3 (1.89) | | 78.6 (1.49) | 155.1 (3.63) | | -149.2 (-3.19) | | -2.2 (-1.86) | c | c | -.9 (-1.43) | 1.2 (3.88) |

TABLE 3.2

THE VARIABLES

| Symbol | Definition |
|---|---|
| | Dependent |
| Food name - last two letters of the price variables below | Quantity of a specific food consumed by household (kilograms per year) |
| ... | Household expenditure on a specific food (Leones per year) |
| ... | Share of total annual household expenditure devoted to a specific food (expressed as a decimal) |
| | Independent |
| TEXP | Expenditure - total expenditure by household (Leones per year)[a] |
| $TEXP^2$ | Expenditure squared |
| | Price (Leones per kilogram) - |
| PRB | Rice |
| PCA | Cassava |
| PPO | Palm oil |
| PDF | Fish, dried or tinned |
| PNF | Non-food |
| PGN | Groundnut[b] |
| POC | Other cereals (all cereals except rice) |
| PFF | Fish, fresh, frozen or iced |
| PSG | Sorghum |
| PBN | Broadbean |
| PON | Onions |
| PPC | Peppers and chillies |

[a]In 1974/75 Le 1.00 equalled U.S. $1.10 [Spencer and Byerlee, p. 24].

[b]Peanut.



TABLE 3.2--Continued

| Symbol | Definition |
|---|---|
| PSL | Salt |
| PMG | Maggi cubes[c] |
| PKL | Kola nut[d] |
| PPW | Palm wine[e] |
| POL | Other legumes (all legumes except groundnuts) |
| PVG | Vegetables |
| PFT | Fruits |
| PCN | Salt and other condiments (salt, sugar, Maggi cubes and condiments, unspecified) |
| PAB | Beverages, alcoholic |
| | Household characteristics |
| | Size and composition |
| SIZE | Size (number of persons) |
| INF | Children aged 0-5 years (number) |
| YCH | Children aged 6-10 years (number) |
| CH | Children aged 11-15 years (number) |
| MAD | Males aged 16-65 years (number) |
| FAD | Females aged 16-65 years (number) |
| ... | Persons over 65 years (number) |
| DEPR | Dependency ratio [(number of persons aged 0-15 years and over 65) ÷ (number of persons aged 16-65 years)] |
| WIV | Wives (number) |
| AGEHD | Age of household head (years) |

[c]Bouillon cubes, commonly referred to by the brand name, "Maggi".

[d]A stimulant, often used on ceremonial occasions.

[e]Made from the sap of certain palm trees.

TABLE 3.2 --Continued

| Symbol | Definition |
| --- | --- |
| | Other |
| | Ethnic group or area[f] |
| LIMB | Binary variable = 1 if Limba |
| TEMN | Binary variable = 1 if Temne |
| ... | Each binary variable = 0 if member of the remaining group |
| | Region |
| REG1 | Binary variable = 1 if Southern |
| REG2 | Binary variable = 1 if Northern |
| ... | Each binary variable = 0 if Eastern |
| | Production characteristics |
| | Percentage of the value of output plus labor sold out derived from |
| SHOOPT | Onions, peppers and chillies, and tomatoes |
| SHOCC | Cocoa and/or coffee |
| SHOLSO | Labor sold out |
| SHOSS | All specified sources (the three above plus oil palm products and non-farm activities including fishing) |
| SHLUR | Percentage of total labor devoted to upland rice |

[f]The households are divided into three groups. One consists of 16 Limba households, a second of 31 Temne households, and a third of 83 Mende, 1 Loko and 7 Temne households. The 83 Mende households constitute 60 percent of the total sample.



TABLE 3.2--Continued

| Symbol | Definition |
| --- | --- |
| | Market orientation |
| MKTOR | Total sales as a percentage of value of total output (not including the value of labor sold out) |
| SHCPH[g] | Percentage of household consumption of a specific food that is produced by the consuming household |

[g]This represents nine variables, one for each of the foods for which it was calculated.

The size variable measures the total number of persons in the household. Household composition is defined by a set of variables that distributes this total number among groups defined by age and sex. The number of persons over 65 is not used as a variable in order to avoid multicollinearity. As SIZE is a linear combination of the subgroups by age and sex, at least one subgroup must be omitted from the equation if SIZE is to be included as a variable. We exclude persons over 65.

The set of size and composition variables also defines the size of the farm. Under West African conditions land availability is rarely a limitation on farm size, although the quantities of particular types of land available are clearly important in determining the type of farming activity the household pursues.

The dependency ratio is a measure of household composition that is independent of size. We expect the regression analysis to indicate whether it is more useful to use this single ratio as an indication of household composition or to use the set of variables by age and sex. The latter, of course, is a more flexible procedure, as it permits us to recognize the fact that the relevant features of household composition are not necessarily the same for all types of foods.

The number of wives and the age of the household head are also variables that may influence food consumption behavior, as we shall discover.

We have already discussed the production and market characteristics variables.

Rice

For rice, the most important single food consumed in Sierra Leone, we look at the regression in some detail (Table 3.1). Households with large total expenditures consume more rice than others. But the higher the expenditure figure the smaller the additional effect. Of course, this is consumption per household, not per consumer.[1] Households facing high relative prices of palm oil consume less rice on the average than others and those facing high relative prices of dried fish (and perhaps cassava[2]) consume more rice, if

[1]However, we know from our tabular analysis that consumption per consumer equivalent rises with income per consumer equivalent, at least up to the highest income class [Smith et al., 1980, Table 3.4.a, p. 44].

[2]This coefficient is not statistically significant.



the households are similar in all other respects. Thus rice appears to be a substitute in consumption for dried fish and cassava and a complement for palm oil.

Household size and composition affects rice consumption levels. Households consume more rice than the average if they have above average numbers of infants and of children between 11 and 15 years of age, while those with above average numbers of children between six and ten years of age consume less. An infant certainly eats less rice than a child in the six-to-ten-year-old age group, so it may seem odd that the presence of an infant is associated with a positive change in rice consumption while the present of an eight-year old is associated with the reverse effect. But in Sierra Leone, as in much of West Africa, the presence of an infant in the household is likely to be associated with the presence of pregnant or lactating women or of female relatives. As the numbers of pregnant or lactating women, or of female relatives of the mothers of small children, are not held constant in this regression, the influence of these factors is undoubtedly being picked up by the variable for the number of infants.

Other things equal, the more wives a household head has, the greater the level of rice consumption. Note that this cannot be simply the effect of an increase in the household size, for neither the variable for size nor that for the number of female adults had a statistically significant effect. Presumably the relationship detected here is associated with the fact that rice must be pounded before it can be cooked and that this is very time consuming. Moreover, the wife has a special responsibility for seeing that her own children are properly fed. The economist, of course, may prefer simply to note that the number of children enters explicitly into this regression, so each regression coefficient measures the effect of a change in the variable with the number of children held constant. An increase in the number of wives increases the ratio of wives to children. (See Smith et al., 1981a, pp. 60-61, for more details.)

The regional and ethnic variables must be considered jointly. They show us that Northern households (REG2), almost all of them Limba or Temne, consume more rice than an average household in the South or East, but that Limba households do not consume as much more as do the Temne households. Mende households, all of them in the South or East, consume less rice, other things being equal, but other things are not equal, for average expenditure levels and average household size vary among ethnic groups and among regions as do relative prices and other variables. Rice consumption per consumer equivalent, for instance, is highest in the South and about equal among the Mende and the Temne, according to the tabular analysis, in which most other variables were not controlled for. [Smith et al., 1980, Tables 3.4.A and 3.4.B, p. 44.]

In the case of rice, the production and market orientation variables show no statistically significant relationship to the level of household rice consumption. For some commodities, however, these variables are statistically significant, although the direction of the influence might be positive or negative. For palm oil and groundnuts, for instance, the quantity consumed by the household is positively related to the share of the consumption of those foods which is provided by the household's own production.

Let us look more closely at the negative relationship between the price of palm oil and the quantity of rice consumed by the household. One might expect palm oil and rice to be complements on the demand side, for rice is almost always served with a sauce consisting of palm oil, green leaves and various vegetables with bits of meat or fish, plus seasoning. Native informants in Sierra Leone, however, suggest that the dominant relationship may be one of substitution. When palm oil is scarce or poor in quality, people eat sparingly of the sauce and increase the proportion of rice they consume, but when the oil is abundant or of good quality, they take more sauce and less rice. As both palm oil and rice are important sources of food energy, there is also a physiological basis for a substitution relationship. If these are indeed substitutes on balance on the demand side, whence the negative sign of the regression coefficient? Several mechanisms may be involved, but it seems likely that the dominant one is as follows: a high relative price for palm oil leads to relatively high production of palm oil; high palm oil production is associated with high consumption of palm oil[1] and high consumption of palm oil leads to reduced consumption of rice. To this we may add the observation that the heavy use of female labor in the production of palm oil may induce the women to reduce the amount of time spent in pounding rice, in most households a necessary preliminary to cooking it. Preparing cassava (which in Sierra Leone is usually the "sweet" cassava that can be boiled without previous fermentation) is far less time-consuming.

---

[1]High production of palm oil means that a household has access to a relatively large proportion of its total palm oil consumption at the low farm gate price, rather than the higher price in the retail market. For a detailed discussion of these possibilities, see pp. 51-59 in Smith et al., 1981a.



## An Overall View

Household food consumption levels for almost every commodity rise as expenditure rises. $(TEXP)^2$ appears in most regressions; when both TEXP and $(TEXP)^2$ appear, the consumption-expenditure relation is convex from above.

For some commodities, among them sorghum, groundnuts, broadbeans, peppers and chillies, salt, vegetables and fruits, the expenditure response is small, even though it is often quite significant in a statistical sense. (But note that each of the last four "commodities" has non-homogeneous components.)

For four foods (cassava, palm wine, alcoholic beverages and fruits) the data do not confirm the existence of an income relationship, even at the 10 percent level of significance. (In part this may reflect the fact that the data for cassava are not as reliable as those for most of our commodities, and that "fruit" is a conglomeration of quite different components.)

Commodity substitutions in response to differences in relative prices are quantitatively important for almost all foods. The exceptions are onions, palm wine and two groups, vegetables and alcoholic beverages.

The relative price of cassava is the price variable most often helpful in explaining the consumption of some other commodity. (It appears in at least one regression for each of 12 foods.) The relative prices of dried fish, groundnuts, rice and non-food goods are also useful in explaining the consumption of other foods. These price variables have negative coefficients more frequently than one would expect if these were pure demand regressions describing the behavior of households buying all their food in the market. Most of these households produce large fractions of their own food, so prices affect household consumption through their effects on household production as well as through their effects within the consumption sphere. The data show negative coefficients for the price of rice in the regression for cassava, fresh fish, salt and kola nut, as well as for the price of palm oil in the rice regression.

The cassava-rice coefficient is negative in the cassava equation and positive in the rice equation, but the coefficients include the income effects of changes in price. Rice represents 25 percent of total household expenditures in the sample, and cassava only 7.5 percent, so the reduction in well-being associated with a high relative price of rice is likely to force economies in the consumption of a number of foods, including cassava. This income effect may be an important factor in explaining the reduced consumption associated with a high price of rice for each of the four foods, cassava, fresh fish, salt and kola nut, but interrelations on the production side may also be involved. The price of cassava will have a much smaller income effect on the consumption of other foods than the price of rice.

Household size and composition are clearly important. Each size and age-sex variable appears in at least one regression for five or more of the foods; the number of infants is a useful variable for ten foods. In general these variables are more important for understanding the major foods than for some of the minor ones. As we have expected, no single set of age-sex variables is optimal for use in a large number of equations. The dependency ratio (DEPR), a specific weighted combination of these variables, is serviceable for only two foods and statistically significant at the 10 percent level or better only for broadbeans. To be sure, had the other variables not been available as alternatives, the dependency ratio might have played a greater role.

The age of the household head and the number of wives he possesses prove to be effective variables at least once for each of seven or eight foods. The number of wives, incidentally, is often serviceable when the number of female adults is not, and vice versa; for palm oil and groundnut both variables are informative and statistically significant at the one percent level. Such a variable as WIF (like the price variables) is important for both the production and consumption effects associated with the particular age-sex group.

Ethnic affiliation also affects consumption patterns. Limba or Temne households behave differently than Mende households in the case of seven individual foods. Limba households, for instance, consume less dried fish than do Mende households but more sorghum, cereals other than rice, Maggi cubes and palm wine. Households in the Temne group consume less rice than households in the Mende group, but more sorghum, cereals other than rice, groundnuts, broadbeans, Maggi cubes, and "salt and other condiments."

The regional variables were often deleted because of high collinearity with other variables, but Region 2 (the Northern Region) was a statistically significant classification (at the one percent level) for rice and groundnuts.

One concern in this study was to determine whether production characteristics and/or market orientation affect food consumption decisions. Clearly either or both may do so. Some production or market variable aids the explanation for 11 of the 14 single foods.

Market orientation, the percentage of the value of total output that is sold, improves the explanation for six foods or food groups, while the share of household consumption that is produced at home is a helpful variable in explaining the



consumption of six foods, two-thirds of the total number for which it was available.[1]

Producing a large fraction of household consumption has a positive effect on the consumption of palm oil, groundnuts, onions, and peppers and chillies, and an adverse effect on the consumption of cassava and broadbeans. A high degree of market orientation has an adverse effect upon the consumption of cassava, sorghum, "other cereals" (all cereals except rice) and groundnuts,[2] much as one might expect. Salt consumption is positively associated with market orientation.

Of the variables representing the percentage of total product devoted to specific crops, SHOOPT, the share of onions, peppers and tomatoes, was the most useful, appearing in five food regressions and two for groups of foods. As one would expect, SHOOPT is positively associated with the consumption of onions, peppers and chillies, and vegetables, but also with the consumption of rice, cassava and fruits. It is negatively related to the consumption of dried fish. (Many of the households that produce large amounts of onions, peppers and tomatoes also produce large quantities of fresh fish.)

Two variables (SHOSS and SHLUR) were tested only for cassava and palm oil. SHOSS, the percentage of the value of output plus labor sold out that came from the list of specified sources, is statistically significant at the one percent level and positively associated with consumption for each of the two foods, while SHLUR, the share of labor devoted to upland rice, is significant at the same level for cassava, and also is positive in its effect. SHOLSO, the contribution of labor sold out to the total value of output plus labor sold, appears only in regressions for groundnuts, cassava and fruits.

The six regressions for groups of foods are usually dominated by one or two of the individual foods that comprise them. In those cases, the regressions for the single foods are to be preferred because they describe the behavior of significant foods that are reasonably well defined rather than the average responses of some conglomerate of individual parts. "Other cereals" is not dominated by its principal component, sorghum. It includes fundi and millet as well as benniseed

---

[1] We did not use the share of consumption produced at home for palm wine, as 94 percent of consumption was home-produced, or for salt and Maggi cubes, where none was produced at home. Nor did we use this variable for fish or for groups of foods.

[2] The coefficient for groundnuts is not statistically significant at the ten percent level.

and maize; the behavior of the group is quite different from that of sorghum alone.

## Elasticities

The most convenient form in which to present relationships between consumption quantities and the prices or expenditure (income) levels that affect them is in the form of an elasticity. Given the form of the regression equation, these elasticities can vary with price and expenditure level and (in the case of the own-price elasticity) with the levels of other variables in the regression, so we present elasticity values calculated at the mean levels of the variables for the households in each of three expenditure groups. The low group consists of households whose total expenditures were below 350 Leones per year, middle group households had expenditures between 350 and 750 Leones and the upper group households had annual expenditures that were over 750 Leones. The mean values of TEXP for the three expenditure groups are 237, 513 and 1074 Leones, respectively. Both consuming and nonconsuming households were included when calculating the mean values of the variables. The mean quantity, $q_i$, is the mean of the predicted values of $q_i$ at the mean levels of the independent variables for the expenditure group.

Table 3.3 contains expenditure and own-price elasticities by expenditure group.[1] Expenditure and price elasticities play important roles in allocating foods (and thus nutrients) among households. Expenditure responses are almost invariably positive, except for cassava, and often strong, as for rice, palm oil, fresh fish and "other legumes". Own-price elasticities are frequently large, as for groundnuts, dried fish, peppers and chillies, Maggi cubes, kola nuts and "other legumes." Most are negative.

Positive own-price elasticities (as for sorghum, palm oil, peppers and chillies, and legumes other than groundnuts) may reflect the fact that these regressions measure both production and consumption responses. Indeed, if a household produces its entire consumption of a certain food, and sells none, production and consumption responses are identical. This would be an extreme situation, but there are many cases in which the level of home production may

[1]The elasticities from the share regressions and the quantity regressions for groups of households are given in Smith et al., 1981a, Chapter 7.



TABLE 3.3

EXPENDITURE AND OWN-PRICE ELASTICITIES BY EXPENDITURE GROUP

| Commodity | Expenditure Elasticity | | | Own-Price Elasticity | | |
|---|---|---|---|---|---|---|
| | Expenditure Level | | | Expenditure Level | | |
| | Low | Medium | High | Low | Medium | High |
| Rice | .87 | .75 | .48 | -.90 | -.92 | -.56 |
| Sorghum | .12 | .12 | .28 | .83 | .42 | .43 |
| Cassava | .00 | -.04 | -.16 | -.70 | -.86 | -.47 |
| Palm Oil | 3.92 | 1.76 | .80 | 4.47 | .43 | .21 |
| Groundnut | -.19 | .11 | .24 | 22.5 | -2.93 | -2.28 |
| Broadbean | .07 | .14 | .18 | -.05 | -.12 | -.16 |
| Fish, fresh | 1.09 | .88 | 1.36 | .89 | -.14 | .57 |
| Fish, dried | .51 | 1.18 | 1.92 | -.72 | -1.06 | -2.19 |
| Onions | .72 | .63 | .60 | -.72 | -.63 | -.60 |
| Peppers and chillies | .18 | .48 | .75 | 6.99 | 4.48 | 1.73 |
| Salt | .26 | .35 | .33 | -1.15 | -1.04 | -.74 |
| Maggi cubes | .70 | 1.77 | 1.05 | -1.39 | -2.09 | -1.19 |
| Kola nut | .72 | 2.03 | 2.59 | -.66 | -1.49 | -1.98 |
| Other cereals | .31 | .26 | .24 | .74 | .17 | .06 |
| Other legumes | 1.24 | 1.65 | 1.35 | 3.87 | 1.96 | 1.79 |
| Vegetables | .25 | .59 | .91 | .25 | -.59 | -.91 |
| Fruits | .39 | 1.29 | .85 | .36 | .27 | .10 |
| Salt and other condiments | .53 | .70 | .63 | -.05 | -.33 | -.37 |
| Beverages, alcoholic | 1.20 | .85 | 1.03 | -1.20 | -.85 | -1.03 |

be the principal determinant of household consumption. For instance, home production accounts for 88 percent of the sorghum consumed, 72 percent of the peppers and chillies, and over 90 percent of legumes other than groundnuts. When the average percentage consumed from home production is as large as these figures, many households must be producing all they consume, or practically all. If there is a rise in the relative farm gate price of the commodity,[1] households already producing some for the market will increase their output and some not producing anything for sale may begin to do so. We know that for some foods, at least, high production encourages high consumption. If the farm gate price is high enough so that producing a quantity of sorghum to exchange for other goods, including food, is an efficient use of resources, producing sorghum to consume at home instead of buying food from the market should also be efficient, particularly when we remember that home consumption escapes the marketing margin.

Furthermore, producing more sorghum, for instance, is likely to mean producing less of some other crops, so less food is available from those crops or from the exchange of those for food in the market. Greater consumption of the food now being produced in larger quantity may be the most economical way of replacing the foods lost in the process of expanding the production of sorghum, or whatever the food may be.

Table 3.4 gives the cross-elasticities. Cassava, palm oil, groundnuts, fish, Maggi cubes and kola nuts have large cross-price elasticities with respect to the prices of a number of other commodities. The commodities most often giving rise to large cross-elasticities are dried fish, non-food, rice, groundnuts, palm oil and cassava.

The values of these price elasticities reinforce the views of Mellor [1978] and Timmer [1978] that price can be a powerful short-run allocator of food intake. Mellor concentrates on income effects, which are clearly important. However, not all the price effect is through the effect of price on real income. For instance: the own-price elasticity for rice is -.92 at the medium expenditure level and the expenditure elasticity is .75. The mean share of expenditure devoted to rice by the middle-expenditure group of households was 24.6 percent,[2]

[1] When the percentage of consumption provided by home production is large, the price used in the regression is primarily a producer price. If that rises, the farm gate price has risen.

[2] The share for low-expenditure households was 24 percent; for high-expenditure households 23 percent.



TABLE 3.4

CROSS-PRICE ELASTICITIES BY EXPENDITURE GROUP

| Commodity | With Respect to Price of | Expenditure Level: Low | Medium | High |
|---|---|---|---|---|
| Rice | Palm oil | -1.13 | -.52 | -.25 |
| | Fish, dried | .86 | .51 | .23 |
| | Cassava | .31 | .18 | .10 |
| Sorghum | Rice | .99 | .41 | .56 |
| | Cassava | -.42 | -.22 | -.31 |
| | Non-food | -1.52 | -.73 | -.96 |
| Cassava | Rice | -3.01 | -1.18 | -1.22 |
| | Fish, dried | -1.62 | -.82 | -.71 |
| | Other cereals | 1.57 | 1.25 | .99 |
| | Groundnuts | 3.76 | 1.64 | 1.56 |
| Palm oil | Fish, dried | 2.65 | .79 | .29 |
| | Groundnuts | 4.94 | 1.27 | .51 |
| | Non-food | -15.99 | -4.25 | -1.81 |
| Groundnut | Fish, dried | 13.74 | -2.05 | -1.14 |
| | Cassava | -5.69 | .83 | .57 |
| | Non-food | -63.97 | 8.50 | 5.49 |
| Broadbean | Fish, dried | -.01 | -.02 | -.02 |
| Fish, fresh | Rice | -7.34 | -2.84 | -4.67 |
| | Palm oil | 5.46 | 2.12 | 3.07 |
| | Fish, dried | 1.84 | .92 | 1.26 |
| | Cassava | -1.93 | -.94 | -1.58 |
| Fish, dried | Rice | 1.49 | 1.42 | 1.34 |
| | Fish, fresh | -1.69 | -1.76 | -1.09 |
| | Cassava | -1.53 | -1.85 | -1.78 |
| | Groundnuts | 1.94 | 2.07 | 1.79 |

| Commodity | With Respect to Price of | Expenditure Level: Low | Medium | High |
|---|---|---|---|---|
| Peppers and chillies | Cassava | -9.06 | -6.15 | -2.86 |
| | Onions | 1.89 | 1.19 | .38 |
| Salt | Rice | -1.11 | -.17 | -.59 |
| | Fish, fresh | .44 | .31 | .17 |
| | Cassava | -.67 | -.54 | -.46 |
| | Non-food | 2.23 | 1.65 | 1.31 |
| Maggi cubes | Rice | 2.31 | 2.72 | 1.40 |
| | Cassava | -1.62 | -2.40 | -1.26 |
| Kola nut | Rice | -2.43 | -3.07 | -2.50 |
| | Palm oil | 3.69 | 4.68 | 3.35 |
| | Fish, dried | -1.32 | -2.15 | -1.46 |
| Other cereals | Cassava | .78 | .36 | .53 |
| | Groundnuts | 1.88 | .76 | 1.02 |
| | Non-food | -3.70 | -1.54 | -2.18 |
| Other legumes | Groundnuts | -8.55 | -6.19 | -5.57 |
| | Non-food | 3.44 | 2.58 | 2.43 |
| Fruits | Cassava | -2.35 | -4.02 | -1.57 |
| | Vegetables | 1.59 | 2.47 | .62 |
| Salt and other condiments | Cassava | -.48 | -.37 | -.26 |

so a one percent rise in the price of rice is approximately equivalent to a fall of .246 percent in the purchasing power of household expenditure. The income effect of such a fall in purchasing power is to reduce rice consumption by approximately 0.18 percent.[1] Of the total own-price elasticity of -.92, the remainder, -.74, is a substitution effect. Clearly there are substitution (and production) effects, the former of which are ignored by Mellor but not by Timmer. No commodity other than rice and "non-food" represents more than 7 1/2 percent of total expenditure on the average, so the income effect will normally be an even smaller proportion of the total price effect.

The elasticities often change markedly with expenditure levels: for rice, cassava and palm oil expenditure elasticities decline as expenditure rises; for dried fish, kola nuts and vegetables they increase. Declines in the absolute values of own-price elasticities occur for a number of foods, including rice, fresh fish, peppers and chillies, salt, and "other cereals," while marked declines in the absolute values of cross-elasticities take place for rice, palm oil and groundnuts. In part this is because budget shares for most foods tend to decline at higher expenditure levels, thus reducing the income effect component of the price elasticity, but in some cases declining expenditure elasticities at higher expenditure levels also play a part.

Where elasticities and cross-elasticities are large and fall with income, the allocation effects of price and income changes become particularly important for low-income households. Responses to prices and income changes can affect the nutrition of these households in a significant way.

Before leaving these results we must remind the reader that these elasticity values apply only to consuming households. In using them for policy analysis one must remember that there are many households that do not consume certain foods. The present results do not tell us whether these households would continue to be non-consumers in the face of price and income changes, but a Tobit analysis could be used for this purpose.

## Conclusion

Nutritionists and others often assert that as households shift from producing their own food to producing for sale the quality of the diet decreases. These data provide partial support for this proposition for households at a constant level of total expenditure. Production and market orientation variables

[1] (.00246) x (.75) = .0018.



have no demonstrable effect on the consumption of rice, but households that produce large fractions of their own consumption do consume more palm oil and groundnuts than others (but less cassava and broadbeans). A high degree of market orientation reduces the consumption of cassava,[1] sorghum, and "other cereals" (all cereals except rice). However, palm oil is produced for sale as well as for consumption and the market-oriented production of onions, peppers and chillies is associated with high consumption of these three foods. The share of labor devoted to upland rice, usually grown as a mixed crop, is positively associated with cassava consumption.

These results do not include the effects of cash crop production on income. Using tabular analysis with income levels not held constant [Smith et al., 1980, pp. 56, 60, 61], we found that producing a large portion of the quantity consumed was associated with increased consumption (per consumer equivalent) of cassava, palm oil and groundnuts. But for rice, the most important crop, the evidence was mixed [ibid., p. 46].

Economists usually assert that cash crop production raises incomes and thus leads to better diets. Certainly in rural Sierra Leone there are positive expenditure elasticities for rice, palm oil, fish and vegetables; for rice and palm oil these tend to fall as expenditure levels rise. Whether these elasticities are large enough to justify ignoring the possible adverse effects of cash crop production is another question.

Some argue that habit and physical environment are the primary determinants of food consumption by households producing mainly for their own use. Certainly food preferences, climate and soil are major determinants, but the data show clearly that rural households in Sierra Leone adapt their consumption practices to the prices they confront. Price elasticities (both own-price and cross-price) are often large, and often largest at low expenditure levels. However, the prices that affect these households are both sales prices and the prices paid for food purchases from the market. These single-equation regressions and the elasticities derived from them summarize the total effects of both production and consumption responses, so the signs are not always what one would expect if he were thinking of demand regressions affected only by influences operating on the consumption side of the household's activities.

[1] But another measure of production for the market, SHOSS (the share of value output coming from a specified list of activities), is positively associated with cassava consumption.

Rice consumption at low expenditure levels is highly responsive to the prices of palm oil, dried fish, groundnuts and non-food goods, but is little affected by the prices of cassava and of other cereals. The influence of a production response on the elasticity of rice consumption with respect to the price of palm oil is seen in the negative sign of the cross-elasticity coefficient. Greater production of palm oil is associated with greater consumption of palm oil and less of rice.

In short, income and price variables play significant roles in influencing food consumption among rural households in Sierra Leone. Their effects must be taken into account in any prediction of the nutritional effects of economic policies.

# CHAPTER IV

## SYSTEMS ESTIMATION OF THE HOUSEHOLD-FIRM MODEL

In principle, food consumption should be estimated as a system. Food consumption decisions are interrelated among themselves; the labor-leisure choice affects the level of income available for expenditure; and, in the semi-subsistence household, consumption and production are, in effect, joint decisions. To take account of all these relationships-to trace all the impacts of socio-economic variables on household food consumption-it is necessary to account for those felt indirectly through influence on the production and labor supply activities of the household as well as directly on food consumption. This requires a household-firm model.

### Modelling the Rural Household

We assume certainty and abstract from time. A household utility function is assumed with arguments being household consumption of various goods and of leisure. Goods may be bought or sold in the market and produced. Labor may be bought or sold in the market. Goods are produced using labor, land and fixed capital. Land is assumed fixed in total amount but must be distributed between uses. A time constraint exists equating household leisure plus labor time to total time available. Finally, a budget constraint exists equating the value of net product transactions plus exogenous income to the value of net labor transactions. Product prices and wage are taken exogenously by the household, markets are assumed to be perfectly competitive and family and hired labor are assumed perfect substitutes.

Formally, let the household maximize

$$U = U(\bar{L}, X_i^c) \quad , \quad \text{where } \bar{L} = \text{leisure}$$

$$X_i^c = \text{good i consumed, } i=1, \ldots, n$$

subject to:

$$G(X_i, L_T, D, \bar{K}) = 0$$

$$X_i^c = X_i - S_i \qquad i=1, \ldots, n$$

$$S_L = L_H - L_T$$

$$\bar{L} = T - L_H$$

$$\sum_{i=1}^{n} P_i S_i + A + P_L S_L = 0$$

where

$G(\cdot)$ = implicit production function

$X_i$ = production of good $i=1, \ldots, n$

$L_T$ = total labor demanded

$D$ = land

$\bar{K}$ = fixed capital

$S_i$ = net sales of good i (purchase if negative), $i=1, \ldots, n$

$S_L$ = net sales of labor (purchase if negative)

$A$ = exogenous income

$T$ = total time available to household to allocate between labor and leisure

$L_H$ = total household labor time worked

$P_i$ = price of good i, $i=1, \ldots, n$

$P_L$ = price of labor



Assume the utility function to be twice differentiable, increasing in its arguments and strictly quasi-concave. Assume the implicit production function to be twice differentiable increasing in outputs, decreasing in inputs and strictly quasi-convex. We will also assume interior solutions even though border solutions are easily handed algebraically (this is because estimation incorporating border conditions is very messy). We set up the Lagrangian function as

$$W = U(\bar{L}, X_i^c) + \lambda\left(\sum_{i=1}^{n} P_i(X_i - X_i^c) + A + P_L(T - \bar{L} - L_T)\right) + \mu(G(X_i, L_T, D, \bar{K})) \tag{1.1}$$

Our first order conditions are:

$$\partial W/\partial X_i^c = \partial U/\partial X_i^c - \lambda P_i = 0 \qquad i=1, \ldots, n$$

$$\partial W/\partial \bar{L} = \partial U/\partial \bar{L} - \lambda P_L = 0$$

$$\partial W/\partial X_i = \lambda P_i + \mu \partial G/\partial X_i = 0 \qquad i=1, \ldots, n \tag{1.2}$$

$$\partial W/\partial L_T = -\lambda P_L + \mu \partial G/\partial L_T = 0$$

$$\partial W/\partial \lambda = \sum_{i=1}^{n} P_i(X_i - X_i^c) + A + P_L(T - \bar{L} - L_T) = 0$$

$$\partial W/\partial \mu = G(X_i, L_T, D, K) = 0$$

These may be expressed in the more conventional way of equating marginal rates of substitution in consumption between goods to price ratios to marginal rates of transformation in production:

$$\frac{\partial U/\partial X_i^c}{\partial U/\partial X_j^c} = \frac{P_i}{P_j} = \frac{\partial G/\partial X_i}{\partial G/\ X_j} = \frac{-\partial X_j}{\partial X_i} \quad , \quad i \neq j=1, \ldots, n$$

$$\frac{\partial u/\partial \bar{L}}{\partial u/\partial X_i^c} = \frac{P_L}{P_i} = \frac{-\partial G/\partial L_T}{\partial G/\partial X_i} = \frac{\partial X_i}{\partial L_T} \quad , \quad i=1, \ldots, n$$

This model is recursive. The household's production decisions are first made and subsequently used in allocating available "full income" between consumption of goods and leisure. This result follows from the assumption of perfect markets for goods and labor. Intuitively this allows the family to separate its decisions on goods demanded and household goods supplied, the difference being labor hired (or sold out). Thus the model eliminates those aspects of jointness between production and consumption decisions that result from markets that are less than perfect--in particular, the effects of a two-price system in which buying prices for food characteristically exceed farm gate prices. The simplification is worthwhile because it gives us access to the other advantages of systems estimation. More formally, in the first order conditions, the partial derivatives with respect to outputs yield n equations in n+2 unknowns (n good outputs, total labor demanded and the ratio of two multipliers). Two more equations are added by the partial derivative with respect to total labor demanded and with respect to the multiplier of the implicit production function. This system of n+2 equations in n+2 unknowns can be solved in terms of all prices, the wage rate, and fixed land and capital as the result of the quasi-convexity of the implicit production function, first order conditions and the implicit function theorem. Such solutions may then be substituted into the budget constraint. With the partial derivatives with respect to leisure and consumption of goods this yields an additional n+2 equations in n+2 unknowns (n good consumptions, leisure and a multiplier), which may also be solved in terms of prices, the wage rate and nonearned income, as the second order conditions are met.

Conditional on the production decisions this second set of n+2 equations is identical to the first order conditions of the labor-leisure choice problem.



This, along with our assumptions about the utility function, implies that the usual constraints of economic theory apply: zero homogeneity of demand with respect to prices, wage rate and unearned income, and symmetry and negative semi-definiteness of the Slutsky substitution matrix. Likewise on the production side.

<u>The Consumption-Leisure Component</u>

<u>The Expenditure Equations</u>

The estimation of the consumption-leisure component of the model is carried out with a quadratic expenditure system based on the indirect utility function

$$V = -\prod_{k=1}^{n+1} P_k^{a_k} / \left(A+P_L T+\pi-\sum_{k=1}^{n+1} P_k C_k\right) + \prod_{k=1}^{n+1} P_k^{(a_k-d_k)}, \text{ with} \qquad (2.1)$$

$\sum_{k=1}^{n+1} a_k = \sum_{k=1}^{n+1} d_k = 1$, where leisure is treated as the n+1 good, and $\pi = \Sigma P_i X_i - P_L L_T$, interpreted as short-run profits. The $C_k$ and $d_k$ are constants to be determined from the data. The resulting expenditure equation is

$$P_i X_i^c = P_i C_i + a_i\left(P_L T+\pi+A-\sum_{k=1}^{n+1} P_k C_k\right) - (a_i-d_i) \prod_{k=1}^{n+1} P_k^{-d_k} \qquad (2.2)$$

$$\left(P_L T+\pi+A-\sum_{k=1}^{n+1} P_k C_k\right)^2 \qquad i=1, \ldots, n+1$$

This has as a special case the linear expenditure system provided $a_i=d_i, \forall_i$ [Strauss et al., 1981a, pp. 8-9].

Household characteristics are entered into the analysis by translation. Using a linearly homogeneous specification for the translation parameters we write $V_i = \sum_{r=1}^{K} \sigma_{ir}\eta_r$, where $\eta_r$, r=1, . . ., K are household characteristics and the $\sigma_{ir}$'s are parameters. Likewise, for total time we may write $T = \sum_{r=1}^{q} \gamma_r m_r$, where $m_r$, $r=1, \ldots, L$ are household characteristics and the $\gamma$'s are parameters. The resulting expenditure equation of the QES is

$$P_i X_i^c = P_i C_i + P_i \sum_{r=1}^{K} \sigma_{ir}\eta_r + a_i\Big(P_L \sum_{r=1}^{q} \gamma_r m_r + \pi + A - \sum_{k=1}^{n+1} P_k\big(C_k + \sum_{r=1}^{K} \sigma_{kr}\eta_r\big)\Big) \quad (3.1)$$

$$-(a_i - d_i) \prod_{k=1}^{n+1} P_k^{-d_k} \Big(P_L \sum_{r=1}^{q} \gamma_r m_r + \pi + A - \sum_{k=1}^{n+1} P_k\big(C_k + \sum_{r=1}^{K} \sigma_{kr}\eta_r\big)\Big)^2$$

Since leisure is not directly observed we subtract from both sides of the leisure expenditure equation the value of time available to the household. The left hand side becomes the negative of the value of household labor, which we do observe. Thus the leisure equation becomes

$$-P_L L_H = P_L C_L + P_L \sum_{r=1}^{K} \sigma_{ir}\eta_r - P_L \sum_{r=1}^{q} \gamma_r m_r + a_i\Big(P_L \sum_{r=1}^{q} \gamma_r m_r + \pi + A - \sum_{k=1}^{n+1} P_k\big(C_k + \sum_{r=1}^{K} \sigma_{kr}\eta_r\big)\Big) \quad (3.2)$$

$$-(a_i - d_i) \prod_{k=1}^{n+1} P_k^{-d_k} \Big(P_L \sum_{r=1}^{q} \gamma_r m_r + \pi + A - \sum_{k=1}^{n+1} P_k\big(C_k + \sum_{r=1}^{K} \sigma_{kr}\eta_r\big)\Big)^2$$

This device avoids the need to impose values for T, such as a male having exactly sixteen hours per day available for work and leisure. With n+1 commodities, K translation demographic variables and q demographic variables for total time this system has at most (3+K) (n+1)-2+q parameters to estimate (fewer if some of the $\eta_r$'s and $m_r$'s are identical).

## The Data

The consumption data are those used for the single-equation regressions. Labor supplied data were formed by summing hours worked for agricultural and nonagricultural enterprises and for labor sold out. Units are in terms of male equivalents with weights 1 for males over 15, .75 for females over 15 and .5 for children aged 10-15. The weights are derived from relative wage rates in the sample as reported by Spencer and Byerlee [1977].



Prices were formed by the eight geographical regions. Annual sales prices were formed using the larger sample of 328 households for which reliable production and labor use data were available. Value of regional sales was divided by sales quantity for each of 195 commodities. Likewise, regional purchase prices were formed for 113 commodities. A concordance between commodities purchased and sold was established and a commodity price for each region was then formed by taking a weighted average of sales and purchase prices with region specific weights being the share of total expenditure for a commodity coming from either purchases or home production. Commodities were then aggregated into six groups with values consumed being used as weights to form arithmetically weighted prices. Wage is in terms of male equivalents.

Sample characteristics are shown in Tables 4.1 and 4.2. The sample is divided into three expenditure groups when computing the averages as it is for much of the later analysis. These groups are total expenditure under 350 Leones, between 350 and 750 Leones, and greater than 750 Leones. To get an idea of how poor these households are, the annual per capita expenditures in 1974-75 U.S. dollars are \$54, \$88, and \$136 respectively for the low, middle and high expenditure groups. When the capital city, Freetown (sampled for a migration component of the 1974-75 survey) is divided into three groups, the average income of the middle group is \$153. Hence, even our "high" expenditure households are quite poor both compared to urban Sierra Leone as well as compared to other countries.

One can see from Table 4.1 that the lower expenditure group faces relatively lower prices for root crops and other cereals and for nonfoods, but

Table 4.1

Mean Values of Data by Expenditure Group[1]

| Variable | Expenditure Group | | | |
|---|---|---|---|---|
| | Low | Middle | High | Mean |
| Expenditures[2] | | | | |
| Rice | 58.2 | 125.2 | 262.9 | 146.7 |
| Root crops & other cereals | 10.7 | 32.4 | 147.4 | 61.3 |
| Oils and fats | 19.2 | 37.2 | 122.8 | 58.1 |
| Fish and animal products | 30.6 | 61.9 | 118.3 | 69.5 |
| Miscellaneous foods | 28.0 | 65.8 | 99.0 | 64.1 |
| Nonfoods | 90.0 | 190.1 | 324.0 | 199.9 |
| Value of household labor supplied | 306.4 | 361.8 | 530.1 | 396.5 |
| Prices[2] | | | | |
| Rice | .25 | .23 | .27 | .25 |
| Root crops & other cereals | .36 | .66 | .63 | .55 |
| Oils and fats | .73 | .62 | .66 | .67 |
| Fish and animal products | .62 | .60 | .39 | .54 |
| Miscellaneous foods | .56 | .58 | .60 | .58 |
| Nonfoods | .62 | .64 | .75 | .66 |
| Household labor | .08 | .08 | .09 | .08 |
| Household characteristics[3] | | | | |
| Total size | 4.8 | 6.4 | 8.7 | 6.7 |
| Members under 10 years | 1.2 | 2.1 | 2.7 | 2.0 |
| Members, 11-15 years | .5 | .7 | 1.1 | .8 |
| Males over 15 years | 1.7 | 1.8 | 2.6 | 2.1 |
| Females over 15 years | 1.4 | 1.8 | 2.3 | 1.8 |
| Number of households | 44 | 51 | 43 | 138 |

[1]Households in low expenditure group are those with total expenditure less than 350 Leones. Households in middle expenditure group are those with total expenditure between 350 and 750 Leones. Households in high expenditure group are those with total expenditure greater than 750 Leones.

[2]In Leones per kilogram for foods and per hour of male equivalent for labor. One Leone = U.S. $1.1 in 1974/75.

[3]In numbers.



Table 4.2

Actual Average Total Expenditure Shares by Expenditure Group

| Commodity | Expenditure Group | | | |
|---|---|---|---|---|
| | Low | Middle | High | Mean |
| Rice | .25 | .24 | .24 | .24 |
| Root crops and other cereals (other than rice) | .05 | .06 | .14 | .10 |
| Oils and fats | .08 | .07 | .11 | .10 |
| Fish and animal products | .13 | .12 | .11 | .12 |
| Miscellaneous foods | .12 | .13 | .09 | .11 |
| Nonfoods | .38 | .37 | .30 | .33 |

higher prices for oils and fats and fish and animal products.[1] Household size tends to be smaller for the lower expenditure group as does the proportion of family members under ten years.

The final QES specifications which we estimate have seven commodities, three translation demographic variables and three total time demographic variables [Strauss et al., 1981a, pp. 16-18]. Estimation of this system led to the results shown in Tables 4.3 and 4.4.[2]

[1]A relatively large number of low-expenditure households are found in areas in which cassava constitutes a large proportion of "root crops and other cereals." A relatively large number of high-expenditure households are found in areas that produce fish.

[2]For details concerning the estimation procedure see ibid., pp. 18-22.

For the complete set of coefficients and their standard errors see Strauss et al., 1981a, Table A.III, p. 34. Using the regional dummy, twenty-two of forty-two parameters have the absolute value of their coefficients greater than 1.96 times their standard errors, twenty-six have absolute values of coefficients more than 1.65 times their standard errors, and thirty have standard errors less than their coefficients' absolute value.

Table 4.3

Share of Marginal Total Expenditure[1] by Expenditure Group[2]

| Commodity | Low | Middle | High | Mean |
|---|---|---|---|---|
| | Expenditure Group | | | |
| Rice | .22 | .16 | .02 | .13 |
| Root crops and other cereals | .03 | .06 | .12 | .07 |
| Oils and fats | .13 | .20 | .36 | .23 |
| Fish and animal products | .13 | .11 | .07 | .11 |
| Miscellaneous foods | .09 | .07 | .04 | .07 |
| Nonfood | .40 | .40 | .39 | .39 |

[1]Partial derivative of commodity expenditure with respect to total income divided by partial derivative of total expenditure with respect to total income. Evaluated at expenditure group means using QES with regional dummy.

[2]See Table 4.1 for definitions of expenditure groups.



Table 4.4

Uncompensated Quantity Elasticities with Respect to Price[1] by Expenditure Group[2]

| With Respect to Price of | For Expenditure Group OF | Rice | Root Crops and Other Cereals | Oils and Fats | Fish and Animal Products | Miscellaneous Foods | Nonfoods | Household Labor |
|---|---|---|---|---|---|---|---|---|
| Rice | Low | -1.26 | -.16 | -.23 | .02 | .03 | -.01 | .01E-1 |
| | Middle | -.78 | -.13 | -.31 | .02 | .02 | -.02 | .04E-1 |
| | High | -.45 | -.12 | -.38 | .05 | .07 | -.04 | .01 |
| | Mean | -.74 | -.10 | -.29 | .03 | .03 | -.03 | .01 |
| Root Crops and Other Cereals | Low | -.02 | -.15 | -.02 | -.02 | -.02 | -.02 | .01 |
| | Middle | -.02 | -.26 | -.04 | -.02 | -.01 | -.02 | .01 |
| | High | -.01 | -.31 | -.02 | -.01 | -.01 | -.01 | .01 |
| | Mean | -.01 | -.22 | -.02 | -.02 | -.01 | -.02 | .01 |
| Oils and Fats | Low | .04 | .04 | -.82 | .05 | .03 | .05 | -.02 |
| | Middle | .01E-1 | .04E-1 | -1.10 | .02E-1 | .01E-1 | .04E-1 | -.62E-1 |
| | High | -.01E-1 | .05E-1 | -1.25 | .02E-1 | .01E-1 | .01 | -.03E-1 |
| | Mean | .04E-1 | .01 | -.97 | .01 | .01 | .01 | -.01 |
| Fish and Animal Products | Low | .02 | -.08 | -.12 | -1.29 | .01 | -.01 | .01E-1 |
| | Middle | .03 | -.06 | -.15 | -.92 | .01 | -.01 | .03E-1 |
| | High | .06 | -.05 | -.15 | -.81 | .04 | -.03E-1 | -.04E-1 |
| | Mean | .04 | -.04 | -.12 | -.95 | .02 | -.01 | .01E-3 |
| Miscellaneous Foods | Low | .01 | -.06 | -.10 | -.03E-1 | -.99 | -.01 | .04E-1 |
| | Middle | .01 | -.06 | -.14 | -.03E-1 | -.60 | -.02 | .01 |
| | High | .04 | -.04 | -.14 | .02 | -.63 | -.02 | .01 |
| | Mean | .02 | -.04 | -.11 | .03E-1 | -.71 | -.02 | .01 |
| Nonfoods | Low | .10 | -.16 | -.21 | .06 | .06 | -1.17 | -.01 |
| | Middle | .07 | -.16 | -.36 | .02 | .03 | -.90 | .01 |
| | High | .14 | -.12 | -.38 | .07 | .08 | -1.05 | -.04E-1 |
| | Mean | .09 | -.11 | -.30 | .04 | .05 | -1.01 | -.04E-1 |
| Labor | Low | 1.30 | .72 | 1.81 | 1.38 | 1.03 | 1.39 | -.06 |
| | Middle | .56 | .48 | 1.53 | .71 | .44 | .74 | .09 |
| | High | .20 | .31 | 1.16 | .43 | .31 | .65 | .28 |
| | Mean | .47 | .38 | 1.25 | .67 | .47 | .78 | .14 |

[1]Calculated at mean for each expenditure group. Uses QES with regional dummy.

[2]See Table A.II for definitions.

Results

Shares of marginal total expenditure are reported in Table 4.3. The share for rice declines with higher total expenditure as one would expect although the .02 share for high expenditure households seems a little low. The low share for root crops and other cereals is not surprising, though one would not have expected the marginal share to rise with expenditure.[1] Note that in both the low and the high expenditure groups the marginal share is less than the average (Cf. Table 4.2). In particular, the share is not negative at our mean evaluation points. This is interesting because many observers have hypothesized that cassava may be an inferior good for higher income groups in West Africa. This may still be the case, however, since the group, root crops and other cereals, contains expenditures on sorghum roughly equal to those on cassava, and sorghum is not usually believed to be an inferior good.

Uncompensated price elasticities of demand are reported in Table 4.4.[2] For rice the own price elasticity declines in absolute value with expenditure group. Part, but not all, of this is due to an income effect declining with expenditure group. This is certainly not surprising. Root crops seem not to be price responsive. The higher expenditure group is slightly more responsive to price, partly due to an increasing income effect. The relative unresponsiveness of total household labor supplied to wage rate changes (-.06 to .28) is not really surprising since this is measuring total supply, not its allocation between uses, and because for farm activities labor supplied is likely to be far less influenced by price than by the cropping pattern and technology used (assuming

---

[1]Middle and high expenditure households tend to be in areas for which the root crops and other cereals group contains a relatively high proportion of cereals.

[2]For the income-compensated elasticities see Strauss et al., 1981a, pp. 26-28.



annual labor supply adjusts to labor demand). Cropping pattern and technology are held fixed in the demand component of the household-firm model. The negative sign for the low expenditure group is due to the income effect (see below) and gives some slight evidence for a backward bending supply curve.

The cross price effects with respect to rice price are negative except for fish and miscellaneous foods. This is not surprising due to the large budget share of rice leading to a relatively large income effect. The fact that this is not as true for effects with respect to nonfood price is somewhat surprising since one would expect substitution effects of food commodities and rice to be larger than between food commodities and nonfood. This does not seem to be the case for our sample. Another cross price effect of some interest is between rice and root crops. One can see that root crop demand is more responsive to changes in price of rice than rice demand is to changes in price of root crops. Since rice represents a larger budget share its income effect is likely to be greater.

Changes in expenditure caused by a unit change in household composition variables are shown in Table 4.5. These changes are evaluated at the sample average except for the regional dummy variable which is set to one for northern households and to zero for southern households. The largest marginal expenditures for commodities are for rice, nonfoods, and oils and fats. Total expenditures increase for increases in each age/sex group. For males over 15 the value of household labor supply is affected importantly. Also, region makes no real difference.

As persons under 10 do not affect total household time the change in the value of household labor is the negative of the marginal change in expenditure on leisure.

Table 4.5

Marginal Expenditure by Commodity Due to Unit Change in Age-Group Variables by Region[1] (in Leones)

| Commodity | Region | Age Group | Under 10 | 11-15 | Males over 15 | Females over 15 |
|---|---|---|---|---|---|---|
| Rice | North | | 10.1 | 6.8 | 17.6 | 9.2 |
| | South | | 9.7 | 7.0 | 18.4 | 9.5 |
| Root crops and other cereals | North | | 4.3 | -2.5 | 3.7 | -1.2 |
| | South | | 4.5 | -2.7 | 3.4 | -1.3 |
| Oils and fats | North | | -5.9 | 8.7 | 28.9 | 13.2 |
| | South | | -5.4 | 8.4 | 28.0 | 12.8 |
| Fish and animal products | North | | -1.8 | 2.0 | 10.9 | 4.0 |
| | South | | -1.9 | 2.1 | 11.1 | 4.1 |
| Miscellaneous foods | North | | 10.1 | -2.5 | 3.0 | -1.2 |
| | South | | 10.0 | -2.4 | 3.2 | -1.2 |
| Nonfoods | North | | 8.7 | 5.6 | 39.2 | 13.0 |
| | South | | 8.7 | 5.6 | 39.1 | 13.0 |
| Household labor supply | North | | 25.5 | 18.1 | 103.3 | 37.0 |
| | South | | 25.6 | 18.0 | 103.2 | 37.0 |

[1]Calculated at sample averages except for regional dummy variable.

In each age bracket the marginal changes in goods expenditure less the change in value of labor supplied equals zero since the sum of total expenditures minus the value of labor supplied always equals the "profits" part of total income, which is constant. For persons over 10 total income changes, for their time constitutes the time available to the household.



## The Production Component

### Specifying the Production Side

To specify the production side of the model we replace the original implicit production function, $G(X_i, L_T, D, \bar{K}) = 0$ by $G(X_i, L_T, D, \bar{K}) = H(X_i) - F(L_T, D, \bar{K})$. That is, we assume outputs as a group to be separable from inputs as a group. We further assume almost homogeneity of degree $\frac{1}{s}$, that is, $H(\lambda X_i) = F(\lambda^s L_T, \lambda^s D, \lambda^s \bar{K})$. For outputs we use a constant elasticity of transformation (CET) function. This function, of the form $H(X_i) = (\Sigma \delta_i X_i^c)^{1/c}$, where $\delta_i > 0$ and $c > 1$ to insure convexity, entails only m + 1 parameters. For inputs we use a Cobb-Douglas (CD) function, $F(L_T, D, K) = A_o L_T^{B_L} D^{B_D} K^{B_K}$. Hence

$$(\sum_i \delta_i X_i^c)^{1/c} = A_o L_T^{B_L} D^{B_D} K^{B_K} \tag{5.1}$$

The parameter c can be transformed into $\frac{1}{c-1}$, the elasticity of transformation between outputs. That is, $\frac{1}{c-1}$ is the elasticity of the ratio of two outputs with respect to the marginal rate of transformation, $-\partial X_i/\partial X_j$, between them. For this production function the elasticity of transformation parameter is constant and the same for all pairs of outputs.

The $\delta_i$ parameters have their meaning in the marginal rate of transformation. It is easily seen that $\frac{-\partial X_i}{\partial X_j} = \frac{\delta_j}{\delta_i}\left(\frac{X_j}{X_i}\right)^{c-1}$. On the input side, the B parameters have the usual meaning for a Cobb-Douglas specification, that is, the percent change in all outputs due to an infinitesimal change in the particular input. The sum of the B's is the degree of almost homogeneity.

Maximizing profits subject to (5.1) (normalizing $A_o = 1$) and to D and K being fixed, we arrive at the output supply and labor demand equations:

$$p_i X_i = B_L^{B_L/1-B_L} \delta_i^{-1/(c-1)} p_i^{c/(c-1)} \qquad (5.2)$$

$$(\Sigma_k \delta_k^{-1/(c-1)} p_k^{c/(c-1)})^{(cB_L-1)/c(1-B_L)}$$

$$(D^{B_D} K^{B_K})^{1/(1-B_L)} p_L^{(-B_L/(1-B_L))}$$

$$i=1, \ldots, n$$

$$p_L L_T = (D^{B_D} K^{B_K})^{(\frac{1}{1-B_L})} B_L^{(\frac{1}{1-B_L})} p_L^{(-B_L/(1-B_L))}$$

$$(\Sigma_i \delta_i^{\frac{-1}{c-1}} p_i^{c/(c-1)})^{(\frac{c-1}{c(1-B_L)})}$$

These equations point out some of the simplifications made by selection of this functional form. Elasticities of value output with respect to fixed input are $\frac{B_i}{1-B_L}$, where i is either D or K. This means these elasticities are the same for all outputs. Also, the elasticities of value output with respect to wage $\frac{B_i}{1-B_L}$ are identical for all outputs. Own price elasticities of value output and of value labor demand are not identical across commodities as seen by

$$\frac{\ln p_i X_i}{\ln p_i} = \frac{1}{c-1} + p_i^{\frac{c}{c-1}} \delta_i^{\frac{1}{c-1}} (cB_L-1)/((1-B_L)(c-1)A) \qquad (5.3)$$

where $A = \Sigma_i p_i^{c/(c-1)} \delta_i^{-1/(c-1)}$ and $\frac{\partial \ln p_L L_T}{\partial \ln p_L} = -B_L/(1-B_L)$.

In estimating the production system we used farm sales prices rather than the "consumption" prices (averages of farm gate and market purchase prices) used for the consumption system. For further detail about the data see Strauss et al., 1981b, pp. 9-12.



Sample Characteristics

Production characteristics of the sample of 138 households are shown in Table 4.6. For reporting average values, the sample is divided into the ten households in Enumeration Area 13 (EA13) and the remainder. The former are mostly commercial fishermen who also grow and sell a large amount of vegetables to the Freetown market. In their production characteristics they are quite different from the rest of the households. (This is not so true of their consumption characteristics). The fishing households cultivate much less land than the other households (an average of 1.6 rather than 6.8 acres), but have considerably more capital in the form of boats and the like. Prices are also different, with the price of fish and animal products being considerably lower in EA13.

Table 4.7 presents the quantities of production, total consumption and the difference, net marketed surplus, by expenditure group, formed by separating households according to whether their total expenditure on goods is under 350 Leones, between 350 and 750 Leones, or over 750 Leones. Except for rice the high expenditure group tends to sell more or buy more than do lower expenditure groups. The only groups for which net purchases from the market are made are nonfoods, labor for middle and high expenditure groups and fish and animal products for low and middle expenditure groups. We have to remember, however, that these are net figures. A household may hire labor during peak season and sell labor in the offpeak season. The figures reported here combine these two transactions.

Finally, and not surprisingly, households specialize in production more than in consumption. Using our commodity definitions we have three households which do not produce rice, 19 which have no production of root crops and other cereals, 24 for oils and fats, 35 for fish and animal products, 12 for miscellaneous foods, and 59 for nonfoods.

Table 4.6

Mean Values of Production-Related Data, EA 13 and Other Households

| Variable | EA 13 | Non-EA 13 | Entire Sample |
|---|---|---|---|
| Value of Production[1] | | | |
| Rice | 62.7 | 283.5 | 267.5 |
| Root crops & other cereals | 27.9 | 64.4 | 61.8 |
| Oils and fats | 20.6 | 104.2 | 98.1 |
| Fish and animal products | 733.5 | 23.0 | 74.5 |
| Miscellaneous foods | 331.8 | 53.3 | 73.5 |
| Nonfoods | 82.8 | 25.0 | 29.2 |
| Value of Labor Demand | 954.7 | 367.5 | 410.0 |
| Prices[2] | | | |
| Rice | .19 | .22 | .22 |
| Root crops & other cereals | .25 | .14 | .15 |
| Oils and fats | .37 | .41 | .41 |
| Fish and animal products | .17 | .52 | .49 |
| Miscellaneous foods | .15 | .29 | .28 |
| Nonfoods | 2.23 | 1.25 | 1.32 |
| Labor | .15 | .08 | .08 |
| Household Characteristics | | | |
| Cultivated land[3] | 1.6 | 6.8 | 6.4 |
| Capital[4] | 214.3 | 35.1 | 48.1 |
| Proportion of households in EA 13 | 1.00 | 0.00 | .07 |

[1]In Leones. Valued by weighted sales prices.

[2]Weighted sales prices. In Leones per kilogram for foods and per hour of male equivalent for labor.

[3]In acres.

[4]Annual flow in Leones.



Table 4.7

Quantities[1] Produced, Consumed, and Marketed by Expenditure Group

| Commodity | Expenditure Group | Produced | Consumed | Marketed |
|---|---|---|---|---|
| Rice | Low | 902.8 | 232.8 | 670.0 |
| | Middle | 1,164.3 | 544.3 | 620.0 |
| | High | 1,622.2 | 973.7 | 648.5 |
| | Mean | 1,227.5 | 586.8 | 640.7 |
| Root crops and other cereals | Low | 69.0 | 29.7 | 39.3 |
| | Middle | 335.8 | 49.1 | 286.7 |
| | High | 744.6 | 194.9 | 549.7 |
| | Mean | 422.1 | 111.5 | 310.6 |
| Oils and fats | Low | 85.5 | 26.3 | 59.2 |
| | Middle | 242.0 | 60.0 | 182.0 |
| | High | 447.2 | 186.1 | 261.1 |
| | Mean | 242.2 | 86.7 | 155.5 |
| Fish and animal products | Low | 18.0 | 49.4 | -31.4 |
| | Middle | 48.3 | 103.2 | -54.9 |
| | High | 508.7 | 303.3 | 205.4 |
| | Mean | 151.5 | 128.7 | 22.8 |
| Miscellaneous foods | Low | 93.0 | 50.0 | 43.0 |
| | Middle | 191.3 | 113.4 | 77.9 |
| | High | 515.3 | 165.0 | 350.3 |
| | Mean | 262.3 | 110.5 | 151.8 |
| Nonfoods | Low | 10.8 | 145.2 | -134.4 |
| | Middle | 19.4 | 297.0 | -277.6 |
| | High | 33.9 | 432.0 | -398.1 |
| | Mean | 22.1 | 302.9 | -280.8 |
| Labor[2] | Low | 3,963.8 | 3,800.3 | 163.5 |
| | Middle | 4,286.7 | 4,425.1 | -138.4 |
| | High | 5,687.8 | 6,141.4 | -453.6 |
| | Mean | 4,670.2 | 4,829.7 | -159.5 |

[1]In kilograms for foods, hours for labor.

[2]Produced and consumed correspond to supply and demand.

The relatively large number of zero outputs gives rise to statistical problems. These were dealt with by using a multivariate Tobit model [Strauss et al., 1981b, pp. 16-21]. This assumes that there is a positive probability of producing non-produced outputs. As some production of each of our six commodity groups occurs in each ecological zone (though not necessarily by the households in our sample), there is evidently no broad environmental reason why each good cannot be produced [ibid., p. 20].

Estimates of the System in Quantity Form

The system of output supplies and labor demand was estimated in quantity form, using numerical maximum likelihood techniques. For parameter estimates and their asymptotic standard errors see ibid., Table A.2, p. 65. The results are useful, but not nearly as satisfactory as those for the consumption component. Nine out of sixteen production function parameters have absolute values of coefficients greater than their standard errors, with four having this ratio greater than two. One parameter (for rice) is significant at a probability level less than .1 (corresponding to a standard normal statistic greater than 1.29) and two have probability levels of roughly .11. For the $\delta_{i0} + \delta_{i1}$ parameters (which correspond to EA13 households), two have coefficients with absolute values greater than 1.29 times their standard errors.

The coefficient c is 4.25, corresponding to an elasticity of transformation between outputs of .31. The production function is almost homogeneous of degree .78, significantly less than one. The coefficients of capital and labor are 0.36 and 0.35, respectively, but that for land, .07, is low, very different from the usual single agricultural output Cobb-Douglas result, in which land has the largest coefficient. This need not be surprising, however, if it is true, as is widely believed, that land is not particularly scarce in much of West Africa. If the marginal product of land is low, the



land coefficient ($B_D$), the ratio of the marginal product to the average product of land, may also be low. Still there are other reasons why $B_D$ might be low. First, some of our outputs, such as fishing and animal products, oils and fats and nonfoods, are not going to be much affected directly by land cultivated by the household. Capital and labor are far more important inputs for these activities. Perhaps, had the production function specification been to allow separate functions for these activities, the land coefficient might have been higher for the remaining crop activities. Be that as it may, this was not possible due to the data inadequacies described earlier. In any case, given the output detail and function specification used, these coefficients may not be unreasonable. A second potential reason is the absence of any quality adjustments in defining the land variable. This misspecification affects all coefficients. Had the model been linear in parameters, however, and if increasing size of farm was associated with lower quality land, then land's estimated coefficient would be lower than the true value. Whether this result applies given that the model is highly nonlinear in parameters is not clear.

Output Elasticities

Price elasticities of quantity of output supply and labor demand are given in Table 4.8 for EA 13 households, the remaining households and the sample average. The elasticities are evaluated at average values for these three groups. All the output elasticities are less than .5. In general, the more important the activity to the group of households, the more price responsive it is. For EA 13 households, fish and animal products and miscellaneous foods (remember, vegetable production is important for these households) have own-price elasticities of .45 and .35 respectively. For non-EA 13 households rice is the most price responsive, having an elasticity of .36. For these households, root crops and other cereals, oil and fats and miscellaneous foods have own-price elasticities ranging from .09 to .14. Labor demanded is much more elastic

Table 4.8

Elasticities of Expected Quantities of Outputs Supplied and Labor Demanded with Respect to Price From CET-CD System in Quantity Form[1]

| With Respect to Price of | Household Group | Rice | Root Crops and Other Cereals | Oils and Fats | Fish and Animal Products | Mis-cel-laneous Foods | Nonfoods | Labor |
|---|---|---|---|---|---|---|---|---|
| Rice | EA 13 | .08 | .02E-1 | .03E-2 | .06E-1 | .06E-1 | .03E-1 | .03 |
| | Non-EA 13 | .36 | .03 | .04 | .02 | .05 | .01 | .53 |
| | Mean | .11 | .01 | .03E-1 | .01 | .02 | .06E-1 | .14 |
| Root Crops and Other Cereals | EA 13 | .08E-1 | .12 | .01E-1 | .03 | .03 | .01 | .18 |
| | Non-EA 13 | .03 | .09 | .01 | .07E-1 | .01 | .04E-1 | .16 |
| | Mean | .02 | .10 | .04E-1 | .01 | .03 | .08E-1 | .20 |
| Oils and Fats | EA 13 | .02E-2 | .04E-2 | .02 | .01E-1 | .01E-1 | .04E-2 | .06E-1 |
| | Non-EA 13 | .02 | .08E-1 | .13 | .06E-1 | .01 | .03E-1 | .14 |
| | Mean | .02E-1 | .02E-1 | .02 | .02E-1 | .03E-1 | .09E-2 | .02 |
| Fish and Animal Products | EA 13 | .04 | .05 | .07E-1 | .45 | .14 | .06 | .83 |
| | Non-EA 13 | .03 | .01 | .02 | .08 | .02 | .05E-1 | .20 |
| | Mean | .02 | .02 | .05E-1 | .09 | .03 | .09E-1 | .23 |
| Miscellaneous Foods | EA 13 | .01 | .02 | .02E-1 | .05 | .35 | .02 | .27 |
| | Non-EA 13 | .02 | .06E-1 | .09E-1 | .05E-1 | .14 | .03E-1 | .11 |
| | Mean | .01 | .01 | .03E-1 | .01 | .15 | .05E-1 | .13 |
| Nonfoods | EA 13 | .03E-1 | .04E-1 | .05E-2 | .01 | .01 | .13 | .06 |
| | Non-EA 13 | .04E-1 | .01E-1 | .02E-1 | .09E-2 | .02E-1 | .04 | .02 |
| | Mean | .03E-1 | .02E-1 | .05E-2 | .02E-1 | .04E-1 | .04 | .03 |
| Labor | EA 13 | -.14 | -.20 | -.03 | -.54 | -.54 | -.23 | -1.37 |
| | Non-EA 13 | -.47 | -.15 | -.21 | -.12 | -.23 | -.07 | -1.17 |
| | Mean | -.17 | -.14 | -.03 | -.13 | -.24 | -.07 | -.79 |

[1]Calculated at mean values for each household group using $\frac{p_j}{E(X_i)} \frac{\partial E(X_i)}{\partial p_j}$. Uses EA 13 - Non-EA 13 dummy.



than outputs for all households, being -1.37 and -1.17 for EA 13 and non-EA 13 households respectively.

For oils and fats (which includes palm kernels, a cash crop) the own-price elasticity of .13 for non-EA 13 households is at first glance surprisingly low. However, it should be remembered that exogenous variables are averaged over households only some of which are major producers of oils and fats. This may bring price responsiveness down. More importantly, the stock of oil palm trees of bearing age is fixed so the major response to price can come only by varying labor, that is, by varying the amount of fruit picked and processed.[1]

Cross price elasticities of outputs tend to be low except with respect to wage rate. The latter is not surprising since labor demand is reasonably price responsive. The cross price elasticity with respect to wage can be written as the product of the own price elasticity of labor demand and the output elasticity of labor, where the latter is written $\frac{E(L_T)}{E(X_i)} \frac{\partial E(X_i)}{\partial E(L_T)}$. Cross price elasticities of labor demand are also not negligible. As with own-price output elasticities, the more important the activity corresponding to the price that is changing, the more responsive labor demand is. The signs of the output cross elasticities are positive. That is, an increasing price of output i leads to increased production of output j. As output price changes, there is a substitution effect, that is movement along a production transformation frontier. This should be negative. There is also an output effect, a shift of the transformation frontier, due to changes in outputs other than i and j, and, more importantly, due to changes in labor demand. An increase in price i should increase labor demand as well as output i, shifting the transformation frontier between goods i and j outward. Whether the outward shift

[1]The palm products produced by the sample households came almost entirely from wild oil palm trees. [Spencer et al., 1979, p. 30.]

of the transformation frontier is sufficient to outweigh the substitution effect is an empirical question. For the CET-CD production function, it turns out that sign $\left(\frac{\partial E(X_i)}{\partial p_j}\right)$ = sign $(c\beta_L - 1)$, which is positive for our estimates.

## The System as a Whole

### Total Price Effects

Having estimated separately the demand system and production system components of the household-firm model we can now examine the model in its entirety. Table 4.4 gave the price elasticities holding profits constant. If we now allow profits to vary we can write

$$\frac{\partial X_i^c}{\partial p_j} = \frac{\partial X_i^c}{\partial p_j}\bigg|_{d\pi=0} + \frac{\partial X_i^c}{\partial \pi}\frac{\partial \pi}{\partial p_j}.$$

In elasticity form,

$$\frac{p_j}{X_i^c}\frac{\partial X_i^c}{\partial p_j} = \frac{p_j}{X_i^c}\frac{\partial X_i^c}{\partial p_j}\bigg|_{d\pi=0} + \frac{p_j \partial X_i^c \partial \pi}{X_i^c\ \partial \pi \partial p_j}. \qquad (6.1)$$

The first term is simply the usual uncompensated elasticity of demand of good i with respect to price j. The second term is what we might call the "profit effect" in elasticity form. The term $\frac{\partial X_i^c}{\partial \pi}$ is easily gotten from the marginal full income expenditures in Table 4.9. As $\pi = E(\pi) + u$, where u is an error term with mean zero, independent of price and fixed inputs, $\frac{\partial \pi}{\partial p_j} = \frac{\partial E(\pi)}{\partial p_j}$. For the computation of $\frac{\partial E(\pi)}{\partial p_j}$, see Strauss et al., 1981b, pp. 30-32.

Table 4.10 reports the "profit effects" (the second term in equation 6.1) in elasticity form, for low, middle, high and mean expenditure households, assuming proportional changes in sales and purchase prices. In most cases the effects are larger, often much larger, for the lowest expenditure households, declining with higher expenditure. Two reasons exist for this tendency to decline. First, for some goods marginal expenditures out of full income decline with higher expenditure. Second, labor supplied and mean consumption of



Table 4.9

**Marginal Full Income Shares[1] by Expenditure Group**

| Commodity | Low | Expenditure Group Middle | High | Mean |
|---|---|---|---|---|
| Rice | .15 | .11 | .01 | .09 |
| Root crops & other cereals | .02 | .04 | .09 | .05 |
| Oils and fats | .09 | .14 | .26 | .16 |
| Fish and animal products | .09 | .08 | .05 | .07 |
| Miscellaneous foods | .06 | .05 | .03 | .05 |
| Nonfoods | .27 | .27 | .28 | .28 |
| Leisure | .31 | .31 | .29 | .30 |

[1] Partial derivative of commodity expenditure with respect to full income. Evaluated at expenditure group means.
These values come from the QES estimates.

Table 4.10

Profit Effects in Elasticity Form by Expenditure Group

| With Respect to Price of | For Expenditure Group OF | Rice | Root Crops and Other Cereals | Oils and Fats | Fish and Animal Products | Miscellaneous Foods | Nonfoods | Household Labor Supply |
|---|---|---|---|---|---|---|---|---|
| Rice | Low | .82 | .63 | 1.44 | .91 | .66 | .94 | -.32 |
| | Middle | .11 | .15 | .46 | .16 | .10 | .18 | -.11 |
| | High | .05E-1 | .08 | .26 | .05 | .03 | .11 | -.07 |
| | Mean | .08 | .09 | .35 | .14 | .09 | .17 | -.10 |
| Root crops and other cereals | Low | .49 | .38 | .86 | .54 | .40 | .56 | -.19 |
| | Middle | .14 | .19 | .56 | .19 | .12 | .22 | -.13 |
| | High | .01 | .16 | .58 | .12 | .07 | .24 | -.15 |
| | Mean | .12 | .16 | .55 | .21 | .14 | .27 | -.15 |
| Oils and fats | Low | .36 | .28 | .63 | .40 | .29 | .41 | -.14 |
| | Middle | .08 | .11 | .31 | .11 | .06 | .13 | -.07 |
| | High | .03E-1 | .04 | .17 | .03 | .02 | .07 | -.04 |
| | Mean | .05 | .07 | .24 | .09 | .06 | .12 | -.06 |
| Fish and animal products | Low | .71 | .54 | 1.24 | .78 | .58 | .81 | -.28 |
| | Middle | .25 | .35 | 1.05 | .35 | .22 | .41 | -.24 |
| | High | .09E-1 | .13 | .45 | .10 | .06 | .19 | -.12 |
| | Mean | .16 | .21 | .73 | .27 | .18 | .36 | -.20 |
| Miscellaneous foods | Low | .23 | .18 | .40 | .25 | .19 | .26 | -.09 |
| | Middle | .08 | .11 | .33 | .11 | .07 | .13 | -.08 |
| | High | .05E-1 | .06 | .22 | .05 | .03 | .09 | -.06 |
| | Mean | .06 | .07 | .25 | .10 | .06 | .13 | -.07 |
| Nonfoods | Low | .12 | .10 | .22 | .14 | .10 | .14 | -.04 |
| | Middle | .04 | .06 | .18 | .06 | .04 | .08 | -.04 |
| | High | .02E-1 | .04 | .12 | .02 | .02 | .06 | -.04 |
| | Mean | .04 | .04 | .14 | .06 | .04 | .08 | -.04 |
| Labor | Low | -.56 | -.43 | -.99 | -.62 | -.46 | -.64 | .22 |
| | Middle | -.13 | -.19 | -.56 | -.19 | -.11 | -.22 | .13 |
| | High | -.08E-1 | -.11 | -.38 | -.08 | -.05 | -.15 | .10 |
| | Mean | -.10 | -.13 | -.43 | -.17 | -.11 | -.21 | .12 |

[1]Calculated as $\frac{p_j}{x_i^c}\frac{\partial x_i^c}{\partial \pi}\frac{\partial E(\pi)}{\partial p_j}$ at expenditure group means, using parameter estimates from the CET-CD system in quantity form, and assuming proportional sales and purchase prices.



all goods increase with higher expenditure level. Indeed even for root crops and oils and fats, for which marginal expenditures out of full income rise with total expenditure level, the profit effect, which is in an elasticity form, falls. Goods having higher marginal expenditures, such as oils and fats and nonfoods, tend to have larger profit effects. This factor is also responsible for many of the cross profit effects being large. A change in full income generated by a changing price is distributed over all commodities according to the marginal expenditure out of full income.

The largest own profit effect, at the sample mean, is .27 for fish and animal products. Oils and fats has an effect of .24. The other own effects at the mean household level are all lower than .17.

For the low expenditure group the largest own profit effect is .82 for rice, followed by .78 for fish and animal products and then .63 for oils and fats. In addition to the reasons previously advanced the profit effect for rice is large because the term $\frac{\partial E(\pi)}{\partial p}$ rises substantially when computed for the low expenditure group.

The signs of the profit effects with respect to goods prices are positive except for household labor supply. This is due to the marginal expenditures out of full income being positive for all goods. The sign on household labor is the opposite of the sign on household "leisure." Since "leisure" is a normal good for these households, labor supply is lowered as total income increases due to rising goods prices. With respect to wage rate the signs for effects on goods are negative, for the same reason. Profits are reduced as wage increases so expenditures fall. Household labor, however, increases in this case.

## Elasticities of Consumption

Having derived the profit effects we can add these to the uncompensated elasticities with respect to price, which hold profit constant, to arrive at the total price elasticities of quantities of goods demanded and of labor supplied. See Table 4.11. The own total price effects for commodities remain negative when profit effects are added except for root crops and other cereals at the low expenditure group. The fact that root crops and other cereals consumption responds positively to own price for low expenditure households is reflective of the lack of responsiveness of consumption to own price holding profits constant and of the higher profit effect for these households. In the other cases the short run responsiveness, holding profits constant, to own price is much greater and overwhelms the profit effect. However, the profit effect does have the interesting consequence that the total own price elasticities for several commodities such as rice, oils and fats, and fish and animal products no longer drop in absolute value with higher expenditure levels. Indeed, for rice the total own price elasticity is as low for low expenditure households as for high expenditure households. For root crops and other cereals, the negative response of consumption to own price is greater for high than for middle expenditure households. This is mostly a result of the uncompensated (profits constant) price elasticities being higher in absolute value for the high expenditure group. Secondarily, the profit effects are slightly higher for the middle than for the high expenditure group. For household labor supply the response to wage is now positive at all expenditure levels, rising to almost .4 for high expenditure households and being roughly .25 at the sample mean. The fact that this still rises with the higher expenditure group is due to the classical demand substitution effects[1] rising with expenditure [Strauss et al., 1981a, p. 27].

In general, the total cross price effects are positive. Negative classical demand income effects are reversed in sign by the profit effects. The exceptions are for root crops and other cereals and oils and fats consumption with respect to nonfoods price, and for those two commodities with respect

---

[1]Substitution away from leisure as the wage rate rises.



Table 4.11

Total Quantity Elasticities with Respect to Price[1] by Expenditure Group

| With Respect to Price of | For Expenditure Group OF | Rice | Root Crops and Other Cereals | Oils and Fats | Fish and Animal Products | Miscellaneous Foods | Nonfoods | Household Labor Supply |
|---|---|---|---|---|---|---|---|---|
| Rice | Low | -.44 | .47 | 1.21 | .93 | .69 | .93 | -.32 |
| | Middle | -.67 | .02 | .15 | .18 | .12 | .16 | -.11 |
| | High | -.44 | -.04 | -.12 | .10 | .10 | .07 | -.06 |
| | Mean | -.66 | -.01 | .06 | .17 | .12 | .14 | -.09 |
| Root crops and other cereals | Low | .47 | .23 | .84 | .52 | .38 | .54 | -.18 |
| | Middle | .12 | -.07 | .52 | .17 | .11 | .20 | -.12 |
| | High | .01E-1 | -.15 | .56 | .11 | .06 | .23 | -.14 |
| | Mean | .11 | -.06 | .53 | .19 | .13 | .25 | -.14 |
| Oils and fats | Low | .40 | .32 | -.19 | .45 | .32 | .46 | -.16 |
| | Middle | .08 | .11 | -.79 | .11 | .06 | .13 | -.07 |
| | High | .02E-1 | .05 | -1.08 | .03 | .02 | .08 | -.04 |
| | Mean | .06 | .08 | -.73 | .10 | .07 | .13 | -.07 |
| Fish and animal products | Low | .73 | .46 | 1.12 | -.51 | .59 | .80 | -.28 |
| | Middle | .28 | .29 | .90 | -.57 | .23 | .40 | -.24 |
| | High | .07 | .08 | .30 | -.71 | .10 | .19 | -.12 |
| | Mean | .20 | .17 | .61 | -.68 | .20 | .35 | -.20 |
| Miscellaneous foods | Low | .24 | .12 | .30 | .25 | -.80 | .25 | -.09 |
| | Middle | .09 | .05 | .19 | .11 | -.53 | .11 | -.07 |
| | High | .05 | .02 | .08 | .07 | -.60 | .07 | -.05 |
| | Mean | .08 | .03 | .14 | .10 | -.65 | .11 | -.06 |
| Nonfoods | Low | .22 | -.06 | .01 | .20 | .16 | -1.03 | -.05 |
| | Middle | .11 | -.10 | -.18 | .08 | .07 | -.82 | -.03 |
| | High | .14 | -.08 | -.26 | .09 | .10 | -.99 | -.05 |
| | Mean | .13 | -.07 | -.16 | .10 | .09 | -.93 | -.05 |
| Labor | Low | .74 | .29 | .82 | .76 | .57 | .75 | .16 |
| | Middle | .43 | .29 | .97 | .52 | .33 | .52 | .22 |
| | High | .19 | .20 | .78 | .35 | .26 | .50 | .38 |
| | Mean | .37 | .21 | .82 | .50 | .36 | .57 | .26 |

[1]Sum of uncompensated quantity elasticities and profit effects in elasticity form. Assumes proportional sales and purchase prices.

to rice price for the high expenditure group (and sample mean for root crops and other cereals). Some of the positive cross price elasticities are of large magnitude, for example, oils and fats consumption with respect to the price of root crops and other cereals. However, in general the cross price responsiveness declines with higher expenditure, as the profit effects do, and is not large when evaluated at the sample mean. For labor supply the cross price effects are negative, due to the profit effect. The cross effects with respect to wage rate are cut substantially from the effects when profits are held constant, but remain positive and non-negligible. Rises in the wage rate increase total income by increasing the value of time available to the household, but decrease total income by decreasing the profit component. Evidently, the former effect is the dominant one because the positive income effect, found by subtracting the income compensated from the uncompensated elasticities, is larger in absolute value than the negative profits effect.

The total own-price elasticity for rice, at the sample mean, is -.66, quite in contrast with total own-price elasticities for aggregate agricultural output in Taiwan of .22 [Yotopoulos, Lau and Lin, 1976], and for rice in Malaysia and South Korea of .38 and .01, respectively [Barnum and Squire, 1979; Ahn, Singh and Squire, 1980]. The first of these results is from a Linear Logarithmic Expenditure System; the last two from Linear Expenditure System estimations. The Malaysian study is for households practicing monoculture; rice is the only agricultural good. In the study of South Korean data rice was one of three foods produced. Average farmers' incomes were much higher in Taiwan and South Korea than in Sierra Leone.

In all three of these studies positive profit effects outweighed negative own-price effects. In Sierra Leone, the profits effects, though positive, were not generally strong enough to do this. The negative own-price



effect holding profits constant from the Sierra Leone data was -.74 at the sample mean, almost identical with the negative own-price elasticity for the single aggregate agricultural good in Taiwan (-.72), but the profit effect in Sierra Leone was much less than that in Taiwan. Of course in the Sierra Leone study the price of rice is one of five goods prices affecting output and the effect of any increase in profit is distributed over seven commodities, including leisure. The South Korean study covered six commodities; the other two dealt with only three, including leisure.

Market Surplus Elasticities

Let $MS_i \equiv$ marketed surplus of commodity i. We have $MS_i = X_i - X_i^c$. Given our data construction marketed surplus includes net sales plus wages paid in kind minus wages received in kind. Then

$$\frac{\partial MS_i}{\partial p_j} = \frac{\partial X_i}{\partial p_j} - \frac{\partial X_i^c}{\partial p_j} \text{ and in elasticity form}$$

$$\frac{p_j}{|MS_i|}\frac{\partial MS_i}{\partial p_j} = \frac{X_i}{|MS_i|}\frac{p_j}{X_i}\frac{\partial X_i}{\partial p_j} - \frac{X_i^c}{|MS_i|}\frac{p_j}{X_i^c}\frac{\partial X_i^c}{\partial p_j} \qquad (7.1)$$

The elasticity of marketed surplus is then a weighted difference of output elasticities and of total price elasticities of quantities consumed. The weights are the ratio of quantity produced to surplus, for production, and quantity consumed to surplus, for consumption. Given our Tobit estimation of the production side, we use $\frac{\partial E(X_i)}{\partial p_j}$ in the first term. Also, the divisor is the absolute value of marketed surplus. This is used so that one can easily tell the sign of $\frac{\partial MS_i}{\partial p_j}$, that is whether production increases more or less than consumption.

If the sign of the elasticity is positive and the net surplus is positive, then an increase in price will result in more being sold on the market. If the elasticity is positive and the household is a net purchaser (a negative surplus), then an increase in price will lead to less being purchased on the market. A negative elasticity and a positive surplus will lead to less being sold to the market and negative elasticity and a negative surplus means more will be purchased. We continue to assume proportional sales and purchase prices.

As Krishna [1962] has pointed out, the magnitudes of the own price marketed surplus elasticities may be a good deal higher than the output elasticities if production is very much larger than surplus. Providing the total own price elasticities of consumption are negative, these will reinforce the effect of increasing production, further increasing the marketed surplus elasticity. Indeed, the only way in which this measure can be negative is for the total own price elasticity to be sufficiently positive and the ratio of consumption to marketed surplus to be large enough so that their product outweighs the effect of increasing production. Given our total price elasticities this will only be possible for root crops and other cereals for low expenditure households.

The matrix of marketed surplus price elasticities is shown in Table 4.12. All the own price elasticities are positive and reasonably high. There is a tendency for the price responsiveness of marketed surplus to decline at higher expenditure levels. In large part this is due to the absolute value of marketed surplus, part of the denominator, increasing with higher expenditure levels (see Table 4.7). The marketed surplus being low is the reason for the high magnitude of the own price elasticity for root crops and other cereals for low expenditure households. If absolute changes in kilograms marketed due to a one-percent increase in price were shown they would be roughly equal for the low and middle expenditure groups, rising for the high expenditure group. For household labor the large values of the marketed surplus elasticity with respect to wage rate are also caused by the small values of marketed surplus in the denominator.



Table 4.12

Price Elasticities of Marketed Surplus[1] by Expenditure Group

| With Respect to Price of | For Expenditure Group OF | Rice | Root Crops and Other Cereals | Oils and Fats | Fish and Animal Products | Miscellaneous Foods | Nonfoods | Household Labor Supply |
|---|---|---|---|---|---|---|---|---|
| Rice | Low | .89 | .66 | -.32 | -1.05 | -.47 | -1.00 | -18.45 |
| | Middle | .73 | .05 | -.04 | -.23 | -.09 | -.17 | -5.74 |
| | High | .75 | .04 | .09 | -.12 | -.03 | -.08 | -1.31 |
| | Mean | .71 | .06 | -.03 | -.72 | -.05 | -.15 | -4.42 |
| Root crops and other cereals | Low | -.11 | 3.10 | -.31 | -.70 | -.34 | -.58 | -7.53 |
| | Middle | -.09 | .37 | -.17 | -.23 | -.09 | -.21 | -5.54 |
| | High | .02 | .39 | -.40 | -.10 | .02 | -.25 | -3.09 |
| | Mean | -.08 | .46 | -.29 | -.73 | -.04 | -.27 | -6.61 |
| Oils and fats | Low | -.08 | .06 | .79 | -.58 | -.27 | -.50 | -7.09 |
| | Middle | -.07 | -.01 | .29 | -.19 | -.07 | -.14 | -2.56 |
| | High | -.02E-1 | -.01 | .78 | -.04 | -.07E-1 | -.09 | -.58 |
| | Mean | -.05 | -.02 | .44 | -.44 | -.04 | -.14 | -2.35 |
| Fish and animal products | Low | -.18 | .04 | -.41 | 2.15 | -.56 | -.86 | -10.84 |
| | Middle | -.22 | .03 | -.29 | 1.81 | -.22 | -.43 | -10.56 |
| | High | -.09 | .02 | -.21 | 1.33 | -.01 | -.21 | -2.56 |
| | Mean | -.16 | .02 | -.33 | 5.94 | -.08 | -.38 | -8.80 |
| Miscellaneous foods | Low | -.05 | .11 | -.09 | -.32 | 1.97 | -.27 | -4.22 |
| | Middle | -.06 | .03 | -.06 | -.13 | 1.29 | -.12 | -3.77 |
| | High | -.06 | .03 | -.05 | -.07 | .49 | -.08 | -1.36 |
| | Mean | -.06 | .04 | -.08 | -.34 | .81 | -.12 | -3.44 |
| Nonfoods | Low | -.07 | .08 | .03E-1 | -.30 | -.17 | 1.12 | -1.59 |
| | Middle | -.09 | .02 | .06 | -.14 | -.09 | .88 | -1.24 |
| | High | -.21 | .04 | .19 | -.12 | -.04 | 1.08 | -.80 |
| | Mean | -.12 | .04 | .09 | -.52 | -.06 | 1.01 | -1.85 |
| Labor | Low | -1.22 | -5.45 | -1.49 | -3.30 | -2.37 | -.83 | 27.41 |
| | Middle | -.58 | -.60 | -.37 | -2.02 | -1.29 | -.56 | 16.41 |
| | High | -.42 | -.54 | -.58 | -.93 | -.44 | -.55 | 8.57 |
| | Mean | -.49 | -.72 | -.51 | -5.82 | -.78 | -.62 | 17.18 |

[1]Calculated as $\frac{X_i}{|MS_i|} \frac{p_j}{X_i} \frac{\partial E(X_i)}{\partial p_j} - \frac{X_i^c}{|MS_i|} \frac{p_j}{X_i^c} \frac{\partial X_i^c}{\partial p_j}$ and assuming proportional sales and purchase prices.

The cross price elasticities of marketed surplus tend to be negative because of the strong profit effects in the cross total price elasticity of demand. The latter term is generally positive and often large. Since it is subtracted, after being weighted appropriately, from a generally small positive cross price effect on production, the difference will usually be negative. For example, an increasing price of root crops and other cereals will lead to a decrease in the marketed surplus of oils and fats. That is, sales of oils and fats will decrease. Also, a decrease in the marketed surplus of nonfoods will take place. However, since nonfoods are purchased on the market (the surplus is negative) the decrease in marketed surplus means that more will be purchased on the market.

Some positive cross price elasticities exist. For example, the surplus for root crops and other cereals responds positively to all prices except for oils and fats and the wage rate. Also, the surplus for oils and fats responds positively to nonfoods price.

Some of the magnitudes of the cross price elasticities are fairly large. Again this is caused by the strong profit effect on consumption. The magnitudes do tend to fall with the higher expenditure groups, as they do for the own price elasticities. They are not negligible, however, so it is not wise to ignore them as most past studies have done.

<u>Effects of Prices and Expenditure on Caloric Availability</u>

This study is concerned ultimately with determinants of food consumption. This can be further translated into the effects of prices and other variables on the availability to the household of different nutrients. Of greatest interest to development economists recently is caloric availability. Only the impact on calories is examined here, although one can in principle use our results to examine the impact of socio-economic variables on many nutrients.



We want to calculate $\frac{\partial cal}{\partial p_j} = \sum_{i=1}^{5} \frac{\partial cal}{\partial X_i^c} \frac{\partial X_i^c}{\partial p_j}$, where cal≡calories and 1-5 are our food groups. In elasticity form we want $\frac{p_j}{cal} \frac{\partial cal}{\partial p_j} = \frac{1}{cal} \sum_{i=1}^{5} \frac{\partial cal}{\partial X_i^c} \frac{p_j \partial X_i^c}{\partial p_j}$.

We calculate effects on calories of price changes both when profits are constant and when they are variable. The difference will point out clearly the effect of allowing families to adjust their production patterns. In addition, the results from holding profits constant will be useful since they correspond to a short run situation which might be found at times.

Elasticities of caloric availability with respect to total expenditure are reported in Table 4.13.[1] Total expenditure is endogenous in our model, but the results will still be of interest. The magnitudes are around .85 with little variation among expenditure groups. That the elasticity for the high expenditure group is slightly higher than for the low expenditure group is because the marginal total expenditure share of oils and fats, an important contributor of calories, rises with the expenditure group. This apparently offsets the declining total expenditure share on rice. The elasticity magnitudes we report compare to a range of .15 to .30 used by Reutlinger and Selowsky [1976]. They believed .15 and .30 to be bounds on the calorie elasticity with respect to income.

Our estimates of the total expenditure elasticity of calorie availability are much closer to those of Pinstrup-Anderson and Caicedo [1978]. They estimate Engel curves from cross section household data in Colombia and find a calorie elasticity with respect to income of over .5 ranging to over .6 for low income households.

Tables 4.14 and 4.15 report caloric elasticities with respect to prices with profits held constant (4.14) and allowed to vary (4.15). In the very short

[1] See Strauss et al., 1981b, Appendix B, for detail concerning the conversion from kilograms to calories.

TABLE 4.13

Elasticities of Calorie Availability with Respect to Total Expenditure[1] by Expenditure Group

| Expenditure Group: Low | Middle | High | Mean |
|---|---|---|---|
| .85 | .83 | .93 | .86 |

[1]Calculated as $\frac{TEXP}{CAL} \Sigma \frac{\partial Cal}{\partial X_i^c} \frac{\partial E(X_i^c)}{\partial TEXP}$. (See Table 4.9 for $\frac{\partial E(p_i X_i^c)}{\partial TEXP}$ .)



Table 4.14

Elasticities of Calorie Availability with Respect to Price, Profits Constant[1], by Expenditure Group

| With Respect to Price of: | Expenditure Group | Change in Calories[2] (x 1000) | Elasticity |
|---|---|---|---|
| Rice | Low | -11.9 | -.58 |
| | Middle | -18.5 | -.38 |
| | High | -23.2 | -.28 |
| | Mean | -19.1 | -.38 |
| Root Crops and Other Cereals | Low | -0.7 | -.03 |
| | Middle | -2.1 | -.04 |
| | High | -5.2 | -.06 |
| | Mean | -2.3 | -.05 |
| Oils and Fats | Low | -1.5 | -.07 |
| | Middle | -6.0 | -.12 |
| | High | -20.9 | -.25 |
| | Mean | -7.4 | -.15 |
| Fish and Animal Products | Low | -3.9 | -.19 |
| | Middle | -4.0 | -.08 |
| | High | -6.9 | -.08 |
| | Mean | -4.2 | -.08 |
| Miscellaneous Foods | Low | -1.5 | -.07 |
| | Middle | -4.4 | -.09 |
| | High | -6.3 | -.08 |
| | Mean | -4.2 | -.08 |
| Nonfoods | Low | 0.2 | .08E-1 |
| | Middle | -1.1 | -.02 |
| | High | -1.9 | -.02 |
| | Mean | -0.9 | -.02 |
| Labor | Low | 23.0 | 1.12 |
| | Middle | 28.0 | .57 |
| | High | 36.5 | .45 |
| | Mean | 28.1 | .56 |

[1]Calculated as $\frac{p_j}{cal} \sum_i \frac{\partial cal}{\partial X_i^c} \frac{\partial E(X_i^c)}{\partial p_j} \Big|_{d\pi=0}$ at expenditure group means.

[2]Change in kilocalorie availability due to infinitesimal percentage change in price, $\frac{p_j}{100} \sum_i \frac{\partial kcal}{\partial X_i^c} \frac{\partial E(X_i^c)}{\partial p_j} \Big|_{d\pi=0}$ .

Table 4.15

Elasticities of Calorie Availability with Respect to Prices, Profits Variable[1], by Expenditure Group

| With Respect to Price of: | Expenditure Group | Changes in Calories[2] (x 1000) | Elasticity |
|---|---|---|---|
| Rice | Low | 3.9 | .19 |
| | Middle | -11.7 | -.24 |
| | High | -16.7 | -.20 |
| | Mean | -12.8 | -.26 |
| Root Crops and Other Cereals | Low | 8.8 | .43 |
| | Middle | 6.4 | .13 |
| | High | 8.6 | .11 |
| | Mean | 7.5 | .15 |
| Oils and Fats | Low | 5.5 | .27 |
| | Middle | -1.4 | -.03 |
| | High | -16.9 | -.21 |
| | Mean | -3.0 | -.06 |
| Fish and Animal Products | Low | 9.8 | .48 |
| | Middle | 11.5 | .23 |
| | High | 3.9 | .05 |
| | Mean | 8.8 | .18 |
| Miscellaneous Foods | Low | 2.9 | .14 |
| | Middle | 0.6 | .01 |
| | High | -0.8 | -.01 |
| | Mean | 0.3 | .07E-1 |
| Nonfoods | Low | 2.6 | .12 |
| | Middle | 1.5 | .03 |
| | High | 1.1 | .01 |
| | Mean | 1.9 | .04 |
| Labor | Low | 12.2 | .59 |
| | Middle | 19.8 | .40 |
| | High | 27.3 | .33 |
| | Mean | 20.3 | .41 |

[1]Calculated as $\frac{P_j}{cal} \sum_i \frac{\partial cal}{\partial X_i^c} \frac{\partial E(X_i^c)}{\partial P_j}$ assuming proportional sales and purchase prices.

[2]Change in kilocalorie availability due to one percent change in price, $\frac{P_j}{100} \sum_i \frac{\partial kcal}{\partial X_i^c} \frac{\partial E(X_i^c)}{\partial P_j}$.



run, profits being constant, increases of commodity prices result in decreased caloric availability, except with respect to nonfoods price at the low expenditure group. There is no general pattern of elasticities across expenditure group, but the absolute change in caloric availability often increases with expenditure group. For commodity prices the largest response of caloric availability is for changes in the price of rice, the major staple. These range from -.58 to -.28. This is a rather large impact, suggesting short run nutritional vulnerability of rural households to rice price increases.

With respect to absolute changes in caloric availability the largest, -19,000 calories, occurs for an average household when rice price changes. This change translates into a change of slightly under -52 calories per household per day, or roughly -8 calories per capita per day (using the mean household size of 6.5 persons).

When profits can vary the situation changes substantially. Now most of the commodity price elasticities of calories are positive. Increasing price may result in decreased consumption of that good, but the expected increase in total income is distributed on increases in consumption of other foods, enough so to increase total caloric availability. The exceptions to this are for rice and oils and fats prices at all but the low expenditure group, and for the price of miscellaneous foods at the high expenditure group. The magnitudes of the positive elasticities are not high for the sample mean, but some are sizable for the low expenditure group. Even absolute changes in calorie availability tend to decline as expenditure group rises except for changes in the prices of rice, oils and fats, and labor.

For all commodities the positive effect of a change in price with profits variable is greatest for low expenditure households, reflecting the fact that for every commodity own-price profit effects are greatest among such households. For rice and for oils and fats it is only for low expenditure households that the profit effect is large enough to dominate the negative own-price effects upon calorie availability with profits constant. (This is partially because in the middle and high expenditure households the negative own-price effects--profits constant--are stronger for rice and for oils and fats than for other commodities.)

While caloric availability increases for low expenditure households with changes in rice and in oils and fats prices, it decreases for middle and high expenditure households, and at the sample mean. For rice price the elasticities for the two higher expenditure groups are still sizably negative, between -.2 and -.25. Hence, when profit effects are accounted for, rice price increases seem to lessen the discrepancy in calories available to the rural expenditure groups. They increase availability for very low expenditure households and decrease availability for higher expenditure households. The mean daily caloric availability per capita for high expenditure households is quite high (2600 calories) [Strauss et al., 1981, Table B.1, p. 68]. Although some households in this group will have caloric availability lower than the mean, it may be that lower availability will still allow these households to have available sufficient calories for weight maintenance under "normal" activity levels.

These results have significant implications for the development process in Sierra Leone and for future modeling of this kind. First, we state the obvious: prices and total income affect household caloric availability, although the ability of the household to adapt its production pattern mitigates this effect. Response by the households in its role as a firm does make a difference. Secondly, for the representative low expenditure household, with caloric availability in our sample of 1200 per capita per day [ibid.], to reach a caloric availability of even 1900 calories per capita per day would require increases in income of a magnitude not likely to occur anytime soon.



With prices and household characteristics constant, an average low expenditure household would need an increase in annual total income of about 270 Leones to reach the availability level of 1900 calories per capita per day. This new level of total income would result in total expenditures of roughly 445 Leones. That figure is 88 percent higher than the existing expenditure level of the representative low expenditure household--237 Leones. Assuming, optimistically, an annual growth rate in total expenditures of three percent, it would take nearly 22 years for an average low expenditure family to reach this point (longer, if its size grew along with total expenditure).

## Evaluation of the Systems Approach

The advantages of systems estimation are clear. It provides a comprehensive picture of the household firm that covers all commodities, the choice between consuming leisure and consuming goods, and the effect of price changes upon profit and thus upon production choices, income and consumption. The commodity estimates it provides are consistent. They can be used jointly as well as severally. The set of commodity estimates can provide a picture of total food flows or an estimate of total calorie availability, as in Smith et al., 1981b.

Systems estimation is efficient. It makes fuller use of the information in the model and the data than can be done with single-equation estimation. Consider a system of demand equations. Consumption decisions are interdependent; no single food decision can stand alone. (The equations for the different foods include many of the same variables.) Furthermore, disturbances are correlated across equations. Implicit in this situation are two kinds of information that can be used with systems estimation but cannot be used in single-equation regression analysis: (1) cross-equation parameter restrictions that exist because all demand equations arise from a common utility function, and (2) correlations that exist among the disturbances across equations. Similar considerations arise with respect to the production side of the model.

The principal disadvantage of systems estimation is that it is expensive in terms of money, time, computer capacity and, most important, the use of highly trained professional manpower. Only a nation with access to the services of a skilled econometrician can use the method; it will also require a great deal of computer time and a large computer. The ability of the computer to process large quantities of data limits the size and complexity of the problem that can be solved, and thus sets limits upon the amount of commodity detail and the flexibility of the production model that can be used. In single-equation estimation the number of parameters in each equation must be less than the number of observations (of households). In systems estimation the number of parameters in the system must be less than the number of households, and the number of parameters in the system is, at the least, a multiple of the number of commodities considered. Consequently, systems estimation requires various simplifying assumptions. In addition the number of dependent variables must be reduced by consolidating the great variety of individual foods into a small number of groups of foods.

The simplifying assumption of perfect markets for labor and goods in this study makes systems estimation feasible, but does so by skimming over certain institutional facts: that goods produced at home normally have a lower opportunity cost than goods obtained from the market and that labor is not always in fact obtainable from the market at the time and in the quantity desired.

The systems model used here recognizes that production and consumption decisions are related, but sees that relationship operating only through income. The influence of amount of income is recognized, but not the influence of the form in which income is obtained. Yet in the single-equation estimates we saw



that the form as well as the amount of income produced affects consumption. The decision to consume is the decision to produce for much of the food consumed in Sierra Leone.

This significance of the form in which income is produced is closely related to the existence of a two-price system in rural Sierra Leone. Food purchased from the market costs more than that produced at home, so the amount of a given food consumed depends upon both the price for which the producer can sell it at home as well as upon the price in the market, as we have recognized in analyzing our single-equation results. The systems model used here does not deal with these relationships. A model could be built for the purpose, but it would require drastic simplification in other respects if it were to be computationally feasible.

The limited number of commodities that can be dealt with in the systems model suggests certain cautions in the use of the results. The most reliable estimates are those for rice and for the two relatively well-defined commodity groups: oils and fats, and fish and animal products. These two groups are dominated by palm products and by fish. There are, however, problems with the fish group because it comprises both dried and fresh fish and because the data in one major fish producing area (EA 13) were somewhat unreliable.

The behavior of root crops and other cereals will not be easy to interpret, because its two major components, cassava and sorghum, perform quite differently, as the single-equation analysis has made clear. The systems model can give us little help with such foods as groundnuts and palm wine simply because of the limitations on the amount of commodity detail that is feasible.

For information about the behavior of cassava, sorghum, palm wine or any other food that lost its identity when grouped into the five categories used in the systems model, the single equation results should be used, as they should be for information about the effects of certain variables that had to be omitted or combined with others in doing the systems estimation. The advantages of the consistent, comprehensive set of estimates provided by systems estimation are many, but some of the information we may need about specific commodities and particular variables is only obtainable at a reasonable cost from simpler procedures such as single-equation estimation.

The methods of estimating food consumption behavior used in this project have proven successful for the study of rural households, but further improvements are possible. Single-equation regressions that use factor supplies rather than income as right-hand-side variables might be more effective in capturing the full effects of jointness in production and consumption decisions, but at the cost of losing the direct measurement of income--consumption relationships that we rely on so heavily in cross-sectional analysis. Strauss, in his dissertation [1981, pp. 189-191] and in Working Papers 14 and 17 [Strauss et al., 1981a and 1981b, passim] has suggested a number of possibilities that should be explored.

For use in developing countries, probably the most important extension of these methods would be the development of a simple three or four-equation model that would preserve the essential simultaneity of the production and consumption decisions of semi-subsistence households without losing the reality of the two-price setting in which they operate or becoming excessively complex. Developing such a model should not be too difficult.

# CHAPTER V

## FOOD FLOWS AND SIMULATIONS--<br>RURAL SIERRA LEONE

To this point we have been studying the food consumption behavior of the households in our sample, but have made no attempt to estimate consumption or production patterns for the rural sector as a whole. To do the latter we must adjust for the fact that the sample contains a smaller proportion of the rural population in some geographical areas than in others.

The data were collected according to a sampling plan that called for a stratified sample consisting of equal numbers of households in each of the eight agro-climatic resource regions (ecological zones) covered. Two parts of Sierra Leone were excluded: the Western Area because it is primarily urban and the northern part of the Eastern Province because patterns of agricultural behavior there were likely to be affected by the presence of diamond mining. The remainder of the country was divided into eight zones, Numbers 1, 3, 5 and 7 of which constitute the Northern Province and Numbers 2, 4 and 8 of which correspond closely to the Southern Province. (See Figure 1, page 8 ). Zone six represents roughly the southern two-thirds of the Eastern Province.

Our procedure was to estimate per capita consumption levels in each of the eight ecological or resource region zones, weight each zonal estimate by the proportion of the total rural population found within that zone, and combine these weighted consumption ratios into a single per capita consumption ratio for the whole rural population. For details see Smith et al., 1981b, pp. 3-7 and 15-18.

Per Capita Production and Consumption Estimates

Table 5.1 contains per capita estimates of production, total consumption and consumption from home production, for the rural population of the eight ecological zones. These figures can be converted into aggregates for the 1974-75 rural population by multiplying by 2,042,100.

Although some of the standard errors of the consumption figures for major foods are as high as 20 to 25 percent of the estimate, this is not surprising, considering the nature of the sample and the problems inherent in using the disappearance method and data collected in local quantity units. Standard errors are higher for quantities consumed from home production (up to 29 and 36 percent for rice and cassava respectively). For production the standard errors for major commodities are smaller than for consumption from home production, except for palm kernel (not at the core of our interest).

Table 5.1 provides estimates for both the rural population of all eight zones and the population of all except zone 7. Although zone 7 has nearly one-fourth of the entire rural population, there were only five households from this zone in our sample. Therefore in what is to follow we shall make estimates only for the rural population of the eight zones exclusive of zone 7.

The principal foods consumed are rice, cassava, fish and palm oil. Excluding zone 7, the average rural household produces 75 percent of the rice it consumes, 50 percent of its palm oil and 83 percent of the alcoholic beverages consumed, but only 16 percent of the fish.



In general, consumption estimates for the rural population outside zone 7 agree well with the per capita figures for the sample as shown in Table 2.1 above. Cassava, alcoholic beverages (principally palm wine) and fish are exceptions. There are marked regional differences in the consumption of cassava and palm wine; in each case the sample contains a greater proportion of large consumers than does the rural population outside zone 7. In the case of fish, Table 5.1 measures them in fresh fish equivalents, which drastically increases the number of kilograms corresponding to the dried fish component.

Excluding zone 7 the principal outputs (in kilograms per capita) are palm kernel (313 kg),[1] rice (207 kg), fish (76 kg), vegetables (33 kg) and cassava root (22 kg). For the entire rural population covered (seven zones), per capita daily calorie availability was 2011 calories (Table 5.2),[2] with the 39 percent of the population that lives in the North consuming slightly less.[3]

The principal sources of calories, for the seven zones, are rice, palm oil and fish, 44 percent of all calories coming from rice. Rice is somewhat more important in the North than in the South, and fish considerably more so, but palm oil in the South provides nearly three times the calories that it does in the North. Groundnuts are a far more important

---

[1]The palm product data do not include output from oil palm plantations.

[2]Our estimate of calories from fish is somewhat high; the conversion factor used for dried fish was evidently intended for fish dried more thoroughly than is usual in Sierra Leone.

[3]As these are per capita figures, the figure for the total of the seven zones is the population-weighted average of the individual figures for the North and the South.

TABLE 5.1

PER CAPITA CONSUMPTION AND PRODUCTION ESTIMATES FOR RURAL POPULATION OF AREA SAMPLED, SIERRA LEONE, 1974/75[a]
(Kilograms)

| Commodity Group | Consumption | | | | Production | |
|---|---|---|---|---|---|---|
| | All Eight Zones | | Excluding Zone Seven[b] | | All Eight Zones | Excluding Zone Seven[b] |
| | Total | From Home Production | Total | From Home Production | | |
| Clean rice | 86.8[c] | 63.1[c] | 88.1[c] | 66.2[c] | 198.0[c] | 206.9[c] |
| | (18.4)[c] | (18.4)[c] | (18.4)[c] | (18.4)[c] | (34.1)[c] | (34.1)[c] |
| Other cereals | 9.7 | 8.5 | 12.8 | 11.2 | 10.0 | 13.2 |
| | (3.3) | (3.1) | (3.3) | (3.1) | (3.3) | (3.3) |
| Cassava | 21.9 | 14.3 | 26.7 | 18.9 | 16.9 | 22.4 |
| | (3:1) | (5.1) | (3.1) | (5.1) | (5.4) | (5.4) |
| Yams | 0.7 | 0.6 | 0.9 | 0.8 | 1.0 | 1.3 |
| | (0.7) | (0.7) | (0.7) | (0.7) | (1.3) | (1.1) |
| Other root crops | 0.3 | 0.3 | 0.5 | 0.4 | 0.4 | 0.5 |
| | (0.1) | (0.1) | (0.1) | (0.1) | (0.1) | (0.1) |
| Palm kernel[d] | ... | ... | ... | ... | 241.3 | 312.8 |
| | | | | | (260.6) | (260.6) |
| Palm oil | 12.4 | 6.9 | 14.1 | 7.0 | 9.2 | 9.8 |
| | (2.7) | (1.6) | (2.7) | (1.6) | (2.1) | (2.1) |
| Palm kernel oil | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 | 0.1 |
| | (0.1) | (0.0) | (0.1) | (0.0) | (0.0) | (0.0) |
| Other oils and fats | 2.3 | 2.2 | 3.0 | 3.0 | 3.1 | 4.1 |
| | (2.8) | (2.8) | (2.8) | (2.8) | (4.1) | (4.1) |
| Groundnuts | 6.6 | 5.2 | 8.5 | 6.8 | 8.2 | 10.7 |
| | (2.4) | (2.3) | (2.4) | (2.3) | (4.3) | (4.3) |
| Other legumes | 1.8 | 1.7 | 2.3 | 2.1 | 1.7 | 2.2 |
| | (0.9) | (0.8) | (0.9) | (0.8) | (0.8) | (0.8) |
| Fish[e] | 53.7 | 7.7 | 65.1 | 10.1 | 57.2 | 75.6 |
| | (13.2) | (5.0) | (13.2) | (5.0) | (5.1) | (5.1) |
| Game | 1.4 | 0.3 | 1.7 | 0.4 | 0.3 | 0.4 |
| | (0.6) | (0.1) | (0.6) | (0.1) | (0.1) | (0.1) |
| Other meat | 1.2 | 0.4 | 1.6 | 0.5 | 0.4 | 0.5 |
| | (0.8) | (0.4) | (0.8) | (0.4) | (0.4) | (0.4) |
| Other animal products | 0.2 | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 |
| | (0.1) | (0.1) | (0.1) | (0.1) | (0.1) | (0.1) |



TABLE 5.1-(Continued)

| Commodity Group | Consumption | | | | Production | |
|---|---|---|---|---|---|---|
| | All Eight Zones | | Excluding Zone Seven[b] | | All Eight Zones | Excluding Zone Seven[b] |
| | Total | From Home Production | Total | From Home Production | | |
| Vegetables | 9.6 | 6.0 | 12.5 | 7.9 | 25.0 | 33.0 |
| | (3.5) | (2.4) | (3.5) | (2.4) | (3.3) | (3.3) |
| Citrus fruits | 3.5 | 3.0 | 4.6 | 3.9 | 6.4 | 8.4 |
| | (1.4) | (1.6) | (1.4) | (1.6) | (3.6) | (3.6) |
| Banana, plantain and avocado | -0.0 | -0.2 | 0.2 | 0.0 | 0.3 | 0.4 |
| | (0.4) | (0.3) | (0.4) | (0.3) | (0.3) | (0.3) |
| Other fruits | 1.6 | 1.3 | 2.4 | 2.1 | 2.4 | 3.1 |
| | (0.9) | (0.8) | (0.9) | (0.8) | (0.9) | (0.9) |
| Sugar[f] | 0.3 | ... | 0.4 | ... | ... | ... |
| | (0.1) | | (0.1) | | | |
| Salt and other condiments[f] | 2.2 | ... | 2.7 | ... | ... | ... |
| | (0.3) | | (0.3) | | | |
| Kolanut | 2.5 | 2.4 | 3.3 | 3.2 | 2.6 | 3.5 |
| | (0.7) | (0.7) | (0.7) | (0.7) | (3.6) | (3.6) |
| Beverages, non-alcoholic | 0.6 | 0.5 | 0.7 | 0.6 | 1.0 | 1.3 |
| | (0.8) | (0.8) | (0.8) | (0.8) | (0.5) | (0.5) |
| Beverages, alcoholic | 43.9 | 41.3 | 10.8 | 9.0 | 44.1 | 9.9 |
| | (4.5) | (4.1) | (4.5) | (4.1) | (4.3) | (4.3) |

[a]Standard errors are given in parentheses.

[b]The Northern Plateau.

[c]The standard errors for eight and for seven zones are identical because Zone 7 could not be used in estimating them.

[d]Palm kernel is not consumed in significant amounts. We include it here because it is produced jointly with palm oil when the fresh fruit is processed. Palm kernel can also be produced without producing oil by collecting the dried fruit.

[e]In fresh fish equivalents. Dried fish weights were converted to their fresh weight equivalent by multiplying by 1.613. Production figures are for fresh fish only.

[f]None is produced by the households in our sample.

TABLE 5.2

DAILY CALORIES PER CAPITA (TOTAL, FROM HOME PRODUCTION AND FROM MARKET), FOR NORTHERN AND SOUTHERN HOUSEHOLDS

| Commodity Group | North (Zones 1, 3 and 5) | | | South (Zones 2, 4, 6 and 8)[a] | | | Seven Zones, All Sources |
|---|---|---|---|---|---|---|---|
| | Total Calories | From Home Production | From the Market | Total Calories | From Home Production | From the Market | |
| Rice | 929.7 | 628.5 | 301.2 | 845.0 | 680.9 | 164.1 | 878.3 |
| Other cereals | 132.9 | 115.9 | 17.0 | 123.3 | 108.7 | 14.6 | 127.1 |
| Cassava | 18.8 | -1.7 | 20.5 | 122.6 | 95.1 | 27.5 | 81.9 |
| Yams | 0.3 | 0.0 | 0.3 | 4.0 | 3.8 | 0.2 | 2.5 |
| Other root crops | 6.3 | 6.0 | 0.3 | 0.2 | 0.0 | 0.2 | 2.6 |
| Palm oil | 152.2 | 30.3 | 121.9 | 445.2 | 256.5 | 188.7 | 330.2 |
| Palm kernel oil | 1.9 | 0.4 | 1.5 | 6.7 | 1.2 | 5.5 | 4.8 |
| Other oils and fats | 2.0 | 0.9 | 1.1 | 118.7 | 117.8 | 0.9 | 72.9 |
| Groundnuts | 152.7 | 97.3 | 55.4 | 112.5 | 104.5 | 8.0 | 128.2 |
| Other legumes | 26.7 | 23.6 | 3.1 | 18.1 | 18.0 | 0.1 | 21.5 |
| Fish | 367.6 | 23.6 | 344.0 | 229.8 | 13.1 | 216.7 | 283.8 |
| Game | 2.4 | 0.2 | 2.2 | 4.5 | 1.2 | 3.3 | 3.7 |
| Other meat | 3.3 | 1.2 | 2.1 | 8.3 | 3.3 | 5.0 | 6.3 |
| Other animal products | 3.1 | 2.3 | 0.8 | 0.2 | 0.0 | 0.2 | 1.3 |
| Vegetables | 21.0 | 15.9 | 5.1 | 13.6 | 8.6 | 5.0 | 16.5 |
| Citrus fruit | 0.4 | 0.4 | 0.0 | 5.7 | 5.1 | 0.6 | 3.6 |
| Bananas, plaintains and avocados | 0.2 | -0.1 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 |
| Other fruits | 27.6 | 27.5 | 0.1 | 3.2 | 0.5 | 2.7 | 12.8 |
| Sugar | 5.9 | 0.0 | 5.9 | 2.9 | 0.0 | 2.9 | 4.1 |
| Salt and other condiments | 0.3 | 0.0 | 0.3 | 0.4 | 0.0 | 0.4 | 0.4 |
| Kolanut | 0.2 | -0.3 | 0.5 | 24.5 | 21.4 | 3.1 | 15.0 |
| Beverages, non-alcoholic | 0.1 | 0.0 | 0.1 | 1.6 | 1.6 | 0.0 | 1.0 |
| Beverages, alcoholic | 19.4 | 13.2 | 6.2 | 7.7 | 5.6 | 2.1 | 12.3 |
| Total | 1,875.0 | 985.1 | 889.9 | 2,098.9 | 1,447.0 | 651.9 | 2,011.0 |
| Population (in thousands) | 606.7 | | | 939.9 | | | 1,546.6 |

[a]Zone 6, the sampled portion of the Eastern Province, is here included with the Southern Province.



source of calories than cassava in the North; in the South they are almost equal to cassava in importance.

In the North palm oil comes largely from the market; in the South 58 percent of it is produced by the household that consumes it. The percentage of total calories coming from the market is far greater in the North (47 percent) than in the South (31 percent).

## Food and Calorie Flows

Organizing the information in Tables 5.1 and 5.2 into a modified Food Accounting Matrix [cf. Hay, 1978, pp. 251-255] shows the flow of food from the household that produces it to the market or direct consumption and from the market into consumption by other rural households or by households in the non-rural sector (Table 5.3). Reading down any production or marketing column we find where the product goes (how the activity represented by the column disposes of the product it produces or handles). At the bottom (row 37), we find the total quantities produced or marketed. Consumption columns 19-27 list the quantities consumed by the rural households that provide the energy for the production activities. Columns 28-36 list consumption by non-rural households; in exchange for this food these households provide other commodities required to support the rural households in their contribution to production.

In its standard form the Food Accounting Matrix presents the information in columns 19-37 to the right of columns 1-18, not beneath them. Thus one would read continuously from left to right across each row in the table, proceeding from the production account sector to the market accounts and the two consumption activity sectors. To simplify binding the report we have put the consumption activities columns beneath the production and market columns. Proceeding from left to right across each production row

TABLE 5.3

PER CAPITA FOOD AND CALORIE FLOWS IN RURAL SIERRA LEONE,[a] 1974/76
(Food in kilograms per year; calories in calories per day)

| Disposals ↓ / Acquisitions → | | | Production Accounts (Activities) | | | | | | | | | | Appropriation Accounts: Market | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rice | Sorghum | Other cereals | Cassava | Palm oil | Groundnuts | Fish | Alcoholic beverages | All other | Total calories | Rice | Sorghum | Other cereals | Cassava | Palm oil | Groundnuts | Fish | Alcoholic beverages | All other | Total calories |
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | $C_h$ | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | $C'_m$ |
| Production Accounts (Activities) | Rice | 1 | 37.5 | | | | | | | | | | | | | | | | | | | |
| | Sorghum | 2 | | b | | | | | | | | | | | | | | | | | | |
| | Other cereals | 3 | | | b | | | | | | | | | | | | | | | | | |
| | Cassava | 4 | | | | b | | | | | | | | | | | | | | | | |
| | Palm oil | 5 | | | | | b | | | | | | | | | | | | | | | |
| | Groundnuts | 6 | | | | | | b | | | | | | | | | | | | | | |
| | Fish | 7 | | | | | | | b | | | | | | | | | | | | | |
| | Alcoholic beverages | 8 | | | | | | | | b | | | | | | | | | | | | |
| | All other | 9 | | | | | | | | | b | | | | | | | | | | | |
| Appropriation Accounts: Market | Rice | 10 | 103.2 | | | | | | | | | | | | | | | | | | | |
| | Sorghum | 11 | | 0.1 | | | | | | | | | | | | | | | | | | |
| | Other cereals | 12 | | | 1.9 | | | | | | | | | | | | | | | | | |
| | Cassava | 13 | | | | 3.5 | | | | | | | | | | | | | | | | |
| | Palm oil | 14 | | | | | 2.8 | | | | | | | | | | | | | | | |
| | Groundnuts | 15 | | | | | | 3.9 | | | | | | | | | | | | | | |
| | Fish | 16 | | | | | | | 65.5 | | | | | | | | | | | | | |
| | Alcoholic beverages | 17 | | | | | | | | 0.9 | | | | | | | | | | | | |
| | All other | 18 | | | | | | | | | 344.3 | | | | | | | | | | | |
| Appropriation Accounts: Consumption Activities, Rural Households | Rice | 19 | 66.2 | | | | | | | | | | 21.9 | | | | | | | | | |
| | Sorghum | 20 | | 3.7 | | | | | | | | | | 0.6 | | | | | | | | |
| | Other cereals | 21 | | | 7.5 | | | | | | | | | | 1.0 | | | | | | | |
| | Cassava | 22 | | | | 18.9 | | | | | | | | | | 7.8 | | | | | | |
| | Palm oil | 23 | | | | | 7.0 | | | | | | | | | | 7.1 | | | | | |
| | Groundnuts | 24 | | | | | | 6.8 | | | | | | | | | | 1.7 | | | | |
| | Fish | 25 | | | | | | | 10.1 | | | | | | | | | | 55.0 | | | |
| | Alcoholic beverages | 26 | | | | | | | | 9.0 | | | | | | | | | | 1.8 | | |
| | All other | 27 | | | | | | | | | 24.9 | | | | | | | | | | 12.3 | |
| Appropriation Accounts: Consumption Activities, All Other | Rice | 28 | | | | | | | | | | | 81.3 | | | | | | | | | |
| | Sorghum | 29 | | | | | | | | | | | | -0.5 | | | | | | | | |
| | Other cereals | 30 | | | | | | | | | | | | | 0.9 | | | | | | | |
| | Cassava | 31 | | | | | | | | | | | | | | -4.3 | | | | | | |
| | Palm oil | 32 | | | | | | | | | | | | | | | -4.3 | | | | | |
| | Groundnuts | 33 | | | | | | | | | | | | | | | | 2.2 | | | | |
| | Fish | 34 | | | | | | | | | | | | | | | | | 10.5 | | | |
| | Alcoholic beverages | 35 | | | | | | | | | | | | | | | | | | -0.9 | | |
| | All other | 36 | | | | | | | | | | | | | | | | | | | 332.0 | |
| Total | | 37 | 206.9 | 3.8 | 9.4 | 22.4 | 9.8 | 10.7 | 75.6 | 9.9 | 369.2 | | 103.2 | 0.1 | 1.9 | 3.5 | 2.8 | 3.9 | 65.5 | 0.9 | 344.3 | |
| Calorie Accounts: Rural Households | Rice | C1 | 660.4 | | | | | | | | | | 217.9 | | | | | | | | | |
| | Sorghum | C2 | | 34.6 | | | | | | | | | | 5.6 | | | | | | | | |
| | Other cereals | C3 | | | 76.9 | | | | | | | | | | 10.0 | | | | | | | |
| | Cassava | C4 | | | | 57.1 | | | | | | | | | | 24.8 | | | | | | |
| | Palm oil | C5 | | | | | 167.8 | | | | | | | | | | 162.4 | | | | | |
| | Groundnuts | C6 | | | | | | 101.7 | | | | | | | | | | 26.5 | | | | |
| | Fish | C7 | | | | | | | 17.2 | | | | | | | | | | 266.6 | | | |
| | Alcoholic beverages | C8 | | | | | | | | 8.6 | | | | | | | | | | 3.7 | | |
| | All other | C9 | | | | | | | | | 141.5 | | | | | | | | | | 27.7 | |
| | Total | C10 | | | | | | | | | | 1255.8 | | | | | | | | | | 745.2 |

[a] Not including the Northern Plateau.

[b] Data on quantities used for seed were only available for rice.



TABLE 5.3-(Continued)

| Disposals ↓ / Acquisitions → | | | Appropriation Accounts: Consumption Activities, Rural Households | | | | | | | | | Appropriation Accounts: Consumption Activities, All Other | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rice | Sorghum | Other cereals | Cassava | Palm oil | Groundnuts | Fish | Alcoholic beverages | All other | Rice | Sorghum | Other cereals | Cassava | Palm oil | Groundnuts | Fish | Alcoholic beverages | All other | |
| | | | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 |
| Production Accounts (Activities) | Rice | 1 | 88.1 | | | | | | | | | 81.3 | | | | | | | | | 206.9 |
| | Sorghum | 2 | | 4.3 | | | | | | | | | -0.5 | | | | | | | | 3.8 |
| | Other cereals | 3 | | | 8.5 | | | | | | | | | 0.9 | | | | | | | 9.4 |
| | Cassava | 4 | | | | 26.7 | | | | | | | | | -4.3 | | | | | | 22.4 |
| | Palm oil | 5 | | | | | 14.1 | | | | | | | | | -4.3 | | | | | 9.8 |
| | Groundnuts | 6 | | | | | | 8.5 | | | | | | | | | 2.2 | | | | 10.7 |
| | Fish | 7 | | | | | | | 65.1 | | | | | | | | | 10.5 | | | 75.6 |
| | Alcoholic beverages | 8 | | | | | | | | 10.8 | | | | | | | | | -0.9 | | 9.9 |
| | All other | 9 | | | | | | | | | 37.2 | | | | | | | | | 332.0 | 369.2 |
| Appropriation Accounts: Market | Rice | 10 | | | | | | | | | | | | | | | | | | | 103.2 |
| | Sorghum | 11 | | | | | | | | | | | | | | | | | | | 0.1 |
| | Other cereals | 12 | | | | | | | | | | | | | | | | | | | 1.9 |
| | Cassava | 13 | | | | | | | | | | | | | | | | | | | 3.5 |
| | Palm oil | 14 | | | | | | | | | | | | | | | | | | | 2.8 |
| | Groundnuts | 15 | | | | | | | | | | | | | | | | | | | 3.9 |
| | Fish | 16 | | | | | | | | | | | | | | | | | | | 65.5 |
| | Alcoholic beverages | 17 | | | | | | | | | | | | | | | | | | | 0.9 |
| | All other | 18 | | | | | | | | | | | | | | | | | | | 344.3 |
| Appropriation Accounts: Consumption Activities, Rural Households | Rice | 19 | | | | | | | | | | | | | | | | | | | 88.1 |
| | Sorghum | 20 | | | | | | | | | | | | | | | | | | | 4.3 |
| | Other cereals | 21 | | | | | | | | | | | | | | | | | | | 8.5 |
| | Cassava | 22 | | | | | | | | | | | | | | | | | | | 26.7 |
| | Palm oil | 23 | | | | | | | | | | | | | | | | | | | 14.1 |
| | Groundnuts | 24 | | | | | | | | | | | | | | | | | | | 8.5 |
| | Fish | 25 | | | | | | | | | | | | | | | | | | | 65.1 |
| | Alcoholic beverages | 26 | | | | | | | | | | | | | | | | | | | 10.8 |
| | All other | 27 | | | | | | | | | | | | | | | | | | | 37.2 |
| Appropriation Accounts: Consumption Activities, All Other | Rice | 28 | | | | | | | | | | | | | | | | | | | 81.3 |
| | Sorghum | 29 | | | | | | | | | | | | | | | | | | | -0.5 |
| | Other cereals | 30 | | | | | | | | | | | | | | | | | | | 0.9 |
| | Cassava | 31 | | | | | | | | | | | | | | | | | | | -4.3 |
| | Palm oil | 32 | | | | | | | | | | | | | | | | | | | -4.3 |
| | Groundnuts | 33 | | | | | | | | | | | | | | | | | | | 2.2 |
| | Fish | 34 | | | | | | | | | | | | | | | | | | | 10.1 |
| | Alcoholic beverages | 35 | | | | | | | | | | | | | | | | | | | -0.9 |
| | All other | 36 | | | | | | | | | | | | | | | | | | | 332.0 |
| Total | | 37 | 88.1 | 4.3 | 8.5 | 26.7 | 14.1 | 8.5 | 65.1 | 10.8 | 37.2 | 81.3 | -0.5 | 0.9 | -4.3 | -4.3 | 2.2 | 10.5 | -0.9 | 332.0 | |
| Calorie Accounts | Rice | C1 | | | | | | | | | | | | | | | | | | | 876.3 |
| | Sorghum | C2 | | | | | | | | | | | | | | | | | | | 40.2 |
| | Other cereals | C3 | | | | | | | | | | | | | | | | | | | 96.9 |
| | Cassava | C4 | | | | | | | | | | | | | | | | | | | 81.9 |
| | Palm oil | C5 | | | | | | | | | | | | | | | | | | | 330.2 |
| | Groundnuts | C6 | | | | | | | | | | | | | | | | | | | 128.2 |
| | Fish | C7 | | | | | | | | | | | | | | | | | | | 283.8 |
| | Alcoholic beverages | C8 | | | | | | | | | | | | | | | | | | | 12.3 |
| | All other | C9 | | | | | | | | | | | | | | | | | | | 169.2 |
| | Total | C10 | | | | | | | | | | | | | | | | | | | 2011.0 |

identifies the agents that ultimately make use of the product. Thus 38 kg of the rice produced per capita are retained as seed by the production sector, rural households consume 88 kg per capita and other households 81 kg. Reading across the consumption rows identifies the sources of the quantities consumed.

## The Seven Zones as a Whole

Table 5.3 is based upon the material in Tables 5.1 and 5.2 but the twenty-four commodity groups listed in those tables have been combined into nine [Smith et al., 1981b, pages 23, 26]. Reading down the first column of Table 5.3 we see that 38 kg of rice per capita were used for seed, that 103 kg went to the market and that 66 kg were consumed by the producing household. In addition to the rice consumed from their own production rural households obtained another 22 kg per capita from the market (column 10). The remainder of the 103 kg sent to the market was available for purchase by non-rural households.

On the average, rural households buy one quarter of their total consumption of rice, but sell nearly five times as much as they buy. Except for rice, fish and "all other", most food produced by the rural sector is consumed by the household producing it. Consumption from own production[1] is recorded in Table 5.3 in rows 19-27 of columns 1-9. The quantities provided to the market by the rural sector, generally small by comparison, are given in rows 10-18 of the same columns. The marketed quantity of "all other" is large

[1]With the exception of rice, "consumption from own production" here includes quantities used for seed within the household. No data on seed use were available except for rice.



primarily because it includes palm kernel. Even after eliminating this, however, the market receives 31 kg per capita of the "all other" group, somewhat more than is retained by households for their own consumption. The largest component of this 31 kg consists of vegetables. (*Cf*. Table 5.1.)

While rural households rely heavily on their own production for their food, they also buy significant quantities from the market. Comparison of the production and market entries in rows 19-27 reveals that approximately half the total rural consumption of palm oil is obtained from the market, a third of "all other" food, twenty to twenty-five percent of the rice and groundnuts, and over one-fifth of the cassava. Eighty-four percent of the fish consumed in rural Sierra Leone comes from the market. The role of rural markets and market prices in facilitating efficient patterns of consumption and production is greater than may have been believed in some quarters.

Except for rice, fish and palm kernel (a component of "all other"), only modest amounts per capita are available for consumption outside the rural sector. Yet even a small per capita figure may represent an appreciable aggregate amount. The net marketable surplus of 81 kg of rice per capita is equivalent to approximately 126,000 metric tons for that three-quarters of the rural population contained in the seven ecological zones covered by these figures. Ten and one-half kilograms of fish per capita are equivalent to some 16,000 metric tons of fish, while 2.2 kg of groundnuts per capita are equivalent to some 34,000 metric tons of groundnuts. Of course small per capita figures for net marketed surplus, being calculated as residuals, are not particularly accurate.[1] Negative figures may

[1]Indeed, the small figures probably do not differ significantly from zero, when one takes account of sampling error. We did not calcuate standard errors for the marketed surplus figures.

be errors, reductions in inventories, or the result of gifts, loans or the consumption of commodities produced outside the rural sector. For instance, an appreciable amount of palm oil is produced by the marketing board or others from oil palm fruit produced on plantations. These were not represented in our sample. Likewise perhaps as much as seven percent of the alcoholic beverages consumed by the sample households consisted of beer and distilled beverages, presumably produced outside the rural sector [Smith et al., 1980, pp. 29-30]. The negative entry for cassava root may be erroneous; the data concerning the production and consumption of fresh cassava root were very poor. Quantity measurements for fresh cassava root are notoriously difficult.

The bottom block of Table 5.3 (rows C1-C10) presents daily calorie flows per capita, from home production and from the market, for the rural population of the seven zones. They may be compared with Table 5.2, which gives the breakdown between home and market sources by regions, but not for the two regions taken together.

By Expenditure Classes

Per capita food flows differ markedly among expenditure classes in the 7-zone rural population.[1] See Table 5.4. We have consolidated the nine food groups into five [Smith et al., 1981b, pp. 32-35] and omitted the production rows and all appropriation account columns other than the market accounts.[2]

---

[1]For a tabulation by region see Smith et al., 1981b, pp. 32-35.

[2]The quantity of rice seed used, formerly recorded in the production rows, is added to the quantity sent to market. Doing this increases the amount recorded as available for "all other" households, but gives an accurate measure of the rice available for consumption by rural households.



Households in the low expenditure (L) bracket (under 350 Le per year) consume less than half as much rice per capita as those in the middle (M) bracket (350 but under 750 Le) and only 38 percent as much as the high-expenditure (H) households (750 Le and over). The L households also consume less than half as much rice from their own production as do those in the two higher groups; they buy from the market slightly more than the M households do, but less than one-third as much as the H households. The latter buy nearly half as much as they consume from their own production; the L households about 37 percent of their home-produced consumption. It is often asserted that much of the rice purchased from the market is bought at high prices when rice is scarce, and financed by money lenders who must be repaid by the sale of rice at harvest time, when prices are low. (Cf. Snodgrass et al., 1980, p. 173.) If so, the burden must fall most heavily upon the L households. Still, on the average, they purchase from the market less than 10 percent of the total quantity of rice they sell.[1] It is hard to believe that debts incurred for the purchase of rice during the hungry season can account for a major fraction of the sales of rice by L households.

The M and H households are of course less likely to be distress buyers of rice. The H households, the largest buyers of rice, presumably finance their purchases with their large sales to the market of nonfood crops and of oils and fats, fish and animal products, and miscellaneous foods -- vegetables, for instance (rows 11-15). On a per capita basis and in the aggregate the H households sell less rice to the market than either of the other expenditure groups.

---

[1]After adjusting the figure for quantity marketed for the quantity of rice retained for seed.

# TABLE 5.4

FOOD FLOWS BY EXPENDITURE CLASSES, 1974/75 - FIVE FOOD GROUPS[a]
(kilograms per capita)

| Disposals \ Acquisitions | | | | Production Accounts (Activities) — Expenditure Class[b]: Low - Under 350 Leones: Rice | Low: Root crops and other cereals | Low: Oils and fats | Low: Fish and animal products | Low: Miscellaneous foods | Medium - 350 but Under 750 Leones: Rice | Medium: Root crops and other cereals | Medium: Oils and fats | Medium: Fish and animal products | Medium: Miscellaneous foods | High - 750 Leones and Over: Rice | High: Root crops and other cereals | High: Oils and fats | High: Fish and animal products | High: Miscellaneous foods |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Appropriation Accounts: Market, Expenditure Class | Low | Rice | 1 | 158.8 | | | | | | | | | | | | | | |
| | | Root crops and other cereals | 2 | | 2.2 | | | | | | | | | | | | | |
| | | Oils and fats | 3 | | | 21.0 | | | | | | | | | | | | |
| | | Fish and animal products | 4 | | | | 0.2 | | | | | | | | | | | |
| | | Miscellaneous foods | 5 | | | | | 1.6 | | | | | | | | | | |
| | Medium | Rice | 6 | | | | | | 172.4 | | | | | | | | | |
| | | Root crops and other cereals | 7 | | | | | | | 10.4 | | | | | | | | |
| | | Oils and fats | 8 | | | | | | | | 195.3 | | | | | | | |
| | | Fish and animal products | 9 | | | | | | | | | 7.5 | | | | | | |
| | | Miscellaneous foods | 10 | | | | | | | | | | 13.2 | | | | | |
| | High | Rice | 11 | | | | | | | | | | | 97.3 | | | | |
| | | Root crops and other cereals | 12 | | | | | | | | | | | | 5.4 | | | |
| | | Oils and fats | 13 | | | | | | | | | | | | | 668.6 | | |
| | | Fish and animal products | 14 | | | | | | | | | | | | | | 170.9 | |
| | | Miscellaneous foods | 15 | | | | | | | | | | | | | | | 80.7 |
| Consumption Activities: Rural Households, Expenditure Class | Low | Rice | 16 | 32.8 | | | | | | | | | | | | | | |
| | | Root crops and other cereals | 17 | | 19.6 | | | | | | | | | | | | | |
| | | Oils and fats | 18 | | | 5.2 | | | | | | | | | | | | |
| | | Fish and animal products | 19 | | | | 2.6 | | | | | | | | | | | |
| | | Miscellaneous foods | 20 | | | | | 15.7 | | | | | | | | | | |
| | Medium | Rice | 21 | | | | | | 81.7 | | | | | | | | | |
| | | Root crops and other cereals | 22 | | | | | | | 37.3 | | | | | | | | |
| | | Oils and fats | 23 | | | | | | | | 7.1 | | | | | | | |
| | | Fish and animal products | 24 | | | | | | | | | 9:5 | | | | | | |
| | | Miscellaneous foods | 25 | | | | | | | | | | 45.4 | | | | | |
| | High | Rice | 26 | | | | | | | | | | | 79.8 | | | | |
| | | Root crops and other cereals | 27 | | | | | | | | | | | | 35.4 | | | |
| | | Oils and fats | 28 | | | | | | | | | | | | | 16.5 | | |
| | | Fish and animal products | 29 | | | | | | | | | | | | | | 19.5 | |
| | | Miscellaneous foods | 30 | | | | | | | | | | | | | | | 43.2 |
| Consumption Activities: All Other, Expenditure Class | Low | Rice | 31 | | | | | | | | | | | | | | | |
| | | Root crops and other cereals | 32 | | | | | | | | | | | | | | | |
| | | Oils and fats | 33 | | | | | | | | | | | | | | | |
| | | Fish and animal products | 34 | | | | | | | | | | | | | | | |
| | | Miscellaneous foods | 35 | | | | | | | | | | | | | | | |
| | Medium | Rice | 36 | | | | | | | | | | | | | | | |
| | | Root crops and other cereals | 37 | | | | | | | | | | | | | | | |
| | | Oils and fats | 38 | | | | | | | | | | | | | | | |
| | | Fish and animal products | 39 | | | | | | | | | | | | | | | |
| | | Miscellaneous foods | 40 | | | | | | | | | | | | | | | |
| | High | Rice | 41 | | | | | | | | | | | | | | | |
| | | Root crops and other cereals | 42 | | | | | | | | | | | | | | | |
| | | Oils and fats | 43 | | | | | | | | | | | | | | | |
| | | Fish and animal products | 44 | | | | | | | | | | | | | | | |
| | | Miscellaneous foods | 45 | | | | | | | | | | | | | | | |
| Total | | | 46 | 191.6 | 21.8 | 26.2 | 2.8 | 17.3 | 254.1 | 47.7 | 202.4 | 17.0 | 58.6 | 177.1 | 40.8 | 685.1 | 190.4 | 123.9 |



TABLE 5.4-(Continued)

| Disposals \ Acquisitions | | | | Appropriation Account (Market) — Expenditure Class[b]: Low - Under 350 Leones: Rice | Low: Root crops and other cereals | Low: Oils and fats | Low: Fish and animal products | Low: Miscellaneous foods | Medium - 350 but Under 750 Leones: Rice | Medium: Root crops and other cereals | Medium: Oils and fats | Medium: Fish and animal products | Medium: Miscellaneous foods | High - 750 Leones and Over: Rice | High: Root crops and other cereals | High: Oils and fats | High: Fish and animal products | High: Miscellaneous foods | Totals: By Expenditure Class | Totals: All Expenditure Classes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| Appropriation Accounts: Market, Expenditure Class | Low | Rice | 1 | | | | | | | | | | | | | | | | 158.8 | |
| | | Root crops and other cereals | 2 | | | | | | | | | | | | | | | | 2.2 | |
| | | Oils and fats | 3 | | | | | | | | | | | | | | | | 21.0 | |
| | | Fish and animal products | 4 | | | | | | | | | | | | | | | | 0.2 | |
| | | Miscellaneous foods | 5 | | | | | | | | | | | | | | | | 1.6 | |
| | Medium | Rice | 6 | | | | | | | | | | | | | | | | 172.4 | |
| | | Root crops and other cereals | 7 | | | | | | | | | | | | | | | | 10.4 | |
| | | Oils and fats | 8 | | | | | | | | | | | | | | | | 195.3 | |
| | | Fish and animal products | 9 | | | | | | | | | | | | | | | | 7.5 | |
| | | Miscellaneous foods | 10 | | | | | | | | | | | | | | | | 13.2 | |
| | High | Rice | 11 | | | | | | | | | | | | | | | | 97.3 | 140.7 |
| | | Root crops and other cereals | 12 | | | | | | | | | | | | | | | | 5.4 | 6.1 |
| | | Oils and fats | 13 | | | | | | | | | | | | | | | | 668.6 | 316.7 |
| | | Fish and animal products | 14 | | | | | | | | | | | | | | | | 170.9 | 65.4 |
| | | Miscellaneous foods | 15 | | | | | | | | | | | | | | | | 80.7 | 34.6 |
| Consumption Activities: Rural Households, Expenditure Class | Low | Rice | 16 | 12.0 | | | | | | | | | | | | | | | 44.8 | |
| | | Root crops and other cereals | 17 | | 7.4 | | | | | | | | | | | | | | 27.0 | |
| | | Oils and fats | 18 | | | 5.6 | | | | | | | | | | | | | 10.8 | |
| | | Fish and animal products | 19 | | | | 41.5 | | | | | | | | | | | | 44.1 | |
| | | Miscellaneous foods | 20 | | | | | 10.3 | | | | | | | | | | | 26.0 | |
| | Medium | Rice | 21 | | | | | | 11.1 | | | | | | | | | | 92.8 | |
| | | Root crops and other cereals | 22 | | | | | | | 6.0 | | | | | | | | | 43.3 | |
| | | Oils and fats | 23 | | | | | | | | 5.2 | | | | | | | | 12.3 | |
| | | Fish and animal products | 24 | | | | | | | | | 72.6 | | | | | | | 82.1 | |
| | | Miscellaneous foods | 25 | | | | | | | | | | 31.5 | | | | | | 76.9 | |
| | High | Rice | 26 | | | | | | | | | | | 39.5 | | | | | 119.3 | 88.1 |
| | | Root crops and other cereals | 27 | | | | | | | | | | | | 14.6 | | | | 50.0 | 40.8 |
| | | Oils and fats | 28 | | | | | | | | | | | | | 10.7 | | | 27.2 | 17.3 |
| | | Fish and animal products | 29 | | | | | | | | | | | | | | 37.0 | | 56.5 | 68.7 |
| | | Miscellaneous foods | 30 | | | | | | | | | | | | | | | 16.3 | 59.5 | 48.4 |
| Consumption Activities: All Other, Expenditure Class | Low | Rice | 31 | 146.8 | | | | | | | | | | | | | | | 146.8 | |
| | | Root crops and other cereals | 32 | | -5.2 | | | | | | | | | | | | | | -5.2 | |
| | | Oils and fats | 33 | | | 15.4 | | | | | | | | | | | | | 15.4 | |
| | | Fish and animal products | 34 | | | | -41.3 | | | | | | | | | | | | -41.3 | |
| | | Miscellaneous foods | 35 | | | | | -8.7 | | | | | | | | | | | -8.7 | |
| | Medium | Rice | 36 | | | | | | 161.3 | | | | | | | | | | 161.3 | |
| | | Root crops and other cereals | 37 | | | | | | | 4.4 | | | | | | | | | 4.4 | |
| | | Oils and fats | 38 | | | | | | | | 190.1 | | | | | | | | 190.1 | |
| | | Fish and animal products | 39 | | | | | | | | | -65.1 | | | | | | | -65.1 | |
| | | Miscellaneous foods | 40 | | | | | | | | | | -18.3 | | | | | | -18.3 | |
| | High | Rice | 41 | | | | | | | | | | | 57.8 | | | | | 57.8 | 118.8 |
| | | Root crops and other cereals | 42 | | | | | | | | | | | | -9.2 | | | | -9.2 | -3.5 |
| | | Oils and fats | 43 | | | | | | | | | | | | | 657.9 | | | 657.9 | 309.4 |
| | | Fish and animal products | 44 | | | | | | | | | | | | | | 133.9 | | 133.9 | 7.8 |
| | | Miscellaneous foods | 45 | | | | | | | | | | | | | | | 64.4 | 64.4 | 21.8 |
| Total | | | 46 | 158.8 | 2.2 | 21.0 | 0.2 | 1.6 | 172.4 | 10.4 | 195.3 | 7.5 | 13.2 | 97.3 | 5.4 | 668.6 | 170.9 | 80.7 | | |

[a]Not including the Northern Plateau. [b]Estimated population by expenditure class: Low--467,600; Medium--636,400; High--442,600.

We must also question the generally accepted proposition [ibid., p. v] that farmers give first priority to rice in order to assure food for their families, even though other crops may yield higher returns. Over half the rice produced in each expenditure class goes to the market. Much of this would not need to be produced if the farmer were interested only in growing food for his family. The ratio of rice sold to the market to total rice consumed is almost twice as high (3.5) for low-income households as for medium-income households (1.9).

The households with the highest incomes are those that produce the most palm products, fish and miscellaneous foods (including vegetables). These are also the households that produce the least rice. In general, the wealthiest households are large sellers of oil, fish and vegetables. The least well off are large sellers of rice, marketing almost exactly as much per capita as the M households after accounting for seed usage[1] and nearly twice as much as the H group. The L and M households are the principal sources of the marketable surplus of rice on a per capita basis (112 and 116 kg, respectively, after allowing for seed use); the H households market only 26 kg per capita. Taking account of the population in each expenditure class, the L households produce a marketable surplus of some 50,000 metric tons, and the M households another 70,000. The high expenditure households provide only about 10,000 metric tons (but they produce large marketable surpluses of other products).

If the government is interested in increasing the marketable surplus of rice, perhaps it should concentrate its attention on households in the two

[1]By subtracting 18 percent of total production as rice used for seed.



lower income classes. If the government is interested in improving the economic status of the least well off farmers, perhaps it should spend more effort in encouraging the development of the profitable alternatives to rice production, a good many of which seem to exist.

Total consumption among the L households is low in every category; they consume less than half as much rice per person as the M households. Naturally L households consume the fewest calories per person per day -- 1156, compared with 1627 for M households and 3473 for the H group (Table 5.5).[1]

These figures do not take account of gifts or loans received or paid out in kind. Food sharing and transfers of food among households are important in raising the actual caloric intake of low income households; undoubtedly a part of the high caloric availability figure for the H group represents food that those households have made available to relatives or others who were less fortunate.

Both M and L households obtain about 500 calories daily from the market, but M households produce 1100 calories for themselves, and L households only 600. H households obtain about 1300 calories daily through the market, plus 2200 more from their own production. The households that eat best produce the most for themselves <u>and</u> for the market. Rice provides 39 percent of the total calories among L households, and 46 and 44 percent, respectively, among M and H households.

[1]These are estimates for the population, not for the sample. One would not expect them to be identical with the caloric availability figures for the sample: 1188, 2132 and 2608, respectively. [Strauss et al., 1981b, p. 68.]

TABLE 5.5

PER CAPITA CALORIE SOURCES BY EXPENDITURE GROUP, 1974/75, - FIVE FOOD GROUPS[a]
(calories per day)

| Disposals (Calorie Accounts, Rural Households) / Acquisitions: Production or Market Accounts (Activities) | | Low - Under 350 Leones: Rice | Root crops and other cereals | Oils and fats | Fish and animal products | Miscellaneous foods | Total calories | Medium - 350 but Under 750 Leones: Rice | Root crops and other cereals | Oils and fats | Fish and animal products | Miscellaneous foods | Total calories | High - 750 Leones and Over: Rice | Root crops and other cereals | Oils and fats | Fish and animal products | Miscellaneous foods | Total calories | All Expenditure Classes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | $T_L$ | 6 | 7 | 8 | 9 | 10 | $T_M$ | 11 | 12 | 13 | 14 | 15 | $T_H$ | $T_A$ |
| From Home Production, Expenditure Class Low: Rice | 1 | 327.2 | | | | | | | | | | | | | | | | | | |
| Root crops and other cereals | 2 | | 109.3 | | | | | | | | | | | | | | | | | |
| Oils and fats | 3 | | | 125.8 | | | | | | | | | | | | | | | | |
| Fish and animal products | 4 | | | | 5.4 | | | | | | | | | | | | | | | |
| Miscellaneous foods | 5 | | | | | 65.7 | | | | | | | | | | | | | | |
| Total | $T_L$ | | | | | | 633.4 | | | | | | | | | | | | | |
| Medium: Rice | 6 | | | | | | | 652.8 | | | | | | | | | | | | |
| Root crops and other cereals | 7 | | | | | | | | 145.1 | | | | | | | | | | | |
| Oils and fats | 8 | | | | | | | | | 137.0 | | | | | | | | | | |
| Fish and animal products | 9 | | | | | | | | | | 12.4 | | | | | | | | | |
| Miscellaneous foods | 10 | | | | | | | | | | | 142.9 | | | | | | | | |
| Total | $T_M$ | | | | | | | | | | | | 1090.2 | | | | | | | |
| High: Rice | 11 | | | | | | | | | | | | | 1023.3 | | | | | | 660.4 |
| Root crops and other cereals | 12 | | | | | | | | | | | | | | 281.5 | | | | | 173.3 |
| Oils and fats | 13 | | | | | | | | | | | | | | | 511.0 | | | | 240.6 |
| Fish and animal products | 14 | | | | | | | | | | | | | | | | 51.3 | | | 21.4 |
| Miscellaneous foods | 15 | | | | | | | | | | | | | | | | | 319.5 | | 170.1 |
| Total | $T_H$ | | | | | | | | | | | | | | | | | | 2186.6 | 1265.8 |
| From Market Purchases, Expenditure Class Low: Rice | 1 | 119.8 | | | | | | | | | | | | | | | | | | |
| Root crops and other cereals | 2 | | 25.7 | | | | | | | | | | | | | | | | | |
| Oils and fats | 3 | | | 132.9 | | | | | | | | | | | | | | | | |
| Fish and animal products | 4 | | | | 211.7 | | | | | | | | | | | | | | | |
| Miscellaneous foods | 5 | | | | | 32.1 | | | | | | | | | | | | | | |
| Total | $T_L$ | | | | | | 522.2 | | | | | | | | | | | | | |
| Medium: Rice | 6 | | | | | | | 89.0 | | | | | | | | | | | | |
| Root crops and other cereals | 7 | | | | | | | | 20.0 | | | | | | | | | | | |
| Oils and fats | 8 | | | | | | | | | 100.1 | | | | | | | | | | |
| Fish and animal products | 9 | | | | | | | | | | 292.6 | | | | | | | | | |
| Miscellaneous foods | 10 | | | | | | | | | | | 35.4 | | | | | | | | |
| Total | $T_M$ | | | | | | | | | | | | 537.1 | | | | | | | |
| High: Rice | 11 | | | | | | | | | | | | | 506.8 | | | | | | 217.9 |
| Root crops and other cereals | 12 | | | | | | | | | | | | | | 82.1 | | | | | 40.8 |
| Oils and fats | 13 | | | | | | | | | | | | | | | 328.6 | | | | 167.3 |
| Fish and animal products | 14 | | | | | | | | | | | | | | | | 295.2 | | | 273.7 |
| Miscellaneous foods | 15 | | | | | | | | | | | | | | | | | 73.2 | | 45.5 |
| Total | $T_H$ | | | | | | | | | | | | | | | | | | 1285.9 | 745.2 |
| Totals: By Expenditure Class | | 447.0 | 135.0 | 258.7 | 217.1 | 97.8 | 1155.6 | 741.8 | 165.1 | 237.1 | 305.0 | 178.3 | 1627.3 | 1530.1 | 363.6 | 839.6 | 346.5 | 392.7 | 3472.5 | |
| Totals: All Expenditure Classes | | | | | | | | | | | | | | 878.3 | 214.1 | 407.9 | 295.1 | 215.6 | 2011.0 | 2011.0 |

[a] Not including the Northern Plateau.

[b] Estimated population by expenditure class: Low--467,600; Medium--636,400; High-- 442,600.



## Responses to Price and Wage Changes

For policy purposes it is desirable to have estimates of the effects of price changes on household choices, and to make those estimates from a model based upon the complete set of responses of the household. There are two ways of using such a model. The standard method uses the elasticities of output, consumption and marketed surplus and applies these to predicting the effects of price changes upon hypothetical households, usually an "average" household for the sample as a whole or for a particular expenditure group. Of course this method usually involves using point elasticities where arc elasticities are needed. This was the approach taken in Strauss et al., 1981b. See Chapter 4 of this report.

Alternatively we may solve the system of equations for each of the 138 households in the sample and derive population estimates from the predictions for the individual households. This method takes full account of nonlinearities in the model as well as of the fact that each household faces a different set of independent variables and the response elasticities therefore vary from household to household. Furthermore, one can allow several prices to vary at once without creating complications. This second method is used in this chapter.

The household-firm model predicts total household production and consumption for each commodity. We obtain the marketed surplus by subtraction. In the household-firm model the dependent variables are measured in an artificial unit, a "weighted kilogram", rather than in the natural kilograms in which we have measured the commodity flows just presented in this chapter. The quantity in weighted kilograms is obtained by dividing the total value of the commodities included in the group by their value-weighted average price

[Smith et al., 1981a, pp. 10-11, 18-19; Strauss et al., 1981b, pp. 10-11]. Table 5.6 presents the food and calorie flows in weighted kilograms, with a summary (column 12) that gives the totals in natural kilograms.[1] The figures for rice and for oils and fats consumption agree very closely, but where the components of the commodity group differ markedly in value per kilogram, the weighting can affect the reported quantity figure by large amounts. This is clearly evident in the production figure for oils and fats. Because there is a palm kernel component of 313 kilograms in natural kilograms (and palm kernel sells at 1/3 to 1/4 the price of palm oil), the weighted kilogram equivalent of the palm kernel component becomes only 20.5 kilograms. The weighted and natural figures for oils and fats consumption agree very well, for palm kernel is not part of the consumption group. In the case of root crops and other cereals the consumption figure is drastically affected by the use of weighted kilograms. Cassava root, a large part of the commodity group when measured in natural kilograms, sells at a very low price compared with the prices of sorghum, millet and the other cereals that are also members of the group. Both the production and consumption figures for fish and miscellaneous foods are affected markedly by going from natural to weighted kilograms. For fish there is another complication, for the "natural" weights were in terms of fresh-fish equivalents, but no such conversion of dried fish to their fresh-weight equivalent was made in obtaining the weighted kilogram figure.

The calorie flow figures agree very well, whether derived from weighted kilograms or natural kilogram commodity figures, for a special set of conversion factors was derived for the weighted kilogram data [Strauss et al., 1981b, p. 71].

[1]Like the earlier population estimates, these are based upon observed data.



TABLE 5.6

PER CAPITA FOOD AND CALORIE FLOWS, WEIGHTED KILOGRAMS, 1974/75[a] (FIVE FOOD GROUPS)
(weighted kilograms per year; calories per day)

| Disposals \ Acquisitions | | | Production Accounts (Activities) | | | | | | Appropriation Accounts: Market | | | | | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rice | Root crops and other cereals | Oils and fats | Fish and animal products | Miscellaneous foods | Total calories | Rice | Root crops and other cereals | Oils and fats | Fish and animal products | Miscellaneous foods | Total calories | Weighted kilograms | Natural kilograms |
| | | | 1 | 2 | 3 | 4 | 5 | $C_h$ | 6 | 7 | 8 | 9 | 10 | $C_m$ | 11 | 12 |
| Production Accounts (Activities) | Rice | 1 | 37.5 | | | | | | | | | | | | 206.9 | 206.9 |
| | Root crops and other cereals | 2 | | | | | | | | | | | | | 39.3 | 37.3 |
| | Oils and fats | 3 | | | | | | | | | | | | | 39.6 | 326.7 |
| | Fish and animal products | 4 | | | | | | | | | | | | | 53.5 | 76.5 |
| | Miscellaneous foods | 5 | | | | | | | | | | | | | 44.6 | 70.2 |
| Appropriation Accounts: Market | Rice | 6 | 107.9 | | | | | | | | | | | | 107.9 | 103.2 |
| | Root crops and other cereals | 7 | | 32.2 | | | | | | | | | | | 32.2 | 6.1 |
| | Oils and fats | 8 | | | 30.6 | | | | | | | | | | 30.6 | 316.7 |
| | Fish and animal products | 9 | | | | 46.6 | | | | | | | | | 46.6 | 65.4 |
| | Miscellaneous foods | 10 | | | | | 35.0 | | | | | | | | 35.0 | 34.6 |
| Appropriation Accounts: Consumption Activities: Rural Households | Rice | 11 | 61.5 | | | | | | 25.4 | | | | | | 86.9 | 88.1 |
| | Root crops and other cereals | 12 | | 7.1 | | | | | | 3.6 | | | | | 10.7 | 40.8 |
| | Oils and fats | 13 | | | 9.0 | | | | | | 6.6 | | | | 15.6 | 17.3 |
| | Fish and animal products | 14 | | | | 6.9 | | | | | | 21.6 | | | 28.5 | 69.7 |
| | Miscellaneous foods | 15 | | | | | 9.6 | | | | | | 5.8 | | 15.4 | 48.4 |
| Appropriation Accounts: Consumption Activities: All Other | Rice | 16 | | | | | | | 82.5 | | | | | | 82.5 | 81.3 |
| | Root crops and other cereals | 17 | | | | | | | | 28.6 | | | | | 28.6 | -3.5 |
| | Oils and fats | 18 | | | | | | | | | 24.0 | | | | 24.0 | 309.4 |
| | Fish and animal products | 19 | | | | | | | | | | 25.0 | | | 25.0 | 7.8 |
| | Miscellaneous foods | 20 | | | | | | | | | | | 29.2 | | 29.2 | 21.8 |
| Total | | 21 | 206.9 | 39.3 | 39.6 | 53.5 | 44.6 | | 107.9 | 32.2 | 30.6 | 46.6 | 35.0 | | | |
| Calorie Accounts: Rural Households | Rice | C1 | 630.7 | | | | | | 260.5 | | | | | | 891.2 | 878.3 |
| | Root crops and other cereals | C2 | | 146.0 | | | | | | 74.0 | | | | | 220.0 | 214.1 |
| | Oils and fats | C3 | | | 225.5 | | | | | | 165.3 | | | | 390.8 | 407.9 |
| | Fish and animal products | C4 | | | | 60.4 | | | | | | 189.2 | | | 249.6 | 295.1 |
| | Miscellaneous foods | C5 | | | | | 116.5 | | | | | | 70.4 | | 186.9 | 215.6 |
| | Total | C6 | | | | | | 1 179.1 | | | | | | 759.4 | 1938.5 | 2011.0 |

[a]Not including the Northern Plateau.

Table 5.7 gives us the predicted per capita production, consumption and marketed surplus figures for the seven zones for which we are making population estimates. These estimates are derived from the household model predictions for each household in the sample. The consumption estimates accord very well with the consumption figures in weighted kilograms as given in Table 10.[1] The estimate for rice is about 20% below the figure based upon the observed data, but the only truly bad estimate is that for root crops and other cereals. As that group contains crops as different as cassava and sorghum, even a good prediction about the group as a whole would be hard to interpret in terms of its meaning for individual components of the group. The predicted figure for per capita caloric availability is almost identical with that from the observed data in weighted kilograms.

The production estimates are not as satisfactory, but the estimate for rice, the most important single commodity, is excellent, while that for fats and oils is quite good. The figure for root crops and other cereals is bad and that for fish is a disappointment. Perhaps the latter could not be avoided, given the fact that the size of the model forced us to assume a common joint production function for all outputs and that we had only ten households in the sample to represent the principal producers of fish and vegetables.

Note that the marketed surplus figure for rice in Table 5.7 includes rice retained by the household for use as seed. The weighted kilogram figure for this in Table 5.6 was 37 1/2 kilograms.

---

[1]We would not expect the per capita figures derived from predicted values to agree exactly with those from the observed values. For one thing, the effect of a deviation between the observed and the predicted value for an individual household is quite different if it happens to be in a zone with a large population than in one with a small population.



TABLE 5.7

PER CAPITA ESTIMATES OF PRODUCTION, CONSUMPTION AND THE QUANTITIES AVAILABLE FOR OTHER SECTORS, RURAL SIERRA LEONE (7 ZONES[a]), 1974/75 PRICES
(Commodities in weighted kilograms per year, labor in male-equivalent man-hours per year, and calories in calories per day)

| Item | Row | Production Activities | Consumption Activities | Marketed Surplus |
|---|---|---|---|---|
| Rice | 1 | 212.7 | 69.7 | 143.0 |
| Root crops and other cereals | 2 | 240.8 | 18.5 | 222.3 |
| Oils and fats | 3 | 51.8 | 16.4 | 35.4 |
| Fish and animal products | 4 | 139.7 | 27.4 | 112.3 |
| Miscellaneous foods | 5 | 71.5 | 14.1 | 57.4 |
| Nonfood | 6 | 7.0 | 51.5 | -44.5 |
| Labor used[b] | 7.1 | 585.8 | -- | -- |
| Labor supplied | 7.2 | -- | 687.1 | 101.3 |
| Calories | 8 | -- | 1917.3 | -- |

[a]Not including the Northern Plateau.

[b]In "productive" activities.

For some time the government of Sierra Leone has been attempting to keep the price of rice low in the cities but also to reduce the country's dependence on imports by increasing domestic rice production. One instrument in the latter effort has been a guaranteed farm gate price, but the guarantee did not in fact insure that the farmer actually received the official price. What might be expected if the price actually received by the farmer were to be increased by ten percent relative to the prices of labor and of other commodities?[1] Rice production would increase by 3.3 percent. Rice consumption among the rural population would be affected favorably by the effect on the profit from agricultural production and unfavorably by the higher opportunity cost of consuming rice. The net consequence, for the rural population of the seven zones, would be a five percent reduction in per capita rice consumption and an increase in the marketable surplus of 16.5 thousand metric tons. Fish consumption would rise 3.6 percent and the consumption of non-food items from other sectors five percent. The effect on total calorie consumption per capita would be negligible, a rise of 0.3 percent.

For low-income households, however, our point elasticities [Strauss et al., 1981b, p. 49] show that the caloric content of the diet would rise by

[1]To do so, of course, would require either higher prices in the cities or subsidies, to be financed by taxation or borrowing.



about 1.9 percent as the result of a ten percent rise in the relative price of rice.[1] In middle and high-income households the caloric content would decline by 2.4 and 2.0 percent respectively. For middle-income households, for whom the estimated population mean for calories is 1,630 per day, any loss in the caloric content of the diet could be serious.

The caloric content rises for low-expenditure households because the effect on profits of a rise in the price of rice is greater for those households than for others [Strauss et al., 1981b, p. 35][2] as well as for other reasons. (Whatever commodity price rises, the profit effect is positive for all commodities and greater for low-expenditure households than for others. Strauss et al., 1981b, pp. 33-4 .)

With respect to rice consumption alone the profit effect is not large enough to offset completely the negative effect that a higher rice price would have if profits were held constant. (The total of the two is a 4.4 percent decrease in rice consumption among low-expenditure households.) However, for low-expenditure households the total effects on the consumption of all other foods are positive and these are more than enough to offset the loss of calories from lower consumption of rice.

[1]This is an estimate for the sample, not the population.

[2]Rice is a much more important part of total output for low-expenditure households than for the others, as both the population estimates and the sample data show [Table 5.4 above; Strauss et al., 1981b, p. 15].

Government policy might create a higher relative price for rice; a rise in the rural wage rate is more likely to come from a greater demand for labor. (In March, 1981, our informants in Sierra Leone were concerned about the high price of agricultural labor. Farmers were reported then to be paying 25-30 percent more for hired labor than the official minimum wage.) If there is an increase in demand from outside the rural sector, so the wage change can be taken as exogenous, our model can predict the consequences.[1]

A relative price for labor 10% higher than it was in 1974-75, all other prices held constant, would raise total caloric intake among rural households by 5 percent, increasing the consumption of almost all foods from 4 to 6 percent. All outputs would decline, with the greatest fall (4 percent) being in rice. The marketed surplus of rice would fall 8 percent.

In percentage terms, low-expenditure households would increase their consumption of rice, fish and miscellaneous foods more than households in the middle-income class. Low-expenditure consumption in every food group would rise more rapidly than the consumption of high-expenditure households. [Strauss et al., 1981b, Table VI.4, p. 37.] Calorie consumption also rises more rapidly in the low-expenditure households [ibid., Table VI.9, p. 49].

For the rural population as a whole, household expenditures rise because household labor supply rises. (The model assumes household size and composition to be unaffected by the price of labor.) The profit component falls, of course, but the labor supplied component dominates, so household consumption levels increase.

---

[1]The model does not predict the consequences of a change in the minimum wage, for it assumes household labor and hired labor have the same value. This would not be true if the minimum wage were above the free market wage.



To be sure, an increase in the demand for labor outside the rural sector would probably affect household size and composition by increasing the rate of migration. (Our informants in Sierra Leone were also concerned about the loss of labor by rural areas.) In our model, if a three percent reduction in the number of adult males occurs along with a ten percent rise in the relative wage we get lower aggregate consumption, no change in aggregate outputs and only negligible affects upon per capita consumption and caloric intake [Smith et al., 1981b, pp. 73-76]. Of course the model assumes that the household can hire as much labor as it wishes at the going rate, so the output decision is unaffected by the availability of labor within the household. This assumption, required to simplify the model, does not appear to accord with reality.

The wage rate can also be affected by increases in the prices of agricultural outputs. This mechanism would need to be included in a general equilibrium model but is not a part of our household model. One can, however, simulate the effects of joint increases in the wage rate and commodity prices. If wages rise by ten percent and rice prices by five [ibid., pp. 70-78], the effects are much like those for an increase in the wage rate alone, except that rice output and labor use decline less, while food consumption, except for rice, rises 20-40 percent more. The effect on caloric intake is almost identical with the effect of an increase in the wage rate alone.

For the rural population as a whole (in the seven zones for which we have made an estimate) the price most important to the caloric adequacy of the diet is the free market wage of agricultural labor. A 10 percent rise

---

[1]For simulations of the effects of changes in palm oil prices and fish prices see ibid., pp. 65-69.

in this wage increases caloric availability by 5 percent. Autonomous changes in the price of rice do not have an appreciable effect on calories consumed.

However, the most important policy questions with respect to nutrition concern the effects of price and wage changes on the caloric adequacy of the diets of low-income households. The point elasticity results by expenditure class [Strauss et al., 1981b, pp. 49-52] show that a rise in the price of any output group has a positive effect on the calorie consumption of low-income households. The effects are positive, but much smaller, for households at higher expenditure levels, with two significant exceptions. For oils and fats and for rice a higher price means fewer calories consumed in the two higher expenditure classes. The price of labor, however, has a greater positive effect on caloric consumption than the price of any output group.

In short, any increase in an output price improves the energy content of the diet of low-expenditure households, but an increase in the value of agricultural labor is still more beneficial. One policy conclusion is that any measure that increases agricultural productivity raises household income and consumption and benefits the rural sector in that way. Much is being done along those lines in Sierra Leone. Unfortunately, efforts to expand rice production hold little promise as means of increasing labor productivity. Recent studies show the true returns (exclusive of subsidies) from rice production generally to be low [Spencer, Byerlee and Franzel, 1979, p. 43; Snodgrass et al., 1980, pp. 155-6].

# CHAPTER VI

# THREE VILLAGES IN KANO STATE

During the 1974-75 agriculture year Peter Matlon conducted a survey of production and expenditure activities in three villages in Kano State, Nigeria. Although this study was not planned as a study of food consumption patterns, Matlon collected accurate quantity records for almost all foods likely to enter into household consumption. He generously made his data available for our use.

## The Data

In most respects the Kano State data were similar to those collected during the Sierra Leone survey,[1] but in one respect they were quite different. Matlon's sample consisted of 135 households, 45 selected at random in each of the three villages studied. Twelve of each 45 constituted his "small" sample; the remainder the "large" one. Small sample households were interviewed two to three times weekly for data on cash consumer expenditures and off-farm earnings, and weekly for data on sales and purchases of inputs and outputs and on loans and gifts. The large sample was interviewed monthly. This difference in interview frequency affected the quality of the data obtained and significantly complicated our analysis.

---

[1]For a detailed description see Smith et al., 1982, Chapter 1.

TABLE 6.1

MEAN AMOUNT AVAILABLE FOR ANNUAL HOUSEHOLD CONSUMPTION FROM ALL SOURCES, BY COMMODITY--SMALL SAMPLE, KANO, NORTHERN NIGERIA - 1

| COMMODITY | QUANTITY CONSUMED MEAN OVER ALL HOUSEHOLDS(IN KGS) | PERCENTAGE OF CONSUMPTION AVAILABLE FROM PRODUCTION-2 | PERCENTAGE OF PRODUCTION AVAILABLE FOR CONSUMPTION-3 | QUANTITY CONSUMED MEAN OVER CONSUMING HOUSEHOLDS (IN KGS) | PERCENTAGE OF ALL HOUSEHOLDS CONSUMING |
|---|---|---|---|---|---|
| CEREAL | | | | | |
| EARLY MILLET, GERO | 100 | 100 | 70 | 100 | 100 |
| LATE MILLET, MAIWA | 21 | 100 | 79 | 24 | 91 |
| SORGHUM (GUINEA CORN), DAWA | 934 | 100 | 68 | 934 | 100 |
| MAIZE, MASARA | 51 | 100 | 92 | 52 | 97 |
| RICE, SHINKAFA | 22 | 94 | 54 | 30 | 73 |
| CEREAL PRODUCTS | | | | | |
| MILLET PORRIDGE, TUWO GERO | 0 | * | * | 3 | 3 |
| MILLET FLOUR, GARI | 1 | * | * | 4 | 27 |
| THIN PORRIDGE, KOKO/KUNU | 14 | * | * | 28 | 48 |
| PROCESSED MILLET, HURA/FURA | 97 | * | * | 107 | 91 |
| SORGHUM PORRIDGE, TUWO DAWA-. | 1 | - | - | 20 | 3 |
| WAINA, NAKIYA | 1 | * | * | 3 | 36 |
| CORN FLOUR | 0 | * | * | 3 | 3 |
| RICE (COOKED) | 1 | * | * | 6 | 24 |
| RICE PORRIDGE, TUWO SHINKAFA | 8 | * | * | 55 | 15 |
| BREAD, BUROOI | 1 | * | * | 5 | 24 |
| BISCUITS | 0 | * | * | 0 | 12 |
| STARCHY ROOTS AND TUBERS | | | | | |
| CASSAVA, ROGO | 56 | 83 | 89 | 72 | 79 |
| YAMS, DOYA | 1 | 92 | 85 | 14 | 6 |
| LOCAL POTATOES, DANKALI | 38 | 94 | 81 | 71 | 55 |
| CASSAVA (COOKED) | 4 | * | * | 10 | 39 |
| CASSAVA (FLOUR), GARIN ROGO | 2 | * | * | 7 | 24 |
| LEGUMES,LEGUME PRODUCTS,NUTS | | | | | |
| COWPEAS, WAKE | 63 | 100 | 78 | 70 | 91 |
| GROUNDNUTS, GYADA-4 | 0 | - | - | 1 | 33 |
| BAMBARA NUTS, GURJIYA | 8 | 97 | 78 | 29 | 27 |
| LOCUST BEANS, KALWA | 1 | 0 | 0 | 3 | 30 |
| COWPEA CAKE, KOSAI | 1 | * | * | 1 | 58 |
| COWPEA DUMPLING, DAN WAKE | 0 | * | * | 1 | 30 |
| GROUNDNUT CAKE, KULI KULI | 4 | * | * | 6 | 76 |
| GROUNDNUTS (FRIED) | 0 | * | * | 0 | 9 |
| LOCUST BEAN CAKE, DADDAWA | 20 | * | * | 21 | 97 |
| KOLANUT, GORO | 6 | * | * | 6 | 94 |
| VEGETABLES,VEG. PRODUCTS,FRUITS | | | | | |
| TOMATOES, TOMATUR | 71 | 24 | 83 | 73 | 97 |
| ONIONS, ALBASA-4 | 0 | - | - | 1 | 36 |
| OKRA, KUBEWA | 64 | 83 | 84 | 68 | 94 |
| PUMPKIN, KABEWA | 68 | 98 | 90 | 93 | 73 |
| CALABASH, KWARYA | 18 | 100 | 58 | 84 | 21 |
| CABBAGE, KABEJI | 0 | 0 | 0 | 0 | 0 |
| FRESH PEPPER | 4 | 40 | 100 | 7 | 64 |
| DRIED PEPPER | 10 | 100 | 24 | 12 | 82 |
| BAOBAB LEAVES. KUKA | 0 | 0 | 0 | 1 | 30 |
| HORSERADISH LEAVES, ZOGALLE | 15 | 91 | 90 | 18 | 82 |
| GAWUTA | 5 | 93 | 71 | 9 | 52 |



TABLE 6.1-(Continued)

| COMMODITY | QUANTITY CONSUMED MEAN OVER ALL HOUSEHOLDS(IN KGS) | PERCENTAGE OF CONSUMPTION AVAILABLE FROM PRODUCTION-2 | PERCENTAGE OF PRODUCTION AVAILABLE FOR CONSUMPTION-3 | QUANTITY CONSUMED MEAN OVER CONSUMING HOUSEHOLDS (IN KGS) | PERCENTAGE OF ALL HOUSEHOLDS CONSUMING |
|---|---|---|---|---|---|
| VEGETABLES (OTHERS)-5 | 37 | 98 | 88 | 40 | 94 |
| ORANGES, LEMON ZAKI | 0 | 0 | 0 | 1 | 6 |
| MANGOES, MANGWARO | 1 | 0 | 0 | 6 | 15 |
| GUAVA | 0 | 0 | 0 | 1 | 6 |
| LEMON | 0 | 0 | 0 | 1 | 6 |
| LIME | 0 | 0 | 0 | 1 | 9 |
| PAWPAW | 5 | 100 | 100 | 19 | 30 |
| BANANA | 0 | 0 | 0 | 0 | 0 |
| TAMARIND | 2 | 0 | 0 | 9 | 24 |
| MEAT,FISH,MILK PRODUCTS | | | | | |
| FISH | 0 | * | * | 1 | 3 |
| MEAT (UNSPECIFIED), NAMA | 32 | * | * | 33 | 97 |
| ROASTED MEAT, TSIRE | 4 | * | * | 9 | 42 |
| EGGS | 0 | * | * | 0 | 6 |
| SOURED MILK, NONO | 127 | * | * | 131 | 97 |
| BUTTER, MAI SHANU | 9 | * | * | 10 | 82 |
| MILK (EVAPORATED, TINNED) | 0 | ** | ** | 1 | 3 |
| MILK | 0 | * | * | 1 | 15 |
| MISCELLANEOUS | | | | | |
| PALM OIL, MANJA | 22 | * | * | 22 | 97 |
| GROUNDNUT OIL, MAN RURUWA | 2 | * | * | 2 | 79 |
| SHEA BUTTER OIL | 1 | * | * | 6 | 9 |
| SALT, GISHIRI-6 | 0 | 0 | 0 | 0 | 0 |
| SUGAR, SUKAR | 0 | 0 | 0 | 0 | 0 |
| SUGAR CANE, RAKE | 134 | 80 | 20 | 222 | 61 |
| HONEY | 0 | * | * | 0 | 6 |
| SWEETS | 0 | ** | ** | 0 | 18 |
| COKE | 1 | ** | ** | 10 | 9 |
| TEA | 0 | ** | ** | 2 | 6 |
| BEER | 0 | * | * | 0 | 0 |
| MAGGI CUBES | 0 | ** | ** | 0 | 18 |
| GINGER, CITTA | 0 | ** | ** | 1 | 15 |
| SPICE, KALKASHI | 0 | ** | ** | 0 | 6 |
| CLOVES, KANAMPIRI | 0 | ** | ** | 0 | 0 |

1 NET FOOD AVAILABLE FROM DOMESTIC PRODUCTION, PAYMENTS IN KIND, LOANS IN KIND, GIFTS IN KIND, AND FOOD PURCHASES.
2 NET QUANTITY OF FOOD AVAILABLE FOR CONSUMPTION FROM OWN HOUSEHOLD PRODUCTION (I.E. GROSS PRODUCTION LESS SALES LESS SEED USE LESS LOSSES) DIVIDED BY TOTAL KILOGRAM AMOUNT AVAILABLE FOR CONSUMPTION FROM ALL SOURCES.
3 NET QUANTITY OF FOOD AVAILABLE FOR CONSUMPTION FROM OWN HOUSEHOLD PRODUCTION DIVIDED BY TOTAL GROSS PRODUCTION.
4 ESTIMATES INCLUDE ONLY PURCHASES OF FOOD ITEMS.
5 ESTIMATES INCLUDES ONLY NET AMOUNT AVAILABLE FROM DOMESTIC PRODUCTION PLUS FOOD PURCHASES.
6 ESTIMATES NOT AVAILABLE FOR MARKET PURCHASES.
* NO INFORMATION AVAILABLE ON HOUSEHOLD PRODUCTION.
** NOT APPLICABLE.

\- ESTIMATES OF FOOD RETAINED FROM HOME PRODUCTION NOT USED BECAUSE OF QUESTIONABLE VALIDITY.

## The Food Consumption Pattern

Table 6.1 shows the food consumption pattern of the 36 households in the small sample, the proportion of the food consumed that was produced at home and the extent to which production exceeded the quantities retained for home consumption.[1] Sorghum was the dominant food, some 900 kg being consumed annually per household. Early millet, the first crop available after the rains had begun, was a distant second among the cereals. Cowpeas and nono (soured skimmed milk) were important sources of protein. Non-Fulani households purchased nono from Fulani women; palm oil was bought in the market. Most important consumption items were produced largely by the household that consumed them, nono and palm oil being important exceptions. At the same time the production of most food crops provided an appreciable excess that could be sold.

## The Model

In analyzing the Kano State data we used a single-equation model with total consumption per household (in kilograms) as the dependent variable. As total consumption consists of goods from all sources--the market, home production, and all other (net gifts, loans or wages received in kind), we use an average of market and farm-gate (sales) prices as its price. The price averages are quantity weighted, calculated as the sum of the values of market expenditure and consumption from home production, divided by the total of the quantities consumed from both sources. [Whelan, 1982, chap. 6.]

[1]These consumption estimates do not include either the groundnuts or onions consumed from home production. Neither do they include food purchased from the proceeds of enterprises engaged in by the women of the household.



The regression function is homogeneous of zero degree in prices and expenditure. It is arithmetically linear, except for one quadratic term in expenditure.

The underlying model is

$$q_{ih} = f(Y_h, P, C_h, S_h, M_h)$$

where

$q_{ih}$ is the annual amount of good i consumed in household h,

$Y_h$ is the total expenditure of household h during the year,

$P$ is a vector of relevant prices,

$C_h$ is a vector of characteristics for household h,

$S_h$ is a vector of food source characteristics for household h,

and

$M_h$ is a vector of market orientation characteristics for household h.

The functional form is

$$q_{ih} = \alpha_i + \sum_{j \neq i} \alpha_j (P_j/P_i) + \beta_1 (Y_h/P_i) + \beta_2 (Y_h/P_i)^2 + \sum_n \gamma_n C_{hn} + \sum_m \lambda_m S_{hm} + \sum_r \mu_r M_{hr}$$

The intercept term, $\alpha_i$, is the coefficient of the own-price term (i.e., $P_i/P_i$); the latter does not appear explicitly in this formulation. As a consequence, the size of the own-price elasticity is not readily apparent. The influence of own-price upon the quantity consumed operates through the relative price and expenditure variables.

In examining the relationship between consumption levels and the household production pattern or market orientation the present study places more emphasis on "source" variables ($S_h$) than did the Sierra Leone study and less on other measures of production patterns. The Sierra Leone study experimented with five measures of production organization and one for overall market orientation, plus a set of variables representing the share of a given food produced by the consuming household [Smith et al., 1981a, pp. 30-31]. In the present study there are source variables both for food consumed from home production and for food received in kind from other sources. (The remainder, of course, comes from the market). Sales as a share of the value of food crop output (SSHO) is a market orientation variable, and there is one production pattern variable (SHOG), the value of groundnuts harvested as a share of the total value of food crops harvested. SHOG is also relevant to market orientation, for groundnuts are primarily a cash crop.

Table 6.2 lists the variables used. Total expenditure is the value of all consumption goods and services purchased from the market (including taxes, licenses and school fees) plus, at farm-gate prices, the value of food available for consumption from home production[1] and of net receipts in kind of gifts, loans or wage payments. It does not include the value of non-food production consumed at home (presumably minor), the value of production from the enterprises engaged in by the female members of the household, or food purchased from the proceeds of the womens' enterprises.

Variables beginning with S and ending with AP or AN are source variables. If the variable ends in AN it is the share of consumption that is obtained in kind from sources other than home production: the excess of in-kind gifts received over those given, of in-kind wages received over those paid out and of loans received in kind over such loans repaid or extended to others.

---

[1]Except for groundnuts and onions, for which the data were unreliable.



TABLE 6.2

Variables Used

I. Commodity-Specific Variables

A. DEPENDENT

The total quantity of each commodity available per household (kg)

B. INDEPENDENT

| Commodity | Variable Name | Meaning |
|---|---|---|
| Sorghum | PRPS | Price ratio of palm oil to sorghum |
| | TEXPR | Total expenditure divided by the price of sorghum |
| | SSAN | Share of sorghum received in kind but not from home production |
| Cowpeas | PRWMC | Price ratio of weighted millet to cowpeas |
| | PRSC | Price ratio of sorghum to cowpeas |
| | TEXPR | Total expenditure divided by the price of cowpeas |
| | SCAP | Share of cowpeas from own production |
| | SCAN | Share of cowpeas received in kind but not from home production |
| Palm Oil | PRSP | Price ratio of sorghum to palm oil |
| | TEXPR | Total expenditure divided by the price of palm oil |

II. Non-Commodity-Specific Independent Variables

| Variable Name | Meaning |
|---|---|
| GAND | Binary variable for *gandu*[1] household (=1; =0 otherwise) |
| HHS | Household size |
| IAT | Infants and toddlers under 5 years |
| YCH | Young children, 5-9 years |
| OCH | Older children, 10-15 years |
| MAD | Adult males, 16-49 years |
| WAD | Adult female wives, 16-49 years |
| OAD | Older adults, over 49 years |

TABLE 6.2--Continued

| | |
|---|---|
| HHAGE | Age of household head |
| LITERAT | Binary Variable for literate household head (=1; =0 otherwise) |
| MAOTH | Non-Moslem Hausa (Maguzawa) and any other non-Hausa ethnic group (=1; =0 otherwise) |
| FUL | Binary variable for Fulani ethnic group (=1; =0 otherwise) |
| SHOG | The value of groundnuts harvested as a share of the value of total food crops harvested. |
| SSHO | Total food crop sales as a share of the value of total food crops harvested. |

[1]A gandu household normally has two or more male adults, with their wives and children [Matlon, 1979, pp. 57-59].



Using these source variables creates an econometric problem, for the share variables may be partially endogenous. (Their value may depend in part on decisions made with respect to the dependent variable, consumption.) Such endogeneity biases the parameter estimates. This is a cost we accept in order to test the hypothesis that the total consumption of any food is affected by its source as well as by its price and other variables. Because total expenditure may also be somewhat affected by decisions concerning what the household plans to consume a similar econometric problem exists with respect to the expenditure variables.

## Combining the Samples

Because the recall period for interviews of the 33 households used for the small sample regressions was only two to seven days, while that for the 99 households in the large sample was a month, the dependent variable was measured more accurately in the small sample than in the large one. Yet confining ourselves to the small sample would have been unwise as long as it was possible that useful information could be obtained from the larger data set. Preliminary analyses made it clear that the samples differed too much to permit combining them into a single undifferentiated data set. Consequently we followed a procedure which laid primary emphasis on the small sample but used the large sample data to supplement it.

In summary the procedure for each commodity was as follows: First a regression was selected and fitted, based upon the small sample data. The same regression was then fitted to the large sample data and an F-test was used to determine whether the error variances were equal for the two regressions. If not, the observations in each sample were weighted by the inverse of the square root of the variance of the residuals for that sample.

This done, the Chow test was applied to determine whether or not fitting the same regression to each sample led to the same set of coefficients for each regression; that is, whether $\alpha_{iS} = \alpha_{iL}$ for each variable where $\alpha_{iS}$ is the coefficient of variable i in the small sample regression and $\alpha_{iL}$ the coefficient of variable i in the large sample regression. If no coefficient differed significantly from its counterpart in the other regression, the two samples were pooled and the same regression equation, fitted to the combined sample, became the regression we used.

When one or more coefficients differed significantly between the two samples the basic regression was expanded by adding a shift variable, SSD, and interaction terms (indicated by DI as a suffix) for each variable in the original regression. SSD is a small sample dummy, equal to 1 if the observation is from the small sample and to 0 if it is not. DI is a similar binary variable which is multiplied by the variable in the original basic model. Thus HHS is the observed household size and HHSDI is that same number multiplied by 1 if the household is in the small sample and by 0 if it is not.

This expanded regression was then fitted to the combined data from both samples. If the shift variable and/or any interaction term in the resultant regression failed to be statistically significant at the 0.10 level, those terms were dropped and the remaining regression fitted again to the combined data set. Then one final F-test was run to determine whether there were statistically significant differences between (A) the regression including SSD and all interaction terms and (B) the one that included SSD and/or interaction terms only when the coefficient of that term in (A) was significant at least at the 0.10 level. In no case was such a significant difference found, so the (B) version became our final regression.



The first step in this process, choosing an appropriate regression for the small sample data, required us to choose a small number of variables from a much larger set (some 27 potential variables for each commodity). To do this we used a computer routine, the "All Possible Subsets Regression," from the Biomedical Computer Programs (BMDP) package. This routine determines 1) a regression that minimizes $C_p$ (an estimate of total squared error that takes account of both bias and the variance of the predicted values) and 2) a regression that maximizes $\bar{R}^2$.[1] It also prints out other regressions with near-minimum $C_p$ or near-maximum $\bar{R}^2$.

In general we chose a regression with minimum or low $C_p$ if it contained statistically significant price and income variables. If not, we turned to a regression with maximum or high $\bar{R}^2$. More often than not the equation finally chosen was from the set with high values for $\bar{R}^2$, for maximizing $\bar{R}^2$ normally leads to a regression containing more variables than does minimizing $C_p$. (It always leads to a regression with at least as many.)

Having chosen an appropriate set of variables from the small sample data set, we used exactly the same set of variables when using the large sample or the pooled data. Given our doubts about the reliability of the large sample measurements of the dependent variable it would have been inappropriate to allow the large sample data to alter our choice of relevant variables.

---

[1] For more detail see Whelan [1982, chap. 6] or Smith et al. [1981a, pp. 33, 34].

The estimate of bias included in $C_p$ assumes that every variable in the available set belongs in the true regression model. As our available set included some variables that may not have belonged in the true model (variables included as experiments), the estimate of bias in the $C_p$ value is likely to be overstated.

## Some Results

We estimated consumption behavior regressions for nine of the most important foods in the diet [Smith et al., 1982, chap. 5]. Here we present those for sorghum, cowpeas, and palm oil.

### Three Commodity Regressions

In the case of sorghum (Table 6.3) the parameter values from the large and the small samples were clearly different, so the final model included interaction variables. Likewise every interaction term was statistically significant. To make a prediction for a household in the small sample, using the Final Model-Combined Samples, employs each coefficient from the first page of the table plus the coefficient for the corresponding variable from the set of shift and interaction variables on the second page. The sum of these two coefficients is given in Table 6.3 as the "Small Sample Component". Indeed, these are the coefficients to use for predicting the behavior of any household, for we believe that the observed values of the dependent variable from the large sample were not reliable.

With sorghum, nothing was gained by including the large sample data. Our final result is exactly what we would have had by using the "Original Model" with the small sample, except that now we know that the large sample data cannot help us any. For most commodities, however, the large sample data did provide useful information.

In discussing the results of any of these regressions we employ only the small sample component. Sorghum consumption shows a highly significant quadratic relationship to the level of total real expenditure (expenditure measured in terms of power to purchase sorghum), but for low expenditure households the relationship is negative. Only at the higher end of the distribution does sorghum consumption rise with expenditure. The minimum



point of the consumption expenditure relationship is at a total expenditure level equivalent to 4,932 kilograms of sorghum. (The mean total expenditure of the combined sample was 3,895 kg of sorghum.) Other things equal, households at the mean of the combined sample would consume 778 kg of sorghum per year, which would represent 20 percent of their total expenditure. At an expenditure level of 2,900 kg per year predicted sorghum consumption is 957 kg, 33 percent of expenditure. At the 2,900 level of total expenditure adding one kilogram to the expenditure level reduces sorghum consumption by 24/100 kg.

Clearly sorghum, although (or because?) it is the most important single food consumed, is an inferior good for well over half the households in the sample. If all other variables affecting sorghum consumption are constant, the less the household has to spend, the more it must rely upon sorghum for its food.

Of course household expenditure levels normally are affected by the levels of other variables, in particular household size. If household size increases by one person, the numbers of infants, toddlers and male adults remaining constant, predicted sorghum consumption rises by 266 kg, given the level of household expenditure. But if that person is a female adult she may contribute income that has a purchasing power of 800 kg of sorghum. The net effect of the change in household size and its effect on expenditure would be to increase annual sorghum consumption by perhaps 50 kg at the mean expenditure level; the change in household size dominates.

If both household size and the number of male adults were to increase by one, at a given level of household expenditure, the combined effect of the two changes would be a reduction of 76 kg per year in household sorghum consumption.[1]

[1] See Smith et al., 1982, p. 39, for discussion of the negative coefficient of MAD.

TABLE 6.3

Single-Equation Total Sorghum Consumption Regressions from Small, Large, and Combined Samples, Kano State, Nigeria - 1974-1975[1]

| Equation | Number of Consuming Households | $\bar{R}^2$ | $R^2$ | Intercept | INDEPENDENT VARIABLES[2]: Price[3] | Expenditure[3] | | Household Characteristics | | | | Market Relationship | | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PRPS | TEXPR | TEXPRSQ | HHS | IAT | MAD | HHAGE | SHOG | SSHO | SSAN |
| Small Sample-[4] Original Model | 33 | .87 | .91 | *** 2775.3<br>(3.86) | -45.2<br>(-.65) | *** -.58<br>(-4.94) | *** .588 E-4<br>(6.75) | *** 266.1<br>(5.48) | *** -321.6<br>(-3.08) | *** -342.0<br>(-2.82) | * -17.1<br>(-2.04) | ** -1742.8<br>(-2.77) | *** -1031.7<br>(-3.03) | ** 193.3<br>( 2.45) |
| Large Sample- Original Model | 99 | .62 | .66 | ** -809.7<br>(-1.99) | ** 109.5<br>(2.42) | *** .19<br>(3.14) | -.649 E-7<br>(-.01) | ** 30.5<br>(2.03) | -22.9<br>(-.47) | 38.9<br>(.70) | 6.5<br>(1.52) | -379.3<br>(-1.61) | -319.1<br>(-1.39) | -144.6<br>(-1.16) |
| Combined Samples | 132 | .63 | .66 | 18.59<br>(.04) | 69.4<br>(1.5) | -.01<br>(-.18) | *** .19 E-4<br>(3.57) | *** 54.22<br>(3.1) | -61.0<br>(-1.18) | 28.4<br>(.49) | 1.6<br>(.37) | ** -652.6<br>(-2.51) | ** -466.6<br>(-2.13) | 93.3<br>(.18) |
| Final Model- Combined Samples | 132 | .76 | .80 | * -809.7<br>(-1.94) | ** 109.5<br>(2.36) | *** .19<br>(3.07) | -.65 E-7<br>(-.01) | ** 30.5<br>(1.98) | -22.9<br>(-.46) | 38.9<br>(.68) | 6.5<br>(1.48) | -379.3<br>(-1.57) | -319.1<br>(-1.35) | -144.6<br>(-1.14) |
| Small Sample[5] Component | | | | *** 2775.3<br>(3.86) | -45.2<br>(-.65) | *** -.58<br>(-4.94) | *** .588 E-4<br>(6.75) | *** 266.1<br>(5.48) | *** -321.6<br>(-3.08) | *** -342.0<br>(-2.82) | * -17.1<br>(-2.04) | ** -1742.8<br>(-2.77) | *** -1031.7<br>(-3.03) | ** 193.3<br>(2.45) |
| Large Sample Component | | | | * -809.7<br>(-1.94) | ** 109.5<br>(2.42) | *** .19<br>(3.07) | -.65 E-7<br>(-.01) | ** 30.5<br>(1.98) | -22.9<br>(-.46) | 38.9<br>(.68) | 6.5<br>(1.48) | -379.3<br>(-1.57) | -319.1<br>(-1.35) | -144.6<br>(-1.14) |

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4.

[3] Each expenditure and price variable has been divided by the price of the dependent variable.

[4] $C_p$ equals 5.7.

[5] Each parameter is obtained from the regression just preceding as the sum of the parameters for the terms with and without the DI suffix. For example, the coefficient for PRPS is equal to 109.5 + (-154.7). The intercept is simply the intercept from the same line plus the parameter from the variable SSD.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level



TABLE 6.3-(Continued)

| Equation | INDEPENDENT VARIABLES: Intercept Shift | Price[3] | Expenditure[3] | | Household Characteristics | | | | Market Relationship | | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SSD | PRPSDI | TEXPRDI | TEXPRSQDI | HHSDI | IATDI | MADDI | HHAGEDI | SHOGDI | SSHODI | SSANDI |
| Combined Samples | *** 3585.0<br>(4.6) | ** -154.7<br>(-1.96) | *** -.77<br>(-6.21) | *** .59 E-4<br>(6.24) | *** 235.6<br>(5.01) | *** -298.7<br>(2.77) | *** -380.9<br>(-3.05) | *** -23.6<br>(-2.67) | ** -1363.42<br>(-2.19) | * -712.6<br>(-1.82) | ** 337.9<br>(2.31) |

TABLE 6.4

Single-Equation Total Cowpea Consumption Regressions from Small, Large and Combined Samples, Kano State, Nigeria, 1974-1975.[1]

| Equation | No. of Consuming Households | $\bar{R}^2$ | $R^2$ | Intercept | INDEPENDENT VARIABLES[2]: Price[3] PRWMC | Price[3] PRSC | Expenditure[3] TEXPR | Household Characteristics HHS | IAT | YCH | OCH | FUL | LITERAT | Market SHOG | SSHO | Source SCAP | SCAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Small Sample-[4] Original Model | 30 | .90 | .95 | *** -417.5 (-3.03) | *** 249.5 (2.96) | *** -144.3 (-3.43) | *** .996 E-2 (7.67) | *** 17.9 (4.67) | ** -23.7 (-2.53) | ** -21.19 (-2.59) | *** -26.3 (-2.75) | *** 83.5 (3.94) | 30.4 (1.61) | *** 347.6 ( 3.40) | -289.6 (-5.89) | 91.6 (1.08) | 124.5 (1.51) |
| Large Sample-Original Model | 97 | .23 | .33 | 70.6 (1.47) | -2.96 (-.07) | -16.6 (-.91) | *** .520 E-2 (4.12) | .839 (.33) | -7.4 (-1.27) | 1.8 (.41) | -3.6 (-.93) | -6.4 (-.47) | 5.3 (.61) | -44.5 (-1.64) | -11.6 (-.46) | -4.4 (-.5) | -[5] |
| Combined Samples | 127 | .54 | .59 | 10.5 (.10) | 11.2 (.28) | -27.9 (-1.48) | *** .783 E-3 (9.54) | 3.6 (1.46) | ** -11.8 (-2.10) | -4.1 (-.93) | ** -8.3 (-2.03) | 8.8 (.69) | -1.8 (-.21) | -16.7 (-.59) | ** -58.7 (-2.29) | 29.9 (.31) | 31.6 (.33) |
| Combined Samples with Complete Interaction | 127 | .67 | .74 | 70.7 (1.49) | -3.0 (-.07) | -16.6 (-.92) | *** .520 E-2 (4.19) | .839 (.34) | -7.4 (-1.29) | 1.79 (.42) | -3.6 (-.92) | -6.4 (-.48) | 5.3 (.62) | * -44.5 (-1.67) | -11.6 (-.47) | -4.4 (-.51) | -[5] |
| Final Model- | | | | | | | | | | | | | | | | | |
| Combined Samples with Limited Interaction | 127 | .67 | .73 | -27.1 (-.27) | -5.8 (-.14) | -14.7 (-.82) | *** .511 E-2 (4.11) | 2.16 (.93) | ** -11.8 (-2.35) | .917 (.22) | -5.2 (-1.37) | -8.1 (-.61) | 8.1 (1.03) | * -48.6 (-1.82) | -10.0 (-.40) | 93.3 (1.02) | 99.6 (1.10) |
| Small Sample[6] Component | | | | -341.5 | ** 207.6 (2.33) | *** -124.4 (-2.78) | *** 1.01 E-2 (10.1) | *** 13.86 (3.94) | ** -11.8 (-2.35) | ** -19.2 (2.25) | *** -27.0 (-2.59) | *** 71.2 (3.16) | 8.1 (1.03) | *** 280.3 (2.72) | *** -270.3 (-5.24) | 93.3 (1.03) | 99.6 (1.10) |
| Large Sample Component | | | | -27.1 (-.27) | -5.8 (-.14) | -14.7 (-.82) | *** .511 E-2 (4.11) | 2.16 (.93) | ** -11.8 (-2.35) | .917 (.22) | -5.2 (-1.37) | -8.1 (-.61) | 8.1 (1.03) | * -48.6 (-1.82) | -10.0 (-.40) | 93.3 (1.02) | 99.6 (1.10) |

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4.

[3] Each price and expenditure variable has been divided by the price of the dependent variable.

[4] $C_p$ equals 9.85.

[5] Low tolerance prevented estimating parameters for this variable.

[6] Each parameter is obtained from the regression just preceding as the sum of the parameters for the terms with and without the DI suffix. The intercept is simply the intercept from the same line plus the parameter from the variable SSD.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level



TABLE 6.4-(Continued)

| Equation | INDEPENDENT VARIABLES: Intercept Shift SSD | Price[3] PRWMCDI | Price[3] PRSCDI | Expenditure[3] TEXPRDI | Household Characteristics HHSDI | IATDI | YCHDI | OCHDI | FULDI | LITERATDI | Market SHOGDI | SSHODI | Source SCAPDI | SCANDI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Complete teraction | *** -488.1 (-3.05) | *** 252.5 (2.47) | *** -127.7 (-2.55) | *** .476 E-2 (2.50) | *** 17.1 (3.46) | -16.2 (-1.37) | ** -22.98 (-2.29) | ** -22.7 (-2.01) | *** 89.9 (3.32) | 25.0 (1.11) | *** 392.2 (3.36) | *** -277.9 (-4.63) | 96.03 (1.01) | 124.5 (1.36) |
| Limited Interaction | *** -314.4 (-2.71) | ** 213.4 ( 2.18) | ** -109.7 (-2.27) | *** .496 E-2 (2.83) | *** 11.7 (3.18) | | ** -20.1 (-2.12) | ** -21.8 (-1.97) | *** 79.3 (2.99) | | *** 328.9 (3.06) | *** -260.3 (-4.54) | | |

But normally the effect of increases in these two variables would increase the household expenditure variable also, perhaps by as much as 1,125 kg. In this case the effect on expenditure would still further reduce the level of sorghum consumption, except at expenditure levels above 4,932 kg.

The regression also shows that sorghum consumption has a strong negative association with patterns of production that increase the share of the total value of food crop output that is available in terms of money. (See the coefficients for SHOG and SSHO.) Other things equal, households that produce more for the market consume less sorghum than others.

We postpone discussion of price-consumption relationships to the section on elasticities.

In Table 6.4 we find the behavioral regression for cowpeas. For this commodity, as for all foods except sorghum, using the information in the large sample did make a difference. With cowpeas there were four variables for which the interaction term proved not to be statistically significant, so in the final model the coefficients of those variables were constrained to be the same for both large and small sample households. But the values of these (and other) coefficients are not the same as they were when the original model was fitted to the small sample regression.

There is a highly significant positive relationship between cowpea consumption and total expenditure, all other variables held constant. Consumption is also positively associated with groundnut production, but negatively associated with the share of the total food crop harvest that is sold in the market. We return shortly to the price relationships.



TABLE 6.5

Single-Equation Total Palm Oil Consumption Regressions from Small, Large and Combined Samples, Kano State, Nigeria, 1974-1975.[1]

| | No. of Consuming Households | $\bar{R}^2$ | $R^2$ | Intercept | INDEPENDENT VARIABLES[2]: Price[3] | Expenditure[3] | Household Characteristics | | | | Intercept Shift | Price[3] | Expenditure[3] | Household Characteristics | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | PRSP | TEXPR | HHS | YCH | WAD | OAD | SSD | PRPSDI | TEXPRDI | HHSDI | YCHDI | WADDI | OADDI |
| Small Sample-[4] Original Model | 32 | .70 | .76 | -9.9 (-1.27) | *** 130.311 (3.40) | *** .213 E-1 (5.18) | *** -3.8 (-5.13) | *** 5.3 (3.06) | * 3.5 (1.95) | *** 7.0 (3.34) | | | | | | | |
| Large Sample-Original Model | 97 | .29 | .33 | * -11.8 (-1.84) | *** 119.4 (3.50) | ** .784 E-3 (2.34) | .34 (.62) | * -2.4 (-1.72) | -2.1 (-1.24) | 2.9 (1.39) | | | | | | | |
| Combined Samples | 129 | .33 | .36 | ** -13.13 (-2.43) | *** 127.8 (4.52) | *** .106 E-1 (3.69) | -.612 (-1.27) | -.492 (-.41) | -.318 (-.23) | *** 4.3 (2.52) | | | | | | | |
| Combined Samples with Complete Interaction | 129 | .40 | .46 | ** -11.8 (-1.96) | *** 119.4 (3.72) | *** .784 E-2 (2.49) | .344 (.66) | * -2.4 (-1.83) | -2.1 (-1.31) | 2.9 (1.48) | 1.9 (.15) | 10.9 (.18) | ** .013 (2.08) | *** -4.1 (-3.63) | *** 7.7 (2.84) | * 5.6 (1.91) | 4.1 (1.17) |
| Final Model- Combined Samples with Limited Interaction | 129 | .40 | .45 | ** -11.2 (-2.16) | *** 121.6 (4.46) | *** .753 E-2 (2.48) | .116 (.23) | -2.04 (-1.57) | -2.4 (-1.48) | *** 4.4 (2.70) | | | *** .151 E-1 (2.61) | *** -3.4 (-3.45) | *** 6.7 (2.66) | ** 5.9 (2.05) | |
| Small Sample[5] Component | | | | ** -11.2 (-2.16) | *** 121.6 (4.46) | *** .226 E-1 (4.30) | *** -3.28 (3.59) | ** 4.66 (2.10) | 3.5 (1.46) | *** 4.4 (2.70) | | | | | | | |
| Large Sample Component | | | | ** -11.2 (-2.16) | *** 121.6 (4.46) | *** .753 E-2 (2.48) | .116 (.23) | -2.04 (-1.57) | -2.4 (-1.48) | *** 4.4 (2.7) | | | | | | | |

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4.

[3] Each price and expenditure variable has been divided by the price of the dependent variable.

[4] $C_p$ equals 1.63.

[5] Each parameter is obtained from the regression just preceding as the sum of the parameters for the terms with and without the DI suffix. The intercept is simply the intercept from the same line plus the parameter from the variable SSD.

* Significant at the .10 level.
** Significant at the .05 level.
*** Significant at the .01 level.

Palm oil is obtained from the market. As Table 6.5 shows, its consumption is positively related to total household expenditure but negatively related to household size, given the numbers of young children, adult wives and older adults. We consider the price responses in their elasticity form.

Elasticities

Table 6.6 presents price and expenditure responses in elasticity form.[1] It includes the own-price elasticities, which exist even though there is no single regression coefficient we can point to as giving the own-price response. All elasticities are based on the small sample component coefficients. For each commodity we used all relevant coefficients in the regression, whether or not a coefficient differed significantly from zero.

Before looking at the numerical values we must remember that these consumption behavior elasticities from single-equation regressions may represent either production or consumption responses or some combination of the two. Moreover, because the price variables are village averages, some village-to-village differences not represented by other variables may have been picked up by one or more of the price variables.

As we have seen, the expenditure relationships for cowpeas and palm oil are strong and normal in sign, but the expenditure elasticity for sorghum is negative. Sorghum is an inferior good.

The own-price elasticities for cowpeas and palm oil are strongly negative. Palm oil, of course, is obtained from the market, but cowpeas are almost entirely produced at home. The own-price elasticity for sorghum however, is positive.

[1]See Smith et al., 1982, p. 60, for the formulae used.



TABLE 6.6

Elasticities Calculated for Three Commodities at Mean Observed Values for Combined Sample

| COMMODITY | ELASTICITY | | |
|---|---|---|---|
| | EXPENDITURE | OWN-PRICE | CROSS-PRICE |
| Sorghum | -.61 | .92 | -.31[a] (with palm oil) |
| Cowpeas | 2.43 | -5.52 | 11.36 (with millet)<br>-8.38 (with sorghum) |
| Palm Oil | .86 | -2.03 | 1.16 (with sorghum) |

[a]Based on a statistically insignificant cross-price coefficient.

For households at the mean of the sample, and presumably also at lower expenditure levels, sorghum is a Giffen good. Its money expenditure elasticity is negative and its own-price elasticity positive.[1] For all households whose purchasing power in terms of sorghum is less than 4,932 kg per year sorghum is an inferior good that constitutes a large fraction of the total value of consumption (33 percent of total expenditures for a household whose total annual expenditures are equivalent to 2,900 kilograms of sorghum and larger percentages at lower expenditure levels).

To be sure, the case for which a Giffen good is defined in the literature is one in which income is fixed in money and its level is independent of the price of the commodity being consumed. Our elasticities are calculated for such a case, although the physical situation from which the data arose was somewhat different.[2] If the price of sorghum rises, money expenditures held constant, the household response to the impoverishment implicit in a situation in which a large fraction of total consumption now has a higher opportunity cost is to consume more of the inferior good because, in the language of conventional theory, the income effect dominates the

[1]Given the form of the regression and an income elasticity of -.61 it would take a positive cross-price elasticity at least as large as +.61 to make the own-price elasticity negative.

[2]And the conditions specified for a regression model were not perfectly satisfied. For instance, the expenditure variable is not completely exogenous, for sorghum consumption constitutes a (large) part of that expenditure.



substitution effect.[1]

There are strong cross-price relationships (opposite in sign) between cowpea consumption and the prices of millet or sorghum, yet all three of these commodities are consumed primarily from home production. But as this is a single equation consumption model, we can not be sure whether the relationships measured are consumption or production relationships or both. Successful cowpea production in Nigeria usually implies intercropping, so the possibility of a production connection cannot be excluded. High sorghum prices are associated with increases in palm oil consumption; high palm oil prices are associated with reductions in sorghum consumption (but the latter relationship is based upon a statistically insignificant coefficient).

Except for the commodities listed in Table 6.6, most price or expenditure responses were small or statistically insignificant. We were fortunate to obtain as many significant relationships as we did, for no price variable could assume more than three values, one for each village. Moreover, some caution is required in using these results, for with so few values for each variable not only is multicollinearity likely, but a price variable may pick up the effect of some other variable (possibly locational) that differs across villages.

[1]The physical situation that generated our data was one in which what was fixed was not money income but the household's capacity to produce income (defined in terms of the size of the household, its age and sex distribution, its access to land, and so forth). For the study of semi-subsistence households in developing countries it is useful to extend the concept of the Giffen good to include such cases. Indeed these may be the only cases in which the concept is significant for applied work.

## Calories Available

Far more important than the consumption of individual foods is the nutritional adequacy of the diet as a whole. From the data in Table 6.1 we have calculated the caloric content of the diet for each household in the sample.[1] For much of the world the most pressing nutritional problem is caloric availability. In northern Nigeria the evidence suggests that calories and vitamin A are the nutrients most likely to be seriously deficient [Smith, 1975, pp. 161-2, 263-267].

Table 6.7 gives the regression which relates total calorie consumption to household characteristics and the economic variables. The variables available for use in this regression were those available for the sorghum regression, except that the source variables used here were source variables for calories (SKAP and SKAN) rather than for individual food commodities. The Small Sample -- Original Model regression given in Table 6.7 minimized $C_p$. Naturally it is much like the comparable regression for sorghum, except that the price of palm oil, HHAGE and SSHO, are not present in the calorie equation, while young children (YCH) is significant in the calorie equation although it did not appear in the sorghum equation.

As with sorghum, predicted calorie consumption decreases with increasing expenditure levels at the mean of the combined sample (TEXP equal to 3,895 kilograms of sorghum), but the declining range ends with households at an expenditure level of 4,239 kilograms rather than at 4,932 kilograms. At the mean expenditure level, predicted calories available per household per day were 10,600; at a total expenditure level of 2,900 kilograms of sorghum, calories available were 11,600.

---

[1]Budgetary limitations restricted us to doing this for calories only.



Not only does the declining range of calorie consumption end at a lower expenditure level than was the case for sorghum but the rate of decline is less. An increase in expenditure from 2,900 to 3,900 kilograms, other things equal, reduces caloric availability by 9 percent, sorghum consumption decreases by 19 percent over the same range. These differences are to be expected. As expenditure levels rise, households consume more of other things, including such foods as cowpeas and palm oil. The foods being substituted for sorghum are more expensive sources of calories, but they do provide partial replacement for the calories no longer being obtained from sorghum.

The effects of household size and composition upon total caloric availability are much like those upon sorghum consumption. But what of the relationship to the market? Is the food energy available to rural households greater for households that produce primarily for their own consumption or for those that produce for the market? The share of the total value of harvested food output (SSHO) is not significantly related to the quantity of calories available for consumption, but the larger the share of total food crop output that consists of groundnuts (SHOG), the fewer calories are available for the household at any given level of expenditure and the other relevant variables. (Groundnuts are produced primarily for sale to the market.) However, from a single-equation regression we cannot tell whether this result occurs because producing groundnuts for the market has an adverse effect on the quality of the diet or because the households that produce large quantities of groundnuts would have even worse diets if they produced fewer groundnuts. As Matlon has pointed out [1979, pp. 89-91] the poorest households, those with the least access to productive resources,

TABLE 6.7

Single-Equation Total Calorie Consumption Regressions From Small, Large, and Combined Samples, Kano State, Nigeria - 1974-1975[1]

| Equation | Number of Households | $\bar{R}^2$ | $R^2$ | Intercept | INDEPENDENT VARIABLES[2]: Expenditure[3] | | Household Characteristics | | | | Market Relationship | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TEXPR | TEXPRSQ | HHS | IAT | YCH | MAD | SHOG | SKAN |
| Small Sample-[4] Original Model | 34 | .87 | .90 | *** 18000.6 (4.51) | *** -4.6 (-3.64) | *** .543 E-3 (5.62) | *** 2872.5 (5.00) | *** -4052.5 (-3.50) | * -1661.9 (-1.72) | *** -3866.7 (2.90) | *** -19230.5 (-2.87) | *** 5121.4 (4.46) |
| Large Sample- Original Model | 99 | .71 | .73 | * 2540.9 (1.91) | *** 2.6 (4.42) | .484 E-4 (-1.01) | *** 557.6 (3.09) | -185.5 (-.39) | -395.7 (-.93) | 77.8 (.15) | *** -7843.3 (-4.26) | * 3014.9 (1.75) |
| Combined Samples | 133 | .69 | .71 | *** 6227.9 (4.04) | .499 (.79) | *** .154 E-3 (2.96) | *** 932.5 (4.45) | * -915.3 (-1.76) | ** -1118.7 (-2.37) | 7.0 (.01) | *** -9471.2 (-4.28) | *** 4772.5 (4.95) |
| Combined Samples with Complete Interaction | 133 | .80 | .83 | * 2540.9 (1.79) | *** 2.56 (4.15) | -.491 E-4 (-.95) | *** 557.6 (2.90) | -185.5 (-.37) | -395.7 (-.87) | 77.8 (.14) | *** -7843.3 (-4.0) | * 3014.9 (1.64) |
| Final Model- | | | | | | | | | | | | |
| Combined Samples with Limited Interaction | 133 | .80 | .82 | * 2749.7 (1.95) | *** 2.51 (4.05) | -.426 E-4 (-.82) | *** 598.9 (3.36) | -113.7 (-.23) | * -650.1 (-1.65) | -48.8 (-.09) | *** -7743.3 (-3.93) | *** 4627.4 (5.41) |
| Small Sample[5] Component | | | | 18135.7 | *** -4.90 (4.66) | *** .578 E-3 (7.36) | *** -2626.9 (5.91) | *** -3793.8 (3.96) | * -650.1 (-1.65) | *** -3832.9 (3.46) | *** -17457.8 (3.17) | *** 4627.4 (5.41) |
| Large Sample Component | | | | * 274.9 (1.95) | *** 2.51 (4.05) | .426 E-4 (-.82) | *** 598.9 (3.36) | -113.7 (-.23) | * -650.1 (-1.65) | -48.8 (-.09) | *** -7743.3 (-3.93) | *** 4627.4 (5.41) |

[1]t-statistics are in parentheses.

[2]Variables are defined in Table 4 except SKAN. SKAN is the share of total calories available to the household from neither home production nor market sources.

[3]Each expenditure variable has been divided by the average price of sorghum.

[4]$C_p$ is 3.35.

[5]Each parameter is obtained from the regression just preceding as the sum of the parameters for the terms with and without the DI suffix. For example, the coefficient for TEXPR is equal to 2.5 + (-7.4). The intercept is simply the intercept from the same line plus the parameter from the variable SSD.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level



TABLE 6.7-(Continued)

| Equation | INDEPENDENT VARIABLES[2]: Intercept Shift | Expenditure[3] | | Household Characteristics | | | | Market | Source |
|---|---|---|---|---|---|---|---|---|---|
| | SSD | TEXPRDI | TEXPRSQDI | HHSDI | IATDI | YCHDI | MADDI | SHOGDI | SKANDI |
| Complete Interaction | *** 15459.8 (4.26) | *** -7.2 (-5.85) | *** .592 E-3 (6.17) | *** 2314.9 (4.47) | *** -3866.9 (-3.54) | -1266.2 (-1.37) | *** -3944.5 (-3.15) | * -11387.1 (-1.92) | 2106.5 (1.02) |
| Limited Interaction | *** 15386.0 (4.22) | *** -7.41 (-6.05) | *** .621 E-3 (6.54) | *** 2028.0 (4.48) | *** -3680.1 (-3.44) | | *** -3784.1 (-3.07) | * -9714.5 (-1.66) | |

may follow a "groundnut strategy" -- produce groundnuts for the market in order to be able to buy more food for their families than the same resources could have provided through home production of sorghum, millet and so forth.

Another caution: Our estimates of food consumption in Table 6.1 do not include groundnuts and onions consumed from home production or items purchased with profits from the women's enterprises. Thus our caloric availability figures are somewhat low. If we had had reliable data on groundnuts consumed from home production the negative coefficient for SHOG might not have appeared.

Although no price variable appears explicitly in the calorie regression there is a relationship between caloric availability and the price of sorghum, for total expenditures are measured not in terms of money but in terms of the power to purchase sorghum. At the mean values of the independent variables for the combined sample, the elasticity of calorie availability with respect to the price of sorghum is +0.15 and the expenditure elasticity is -0.15. (Given the form of the regression and the absence of any other price variable, these two elasticities must be equal but opposite in sign.) A ten percent increase in the level of money expenditure, other things equal, reduces calorie availability by 1.5 percent; a ten percent increase in the price of sorghum (which lowers real income) increases calorie availability by 1.5 percent. These elasticities will be larger in absolute amounts as expenditure levels are smaller. At expenditure levels above 4239 kg the expenditure elasticity becomes positive and the sorghum price elasticity negative.

The most important feature of these elasticities is that they are small: for policy purposes changes in income or in the price of sorghum do not have important effects on calorie availability at the mean of the sample.[1]

[1] The effects are larger for the poorest households.



The most interesting aspect is their signs. Until expenditures reach levels somewhat above the mean for the combined samples, the general response to higher spending capacity is to add variety to the diet by increasing the consumption of cowpeas, palm oil, maize, etc., and to do this even at the sacrifice of some calories that the household could have obtained had it consumed larger quantities of sorghum than it did in fact choose to do. The lower-income households, already consuming large quantities of sorghum, have strong preferences for higher quality foods even at a higher cost per calorie. An expenditure of 0.01 Naira on sorghum, an item not usually obtained from the market, provides 428 calories. The same expenditure on palm oil, purchased primarily from the market, provides only 198 calories. Yet as incomes rise for low-income households, sorghum consumption falls and palm oil consumption rises, the values of the other variables remaining the same.

## Conclusion

Even though most of the consumption of the major foods was produced by the consuming households, these Kano State villagers were responsive to such economic variables as levels of household expenditure and prices. Furthermore, it was possible to identify and measure some of these responses even though the price series with which we were working contained only three observations apiece, one for each of the villages.

Consumption choices were also affected by market orientation and production patterns, but not always in the same way. Other things equal, the more market oriented households ate less sorghum, but they ate larger quantities of most other foods -- probably including groundnuts, though our data did not permit us to examine the latter case. Most expenditure responses are positive and most own-price responses negative, as one would expect. But for sorghum, the principal food, there was a highly significant negative expenditure response for all households with real expenditure levels of 4,932 kilograms of sorghum or less. At the mean of the combined samples sorghum was a Giffen good, with an expenditure elasticity of -0.61 and an own price elasticity of +0.92.

Low-income households, already eating large quantities of sorghum, take advantage of improved income to replace part of the sorghum consumed by other food. They prefer to consume less sorghum to the extent that their incomes permit replacement by what they regard as adequate quantities of other foods. According to our data they will accept a modest reduction in total calorie consumption in doing so. However, our data do not include groundnuts consumed from home production or foods purchased with proceeds from the enterprises of female members of the household, so the losses in calorie consumption may be smaller than our data indicate, or indeed non-existent.

Given the unusual nature of the response of sorghum consumption to price and income changes, the consequences of agricultural policy must be carefully considered. For more than half the households a higher price for sorghum would increase sorghum consumption (and perhaps total caloric intake) if total expenditure remained constant, but total expenditure would rise. Taking account of the effect through expenditure, consumption would still rise if there were no effect on sorghum output.[1]

---

[1]In our sample the sorghum produced, valued at its average price, amounts to about one-third of average total expenditure. Thus, with no change in production levels, a one percent increase in the price of sorghum increases total money expenditure by 1/3 of one percent. The joint effect of the price and expenditure changes is to increase sorghum consumption by 7/10 of 1 percent (Given the expenditure elasticity (-0.6), the expenditure change by itself woul reduce sorghum consumption by 0.33 X 0.6 = 0.2 percent; the price change, by itself, would increase sorghum consumption by 0.9 percent: the sum of the two is 0.7 percent.) Of course if the additional effect of increasing sorghum production was to increase expenditure by as much as 1 2/3 percent the overall effect on household consumption would be zero or negative.



Improved methods of producing sorghum, through their effects on output, would lower the price of sorghum. If this happened with no effect on household income it would lower rural consumption (and perhaps caloric availability) for more than half the households). However, unless the off-farm demand for sorghum was such as to create a total market demand that was elastic, the effect of the production improvements would reduce farm incomes. That in turn would lead to more sorghum consumption for the same households and possibly more calories in the diet. Whether the effect through expenditure would dominate the effect of the lower price of sorghum would depend upon the nature of the off-farm demand, about which we have no information. In general, however, sorghum price policy is not apt to have a major effect on the caloric intake of the average household. Still, given that most sorghum produced is consumed by the households that produce it and that improvements in their welfare are taken partly in the form of reduced sorghum consumption, technical improvements that increase output are likely to have a sharply depressing effect upon sorghum prices.

In general, agricultural policies that improve farm household income reduce sorghum consumption except for families that are already appreciably above the mean expenditure level for the combined samples. With this reduction in sorghum consumption may come a small reduction in total food energy available to the household. Still, we can hardly recommend the perpetuation of poverty as a means of improving family welfare unless we regard improved caloric availability as more important than alternative forms of consumption that the household itself finds important. We suggest, however, that the emphasis in programs directed toward improving agricultural productivity should be on foods that are sought after in greater amounts as income rise -- cowpeas and maize for instance, rather than upon sorghum, unless improvements in transportation and marketing can provide greatly expanded off-farm outlets for the latter. Sorghum and millet from the North can play important nutritional roles for the rest of Nigeria, for they are valuable sources of protein, particularly of the two amino acids, methionine and cystine, that have been found to be limiting amino acids in the Nigerian diet [Smith, 1975, pp. 279-280]. Marketing and transportation improvements could also lower the price of palm oil, important to villagers in Northern Nigeria for its vitamin A and its energy content. In general, production improvements that lower the cost of desired alternatives to sorghum will permit low-income households to move toward the more varied diets they desire while making fewer sacrifices than would otherwise have been necessary in terms of the caloric adequacy of their diets.

# CHAPTER VII

# CONCLUSION

The course of economic development has major effects upon the nutritional wellbeing of rural households in developing countries. Can those effects be predicted by studying the food consumption behavior of households that produce most of their own food? Do semi-subsistence households in fact respond to the market in making their food consumption decisions? Can methods be developed to analyze food consumption choices when most of the food consumed does not pass through the market? Can useful information about food consumption be obtained from survey data that consists of householders' reports of production, sales and expenditures, a situation in which the researcher has no direct observation of household consumption? And lastly, can price elasticities be obtained from cross section data, where price variation in space can be observed, but not variation over time? These studies have shown that the answer to each of these questions is yes. Moreover, they have provided a mass of factual information about consumption patterns and the effects of demographic and economic variables upon the food consumption decisions of rural households.

Both in Sierra Leone and in the Kano State villages, the household produces a major portion of the food consumed. Cereals constitute the backbone of the diet in each area, but in Sierra Leone the principal cereal is rice while in the Kano State villages it is sorghum. Rice, palm oil, dried fish and cassava are the most important foods in Sierra Leone; in the Kano State villages they are sorghum, cowpeas, nono (soured skimmed milk) and palm oil. Annual rice consumption per household in the sample from Sierra Leone was about 600 kg; annual sorghum consumption in the three Kano State villages was approximately 900 kg per household.

Total consumption consists of quantities obtained from the market, quantities retained from home production, and, in the case of the Kano State data, gifts, wages in kind and loans or repayments. In the Sierra Leone study the rice production figures were based upon weighing of the output from measured plots and the rice consumption figures were derived from reported quantities of rice pounded. Spencer and Byerlee, who collected the data from Sierra Leone, and Matlon, who collected the Kano State data, were exceptionally careful in defining the quantity units in which the data were reported, in specifying the stage of processing or preparation of each commodity recorded, and in determining accurate conversion ratios between local quantity units and kilograms. Their care in these matters was vitally important for the success of our work in estimating quantities consumed from home production by the disappearance method.

Several problems arise when one sets out to analyze the food consumption behavior of semi-subsistence households. First, it is necessary to have both price and quantity data; expenditure and sales data in value terms alone will not do. Secondly, the data must cover both household expenditure and consumption activities and household production activities. In the semi-subsistence household production and consumption are interdependent activities; in some situations the decision to consume and the decision to produce may be the same decision.

Thirdly, and for many the most serious problem, food consumed by the producing household does not pass through a market. This problem is readily dealt with, however, by valuing home-produced food at its opportunity costs, the local farm-gate price for sales of that particular food.



Lastly, the data that can be collected from production and expenditure studies are data for household consumption, not the consumption of individual members, but to evaluate the nutritional adequacy of consumption it is necessary to take into account the size and composition of the household. The usual methods of doing this have been expressing consumption as consumption per capita or per adult male consumer equivalent. We have found it to be more accurate and more informative to use a number of variables which describe the household size and composition.

The Sierra Leone research experimented with two fundamentally different econometric approaches: single-equation estimation for individual commodities and a household-firm model describing the entire production and consumption system of the household as a whole. Single-equation estimation is inexpensive and can provide great detail about a large number of precisely defined commodities, but the estimates for the different commodities need not be consistent.

The household-firm model provides consistent estimates of each of the dependent variables and makes fuller use of the information in the model and the data than single-equation estimation can do, but it is extremely expensive and requires the services of a skilled econometrician. Moreover, the amount of quantity detail that can be provided is severely limited.

We present first some results from single-equation regressions. Many students of food problems assert that producing for the market reduces the quality of the diets of rural households. The data show that production for the market has an effect upon the consumption of certain commodities, but that the effect may be either positive or negative. In Sierra Leone households that produce large fractions of their own consumption of palm oil and groundnuts consume more of those commodities than others do, but they consume less of cassava and broad beans when most of what they consume is produced by themselves. A high degree of market orientation reduces the consumption of cereals other than rice. Yet palm oil is produced for sale as well as for consumption and the market-oriented production of onions, peppers and chillies is associated with high consumption of these three foods. Production and market orientation variables have no demonstrable effect on the consumption of rice.

In the Kano State villages households selling a large share of their food crop output eat more maize and nono than other households, but less sorghum and cowpeas; those that produce a larger proportion of groundnuts than others consume above-average amounts of rice and cowpeas, but below-average amounts of sorghum; those that produce a large share of the rice or cowpeas they consume eat more of those two crops than others do. Other things equal, the more market oriented households eat less sorghum and more of most other foods.

In Sierra Leone, as elsewhere, higher household incomes are usually associated with larger consumption levels; expenditure elasticities are positive for rice, palm oil, fish, and vegetables. For rice, palm oil and cassava expenditure elasticities decline as expenditure rises. Own-price demand elasticities are usually negative and frequently large, as for groundnuts, dried fish, and peppers and chillies. The own-price elasticity for rice is -.9 at low and medium expenditure levels and -.56 at the high expenditure level. The data revealed some positive own-price responses (as for sorghum, palm oil, peppers and chillies, and legumes other than groundnuts). These may occur because the single-equation regression measures the net effect of both production and consumption responses.



Households that produce more because the market price is favorable may also consume more because the commodity is at hand and available at an opportunity cost that is less than the price paid by households purchasing the commodity from the market. There are also strong cross-price responses. Cassava, palm oil, groundnuts, fish, Maggi cubes and cola nuts have large cross-price elasticities with respect to the prices of a number of other commodities.

There is no question but what the food consumption of these semi-subsistence households is responsive to prices. In particular, rice consumption among households at low expenditure levels is highly responsive to the price of palm oil, dried fish, groundnuts and non-food goods. A rise in the price of palm oil has a negative effect upon the consumption or rice, probably because greater production of palm oil is associated with consuming more palm oil and less rice. Own-price and cross-price elasticities frequently decline in absolute value as expenditure levels rise. The allocation effects of price (and expenditure) elasticities are particularly important for low-income households.

For Sierra Leone we also made estimates of per capita production and consumption for the entire rural population of the seven zones for which the data were adequate. Per capita production of rice was 207 kg, per capita consumption 88 kg and total calorie availability per day per person was 2,011. Households in the lowest expenditure group (under 350 Leones per year) produce 192 kg of rice per capita, more than those in the highest expenditure group. But the low-expenditure households consume only 45 kg of rice per capita and have only 1,156 calories available daily per capita from all sources. Per capita sales of rice to the market by low-expenditure households are 50 percent greater than those of high-expenditure households. Per capita sales of rice to the market[1] by low-expenditure households are three and a half times their total rice consumption. The households with the highest incomes are those that produce and sell fish and miscellaneous foods (including vegetables). The least well off households are large sellers of rice.

For consistent estimation of the whole system, we turn to a simultaneous equation estimate of the household-firm model. With this approach we can distinguish those effects of price changes that operate through changes in production from those that operate on the consumption decisions. The latter are assumed to depend upon the total level of expenditure, but not upon the particular cropping pattern that made this expenditure possible. In this model household expenditure is not exogenous, as it was assumed to be for the single-equation regression estimates, but is the result of production decisions. Thus the production effects of a change in prices alter the total household expenditure; the new prices are then applied in determining how to allocate the new amount. The model is recursive. Given the resources available and the prices of goods and labor we use the production component of the model to estimate the outputs of six categories of goods (rice, root crops and other cereals, oils and fats, fish and animal products, miscellaneous foods and non-foods) plus the quantity of labor required to produce them. Given these outputs we then use the consumption component to estimate the quantities consumed of the six commodity groups and the quantity of household labor supplied (the amount of household labor time that is not consumed as "leisure")

[1]Including the quantities retained for use as seed.



All the own-price output elasticities are less than 0.5. In general, the more important the activity the greater is the response to a change in its price. Except for the EA 13 households, which are large producers of fish and vegetables, rice, with an output elasticity of .36, is the output most responsive to changes in its price. Labor used is much more responsive to changes in the wage rate than goods outputs are to their prices. For households outside EA 13 the own-price elasticity of total labor use is -1.17. Of this the largest single component is the response of rice output to the price of labor (-.47).

When both production and consumption responses to price are taken into account, all own-price elasticities are negative except that for the consumption of root crops and other cereals by low-expenditure households. In other cases the negative short run price response, holding profits constant, overcomes the profit effect. The total consumption elasticity with respect to the price of rice is -.66 for the sample as a whole and -.44 for low-expenditure households. The total effect of increases in wage rates on consumption is positive for each commodity group; household labor supply rises modestly with increases in the wage rate. The consumption of rice, oils and fats, and fish and animal products among low income households responds strongly to increases in the wage rate for agricultural labor. The cross elasticities for the total effects are .74, .82 and .76, respectively.

From a nutritional point of view what matters is the diet as a whole, not the consumption of particular foods. The elasticity of calorie availability with respect to total expenditure is .86 for the sample as a whole, and varies little by expenditure group. When both production and consumption changes are taken into account, an increase in the price of any commodity group increases caloric availability for most households. Significant exceptions occur in the cases of rice and oils and fats. For these two commodities an increase in price reduces total calories, except for low-expenditure households. The elasticity of caloric availability in response to a rise in the price of rice is +.19 for low-expenditure households when production effects are taken into account. A change in rice pricing policy that increased the price received by the farmer would increase caloric availability for low-expenditure households (but would reduce it for households in the middle and high expenditure groups).

The cross-price relationships identified by the single-equation regressions sometimes differ greatly from those revealed by systems estimation. Differences are to be expected, for a variety of reasons: First, except for rice, the commodity definitions are different. Secondly, the single-equation regressions look at a single commodity rather than the whole system, they do not make complete use of all the information available, and the coefficients may be biased. Lastly, while single-equation regressions measure the combined effect of both production and consumption choices, they leave the nature of the production relationships completely unspecified. In the household-firm model the production relationship is given a specific algebraic form and restricted to operating exclusively through the effect upon the profit component of total expenditure.

The most striking difference in results occurs for the cross-elasticity of rice consumption with respect to the price of palm oil (or of oils and fats). In the single-equation results the relationship is negative, while from the systems estimation the effect is positive, and much smaller.



In the systems model a higher price for oils and fats induces both greater use and lower household supply of labor (more labor is hired or less sold out). The added labor use shifts the transformation function outward -- given our data, enough to allow other outputs to increase as well as oils and fats. (With other data, all outputs other than oils and fats might have decreased, but whatever happened to other outputs, all would change in the same direction.) Yet an increase in palm oil processing might in fact cause a household to produce more cassava and less rice. The mechanism could be as follows: Because palm oil processing uses a great deal of female labor, it reduces the amount of household labor available for rice pounding. Some consumption of rice may then be replaced by cassava, which, in Sierra Leone, can be prepared for eating with much less labor.[1] (The data show that the proportion of cassava to rice in the diet is greater in the areas where palm oil production is large. Of course there could be other reasons for this.)

If a mechanism is operating like that just cited, the systems model would not allow it to show through clearly. The single-equation regression, on the other hand, although it says little that is explicit about the mechanisms that are operating, for that very reason imposes no predetermined constraints upon them.

Consider another possibility, that a high price for palm oil induces greater output, and that households that produce more palm oil consume more, and that greater palm oil consumption reduces the amount of rice eaten because palm oil is an excellent alternative source of energy. (The single-equation regression for palm oil reveals that producing a large fraction of the palm oil consumed increases palm oil consumption and that

---

[1]Because "sweet" cassava, which need not be fermented, is the principal type grown there.

the own-price elasticity of palm oil consumption is positive.)

If such mechanisms exist, the form as well as the amount of income has an effect upon consumption. Income received (produced) in the form of palm oil is more likely to be consumed as palm oil than is income received in the form of money, rice, or some other commodity. This possibility is excluded by the particular systems model we are using, but it can be considered with the single-equation regressions.

It is clear that there may be mechanisms important to the understanding of the food choices made by semi-subsistence households that cannot be detected by the systems model we are using because the latter allows production decisions to affect consumption choices only through their effects on the profit component of expenditure. Yet for other purposes the systems model is to be preferred. Neither model deals with all the problems; each can contribute something.

For policy purposes we need to predict the effects of autonomous changes in prices or income upon diets or nutrient availability. To look at the diet as a whole we need the systems model. (For nutrient availability we could use a single-equation single-nutrient regression like the calorie regression developed for the Kano State data, but it would not tell us what changes in the diet brought about the observed effects upon nutrient intake.) With the household-firm model we can predict consumption levels for each individual household and develop population estimates of the consequences of price change from these individual predictions. This is equivalent to using arc elasticities instead of point elasticities and to using for each household the elasticity most appropriate to its individual circumstances. Applying this procedure we discover that increases in agricultural productivity (if reflected in the free market wage of agricultural



labor) have significant effects upon caloric availability. A ten percent autonomous increase in the agricultural wage, other prices remaining fixed, increases caloric availability for the seven-zone population as a whole by five percent. A ten percent increase in the relative price of rice, on the other hand, increases total calorie consumption per capita by only 0.3 percent. If wages rise by ten percent and rice rises by five, the effect on caloric intake is almost identical with the effect of an increase in the wage rate alone. Of course we know from our point elasticity results that caloric availability for low-income households rises about two percent when the price of rice rises by ten, all other prices held constant, so we should expect the caloric intake among those households to rise much more than five percent as a result of such a joint increase in the rice price and the wage rate as we have been discussing. Any increase in an output price improves the energy content of the diet of low-expenditure households, but an increase in the general value of agricultural labor is even more effective. Efforts to improve the nutritional well being of low-expenditure households should concentrate on improving agricultural productivity, yet this may mean devoting less effort to the improvement of rice production and more to the improvement of various more profitable agricultural activities.

The Kano State data showed that those semi-subsistence households likewise respond to market incentives even though most of the food consumed is produced by the household that consumes it. A number of statistically significant measures of price and expenditure elasticities were obtained despite the fact that no price series contained more than three observations. Strong own-price and cross-price elasticities were found for both cowpeas and palm oil. The most interesting result, however, was that sorghum, the principal staple, is an inferior good except for households with expenditure levels appreciably above the mean for the sample. At the mean of the sample and below, increases in real expenditures are associated with decreases in the consumption of sorghum, other variables being held constant. Sorghum is also a Giffen good for more than half the households in the sample. The own-price elasticity of sorghum at the mean is +.92. If household money expenditure is constant and the price of sorghum rises, the impoverishing effect of the opportunity cost of consuming sorghum induces the household to replace some preferred foods by larger quantities of sorghum, which remains the most economical source of food energy even at the higher price. Even taking into account the effect of the higher price of sorghum upon the money value of household output sorghum consumption would increase about 0.7 percent in response to a one percent increase in the price of sorghum, in the absence of any expansion of sorghum output.

The effect of the price of sorghum upon calories available from the diet as a whole is much less, but is still positive at the mean of the sample. The elasticity is +0.15. Below a real expenditure level of 4239 kg of sorghum increases in the level of money expenditure reduce calories available; the effect is greater as the expenditure level is smaller. For policy this is awkward: impoverishment, either in the form of a higher opportunity cost for home-produced sorghum or a lower level of money expenditure, increases the number of calories consumed by an average household. Until households are well enough off to be appreciably above the mean of the sample, they prefer to reduce their energy intake in favor of a more varied and more palatable diet whenever they become better off. The effect on energy intake is not large at the mean of the sample, but it may be appreciable among households at lower expenditure levels. We



can hardly recommend perpetuating poverty as a means of improving family welfare, so we suggest that the emphasis in programs directed toward improving agricultural productivity should be on the food which people desire to consume in larger amounts as their incomes rise -- cowpeas, for instance.

As we have seen, either the single-equation approach or estimation of a complete household-firm system of equations can provide quantitative information about consumption responses to economic and other variables. Either approach can predict the effects of economic variables upon the total food energy content of the diet, but the systems model can show us how those effects operate through changes in production decisions and the level of total expenditures to alter food choices. The single-equation approach can give us the net effects of all the mechanisms involved, but cannot sort out the different relationships that are operating. Yet any particular systems model is liable to exclude certain mechanisms that may be important. For instance, our household-firm model could not ask whether the consumption pattern is affected by the physical form in which income is received as well as by the value of that income. The economist, whose specialty is markets, tends to assume that the form of the income does not matter, because where markets are available any output can be converted into any other output. But an important part of the problem in a developing country is the fact that markets are highly imperfect. This aspect of the situation could not be examined with the systems model we were using. From our single-equation regressions, however, we did discover, both in Sierra Leone and in Kano State, that both the availability of a particular food from one's own production and the extent to which a household produces for the market can affect consumption choices for particular foods. We also found that production for the market often increased the consumption of particular foods when the households compared were at the same total expenditure level. It should not surprise us that access to income in a form easily convertible to money should be conducive to increased consumption of commodities purchased with money.

While the systems model we used was not designed to deal with this group of questions, systems models could be designed for such purposes. Were that done we would understand the mechanisms that are at work better than would be possible with single-equation regressions. Another problem deserving study is the effect of market imperfections (or simply marketing margins) that maintain a differential between the price at which one can purchase food from the market and the opportunity cost value of such a food to the farmer who is producing it himself, the farm-gate price. Still another is the effect of imperfections in labor market such that when a household has used the labor available from its own members its access to additional labor is only at considerably less favorable terms.[1] Models with different commodity groupings would be useful for certain purposes. Cassava is sufficiently important in Sierra Leone to justify treating it as a single commodity even though doing so would require putting the foods grouped with cassava in the present model into another heterogeneous class. Models in which we had distinct production functions for fish and/or the gathering and processing of palm products would be useful, although we would have to give up detail or increase the computational difficulties in order to do this.

[1]The prevalence of labor exchange groups and the difficulties often described as facing households that have no male adults to contribute to such labor exchange arrangements suggest that imperfections in the labor market are a significant problem.



In the present state of the art the limitations upon the size of the model that are inherent in the nature of the computational process make it likely that a model satisfactory for a problem such as one of those just mentioned would be less satisfactory with respect to aspects of the system that are well dealt by the model we have used. A general model that could include all significant aspects of the situation would undoubtedly be infeasible at present, but a series of overlapping special models might be manageable, even though extremely expensive, both in terms of its demands upon the skills of the econometrician and the computational expense involved.

Though it may not be feasible to use a complete systems analysis in examining all these problems, we have shown that methods as simple as the single-equation regression are useful. And improvements in methods are possible. Creative imagination and due attention to the institutional features of developing economies can take us quite a distance even within the boundaries imposed by relatively simple models.

The facts are that semi-subsistence households do respond to economic variables and it is possible to predict those responses. Such predictions are essential -- especially predictions that apply to low-income households -- if economic change and government policy are to help rather than harm the poor as well as the well-to-do of the nation.

## APPENDIX

## SURVEY DATA FOR THE SEMI-SUBSISTENCE HOUSEHOLD

Our point of view is that of the student concerned with the nutritional adequacy of rural diets as they are affected by economic variables and government policy. For these purposes we need data that provide us (1) the necessary information concerning food consumption and the nutritional content of that food, (2) the relevant characteristics of the household concerned and (3) information concerning the economic variables and choices. To provide the nutritional information the data must include the quantities of the several foods consumed, individual foods must be carefully defined, the period of recall on the part of the respondent must be short enough so that his memory can be relied upon, and the data must cover a representative period of time. About the household itself we must note at least the number, age and sex of its members, and, if possible, the amount and type of physical activity of each member and the amount and kind of illness. To understand the economic influences involved we need to know the resources available to the household (in physical and in value terms), the prices paid and received for goods purchased and sold by the household and the quantities and values of all goods purchased for household use, and have complete information about production processes: outputs, inputs purchased, and labor purchased and hired out, with wages for each type of labor hired or sold.

### Requirements for Nutritional Analysis

The nature of the problem defines the data that are to be collected. Ideally, one should design the whole analysis before data collection begins, to make sure that the data needed at each stage of the analysis are collected, that definitions are clear and precise, and that the degree of precision is appropriate for the analysis to be done. But the unforeseen must be expected. Therefore records and descriptions must be kept in more detail than one is likely to think necessary at the moment. Details must be in writing. It is tempting to think that one will remember what was done, but when the time comes at which precise information is needed, the person who remembers it may not be available or the details may have slipped from everyone's memory.

Knowing exactly the problem to be solved and how the analysis is to be carried out is also essential to making the choices required because budgetary limits make it impossible to do everything that one would like and as well as one would like. It is often necessary to accept less precise information concerning certain aspects of a problem in order to have more precise and reliable information about the most crucial aspects. If the important nutritional problems stem from quantities of food energy and protein available, complete and reliable data on the sources of fat, protein and carbohydrates are important, but it may not be necessary to have complete information about most fruits, unless they comprise a large part of the total diet. Even then detailed information about citrus fruits may not be important, but information about breadfruit, avacodos, bananas, plantains and coconuts may need to be collected with great care.

Specifying the Commodity

To evaluate the nutritional adequacy of a diet we must not only know the physical quantities of the commodities consumed, but also have that information for individual commodities, rather than for groups of commodities.



Vegetables and fruits vary tremendously in nutritional composition. To combine all vegetables into one group and all fruits into another may make it impossible to make meaningful statements about such matters as the quantity of vitamin C, vitamin A or fiber in the diet. The proteins of maize and sorghum differ significantly in their amino acid composition. The nutritional value of meat depends significantly upon the animal involved and the part of the animal that is being eaten.

Great care must be taken in determining the name or names of each commodity for which data are being collected. The local name may not be found in the nutrient composition tables to which we go to determine the nutritional content of the food. In such cases a botanist or zoologist may be able to determine the scientific name of the food or animal, for there is reasonable consistency in the use of the scientific name (although even here variations occur). In Sierra Leone a grain called fundi is quite important in the north, but was not to be found in any of the food combination tables we were using. Some of our informants called it a type of millet, but it finally turned out to be Digitaria exilis. We now know that fundi is also called findi or fonio and perhaps by other names as well.

There are other cases in which the food has a familiar name which does not mean what it does in the investigator's own country. "Greens" in Sierra Leone refers to a particular type of leafy vegetable also known as native spinach. The botanical name is Amaranthus hybridus, variety cruentus. In the U.S.A. "greens" refers to leafy vegetables in general rather than to a specific variety. "Condiments" in the United States refers to seasonings, but in Sierra Leone it comprises also vegetables and bits of meat or fish that are included in the sauce served with rice or cassava. What is called a lemon in the United States may be called a lime in Sierra Leone; what we would call a tangerine would there be called a lemon. The bitter tomato (jakato) is a form of eggplant. Lastly, "beef" is the English word used in Sierra Leone for antelope meat.

Other problems arise when the same name is used for two or three different foods or there are different words or spellings for a single food. In the Sierra Leone survey the same commodity was called local gin in the production data and omole in the expenditure data. "Salt" included both dry salt, imported and sold in a package at a relatively high price, and raw native salt, probably rather wet and sold at a much lower price. Equal weights of these two commodities contain quite different quantities of NaCl and sell at quite different prices. Palm kernel may also be referred to as palm nut. Recording such data under the two different names might create no problems for people familiar with oil palm production and processing, but it does create problems for the analyst with no technical expertise in palm product production. In our Kano State villages "hura" and "fura" appear to be different names for the same commodity.

The stage of processing or preparation must also be carefully specified whenever data are recorded. The meaning of either a volume or a weight record is unclear unless we know whether grain is on the stalk or on the cob, whether it has been threshed, cleaned, polished, husked, or shelled. We must know whether peppers, onions and fish are fresh or dried, and whether output figures for egusi refer to the weight or number of the fresh melon, or only to the weight or volume of the dried seeds (the only part of the melon used as food).



Furthermore, each stage of processing or preparation must be defined so clearly that the data can be used by an analyst who is not a commodity expert. Phrases that are common to the trade, like paddy rice, rough rice or husk rice, need to be translated for the non-expert if we hope to extract from such records accurate estimates of the nutritional content of rice in these various forms. If estimates of the nutrients available to a household are to be obtained by the disappearance method, the data must be collected in such a fashion that reliable conversion ratios can be established between one stage and another in the process of food preparation or processing.

These considerations hold also for food moving into or out of storage. Sorghum and millet are normally stored in the head, unthreshed, because they last better that way. Rice is normally stored in the husk, and maize on the cob, perhaps with the husks still on. To evaluate the nutrient content of food from storage the analyst must be able to convert quantities in these forms into the equivalent quantities of foods ready for consumption.

When foods have been held in storage for a time still another problem arises. Any work done with respect to the nutrients available from commodities in storage must allow for storage losses. Loss of moisture while a crop is in storage could cause the same volume of food to weight more when it goes into storage than when it comes out, with little effect upon the nutrients contained, but insects, weavils or molds may damage the grain or change its nutritional quality, while rats, mice or birds may consume it. If weavils prefer the germ of a cereal grain, the grain will lose more of its protein content than of its calories. Losses to rodents, weavils and other types of spoilage may reduce the volume as well as the weight of food held in storage.

Quantity Measures

Once the commodity is precisely defined and identified, the next problem is to get an accurate record of the quantity bought or sold. Ideally, we should like to weigh the commodity that changes hands in each transaction. But this is not feasible, for scales are expensive and the weighing process would consume more time than either the respondent or the interviewer could afford to give.

If our data are to consist of respondents' reports of quantities bought and sold, the quantity measures will have to be the local units. In developing countries measures by weight are uncommon. Most commodities are sold by volume or number.

Our object, of course, is to convert these measures into kilograms, for the quantity of any food in kilograms can be converted into its nutritional equivalent by the use of standard food composition tables. Two kinds of problems arise in working with local quantity units. In one case the unit is quite well defined, and reasonably standard throughout the country, so the investigator's problem is largely one of discovering what the proper definition of the standard may be. The other problem, far more difficult to deal with, arises when the unit is not well standardized, when it varies greatly from situation to situation, region to region or place to place.

In Sierra Leone the volume units that were quite well standardized included the tin (a four-gallon kerosene tin) the bushel, the kettle, the three-pence pan (equal to two penny pans), the penny pan and the cigarette cup (or tin). Fortunately there were published definitions for each of these units. But the published definitions need not always be correct. We found conflicting definitions for the cigarette cup, but had access to weighings of cigarette cups of rice, done by the African Rural Employment Marketing Survey, which allowed us to identify the correct definitions. (There are 8 cigarette cups in one threepence pan, five threepence pans to a kettle, and four kettles in a bushel).



But even having accurate conversion ratios among the standard volume measures does not solve all the problems. In Sierra Leone volume measures are based upon the British Imperial System, which differs from that used in the United States. The gallon in Sierra Leone corresponds to the Imperial gallon, but the "pint" contains 11 fluid ounces while the British pint contains 20. The "bottle" (reputed quart) contains 22 or 23 fluid ounces. At 23 ounces to the bottle, there are seven bottles to the gallon, but a published description of the fluid measures gives six reputed quarts to the gallon. [Smith et al., 1979, p. 75.]

With dry measures another problem arises. In Sierra Leone it is the practice to heap up the contents until no more will stay on. Consequently, the "bushel" in Sierra Leone is some 10 percent larger than the Imperial bushel. The percentage excess of the content of a bushel in Sierra Leone varies among commodities, however, because the amount of heaping that is feasible varies with the commodity. To deal with problems of this sort it is necessary to do actual weighings of important quantity units on a commodity by commodity basis, as Peter Matlon did for his study in Kano State [1979].

Other volume measures may exist that are reasonably well standardized, but reliable published statements of volume equivalents may not exist. In Sierra Leone palm oil was sold for the most part in a wide variety of reused bottles, including the small beer (reputed to contain a pint), the large beer (reputed to contain a quart), the baby cham (champaign), and bottles for

Atwood's Bitters, cod liver oil and so forth. Determining the quantities of palm oil sold in such containers requires careful identification of the container used for each transaction and careful measurement of the volume or weight of the product as sold in each type of container that is used frequently.

When a unit is not standardized, things are even more difficult. The principal case where this problem arises is in transactions that are carried out by number or in such units as the pile, heap, package, or piece. Specifying the number of fish purchased does not give accurate information about the quantities of nutrients obtained unless there is some way to identify the size of the fish. Identification of the variety of fish can help, providing information has been collected concerning the average sizes of the different species on sale in the markets. A similar problem arises with almost anything sold by the number, bundle, pile or heap. This includes such items as coconuts, groundnut balls, and many vegetables and fruits. The problem is particularly serious if a root crop like cassava is an important food, because fresh roots, at least in Sierra Leone, are normally sold by the heap or the pile. Accurate quantity data for purchases of leaves, commonly sold by the bundle, will also be difficult to obtain. Sales of meat, sold by the piece, likewise are extremely difficult to convert into weights.

For reasonably accurate conversions into weights from such local units as bundles, sheets, ties, piles, heaps or pieces, it is necessary to spend a considerable amount of money and time during the original survey in making studies in each local area that define the size and weight of each representative unit -- on a commodity by commodity basis. If sources of animal



protein are important, it will be necessary to make sample studies that identify the kinds of pieces sold and establish representative weights for each type.

There will be problems. This work can only be done well by someone who has an excellent understanding of local practices. Also it may be difficult to get permission from traders to weigh representative samples of the commodities sold in such units. Traders may be disinclined to allow someone to weigh and handle the produce who isn't going to buy it.

A similar problem arises with respect to the units in which many of the major farm crops are harvested, sold or stored: the bundle, sheaf, or tie. These units vary among localities, and in any given locality the harvest bundle is likely to differ in size from the storage bundle and that in turn from the bundle in which the commodity is sold. The size of the bundle also varies from commodity to commodity.

## The Survey Period

To understand the relationship between the nutrients available to the rural household and its productive activities, we must estimate food consumption for the entire agricultural year. In semi-subsistence households food comes from two main sources: the market and the household's own production. Market purchases can be determined with an expenditure survey. In principle, data on household expenditures need not be collected for each of the fifty-two weeks in the year if enough is known about consumption patterns within the year to design a sample that represents accurately whatever seasonal variations may occur. If there is a seven-day cycle of spending or consumption, the shortest period for which data should be collected would be the full week. Any sample over time must be designed to represent fairly any periods of holiday, celebration or fasting that occur during the year. In some cases collecting data for one full week out of each month might be sufficient, with each week regarded as a sample for the entire month. That would be far better than collecting data once a month and expecting the respondent to recall his expenditures for the whole month. Even if data are sought for only one week of the month, there should be a minimum of two interviews so spaced that the maximum recall period would be four days within any given week.

Food available for consumption from household production can be estimated with sufficient accuracy for some purposes by the disappearance method: by subtracting sales and other uses of each commodity from the harvest received. This requires complete data on inventories, output, sales, and the use of output for processing, seed, animal feed, and so on, for the whole production year.

The 12-month period most conducive to accurate estimation of the food available for home consumption is therefore likely to be the period from one harvest season to the beginning of the next. If inventories are normally low at the beginning of the harvest season, inaccurate data on quantities in storage have less effect on estimates of consumption from own production when the consuming year extends from harvest to harvest than when any other twelve-month period is used. The harvest-to-harvest income or consumption year is also best from the standpoint of explaining the economic determinants of food consumption or of other expenditures. Income is a major determinant of expenditure; if there is a single harvest period during the calendar year, the harvest received during that period is the primary component of income for the twelve months that follow. Of course if outputs are spread evenly throughout the whole calendar year, the choice of an income year is not important.



Unfortunately, while the twelve-month period beginning with the harvest may be best for a study of food consumption, it is not the best period to use in analyzing agricultural production which is highly seasonal. For a complete listing of the inputs relevant to harvests received, in an agriculture that operates upon an annual cycle, the period should begin with preparation for planting and end with the harvest. Yet if the expenditure data are collected over the same period, pre-harvest expenditures will be determined largely by the income received in the previous production year, but a twelve to thirteen-month survey would give us no information about that. Similarly, food consumed from own production during the pre-harvest portion of the production year consists largely of quantities in storage at the beginning of that year, but accurate data on quantities in storage are extremely difficult to obtain.

For the most accurate determination of production and consumption decisions, unless harvests are spread quite evenly through the year the survey should extend over both the production and consumption (income) years. The production year would be defined as a twelve-month period during which crops would be planted, grown and harvested and the consumption year as the twelve-month period during which the harvests and the income they provide are being consumed or spent. If the complete survey were planned to cover both of these periods, of course, it might well last 18 months or more, depending upon the length of the growing season.

We have mentioned the need for data on stocks in storage to determine what food is being consumed from the previous harvest. Of course, ending inventories will not be the same for every year, so changes in inventories need to be taken into account when using the disappearance method to calculate the quantities of food available from home production. This is especially important in areas where several bad years often occur in a row. Whenever stocks are commonly held in storage for more than one year, however, as in northern Nigeria, knowledge of inventory levels may be crucial to any estimate of food consumption.

Estimates of food consumed (as distinct from food available for consumption) must take account of the fact that some of the food produced may be used for gifts, advanced to other households as loans, or paid out as wages for hired labor. Conversely, households that receive loan repayments or interest in kind, or whose members work for wages received in kind, will have larger quantities of food available for consumption than would be expected simply on the basis of their own production. Incidentally, gifts, loans and wages paid in kind need not come exclusively from household production; goods purchased from the market may also be used for these purposes.

If reliable storage data can be collected, they will be invaluable for the purpose of studying seasonal fluctuations in food consumption and nutrient intake. In many parts of the developing world nutritional intake levels are at their low points for the year during the pre-harvest period. Sometimes these periods of low nutrient availability extend through the whole period of planting and cultivation. Reliable information is scarce concerning such fluctuations in food availability during the year. If the problems associated with getting reliable data about food in storage could be solved, important contributions could be made to our understanding of seasonal patterns of food consumption.



## Household Characteristics

Detailed information on the characteristics of the household members is important for two reasons. (1) The pattern of consumption depends upon age, sex, relationship to the household head, the number of wives (or husbands) of the household head, and other demographic variables. (2) The same characteristics define the amount and types of labor that the household provides from its own members.

Household composition and characteristics data should be collected several times during the year. If members of the household are away at school or temporarily living in the city, they do not contribute to the labor supply, yet the household may be providing part of their consumption needs. Their effect upon the total consumption of the household is likely to be different than had they been living at home. It is important also to know whether household members working for other households are receiving their meals where they work, whether the household is providing meals for the labor that it hires, how many guests are eating with the household at any particular time and what household members may be guests at meals with other households.

## Economic Factors

To understand the economic determinants of household food consumption, we must collect the relevant economic data. These include an inventory of the resources available to the household (land, capital goods, and monetary capital) in addition to the human resources provided by the members of the household itself. One must also have complete information about consumption expenditures: the quantities purchased, the prices paid, and the total expenditure for each item. Our expenditure list must be comprehensive. It should include taxes, fees, and ceremonies. Data are also needed on loans made in kind or in money, on interest payments and on repayments of loans. Furthermore, we need data on how the household uses the time of its members: how much time is devoted to the production of goods and services for sale, gifts or consumption, and how much to other activities, (1) sleeping, eating and leisure or (2) the political, religious, and social activities associated with community life.

Lastly, we must have complete data on the production side of the household's activities, whether that be defined broadly or narrowly. We must also remember that food preparation and other activities associated with child care and maintaining the household are claimants for the time of household members and must not be overlooked when we analyze household activities. Both food and non-food production must be included. We cannot look only at the production of crops to be sold for income, for cash crop production competes with food production for labor and other resources. Indeed, we can scarcely define cash crops precisely, for many of the major crops can be used either for sale or for home consumption. Nor can those interested in the nutrition of the household concentrate upon the production of food crops, for not only do they compete with cash crops for resources and labor but cash crops are an alternative way of providing food: through purchases from the market with the incomes received from crops sold. Analysis of production decisions requires data on inputs purchased as well as upon outputs sold. Labor hired from outside the household may be a crucial input. The extent to which a household is able to use labor not provided by its own members may have a great effect upon the level of consumption obtainable by the members of the household itself.



## The Sample

A sample drawn for the study of household production and consumption patterns must represent all the important production activities and techniques that are available. It must also contain enough households in each income group to permit special analysis of the behavior of households in the low-expenditure brackets. In general, if we are concerned about nutritional problems, we have a special interest in the factors affecting low-income households. A sample just large enough to provide the statistical significance levels desired for the sample as a whole is not likely to be large enough to provide the levels we need for the studies of nutritional problems that affect primarily households in the lower expenditure ranges of the sample.

Finally, designing a stratified sample that provides the information we need about low income households and different productive activities and techniques of production must not cause us to forget that we also have an interest in the characteristics of the population as a whole. Therefore we must collect sufficient data when designing the sample so that we can move from the sample to estimates for the population as a whole.

## Quality

To this point we have been discussing primarily the kinds of information needed. We must not leave our subject without a few suggestions concerning the quality of the data. The reliability of the data will depend heavily upon the quality of the interviewer and his training. Interviewing schedules must allow time enough for every phase of the work, with an adequate margin for things that go wrong. People will move, heads of households will die, and some respondents will be unavailable at the time when the interviewer had planned to see him.

If, despite all planning, the work falls behind schedule, there must be a consistent and clearly stated procedure for choosing what goes undone. The criteria for making such choices must flow from the ultimate purposes of the study. Making wise choices, however, requires not only understanding the most important objectives of the study, but also how the analysis is to be done, and the kinds of data that are essential to carrying out the analysis successfully. If some objectives of the study as originally planned cannot be fulfilled, those that are dropped must be the ones that can be dropped with least damage to the most important purposes of the study.

The interviewing schedule will depend upon the number of visits planned during the year, month or week, and the number of visits will be determined in part by the period of time for which it is reasonable to expect the respondent to have a clear and accurate memory of what has transpired. The shorter the recall period, the more accurate the results, but budgetary limitations usually require compromise between the level of accuracy desired and the expenditure required to obtain it. Our experience with data from Sierra Leone and the three Kano State villages suggests that a recall period not in excess of four days can give useful data with respect to food consumption (although a shorter period would be better), but that expecting householders to remember ordinary consumption expenditures over a period as long as a month yields data sadly deficient in consistency and reliability.

Interviewers who are personally reliable and trustworthy are vital to the success of any survey. The problem of the interviewer who meets his schedule by inventing answers rather than carrying out the interviews as planned is well known. Other problems will arise because the interviewer is not sufficiently accurate in recording the information that he receives,



not quite capable of handling the arithmetic or logical problems involved, or deficient in the patience required to proceed through the full set of questions to be answered. (But we can hardly hold the interviewer responsible if the questionnaire itself is so long and complex as to tax the patience of the respondent as well as the interviewer.)[1]

Close supervision of interviewers, participation by the survey director in the interviewing process, and careful review of questionnaire results as the schedules are turned in can be very effective in maintaining and improving the quality of the interviews. In particular it may be possible to identify interviewers who are falsifying the data and remove or replace them. In other cases where there are questions about the quality of the data being obtained, early analysis of some of the results may be sufficient to isolate the problem and correct it. If interviewer carelessness or dishonesty is involved there may be time to arrange for his removal or replacement.

In general, if data can be checked and edited as the questionnaires come in and the editing process can be carried along almost concurrently with the interviewing process, great benefits can accrue in the form of improved procedures and results. In addition, problems that arise because the data are insufficiently labelled or incorrectly identified may be detected and dealt with while the team is still in the field and the requisite supplementary information can be obtained.

---

[1]This suggests another fundamental issue that has not been discussed here. This paper has been discussing the kinds of information needed for a complete analysis of the consumption choices of a semi-subsistence household. To design questionnaires that would actually elicit all or most of this information from householders of normal patience and tolerance for their inquisitors may be almost more than one could expect to accomplish.

At bottom, the quality of the information is going to depend upon the respondent: his willingness to cooperate, his honesty (particularly when providing information concerning matters that he may feel are best not revealed to people outside the household -- or even to other members of the household itself), and his actual knowledge of the facts. Cooperation may be greater if the interviewer is from the same ethnic group or has the same native tongue as the respondent, of if the leading personages of the village are supporting the survey. But this may not be enough. Respondents may not wish to reveal the full value or amount of the harvest received, for fear that if known to be well off taxes or claims from relatives and others for charitable assistance would increase. Thus it may be necessary to resort to field measures of the output from sample plots in the hope of having a more accurate measure of the major crops -- particularly crops grown for sale -- than could be had by relying only upon the word of the respondent.

A similar question arises with respect to food in storage. In some societies no one but the head of the household is allowed to enter the storage area. Problems could be created for him if the amount of food in storage were known even to the members of his own household. In such cases obtaining accurate information about the quantities of food being stored may be extremely difficult. To let others know that your storage bins were well filled could be extremely awkward during the pre-harvest period when most people's stocks had dropped to very low levels.

Another question to be considered by the student of food consumption and nutrient availability is whether the informant actually possesses the necessary information. If the male head of household is the informant



(often the case) does he actually know what market expenditures for food have been? Or how much rice was pounded, or what was harvested from the vegetable crops grown primarily by the female members of the household? Male informants in Sierra Leone have asserted that even though the housewife does most of the marketing, what she does is reported to her husband and he knows in great detail exactly what prices she paid and what she obtained for her money. Moreover, they say, he knows how much rice was allotted to each wife for cooking on a particular day, because the allotments are his responsibility and he is in charge of the stocks of food in storage. At the same time I have also been told by male informants that each wife may control certain quantities of food that are regarded as essentially hers and that she may set aside some food she is preparing that she plans to give her boyfriend rather than to members of her family. There seems to be a certain contradiction here. Female students of these questions often doubt the completeness and accuracy of the information possessed by the male head of household.

No matter how accurate and reliable the original data may be, the reliability of the results of the study will be affected by the care taken in labelling and defining the original entries and in documenting the procedures by which they were collected, combined, and edited. All the questions we have previously discussed concerning precise identification of the commodity, specifying its form or stage of processing, and so forth, are crucial to giving the analyst a precise understanding of the material with which he is working. Records that might be sufficient for an analyst who took part in the original collection of the data and is thoroughly familiar with all aspects of food production, sales and preparation may be seriously inadequate if the data are to be used by someone less familiar with the data and the institutional aspects of the situation under study or by someone who is using the data for purposes that were not foreseen when the survey was taking place. A similar problem arises with respect to the collection of all data intended for general purpose use. In such cases the analyst requires extremely careful identification and documentation of the material he is to use or he may misinterpret important aspects of the data rather seriously.

## In Conclusion

To collect the information specified here with the degree of care that has been recommended will be extremely expensive, perhaps too expensive except where the results are expected to be of unusual value. As whatever is done must be done within budget limitations, compromises may be required. But if those compromises are made in terms of a well defined set of objectives, and a clear understanding of the problems to be analyzed and the kind of information needed for carrying out the analysis successfully, much can be accomplished even when funds are not sufficient to allow everything the scientist would like in a world in which reliability and precision were costless.

## REFERENCES


Ahn, C.; Singh, I.J.; and Squire, Lyn. 1980. "A Model of An Agricultural Household in a Multicrop Economy, The Case of Korea." Studies in Employment and Rural Development No. 58. Washington, D.C.: Development Policy Staff, World Bank.

Barnum, Howard, and Squire, Lyn. (1979). A Model of an Agricultural Household. Occasional Paper 27. Washington, D.C.: World Bank.

Hay, Roger W. 1978. "The Statistics of Hunger." Food Policy 3: 243-55.

Kolasa, Kathryn M. 1979. "The Nutritional Situation in Sierra Leone." Rural Development Working Paper No. 2. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Krishna, Raj. 1962. "A Note on the Elasticity of the Marketable Surplus of a Subsistence Crop." Indian Journal of Agricultural Economics 17:79-84.

Matlon, Peter J. 1979. "Income Distribution Among Farmers in Northern Nigeria: Empirical Results and Policy Implications." African Rural Economy Paper No. 18. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Mellor, John. 1978. "Food Price Policy and Income Distribution in Low-Income Countries." Economic Development and Cultural Change 27: 1-26.

Pinstaup-Anderson, P., and Caicedo, A. 1978. "The Potential Impact of Changes in Income Distribution on Food Demand and Human Nutrition." American Journal of Agricultural Economics 60:402-415.

Reutlinger, Shlomo, and Selowsky, Marcelo. 1976. Malnutrition and Poverty: Magnitude and Policy Options. World Bank Occasional Paper No. 23. Baltimore, Maryland: The Johns Hopkins University Press.

Sierra Leone. 1978. National Nutrition Survey. With the assistance of the UCLA Nutrition Assessment Unit. Washington, D.C.: Office of Nutrition, Development Support Bureau, United States Agency for International Development.

Smith, Victor E. 1975. Efficient Resource Use for Tropical Nutrition: Nigeria. MSU International Business and Economic Studies. East Lansing, Michigan: Division of Research, Graduate School of Business Administration, Michigan State University.

Smith, Victor E.; Lynch, Sarah; Whelan, William; Strauss, John; and Baker, Doyle. 1979. "Household Food Consumption in Rural Sierra Leone." Rural Development Working Paper No. 7. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Smith, Victor E.; Strauss, John; Schmidt, Peter; and Whelan, William. 1980. "Non-Price Factors Affecting Household Food Consumption in Sierra Leone." Rural Development Working Paper No. 12. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Smith, Victor E.; Strauss, John; and Schmidt, Peter. 1981a. "Single-Equation Estimation of Food Consumption Choices in Rural Sierra Leone." Rural Development Working Paper No. 13. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Smith, Victor E.; Strauss, John; Trechter, David; Whelan, William; Schmidt, Peter; and Stapleton, James. 1981b. "Food Flows and Simulations: Rural Sierra Leone." Rual Development Working Paper No. 19. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Smith, Victor E.; Whelan, William; and Schmidt, Peter. 1982. "Food Consumption Behavior in Three Villages of Northern Nigeria." Rural Development Working Paper No. 19. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Snodgrass, Milton, et al. 1980. Agricultural Sector Assessment Report for Sierra Leone. Logan, Utah: Consortium for International Development.

Spencer, Dunstan S. C., and Byerlee, Derek. 1977. "Small Farms in West Africa: A Descriptive Analysis of Employment, Incomes and Productivity in Sierra Leone." African Rural Economy Working Paper No. 19. East Lansing Michigan: Department of Agricultural Economics, Michgian State University.

Spencer, Dunstan S. C.; Byerlee, Derek; and Franzel, Steven, 1979. "Annual Costs, Returns, and Seasonal Labor Requirements for Selected Farm and Nonfarm Enterprises in Rural Sierra Leone." African Rural Economy Working Paper No. 27. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Strauss, John. 1981. "Determinants of Food Consumption in Rural Sierra Leone: Estimation of a Household-Firm Model with Application of the Quadratic Expenditure System." Unpublished Ph.D. dissertation. East Lansing, Michigan: Michigan State University.

Strauss, John; Smith Victor; and Schmidt, Peter. 1981a. "Determinants of Food Consumption in Rural Sierra Leone: Application of the Quadratic Expenditure system to the Consumption-Leisure Component of a Household-Firm Model." Rural Development Working Paper No. 14. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.

Strauss, John; Smith, Victor; Schmidt, Peter; and Whelan, William. 1981b. "Joint Determination of Food Consumption and Production in Rural Sierra Leone: Estimates of a Household-Firm Model." Rural Development Working Paper No. 17. East Lansing, Michigan: Department of Agricultural Economics, Michigan State University.





Timmer, C. Peter. 1978. "The Impact of Price Policy on Protein-Calorie Intake." (Mimeographed.)

United Nations. Food and Agriculture Organization. 1980. The State of Food and Agriculture 1979. Rome: Food and Agriculture Organization.

Whelan, William. 1982. "Determinants of Food and Calorie Consumption for Farm Households in the North of Nigeria." Unpublished Ph.D. dissertation. East Lansing, Michigan: Michigan State University.

Yotopoulos, Pan; Lau, Lawrence; and Lin, Wuu-Long. 1976. "Microeconomic Output Supply and Factor Demand Functions in the Agriculture of the Province of Taiwan." American Journal of Agricultural Economics 58:333-340.

## MSU RURAL DEVELOPMENT PAPERS

RDP No. 1 Akhter Hameed Khan, "Ten Decades of Rural Development: Lessons from India," 1978.

RDP No. 2 Lane E. Holdcroft, "The Rise and Fall of Community Development in Developing Countries, 1950-1965: A Critical Analysis and an Annotated Bibliography," 1978.

*RDP No. 3 James E. Kocher and Beverly Fleisher, "A Bibliography on Rural Development in Tanzania," 1979.

RDP No. 4 Enyinna Chuta and Carl Liedholm, "Rural Non-Farm Employment: A Review of the State of the Art," 1979.

*RDP No. 5 David W. Norman, "The Farming Systems Approach: Relevancy for the Small Farmer," 1980.

RDP No. 6 Elon H. Gilbert, David W. Norman and Fred E. Winch, "Farming Systems Research: A Critical Appraisal," 1980.

## MSU RURAL DEVELOPMENT WORKING PAPERS

*RDWP No. 1 Benedict Stavis, "Turning Point in China's Agricultural Policy," 1979.

*RDWP No. 2 Kathryn M. Kolasa, "The Nutritional Situation in Sierra Leone," 1979.

RDWP No. 3 Benedict Stavis, "Agricultural Extension for Small Farmers," 1979.

*RDWP No. 4 Steve Haggblade, Jacques Defay, and Bob Pitman, "Small Manufacturing and Repair Enterprises in Haiti: Survey Results," 1979.

RDWP No. 5 Peter Riley and Michael T. Weber, "Food and Agricultural Marketing in Developing Countries: An Annotated Bibliography of Doctoral Research in the Social Sciences, 1969-79," 1979.

RDWP No. 6 Harold M. Riley and Michael T. Weber, "Marketing in Developing Countries," 1979.

*RDWP No. 7 Victor E. Smith, Sarah Lynch, William Whelan, John Strauss and Doyle Baker, "Household Food Consumption in Rural Sierra Leone," 1979.

*RDWP No. 8 Omar Davies, Yacob Fisseha and Claremont Kirton, "The Small-Scale Non-Farm Sector in Jamaica: Initial Survey Results," 1980.

RDWP No. 9 John Hatch, "A Record-Keeping System for Rural Households," 1980.

RDWP No. 10 Sarah G. Lynch, "An Analysis of Interview Frequency and Reference Period in Rural Consumption Expenditure Surveys: A Case Study Sierra Leone," 1980.

*RDWP No. 11 John Holtzman, John Staatz, and Michael T. Weber, "An Analysis of the Livestock Production and Marketing Subsystem in the Northwest Province of Cameroon," 1980.

RDWP No. 12 Victor E. Smith, John Strauss, Peter Schmidt and William Whelan, "Non-Price Factors Affecting Household Food Consumption in Sierra Leone," 1980.

*RDWP No. 13 Victor E. Smith, John Strauss and Peter Schmidt, "Single-Equation Estimation of Food Consumption Choices in Rural Sierra Leone," 1981.

*RDWP No. 14 John Strauss, Victor Smith and Peter Schmidt, "Determinants of Food Consumption in Rural Sierra Leone: Application of the Quadratic Expenditure System to the Consumption-Leisure Component of a Household-Firm Model," 1981.

*RDWP No. 15 Middleton Wilson, "Some Problems in Operating a Loan Program for Craft and Emerging Small-Scale Non-Farm Enterprises in Jamaica," 1981.

*RDWP No. 16 Yacob Fisseha and Omar Davies, "The Small-Scale Manufacturing Enterprises in Jamaica: Socioeconomic Characteristics and Constraints," 1981

*RDWP No. 17 John Strauss, Victor E. Smith, Peter Schmidt and William Whelan, "Joint Determination of Food Consumption and Production in Rural Sierra Leone: Estimates of a Household-Firm Model," 1981.

RDWP No. 18 Tom Zalla, David J. Campbell, John Holtzman, Larry Lev and David Trechter, "Agricultural Production Potential in the Mandara Mountains in Northern Cameroon," 1981.

*RDWP No. 19 Victor E. Smith, John Strauss, David Trechter, William Whelan, Peter Schmidt and James Stapleton, "Food Flows and Simulations: Rural Sierra Leone," 1981.

*RDWP No. 20 Peter Kilby, "Small Scale Industry in Kenya," 1981.

*RDWP No. 21 Larry Lev, "The Effect of Cash Cropping on Food Consumption Adequacy Among the Meru of Northern Tanzania," 1981.

*RDWP No. 22 Victor E. Smith, William Whelan and Peter Schmidt, "Food Consumption Behavior in Three Villages of Northern Nigeria," 1982.

RDWP No. 23 Mahmoud Badr, et al., "Small Scale Enterprises in Egypt: Fayoum and Kalyubiya Governorates Phase I Survey Results," 1982.

RDWP No. 24 Victor E. Smith, John Strauss, William Whelan, David Trechter and Peter Schmidt, "Food Consumption Behavior: Rural Sierra Leone and Kano State, Nigeria," 1982.

---

*Out of Print.