THESIS

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DETERMINANTS OF FOOD AND CALORIE CONSUMPTION
FOR FARM HOUSEHOLDS IN THE NORTH OF NIGERIA

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DETERMINANTS OF FOOD AND CALORIE CONSUMPTION FOR FARM HOUSEHOLDS IN THE NORTH OF NIGERIA

By

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ABSTRACT

DETERMINANTS OF FOOD AND CALORIE CONSUMPTION FOR FARM HOUSEHOLDS IN THE NORTH OF NIGERIA

By

William Paul Whelan

This study of 133 semi-subsistence farm households in three villages in Kano State, Nigeria, attempts to understand the determinants of food consumption in households which can either grow the food they consume, purchase it from the market, or receive it from several other off-farm non-market sources, particularly as gifts, loans or wages paid in-kind. Single equation total consumption regressions are estimated for nine food commodities and calories. A singular system which disaggregates sorghum consumption by food consumption source is also estimated. Own-price, cross-price and income elasticities are calculated for the nine commodities as well as for calories.

The findings show that sorghum and millet are the major sources of calories, that home production is the primary source of their consumption, and that most of what is produced of these foods is consumed. Estimates of calorie consumption by income strata reveal that the lower income households consume inadequate amounts of food to meet recommended levels of caloric intake. An analysis of household calorie consumption reveals that low income households experience a drop in calorie consumption in response to higher incomes, whereas calorie consumption rises in middle and high income strata households. The total sorghum regression analysis reveals that a greater cash production orientation is associated with lower levels of sorghum consumption. There is, however, no basis for concluding that an increased cash production orientation leads to a lower consumption of individual cereals, even though the total consumption of calories falls. The importance of the source is revealed in the singular system analysis which shows that total sorghum consumption falls in response to a greater cash production orientation because the households consume less sorghum out of own production. This suggests that as resources shift primarily from the production of food crops to cash crops, consumption of those food crops falls because less of those crops are produced. Own-price elasticities calculated from sorghum and early millet single equation regressions reveal that higher own-prices result in supply increases which more than offset increased demand for these commodities by the farm household. Several implications for policy are discussed.

To Pam

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so if we knew the economics of being poor,
we would know much of the economics that
really matters."

T. W. Schultz
Nobel Lecture
December 8, 1979

CHAPTER I

INTRODUCTION

Statement of the Problem

In recent years the World Bank and other development agencies have given explicit attention to meeting the basic needs of the world's population. Of these basic needs food is perhaps the most essential. There is no reason to assume, however, that the process of economic development will automatically ensure that this basic food need is achieved. The possibility exists that the economic development process could lead to degenerating food consumption and nutrition levels if deliberate attention is not paid to the consequences of economic development upon consumption and nutrition (Smith, 1975).[1] Some researchers contend that malnutrition itself is unlikely to disappear during the normal course of development unless policies are deliberately designed to reallocate food or income (Reutlinger and Selowsky, 1976). However, economic policies adopted with non-nutritional objectives often have a greater impact upon nutrition in the aggregate than do policies explicitly intended to affect nutritional levels (Smith, 1977). Little is known about the effects of non-nutrition specific economic policies upon the nutritional levels of rural households and, as Taylor has

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[1]The replacement of grain legumes by new "green revolution" high yielding varieties of wheat in India is a case in point (Berg, 1973).

pointed out, a fruitful research endeavor would be the "delineation of the linkages between the nutritional status of specific groups within the economy and government policies intended to influence various other economic variables" (1977, p. 41).

A primary interest of this study, therefore, is the effect that income and price changes have upon the consumption of foods and calories by rural households, since prices and income changes are the most likely result of the economic development process. If policy makers are aware of the negative impacts of specific price and income changes upon the food and calorie consumption levels of rural households, then specific target-oriented programs can be designed to offset these impacts. These targeted programs can be cost effective if policy makers are able to identify to what extent the food intake level of identifiable groups are adversely affected by outcomes which are either the intended or unintended results of specific economic policies.

For example, if raising the level of rural incomes is an explicit economic policy objective that is achieved, then it is clear that the government is not likely to abandon this policy even if certain groups do not respond to income increases in such a way that their levels of food consumption and nutritional well-being are improved. Although normal Engel relationships are expected for most foods in rural settings in which increased incomes result in increased food consumption, that relationship may not necessarily occur for energy and other nutrients if some substitution in the diet occurs. Whatever the effect of income increases upon food intake and nutritional well-being, it is important to determine if the need exists for targeted food and nutrition programs as governments follow policies which address major economic problems.

If identifiable groups of rural households are adversely affected by economic policies which the government views as successful, then the array of programs which it might adopt to offset this negative effect does not have to be group-specific. It might be advisable to identify several approaches other than direct food and/or nutrition interventions as possible ways of reversing the food consumption effects upon those households which experience lower levels of food and nutrient intake.

The need to identify the consumption effects of economic policy can be best understood in the broader context of an economy faced with rapid rates of rural-urban migration due, perhaps, to low rates of growth in food production and rural incomes as well as to a prevailing lack of amenities in rural areas. In particular, the Nigerian agricultural sector in which this research is carried out can be characterized as having a falling rate of growth of food production. The concern that government policy makers have about unprecedented rates of rural-urban migration is apparent in, for example, a recent Wall Street Journal article entitled "Who Will Farm? A Nigerian Dilemma" (Wall Street Journal, October 15, 1980). As the article's title should suggest, the association between the rapid increase in oil wealth and the drastic reduction in agricultural production levels from much higher rates enjoyed during pre-oil boom days has hardly gone unnoticed by these policy makers and planners. If these policy makers and planners make agriculture more attractive to small-scale Nigerian farmers, then the two serious problems of lagging food production and rapid rural-urban migration can perhaps be dealt with simultaneously. One way of making small-scale agriculture more attractive is to ensure that small-scale farming is sufficiently productive that adequate levels of food consumption are obtained by farm households. It is in this milieu that the food and calorie consumption of farm families and the effect of economic policies upon food and calorie consumption in rural Northern Nigeria are viewed as having particular importance.

Objectives of the Research

The specific objectives of this study can be classified as descriptive, methodological and behavioral.

The first objective, namely descriptive, is established so that scholars, policy makers and other interested individuals can gain a better understanding of some broad indicators of food consumption in rural Northern Nigeria. Of particular interest is the relative importance of different foods in the diet both in terms of quantities consumed and number of consuming households. There are two other interesting and important descriptive items which are examined on a food by food basis in this rural consumption study, namely the mean percentage of consumption retained from own production and the mean percentage of production available for consumption. The description of these food consumption characteristics which typify rural households in Northern Nigeria will be discussed in Chapter V.

The second set of objectives which can be viewed as being methodological are of two sorts, one which deals with the utilization of the available data and the other which deals with the econometric techniques used to analyze these data.

The first methodological set of objectives is to take sample survey data not collected specifically for this study and render it suitable for examining the food and calorie consumption of sample households.

The attainment of this objective can be gauged by examining the extent to which economically meaningful results are obtained from this study.

The other set of methodological objectives pertain to gaining additional insights into the food consumption process of rural households by analyzing consumption according to the source through which food enters the household. The estimation of food consumption separated by source will represent an attempt to uncover relationships which an aggregate measure of total household consumption of individual foods conceals. Where both market and non-market food sources are available, increases in income and relative prices may have significantly different effects upon the consumption of foods from different sources. If this happens to be the case, then policy makers interested in raising the level of living of rural farm households will be better able to design policies which allocate development resources in such a way as to ensure that food consumption needs are attained by rural farm households. This estimation will be made by using a singular system of equations dealing with the consumption of the most important food in the diet and will follow the aggregate single equation food and calorie consumption regressions which will receive the major analytical emphasis in the study.

The single equation food commodity and calorie consumption regressions of Chapters VII and IX receive the major emphasis of the study because of the behavioral insights which they offer. The regression analysis employed is intended for the purpose of accomplishing the third set of objectives of the study, namely that of achieving a better understanding of the behavioral factors which influence the food consumption patterns of semi-subsistence rural households. The importance of real income, relative prices and household characteristics as factors influencing the consumption of different foods is to be determined, as well as the importance of variables denoting the primary source through which the household obtains its food and the extent to which the producing household's production orientation either towards the market or domestic consumption is associated with levels of household food and calorie consumption.

What ties these three sets of objectives together is the fact that the production, marketing and consumption activities of semi-subsistence rural households are so interrelated that any attempt to understand consumption behavior without considering to some extent the household's production and marketing activities will result in obtaining only an inadequate understanding.

Hypotheses

This research will test the hypotheses that certain exogenous factors are linearly related in household consumption to the quantity of nine individual food commodities and to total calories. Among the exogenous factors to be included are price, household size and composition, household characteristics, source of food and marketing orientation. The model which is derived for empirical analysis also tests the hypothesis that real income is non-linearly related to the consumption of the non-foods and calories. This non-linear relationship is hypothesized to be positive except for those foods which are believed to be inferior, most notably sorghum. The hypotheses associated with each of these other non-income factors deserves some explanation at this point.

Economic theory suggests that the price of a good is inversely related to the quantity demanded of a good and that it is directly related to the quantity supplied. In demand studies or production studies where the demand or supply functions can be identified, theory provides some practical guidance for the researcher. However, complications arise when studying the consumption behavior of rural households in low-income countries if the household both produces and purchases the food. This is so because these households respond to price increases (decreases) by making adjustments both in their retail market demand for food and in their food supply activities. In essence theory does not provide any guidance as to whether the net effect that price changes have upon the consumption levels of these individual foods is positive or negative. The hypotheses of interest that will be examined is that the consumption of foods which are primarily home produced will increase as the real price of that food increases. This hypothesis is based upon the belief that the increase in production which results from increases in product prices will result in increases in both the amount of the food sold and the amount of the food consumed.

The hypothesis that household size is linearly related to the household consumption of different foods is suggested by the fact that certain household members produce income in cash or in kind (e.g., food) and they also demand food. Inclusion of age and sex-specific household composition variables in the analysis, permits testing the hypothesis that households as a unit consume more food. Conversely, the companion hypothesis is that households with larger proportions of non-working dependents are those households which experience lower household consumption levels.

Several household characteristic variables are believed to influence the level of consumption of certain foods by rural households. In particular, household type, tribal affiliation, age of the household head, and whether the household head is literate.

One of the most interesting hypotheses of this study is whether the consumption of a food by rural households is influenced by the degree to which the household organizes its overall production pattern either primarily for sale to the market or for subsistence consumption purposes. The hypothesis is important because it tests to what extent the consumption of individual foods is influenced by the production activities of the household. Moreover, it permits testing whether the household consumption of food items which are primarily purchased from the market is positively associated with an agricultural production orientation geared primarily for the market and conversely, whether the consumption of foods which are primarily produced for home consumption are negatively associated with a production orientation towards the market.

Another important hypothesis will be tested by using a singular system of sorghum consumption equations representing the three primary sources of food consumption, namely home production, the retail market and in-kind receipts. The hypothesis which will be tested for sorghum consuming households is that the total reduction in consumption which is associated with an agricultural production pattern geared primarily towards farm sales occurs through a reduction in the consumption out of own production and not through a reduction in consumption either through market purchases or in-kind receipts.

Thesis Organization

The thesis is organized first to provide in Chapter II the necessary background about the production and consumption setting in Northern

Nigeria. A theoretical model is then developed in Chapter II which will be used to examine the consumption patterns of Northern Nigeria households for nine foods as well as for total calories. A discussion of the data sets used in the analysis as well as the specific assumptions required for the analysis then follows in Chapter IV.

The descriptive results in Chapter V start with a discussion of consumption characteristics of the sample households and include an initial examination of the relationship of income to the total consumption of calories. The single-equation food commodity analysis is treated in Chapter VII, after some preliminary discussion in Chapter VI about the analytical procedure followed and variables used. The consumption of sorghum, the most important food in the diet, is then examined by food source in Chapter VIII in the attempt to identify a method by which food consumption in rural settings can be better understood. The final empirical Chapter uses regression analysis to analyze the influence of income and other factors upon one measure of household nutritional welfare, namely total caloric consumption. The results which pertain to the relationship of income to the consumption of calories are then compared with the descriptive evidence about this relationship presented in Chapter V.

CHAPTER II

THE PRODUCTION AND CONSUMPTION SETTING IN NORTHERN NIGERIA

This chapter will discuss some of the general factors which influence the production and consumption environment in the rural areas of Northern Nigeria. After background information pertaining to agricultural production activities is discussed, I will focus my attention upon the consumption environment. Some inferences will then be drawn about the extent to which individuals living within rural areas experience general levels of good nutrition and good health.

Production Environment

The Physical Setting

The study survey was carried out in the Guinea-Savannah ecological zone of Northern Nigeria in Kano State. The area averages 35 inches of rainfall a year. Because of the low level and year-to-year variation in rainfall patterns, agricultural production is significantly curtailed. Rainfall occurs in a unimodal rainy season of about 120 days from May to September. In the 1974-75 agricultural year about 35 inches of rain fell during the period of late April through late September (Matlon, 1977, pp. 26-27).

Farming Systems

The level and variability of rainfall is a constraint upon agricultural production in the Kano State area. Traditional farming systems throughout this semi-arid region have evolved in order to minimize losses caused either by low levels of precipitation, uncertain dates of onset and termination of the rains, and uneven rainfall distribution within the rainy season. Millets and sorghums are the two principal cereal crops grown in the area and are most often grown in mixed fields with millet giving insurance against poor rains. Because it has the lowest moisture requirements of all the staple food crops of West Africa, it does not require irrigation (Annegers, 1972, p. 26). Annegers points out that the most significant characteristic which differentiates the many varieties of millet (Pennisetum spp.) is the maturation time. Early millet matures in 60 to 90 days and requires only 300-600 mm of rainfall, whereas late varieties of millet have longer vegetative cycles of 90 to 150 days.

Another important factor which might account for the widespread popularity of millet is its favorable long-term storage properties where such properties of a dietary staple are often necessary to ensure survival in areas with unpredictable rainfall (Morgan, 1959, p. 64). There are two Nigerian storage practices for millet (and sorghum) which allow either short-term or long-run (three to six years) storage (IDRC, p. 17). On the other hand, sorghum (Sorghum spp.), also known as Guinea Corn, requires somewhat more moisture with most of its varieties requiring 600 to 1,200 mm of rainfall and maturing in 80 to 180 days (Annegers, 1972, p. 26). Cowpeas are also an important food crop produced in the

Table 2-1
Characteristics of the Principal Mixture Types Identified as Important or Representative (Small Sample)*

Mixture	Total Hectares	Number of Fields	Crop Proportions				
			Early Millet	Other Grains	B	C	E
A11	6.87	14					
A12	6.15	7					
A1/B	3.42	8	.13	.28	.58	-	.01
A2/B	7.21	10	-	.51	.48	-	-
A1/C	15.76	16	.18	.71	-	.10	.01
A1/B/C	12.75	14	.12	.36	.44	.08	-
A2/B/C	7.15	9	-	.38	.55	.06	-
Sorghum	1.30	4					
Onion/Pepper	.58	4					
Sugar Cane	2.27	7					
Sub-Total	63.46	93					
All Other	56.73	111					
TOTAL	120.19	204					

Crop Group	Includes
A11	sorghums and millets with <u>more</u> than 20 percent of harvest value in early millet
A12	sorghums and millets with <u>less</u> than 20 percent of harvest value in early millet
B	groundnuts and bambara nuts
C	cowpeas
E	vegetables

Mixture Type	
A1/B	sorghum, millet (inc. early millet), groundnuts
A2/B	sorghum, late millet, groundnuts
A1/C	sorghum, millet (inc. early millet), cowpeas
A1/B/C	sorghum, millets, groundnuts, cowpeas
A2/B/C	sorghum, late millet, groundnuts, cowpeas

*Adapted from Table III-3 and III-4 Crawford, 1980, pp. 48-49, 52-53.

area and are at times intercropped with sorghum and millet. Crawford (1980) has studied the pattern of intercropping which exists in the area for the small sample of this study and identifies ten important and/or representative crop mixtures, some of which contain cowpeas but most of which contain sorghum and millet (Table 2-1). Groundnuts, the principal cash crop in terms of income earned, competes with the principal staple food crops for the available upland soil (tudu), which accounts for over 95 percent of the total land area of the Guinea Savannah zone. Other important cash crops, namely onions, peppers and sugar cane, are grown on the alluvial lowland soils (fadama) which can support dryland farming wihtout supplementary irrigation (Matlon, 1977, p. 28). Farm households in this area generally intercrop on upland soils using traditional production techniques (i.e., hoe cultivation) and have diversified agricultural production strategies which fit well into an environment in which agricultural risks and uncertainties abound. The lack of soil conservation practices appear to be an exception, however.[1]

The Agricultural Calendar

The 52-week agricultural cycle can be conveniently broken down into four phases: the land clearing, preparation and first planting phase, the second planting, weeding and ridging, a long harvest period and finally, a slack period prior to the beginning of the new cycle.[2] The typical agricultural year begins with land clearing and field preparation

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[1]Matlon (1977, p. 30) cites the fact that 80.3 percent of all households surveyed in his sample had had no fallowing period for their land since the time of field acquisition.

[2]The description which follows is based primarily upon Matlon (1978, p. 27). Simmons (1976a, pp. 23-24) gives a slightly different description.

in mid-February with manure hauling and the first planting occurring during April. The prevailing practice of planting early millet is intended to capture any early onset of rain which might occur. This initial period is followed by a more labor-intensive period in which labor demands are at their peak. During this period, which lasts from mid-May until sometime in August, most of the ridging and weeding occurs along with a second planting which makes use of the available rains which fall during this period. In August the early millet harvests begin with the harvests of onions, maize and rice also occurring thereafter. The rain customarily lasts until sometime in September; other crops are weeded during this period. Farm work begins to drop off and the harvesting of groundnuts, rice, peppers and vegetables begins. By late December the harvest of sorghum, sweet potatoes and sugar cane is carried out. The early months of the following calendar year are characterized as non-farming months during which time later crop sales occur. This period lasts until the beginning of the following agricultural year at which time the agricultural cycle repeats itself with some variation depending upon the nature of the subsequent agricultural year's rainfall pattern.

Data that were collected for this analysis covered the May, 1974 through May, 1975 period as was stated earlier. In view of the description given above, the survey period does not cover adequately the amount of food available from harvest to harvest but instead covers the amount available for the priod from first planting to first planting. This necessitates making the assumption that data covering one complete agricultural production year can be treated as representative of one complete consumption year, even though the data were not explicitly collected to cover one complete consumption year. These assumptions will be clarified in Chapter IV and should be kept in mind in interpreting the results of the analysis to follow.

Seasonal Food Availability and Disease Incidence

Hungry Season

Many areas of Western Africa reportedly experience a period of severe pre-harvest calorie and protein shortfall commonly referred to as the "hungry season". Conflicting evidence about the existence of such a phenomenon in Northern Nigeria exists. Early work in the area does not refer to seasonal hunger as being a prevalent feature among the Hausa (McCulloch, 1929). Nicol (1959a, p. 304) refers to a hungry period in his extensive study, although he provided no empirical evidence which could associate different food intake levels with different seasons of the year. He indicated that weight losses occurred after the "post harvest" period, although he did not specify whether this period occurred after the early millet harvest (August) or after the later harvest of sorghum (December). Uchendu states that seasonal food shortage or food hunger is common in this Guinea-Savannah zone of West Africa (Uchendu, 1977, p. 9), yet Simmons (1976a, p. 23-24) concluded that the classic hungry period (June/July) for the region which she studied showed no strong indication that caloric intakes dropped sharply in this period. Chambers, et al., state that the hungry season is less marked in the Zaria area of Northern Nigeria than it is in other areas of West Africa (e.g., Gambia) and say that "seasonal labor peaks (of the "hungry season") are met by higher calorie intake for the family as a unit" (1979, p. 7).

Much of the discussion about the existence of non-existence of a hungry season in Northern Nigeria is the result of the lack of precision as to an agreed upon definition of "hungry season" as well as the lack of a broad range of information that would be required in order to establish its existence. From my brief survey of the literature on this subject, the several important observations which can be made are, first, that there exists some evidence, although inconclusive, that a hungry season does occur in Northern Nigeria; and second, the evidence used to argue one way or another is insufficient to establish a good case either way.

Diseases

One of the most important problems adversely affecting health and nutrition in Northern Nigeria is the lack of a clean year-round water supply (Longhurst, 1979, p. 15). Other important health problems occur at the time when agricultural activity is at its peak during the so-called rainy season which usually lasts from May until September. During this heavy agricultural work period, food is apt to be in short supply because it coincides with the pre-harvest period (hungry season). The wet season brings an upsurge in the incidence of vector-borne diseases, which combined with lower levels of food intake, increase the probability of contracting infectious diseases as well. Chambers, et al. point out that "There is a distinct wet season peak in malaria, measles, diarrhea and guinea worm, coinciding with the times of highest labor demand, which is in June/July" (1979, p. 7), and Matlon mentions the presence of guinea worm in the study area. Longhurst concludes that "The background noise of infection, poor hygiene and disease, particularly malaria, is still so great as to neutralize the favorable food production aspects (of the area)" (1979, p. 15). It can safely be concluded that diseases, particularly those which occur in the rainy season, constitute a major impediment to increased agricultural output in the area and therefore to improved levels of consumption.

The Overall Health Picture

Children appear to be the most vulnerable to dietary inadequacies and disease. There is evidence that food consumption relative to requirements is lowest among children. Nicol found a shortage of calories, Vitamin A, Vitamin C and riboflavin among the children whom he studied. Tomkins, et al., (1978, p. 239) show that a high incidence of protein-energy malnutrition was found in a survey of preschool children among whom gastro-enteritis is common. Some evidence supports the view that marasmus, a nutritional disease caused by insufficient protein and calorie intake, is the predominant form of protein-energy malnutrition in Northern Nigeria (Dema, 1965, p. 35; Nicol, 1959a, p. 305 and 1959b, p. 311; Tomkins, et al., 1978, pp. 240-241). Thomson cites seasonal factors as explaining both protein and calorie shortfalls. Tomkins, et al. cite contamination of food and food vessels as well as the contamination of water as reasons for childhood malnutrition. These authors point out that the consequent "wasting" of individuals who have contracted bacterial infections from the above mentioned sources serves to explain an observed condition not associated with protein intake inadequacy. They also document the existence of stunting as an indicator of kwashiorkor, a nutritional disease caused by insufficient protein intake, and attribute it to infant feeding practices of many rural Hausa parents who follow "the customary twice daily feeding of infants with dilute 'pap' . . . unlikely to achieve energy or protein requirements" (1978, p. 242). This most recent finding corroborates the earlier view expressed by Nicol that "the parents in most of rural Nigeria do not realize the (food) needs of growing children" (Nicol, 1959a, p. 305).

In addition to dietary inadequacies, the very young are also the ones most likely to be susceptible to measles and other gastrointestinal disorders. To the extent that disease and low levels of food availability occur concurrently, the children experience a synergistic assault upon their health which is more severe than the sum of the two effects if they were to occur separately.

Although other age and sec groups are apt to fare better than the very young, the scarce information available seems to indicate that others are also affected to some extent by whatever annual and seasonal fluctuations in food availability occur. Moreover, to the extent that they are exposed to bacterial, viral and parasitic diseases, they too can experience the devastating combination of malnutrition and infection, affecting appetite, nutrient utilization and the quantity and quality of work performance.

Roles of Men and Women Which Influence Food Production and Consumption

Food consumption at the household level is influenced by a number of important factors. First, there is the obvious decision about whether to plant crops or not; if so, which ones, in what mixture, and where and when to do so. If a decision is made not to engage in agricultural pursuits at the household level, the matters of where, when and to whom to sell own labor or non-agricultural home products are crucial. Secondly, decisions have to be made regarding the disposal of whatever agricultural output is produced, in particular, to what extent to consume foods produced by the household or to purchase food from the market. If effective policy measures are to be developed, it is important to identify the household members primarily responsible for each set of decisions which influence food consumption.

The Male Head of Household

Men exercise the major decision-making role on all agricultural matters, and also in the determination of what foods are withdrawn from the granary and purchased from the market. Male heads of households in Northern Nigeria "are largely responsible for the care and maintenance of the household" (Simmons, 1976c, p. 6). Although men "function largely as producers and traders of agricultural raw materials, . . . shopping for cooking ingredients is (also) the men's responsibilities" and was "reportedly done by the head of the household" in two of the three villages Simmons studied (Ibid., pp. 4, 11). Husbands have control over the granary ahd husbands may or may not share some of this control with their wives (Bivens, 1980). This responsibility is frequently given to a brother or a son (Simmons, 1976a, p. 4). The husband has the authority to delegate how much should be removed from the granary for meal preparation. He might not know the respective size of serving of each of the household members, since it is not customary for household members to eat together at the same time. If the husband is aware that a certain individual within the household is receiving inadequate food, he has the discretion to allocate some of his own serving to such a person or persons. According to Bivens (1980), this intra-household food distribution mechanism does not necessarily operate in all households.

Women

Women's activities relate to food consumption in a variety of ways. Some women participate in agricultural production activities to a very limited extent and some are engaged in entrepreneurial activities. Most wives have food preparation and allocation responsibilities within the household and some exercise some control over the household's granary. Older adult females might also purchase food for the family.

Women do not participate in most agricultural field activities in this predominantly Moslem society. Agriculture provides "a limited amount of work for some women who may assist in the cotton, groundnut, pepper and cowpeas harvest, if their husbands allow them to go out at these times (Simmons, 1976c, p. 10), and as Crawford points out, women engage in groundnut picking, which is "socially approved" (Crawford, 1980, p. 74).[3] Using Matlon's small sample data he points out "females supply only about 7 percent of the total agricultural on-farm family labor input" (Ibid., p. 74). Table 2-2 gives Crawford's breakdown of the average number of hours worked per person, by age and sex categories, in agricultural field activities. Although Simmons advances the notion that "harvest work is usually done by the poorer women in the community,

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[3]Other studies suggest that picking peppers, groundnuts and cowpeas are types of farm work most commonly done by female adults. See for example: David Norman, 1972 "An Economic Survey of Three Villages in Zaria Province" Samaru Miscellaneous Paper, No. 37, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

Table 2-2

Annual Family Labor Hours Worked per Person by Age-Sex Category and Income Group[a]

Age-Sex Category	Hours Worked per Person by Income Class[b]			Total Hours	% of Total	Overall Avg. Hours per Person
	Poor	Average	Rich			
Child 0-9	13	18	38	1,501	2.7	21
Boy 10-15	289	256	335	5,830	10.6	307
Girl 10-15	23	10	39	372	.7	21
Man 16-49	430	824	662	34,258	62.5	634
Woman 16-49	21	50	50	3,038	5.5	42
Old Man 50+	710	758	694	9,377	17.1	721
Old Woman 50+	12	3	91	444	.8	32
TOTAL				54,780	100.0	

[a]Actual hours worked in farming and exclusive of household work (unadjusted by man-hour equivalents).

[b]Poor, average, and rich are defined as the bottom, middle and top thirds of the income distribution, respectively.

Source: Crawford, 1980, p. 75.

or by those older women who are generally not so restricted to the compound" (Simmons, 1976c, p. 10), the data available from the Kano area study depicted in Table 2-2 show exactly the opposite situation with the older women working less on the average than younger women and women from richer households working on the average more than women from poorer households. Konan's study states that "forty-six percent of farmers indicate that their wives help with these particular (picking) farming tasks" and that "wives of farmers are more likely to help with farm work than wives of men in other occupational groups" (Konan, 1975, pp. 18-19). One can safely conclude from this and other evidence that although women are active in agricultural field activities to some extent, they neither play an important role in these activities nor do they appear to have a major responsibility for the farm-firm dicisions which are made.

However, women do have a significant impact upon food consumption in three very important ways. First, they influence consumption by engaging in food marketing activities as profit-seeking entrepreneurs who use these profits to meet personal food and non-food needs and wants. Seond, they are instrumental in determining the allocation of the food made available by the husband to the household at large. Third, some women may provide a critical link with the food market. I will examine some of the existing evidence to try to gauge the potential importance of each of these factors upon the nutritional levels of members of the rural community in this three village study.

Perhaps the most important of all female enterprises is the commercial processing and distribution of food products. Women purchase the inputs, most notably the raw ingredients of the food item to be prepared, either from a market or from their husbands. The income generated from the sales of these items belongs to the women. The disposal of that income is not only within their control but men have little or no knowledge about this privileged information. The income can either be saved, used for gifts, or used for the purchase of food and non-food items. Simmons examined how women spent this income and found that "90 percent provided at least part of their own midday meals and those of their small children, as well as snack items, kola nuts, cigarettes, etc." (Simmons, 1976c, p. 6). Food gifts are in some instances given to children by their mother so that they "might feel obliged to provide for her if she later requests assistance" (Ibid., p. 7). It is not clear whether these gifts come from the household's (i.e., husband's) or the woman's personal resources. Nevertheless, the expenditure of the personal income earned by female entrepreneurs should be taken into account in gauging the overall nutritional level of rural dwellers in Northern Nigeria.

An exception should be noted among the Fulani people. Simmons points out that the wife of a Fulani-cattle owner is "given a daily share of milk, whether or not she is cooking that day, and it is her job to sell this milk and use at least part of the returns to buy the household food needed on the days when she does cook" (Ibid., p. 11).

There is a rather egalitarian sharing of household-level food preparation (cooking) labor among the adult women of the household except for those who are old or who are newly married. A rotational cooking scheme exists. Simmons notes that some wives might "cooperate to some extent with each other and share in the cooking tasks even when one woman is responsible for that day" (Simmons, 1976a, p. 5).

The daily food allocation within the household is determined primarily by the wives involved in the cooking chores for that day. The wives may also have some control over the amount of food prepared and distributed. Bivens observed that the head wife determines who within the household consumes how much, although there appears to be no empirical work which addresses this issue. It is the common belief that men receive the largest food servings with the choicest ingredients, although it is also believed that wives involved in the cooking will withhold enough food to ensure that their children receive enough to eat. If these wives do have some control over how much is removed from the granary, this will undoubtedly influence the amount of food prepared and distributed.

It is also worth pointing out that older Moslem women not in seclusion (kulle) may engage in some of the household's food purchasing chores and may provide a critical link to the market for those households without a sufficient supply of children to undertake this task.

Household Consumption Practices

Food preparation practices and meal patterns have important effects upon food and nutrient intake levels.

Food Preparation

The male head of the household is usually responsible for purchasing food for the family or removing food from the granary for the purpose of meal preparation. Bundles of sorghum and millet are generally taken from the granary one or two at a time every few days and given to the women. The women either do the threshing of the grain themselves or give it to an older woman whose occupation is threshing (Simmons, 1976a, p. 4). After any payment in kind is made, "the rest of the threshed grain is then measured and divided among the women who are cooking" (Ibid.). The grain is then kept in their rooms until such time as it is used for cooking. For the most part, "the amount of grain to be cooked each day is common knowledge to all household members, even those not cooking" (Ibid., p. 5). Cooking then takes place in the cooler hours of the day and may explain why the only meals served to the entire household are cooked by the women in the morning and evening periods of each day.

Meal Pattern

The evening meal consists in large part of tuwo (a stiff porridge made from sorghum or millet), miya (a soup or sauce most often consisting of palm oil--or groundnut oil), daddawa (fermented locust bean patties used in miya), salt, peppers and a vegetable.[4] In the three villages under study, tuwo is eaten by everyone in the evening, although the pattern, the quantity and the quality of serving is likely to be different for different household members. In these villages the men from one or several households would share a common pot and eat outside the entrance of the compound. The men also are the first to receive their serving of food and Bivens (1980) has stated that men will receive the choicest pieces of meat, if meat is included in the evening meal.[5] When boys reach the age of five or six they eat their meal from a common pot near the men, but very young boys do not eat near the men because it is considered rude in Hausa society to watch someone else eating, particularly one's own father. Women eat inside the compound and allow young girls to eat inside near them when the girls reach the age of five or six. Children under the age of two or three usually share their

[4]Descriptions of foods are taken from Simmons (1976a) unless otherwise noted.

[5]Annegers (1972, p. 207) points out that the practice of serving the male head of the cooking unit first is common throughout West Africa.

mother's bowl. Nicol has pointed out that "the head of the family and then the other men tend to get priority for food over the women, and the children under the age of thirteen years come last (Nicol, 1959a, p. 305). Observations by Matlon and Bivens tend to corroborate Nicol's findings.[6]

The morning meal often consists of preparing leftovers from the previous evening's meal although some of the leftovers are said to be given to Koranic students. According to Simmons, plate waste, or food actually thrown away after it is cooked is, not surprisingly, negligible. In the morning, men leave early for the fields and are served food there. Matlon noted that some commercially prepared foods are often available for purchase at daybreak to supplement the morning meal.

The men often carry hura (specially prepared millet balls), apparently also called fura, with them to the field and mix that with nono (soured skimmed milk) purchased for the midday meal from Fulani women. The women generally purchase processed food items from the market with income derived from their enterprise activities. Children are likely to eat commercially prepared foods because the more preferred fura with nono is unaffordable. Often the children eat the "snack" food which the mother produces for sale.

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[6]Personal conversation with each.

CHAPTER III

A THEORY OF THE FOOD-CONSUMING HOUSEHOLD IN THE NORTHERN NIGERIAN CONTEXT

The Values and Goals of Farm Households in the Northern Nigerian Setting

The household establishes its values, using normative knowledge, and establishes a set of household prescriptions, or goals, which reflect the values which it has established. This study assumes that all households view foods as "good," at least for the nutritional characteristics they possess. One question of interest to some researchers, although not specifically addressed in this research, deals with the matter of the goals established by the farm household. Of interest in this research is how goals made by the farm-firm might affect the extent to which the foods possessing value[1] are consumed by the household.

Empirical evidence from Northern Nigeria supports this fundamental statement about the African farmer:

> "The purpose of farm activity, as of every other economic activity, is consumption of goods and services within a defined time-frame. The range of objectives may be viewed as production for direct consumption on the farm, particularly of food; production for sale or barter for goods or services which either cannot be produced within the family or for which there is comparative advantage in exchange; and investment to enhance future consumption" (Cleave, 1977, p. 162).

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[1]This is to be understood in the philosophical sense, not in the nutritional sense in which food value connotes the varying degree to which different foods embody energy and nutrients.

If consumption goals influence production goals, as Cleave suggests, but if consumption is ultimately influenced by production, then it is difficult to ignore the interdependence which exists between the production and consumption spheres of household activity.[2]

Back (1952, pp. 27-28) provides an interesting philosophical and economic discussion of this interdependence in which he introduces current and future consumption into a "current utility function." Future consumption, he argued, is composed of the farm's physical production along with what he calls "a personal development function (investment in the human agent)." The production function for the farm "is geared directly to the family's plans for future consumption and indirectly to those parameters of the utility function dealing with current consumption." He claims that an equilibrium is established between current and future consumption by the family and that for low income farmers (in the U.S.) "production is more directly influenced by consumption when allocation in time emphasizes the present" (Ibid., p. 29).

This interdependence between the production and consumption spheres of household activity can be viewed in more concrete terms by recognizing the fact that production cannot succeed without some attention being paid to the food requirements and consumption of the human factors of production, and conversely, consumption cannot occur without the household acting to some extent as a self-operated producing unit or as an economic agent engaged in activities of some other producing unit.

Now that the interdependence between the consumption and production spheres of household activity has been discussed, it is worthwhile to examine one of the questions of interest to researchers that was pointed

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[2]These spheres of activity relate to the establishment and achievement of goals.

out earlier, namely what are the goals of the Northern Nigerian farmers. Among the goals which Northern Nigerian farmers are likely to pursue, two are: food security and cash generation. The discussion which follows will concern only the food security goal.

H. A. Luning tests the hypothesis that farms in Northern Nigeria try to obtain the objective of self-sufficiency of food (Luning, 1967, p. 161) by developing a resource allocation model in which households produce first in order to provide for subsistence needs with surplus resources being used to maximize income once subsistence needs are met. He concludes that self-sufficiency objectives are met (Ibid., p. 168) by virtue of his findings that the number of hectares devoted to the production of so-called "cash" crops is consistent with what would be expected if enough hectares were first set aside to produce the desired quantities of food crops.

In another study, Norman defines food security in similar terms to food self-sufficiency: "The desire to provide enough food for home consumption with any surplus resources being devoted to crops for sale on the market" (1973, p. 33). Norman measures the degree of farmer conformity with this objective by testing the hypothesis that food security involves a strategy or strategies in which farmers attempt to minimize risk. His admittedly "primitive" test of whether farmers pursue food security is to postulate that a farming household which employs a crop production strategy or strategies which result in lower absolute and relative variation in the gross returns per unit of input from some other crop production scheme is a farming household which has food security as a primary objective (Ibid., p. 38). As the strategies followed by farming units in this study involve mixed or inter-cropping as opposed to sole cropping and as the degree of absolute and relative variation in gross returns per unit of input is lower for inter-cropping than it is for sole cropping, Norman concludes that farmers employ strategies consistent with the goal of food security.

Farmers' grain storage practices also imply the importance of food security as a goal. According to Hays, "Clearly storing grain for household consumption receives top priority. In addition most farmers stated that it was important to have in store more grain than would be consumed during the year in case of a 'bad harvest'. Once it was determined that a normal harvest could be expected, then this extra grain would be sold before this new harvest" (Hays, 1975, p. 34).

These findings confirm the opinion of Helleiner (1975, p. 47) and Cleave (1975, p. 163) that in much of rural Africa, food production is the first claim upon land, labor, and other resources.

The discussion so far has been to point out how various authors have suggested that food security is one of the important goals of Northern Nigerian farm households, goals which obviously reflect considerable interdependence between production and consumption activities. Now the focus will shift to a discussion of how households might pursue the goal of food security in a different way than what the previous authors have suggested. It still remains to a large extent an empirical question, however, as to how farmers cope with the uncertainties endemic in Northern Nigeria. Although cash crop orientations as suggested by Luning, inter-cropping as suggested by Norman, and storage practices as suggested by Hays, tend to confirm the notion that farmers do follow a rational food seucrity strategy, the generalizations which are arrived at do not take into account the variation which is likely to exist between rich farmers and poor farmers, or between farm families more directly threatened by hunger as opposed to those who are not because of differences in land availability, farm labor availability or in the ability to procure other factors of production. Peter J. Matlon's (1977) income distribution study in three villages in Northern Nigeria entitled The Size Distribution, Structure and Determinants of Personal Income Among Farmers in the North of Nigeria, did examine the differences among various income groups and discovered by examining the seasonal pattern of sales that the poor pursued a strategy quite different from the one which had been described in the studies outlined earlier in this section. He states that the poor households pursue a "groundnut strategy" in which they derive a surprisingly large share of their income from the sale of the primary cash crop, groundnuts. This is likely to result in more food being consumed by the farm family, he argued, than if the household had devoted all of its resources to the production of food. If poor households concentrate on food crops rather than cash crops in order to ensure first that subsistence food needs are met (because they have inadequate land to produce enough food to satisfy household needs), then this so-called "groundnut strategy" appears to be somewhat paradoxical. Although it might appear more prudent for a family to follow the "food first" strategy because of its implied avoidance of the vagaries of the market, farmers may be obtaining substantially more food overall by following a "groundnut strategy".

Modelling Food Consumption in Farm Households

The previous chapter has discussed the interdependence between the consumption and production activities of the Northern Nigerian farm household. Where households produce much of the food that they consume, consumption decisions affect production patterns and production decisions affect consumption. Instead of having separate theories for production and consumption activities we must therefore have an integrated theory that allows decisions in the two spheres to be made jointly.

One approach in doing this is to model factors influcing the supply side behavior of the household separately from the factors which influence the demand side behavior of the household and, having developed these two model components, to solve them simultaneously as the model. This approach has utilized different theories of the household as firm, some of which have linked the household's activities as a producer of goods and a consumer of goods through the postulated existence of a labor market in which the household is free to buy and sell labor (see, for example, Barnum and Squire, 1979). Through the labor market mechanism the household generates income from off-farm employment, revenue and thereby profits and income from own production, and leisure. Once a labor supply curve is determined and the production side estimated, the resultant income thus becomes endogenous to the system and then consumption choices are addressed. These and similar approaches toward modelling firm-household interrelations are complicated, time-consuming and probably beyond the budgetary limits of most developing country governments. A scarcity of computing facilities and trained personnel in computer science may prevent the adoption of anything other than simple computer techniques, such as those offered in computer "packages". This poses a significant drawback to modelling complicated firm-household interrelationships.

The approach that will be followed here, which is better adapted to the needs and capabilities of most developing countries, is to use a model which assumes a household utility function along with the existence of two constraints, a budget constraint and a production function constraint. A time constraint is not employed in this analysis and total labor supply is assumed fixed. The study will concentrate upon the direct impacts of socio-economic variables upon household food consumption and will not address any indirect linkage which they might have on the production and labor supply behavior of the household. The household utility function is stated in terms of food commodities, although in principle it does not exclude nonfood arguments. Undoubtedly leisure and other arguments enter this utility function, although they will be excluded from this discussion so that the focus of attention will be directed towards the food commodity segments which are the principal subject matter of this study.

A consumption function homogeneous of degree zero in prices and income will be estimated for individual food items, one which cannot be identified either as a demand or a supply function. This is desirable because it takes into account the total effect of socio-economic variables upon both the household supply of food and the household demand for food, such that the equilibrium consumption position resulting from the intra-household market for food can be determined. The specific aim is to determine the net effect of a price change upon consumption, not the increase in quantity supplied by the farm firm of the increase in quantity demanded by the household as a result of this price change. Price changes undoubtedly affect both the quantity supplied and the quantity demanded. In doing so the pure demand side effects are not being measured and household food supply activities are to some extent embodied in these consumption estimates.

It should also be noted that the goals of the household-firm discussed earlier, which certainly do influence the amount of food available to the household and the source or sources from which it comes, are not specifically examined for these household being studied. However, a general overview of the food-related roles of men and women in Northern Nigeria along with the specific goals which households in Northern Nigeria are believed to possess serve as background information useful for developing this study's theory and the food consumption analysis of the following chapters.

Subsistence Needs Filled by Different Sources

Those familiar with Northern Nigeria usually hold that the farm household tries to provide its food from its own production. Polly Hill, in her anthropological analyses of Hausa farmers (1972) suggests that there is an element of prestige and self-respect associated with being a good provider. Moreover, having to rely on the agricultural market for subsistence food implies the belief that the market can provide essential food items in good times as well as bad. The risks associated with reliance on the market for food needs are at least as great as those associated with a strategy of complete food self-sufficiency. An important hypothesis to test is that these status and risk factors are of varying importance in influencing the consumption of food acquired from home production, from the market, and from gifts, loans, and wages in kind. The consumption of food from each of these sources must therefore be analyzed separately. Accordingly, the model presented here allows subsistence needs to be met by foods from alternative sources, market and nonmarket.

This approach leads to a different emphasis upon the household-firm model than that which is usually presented in the literature. Whereas in other models, the household's production decisions are made (estimated) first and subsequently used in deterining how available "total income" is allocated between the consumption of goods and leisure, the variation explored here treats consumptions of the same good from different sources separately.

Two Theoretical Models of Semi-Subsistence Farm Household-Firms

In order to develop the theory for this analysis, it is worthwhile to present first the standard model of neoclassical demand analysis in which a household can only obtain goods through the market. Assuming a simple two commodity case, the consuming household attempts to maximize its utility, U^I subject to a budget constraint, Y, where

$$U^I = U(q_m^a, q_m^b) \qquad (3.1.1)$$

and

$$Y = p_m^a q_m^a + p_m^b q_m^b \qquad (3.1.2)$$

where

Y is income,

p_m^a is the retail price of good a,

p_m^b is the retail price of good b,

q_m^a is the quantity of good a purchased, and

q_m^b is the quantity of good b purchased.

It is well known that this standard theory leads to the following result in which the ratio of the marginal utilities of a and b are equal to the ratio of their market prices.

That is,

$$\frac{\frac{\partial U}{\partial q_m^a}}{\frac{\partial U}{\partial q_m^b}} = \frac{p_m^a}{p_m^b} .$$

In the polar opposite case in which only subsistence consumption exists, we have a pure subsistence model with production acting as the constraint. The consuming household attempts to maximize its utility, U^{II}, subject to the production constraint being faced, Q. That is, it attempts to maximize

$$U^{II} = U(q_f^a, q_f^b) \qquad (3.2.1)$$

subject to

$$Q = Q(\overline{L}, \overline{N}, \overline{K}, x^a, x^b) \qquad (3.2.2)$$

where

q_f^a is the quantity of a consumed from home production,

q_f^b is the quantity of b consumed from home production,

$\overline{L}$ is the fixed amount of land available,

$\overline{N}$ is the fixed amount of labor available,

$\overline{K}$ is the fixed amount of capital available,

x^a is the variable input of good a used as seed, and

x^b is the variable input of good b used as seed.

By definition, total availability can be represented for this case as follows

$$q_t^a = q_f^a + x^a$$
$$q_t^b = q_f^b + x^b .$$

The consuming household's choice is then to determine what amount of q_t^a and q_t^b to consume as q_f^a and q_f^b and what amount to use as variable inputs in the production process, namely as x^a and x^b. The optimal allocation in use is then where the marginal rate of substitution in consumption is equal to the marginal rate of technical substitution in production. That is,

$$\frac{\frac{\partial U}{\partial q_f^a}}{\frac{\partial U}{\partial q_f^b}} = \frac{\frac{\partial Q}{\partial x^a}}{\frac{\partial Q}{\partial x^b}} .$$

A third situation exists in which households can obtain goods for consumption either from home production or the market. The consuming household attempts to maximize

$$U^{III} = U(q_c^a, q_c^b) \qquad (3.3.1)$$

where

$$q_c^a = q_f^a + q_m^a$$
$$q_c^b = q_f^b + q_m^b .$$

The household faces the following two constraints; a cash income and a production constraint. The cash constraint is equal to

$$p_f^a y^a + p_f^b y^b \equiv p_m^a q_m^a + p_m^b q_m^b$$

or, alternatively,

$$0 = p_f^a y^a + p_f^b y^b - p_m^a q_m^a - p_m^b q_m^b \qquad (3.3.2)$$

where

Y is income from sales of outputs a and b,

y^a is sales of good a,

p_f^a is farm gate price of good a,

y^b is sales of good b,

p_f^b is farm gate price of good b,

q_m^a is quantity of good a bought in the market,

p_m^a is price of good a bought in the market,

q_m^b is quantity of good b bought in the market, and

p_m^b is price of good b bought in the market.

The production constraint is

$$Q = Q(\overline{L}, \overline{N}, \overline{K}, x^a, x^b). \qquad (3.3.3)$$

Such a model implies several important simplications, two of which are noteworthy. First, the commodities themselves are not distinguished by source in the utility function and are simply the aggregate amounts of each good consumed from both sources. Implicit in this is the assumption that the physical characteristics of goods a and b are identical irrespective of source. Second, although farm gate and retail prices are used in specifying the income constraint, some average price is used for q_c^a and q_c^b, since the commodity is treated as one commodity and is aggregated across both sources. This need to represent actual farm gate and retail prices in terms of one average commodity price serves as the basis for the theoretical definition of prices which follows later in the thesis. This particular model will be used for the total consumption regressions which appear in Chapter VII. The consumption equation used for good i is

$$q_h^i = f(p_v^i, p_v^j, D_{hk}, Y_h) \quad (3.3.4)$$

where

q_h^i is the amount of good i consumed by household h,

p_v^i is the average price of good in village v,

p_v^j is the average price of good j in village v,

D_{hk} is a set of k variables for household h which reflect shifts in the preference function because of the demographic characteristics of the household,

Y_h is the income of household h.

The simplifications inherent in the aggregate model just discussed can be removed in such a way that the distinctions between farm gate and retail prices and between different sources can be preserved. A model which examines the demand for commodities from different sources will be used for the principal commodity in the diet, sorghum.

The model which will now be discussed is a two commodity two source model because it treats sorghum from these different sources as different commodities. Although in actuality a third source will be used in the estimates used later in the thesis, a two source model contains the essence of the problem, is sufficiently clear and concise for theoretical discussion, and is generalizable to more than simply two sources.

Let us begin by postulating a utility function which is comprised of four arguments, two each for commodities a and b:

$$U = U(q_f^a, q_m^a, q_f^b, q_m^b) \quad (3.4.1)$$

where

q_f^a, q_m^a, q_f^b, and q_m^b are as previously defined.

It is worth noting at this point that there are likely to be objective physical characteristics for either good a or good b that can be differentiated according to source. That is to say, there are likely to be quality, taste, appearance, or other characteristics which differ depending upon whether the good is bought in the market or produced at home. Theory leads us to the conclusion that if this were so, the differences in physical characteristics would suggest that the consumer, if rational, would willingly pay different prices for both only if they were actually different commodities. This statement is not true if the consumer does not have access to the lower cost source, if the consumer is forced to purchase the higher cost good, or if there is a limited supply of the lower cost good. In either of these three cases, the goods may indeed be the same although the prices differ. Since it is observed that purchases from home and from the market occur at different prices, and that in absence of information to the contrary the three conditions mentioned above do not hold, it is therefore argued that the two sources provide two different commodities for which the consumer faces two different sets of prices. Differences in food varieties and moisture content are just two of the suggested explanations for these real physical differences which distinguish specific commodities by source.

The first constraint imposed upon the household in attempting to maximize its utility is the cash income constraint (3.3.2)

$$0 = p_f^a y^a + p_f^b y^b - p_m^a q_m^a - p_m^b q_m^b$$

The other constraint is the production constraint (3.3.3)

$$Q = Q(\overline{L}, \overline{N}, \overline{K}, x^a, x^b)$$

Many models of the household-firm include the household's total time resource as a constraint. This model does not include time as a resource constraint for essentially two reasons. First, the primary focus of the study is upon the food consumption choices made by the household. An analysis of the consumption of leisure, a terribly complex matter in farm households in low income countries, is not essential for this purpose and would require the availability of certain detailed data which were not collected during the survey year. Also, the matter of how to estimate the amount of total time available in specific geographic and cultural situations is problematic (see for example, Barnum and Squire, 1979). If this model were designed to examine in a detailed manner the production side of household-firm behavior, then such a constraint would be warranted in view of the household's choice either to provide labor as a factor of production for its own farm enterprise or to do otherwise. This model will not be used to estimate a production component, however. For this and the other above mentioned reasons, it therefore seems best to leave out this constraint.[2]

The total agricultural production of good a and b are, respectively,

$$q_T^a = q_f^a + y^a + x^a$$

$$q_T^b = q_f^b + y^b + x^b .$$

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[2] If our analysis were to include the labor-leisure choice then the allocation of time would be such that the wage rate was equal to the price of leisure. Although the quantity of labor is held constant throughout the study for each individual household, the quantity of labor available to individual households is different depending upon differences in household size. This is because the study concentrates on the number and composition of consumers of those households which are treated as exogenous factors influencing consumption. Inclusion of household members in the regression analysis, however, implies that the quantity of labor available to the household is being specified as a variable.

Substituting these into (3.3.2) we obtain the following:

$$0 = p_f^a(q_t^a - q_f^a - x^a) + p_f^b(q_t^b - q_f^b - x^b) - q_m^a p_m^a - q_m^b p_m^b \; . \qquad (3.4.2)$$

We therefore maximize (3.4.1)

$$U = U(q_f^a, q_m^a, q_f^b, q_m^b)$$

subject to

(3.4.2) and (3.3.3).

The Lagrangian expression is

$$L = U + \lambda \cdot Q(\overline{L}, \overline{N}, \overline{K}, x^a, x^b) + \mu\, (p_f^a(q_T^a - q_f^a - x^a) + p_f^b(q_T^b - q_f^b - x^b) - q_m^a p_m^a - q_m^b p_m^b)$$

and the first order conditions become

$$\frac{\partial L}{\partial q_f^a} = \frac{\partial U}{\partial q_f^a} - \mu\, p_f^a = 0$$

$$\frac{\partial L}{\partial q_m^a} = \frac{\partial U}{\partial q_m^a} - \mu\, p_m^a = 0$$

$$\frac{\partial L}{\partial q_f^b} = \frac{\partial U}{\partial q_f^b} - \mu\, p_f^b = 0$$

$$\frac{\partial L}{\partial q_m^b} = \frac{\partial U}{\partial q_m^b} - \mu\, p_m^b = 0$$

$$\frac{\partial L}{\partial x^a} = \frac{\partial L}{\partial (y^a + q_f^a)} = \lambda \frac{\partial Q}{\partial x^a} - \mu\, p_f^a = 0$$

$$\frac{\partial L}{\partial x^b} = \frac{\partial L}{\partial (y^b + q_f^b)} = \lambda \frac{\partial Q}{\partial x^b} - \mu\, p_f^b = 0$$

$$\frac{\partial L}{\partial \lambda} = Q(\overline{L}, \overline{N}, \overline{K}, x^a, x^b) = 0$$

$$\frac{\partial L}{\partial \mu} = p^a_f(q^a_T - q^a_f - x^a) + p^b_f(q^b_T - q^b_f - x^b) - q^a_m p^a_m - q^b_m p^b_m = 0 \ .$$

On the demand side these conditions are

$$\frac{\partial U}{\partial q^a_f} = \mu \ p^a_f$$

$$\frac{\partial U}{\partial q^a_m} = \mu \ p^a_m$$

$$\frac{\partial U}{\partial q^b_f} = \mu \ p^b_f$$

$$\frac{\partial U}{\partial q^b_m} = \mu \ p^b_m \ .$$

Hence, the marginal rate of substitution between good a from home production and good b from home production is equal to the ratio of their farm gate prices. That is

$$\frac{\dfrac{\partial U}{\partial q^a_f}}{\dfrac{\partial U}{\partial q^b_f}} = \frac{p^a_f}{p^b_f} \ .$$

Likewise, the marginal rates of substitution between good a from market purchase and good b from market purchase is equal to the ratio of the retail price of good a to retail price for good b. That is

$$\frac{\dfrac{\partial U}{\partial q^a_m}}{\dfrac{\partial U}{\partial q^b_m}} = \frac{p^a_m}{p^a_m} \ .$$

Similarly the marginal rate of substitution between good a from home production and good a from market purchase is equal to the ratio of the farm gate price of good a to the retail price of good a:

$$\frac{\frac{\partial U}{\partial q_f^a}}{\frac{\partial U}{\partial q_m^a}} = \frac{p_f^a}{p_m^a} .$$

Moreover, the marginal rate of substitution between good a from home production and good b from market purchase is equal to the ratio of the farm gate price of a to the retail price of b. That is

$$\frac{\frac{\partial U}{\partial q_h^a}}{\frac{\partial U}{\partial q_m^b}} = \frac{p_f^a}{p_m^b} .$$

The supply equations from these first order conditions become

$$\lambda \frac{\partial Q}{\partial x^a} - \mu p_f^a = 0$$

$$\lambda \frac{\partial Q}{\partial x^b} - \mu p_f^b = 0.$$

Hence the marginal rate of transformation in production is equal to the farm gate price ratio. That is

$$\frac{\frac{\partial Q}{\partial x^a}}{\frac{\partial Q}{\partial x^b}} = \frac{p_f^a}{p_f^b} .$$

From these so-called demand and supply first order conditions, it follows that the marginal rate of substitution in consumption between goods a and b is equal to the marginal rate of transformation in production between goods a and b. That is,

$$\frac{\frac{\partial U}{\partial q_f^a}}{\frac{\partial U}{\partial q_f^b}} = \frac{\frac{\partial Q}{\partial x^a}}{\frac{\partial Q}{\partial x^b}} ,$$

which is equivalent to the farm gate price ratio for goods a and b

$$\frac{\frac{\partial U}{\partial q_f^a}}{\frac{\partial U}{\partial q_f^b}} = \frac{\frac{\partial U}{\partial x^a}}{\frac{\partial Q}{\partial x^b}} = \frac{p_f^a}{p_f^b} .$$

Moreover this is also equal to the marginal rate of substitution of good a from market purchase for good b from market purchase

$$\frac{\frac{\partial U}{\partial q_f^a}}{\frac{\partial U}{\partial q_f^b}} = \frac{\frac{\partial Q}{\partial x^a}}{\frac{\partial Q}{\partial x^b}} = \frac{p_f^a}{p_f^b} .$$

The consumption equations for good a which can be obtained from either the market or home production are

$$q_{fh}^a = f(p_f^a, p_m^a, p_f^b, p_m^b, D_{hp}, Y_h) \qquad (3.4.3)$$

$$q_{mh}^a = f(p_f^a, p_m^a, p_f^b, p_m^b, D_{hp}, Y_h) \qquad (3.4.4)$$

where

q_{fh}^a is the amount of good a demanded by household h from home production,

q_{mh}^a is the amount of good a demanded by household h from market sources, and

p_f^a, p_m^a, p_f^b, p_m^b, D_{hp}, and Y_h are as previously defined.

Two of the expected relationships from these two equations are

$$\frac{\partial q_f^a}{\partial Y} > 0 \text{ and } \frac{\partial q_m^a}{\partial Y} > 0$$

insofar as that income increases are apt to have positive effects upon the consumption of normal food commodities either from the retail market or from home production.

CHAPTER IV

DESCRIPTION OF DATA USED, ITS PREPARATION FOR ANALYSIS, AND SPECIFIC METHODOLOGICAL PROBLEMS POSED BY THE DATA

This chapter is intended to detail the specific data set employed in this analysis, data preparation necessary for analysis, and the nature of several methodological problems presented by the data. It is particularly important for researchers and policy makers to be aware of factors which influence the validity and applicability of the study's results to the Northern Nigerian setting. Moreover, it is hoped that these results will be useful in helping to design other studies which attempt to address the same or similar issues.

Data Availability

The data used in this research were considered more up-to-date, covered a longer time period than any previous consumption and nutrition study in Northern Nigeria, and contained sufficient detail to enable research into the determinants of food consumption and caloric availability from some new and different points of view. They were collected by Peter J. Matlon, a former Assistant Professor of Agricultural Economics in the Department of Agricultural Economics at Michigan State University. He collected the data while he was enrolled as a graudate student at Cornell University. With funding from the U.S. Agency for International Development and logistical support from the Agricultural Economics Department and the Institute of Agricultural Research at Ahmadu Bello

University in Zaria, he collected field survey data during the period of May, 1974 to May, 1975 in three villages in Northern Nigeria. His purpose was to study the determinants of income differences within an essentially traditional society whose production system was experiencing the first stages of technological transition. It was hoped that the study would provide policy makers with a better understanding of the rural poor, their sources of income, the constraints preventing the poorest households from economic expansion, and the effectiveness of current agricultural programs in reaching and assisting the poor. Fortunately, Matlon collected accurate records of the quantities of all foods which were likely to enter into household consumption. His study was not explicitly designed to study the food consumption patterns of the poor and the relatively well-to-do in Hausa society, but his masterful attention to detail allowed for this and other uses to be made of the data which he collected.[1] Moreover, he spent much of his time during the summer of 1979 and during two intensive follow-up visits to Michigan State in assisting this author to develop a deeper understanding of the data.

The Sample Frame

Three criteria were employed in choosing the three villages for the rural incomes study. First, that there be different access to regional marketing systems (both public and private); second, different access to agricultural extension workers; and third, that each have different

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[1]In addition to this study, Matlon's data was used as the data set for the doctoral dissertation of Dr. Eric Crawford, Assistant Professor of Agricultural Economics at Michigan State University, entitled: A Programming Simulation Study of Constraints Affecting the Long-Run Income-Earning Ability of Traditional Dryland Farming Systems in Northern Nigeria.

occupational profiles such that there would be some variation in the importance of off-farm employment as a source of income. Each village had to possess similar characteristics in the following respects: comparable types of soil, comparable amounts of rainfall, each village had extensive mixed cropping for important crops, close daily contact between the enumerators and the survey supervisor and, finally, that the effects of drought upon harvests in the preceding year (1973-74) were minimal. The final constraint necessitated the selection of villages south of 11.6^{o} north latitude, so three villages were chosen in the Guinea-Savannah ecological zone of Northern Nigeria characterized by an average of 35 inches of rainfall per year and by traditional farming techniques in which the three principal crops (millet, sorghum and groundnut) were grown with relatively minor use of chemical fertilizers and improved seed varieties.

Matlon provides a useful description of the three villages which I will briefly summarize (1977, pp. 32-36). The largest of the villages is Rogo (population 6,405) which has an important village market and which is closely tied to external urban markets by daily lorry traffic throughout the year. Barbeji is intermediate in size (population 3,744) and has a market which is smaller than Rogo but considerably larger than the third village, Zoza. Of the three villages, Barbeji is the farthest from outside markets with cash crops being evacuated for the most part by headload, bicycle and donkey. Zoza (population 2,964) on the other hand is the least cash-oriented of the three villages with the heaviest emphasis of the three villages upon sorghum and millet production.[2]

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[2]Zoza had the highest per hectare plantings of sorghum and millet of the three villages studied.

Land pressure was highest in Rogo, with a resident to cultivated hectare ratio of 4.2:1, and was lowest in Zoza with a resident to cultivated hectare ratio of 2:1. The ratio for Barbeji was 2.2:1.

In each village, approximately 45 household heads were selected randomly from recently updated tax lists. Each household was then surveyed to obtain basic types of information that would facilitate division of the sample frame into two distinct subsamples. In particular, households were stratified on the basis of farming techniques and factor-ratio criteria. A subsample of twelve from each of the three villages was then chosen on the basis of a two-way, four cell stratification matrix in which households were classified as being above or below the mean land to worker ratio and as using or not using both chemical fertilizer and seed dressing during the previous year. This approach was designed to provide observations with a sufficient range of these key production variables to increase significance levels in the agricultural production analysis and to economize on project financial resources. These twelve households will hereafter be referred to as "small sample" households and the residual group from the original random sample in each village will be referred to as the "large sample".

Data Collection Method

Small sample households in each village were interviewed three times per week early in the survey year and two times per week later on when the number of enumerators in each village was reduced to one. These interviews collected data on field, task and crop-specific farm labor activities, non-farm labor inputs, off-farm labor activities and earnings, and household cash expenditures. Interviews of the small sample households collected expenditure data two to three times per week and sales data for both farm and off-farm occupations, plus data on gift and loan flows, were collected weekly. Monthly interviews with the small sample households collected data regarding land transfers and labor migration. Table 4-1 presents the types of data collected and the frequency of collection for both the small and large samples. Large sample households were interviewed at four to five week intervals to obtain identical cash and kind flows information, with the exception of household farm labor activities. Additional interviews were conducted with both the large and small samples during the year to obtain subjective and inventory data, and to conduct data consistency checks.

Sources of Food Consumption

The data which are being analyzed in this study were collected to identify specifically the determinants of income among traditional farmers in Northern Nigeria. The detailed quantity character of the data collected in his farm management survey made it possible to transform these data into kilogram estimates suitable for consumption analysis. It must be stated at the outset, however, that the food estimates which appear in this research are not, strictly speaking, estimates of food actually consumed, but are instead estimates of food available for consumption, although for convenience we shall often use "consumed" as meaning "available for consumption". There were no direct measurements of quantities eaten, unlike the studies of Nicol (1959a) and Simmons (1976a). Annual household consumption figures were computed as the food retained from home production plus the food purchased plus the food received as gifts, loans and wages paid in kind. The precise manner

Table 4-1

Two-Tier Sampling Procedure Used, Nigerian Rural Incomes Study: Data Types, Interview Frequency, and Sample Sizes

	Small Sample				Large Sample	
	Interview Frequency					
Information Type	2-3 Weekly	Weekly	Monthly	Once	Monthly	Once
A. Agricultural						
1. Family labor	X					
2. Hired labor	X				X	
3. Non-labor inputs	X				X	
4. Harvests	X				X	
5. Non-labor input purchases		X			X	
6. Crop and livestock		X			X	
7. Crop and livestock sales		X			X	
8. Land transfers			X		X	
9. Crop and livestock transport costs		X			X	
10. Assets inventory				X		X
B. Non-farm occupations						
1. Off-farm labor	X				X	
2. Service earnings	X				X	
3. Purchases		X			X	
4. Sales		X			X	
5. Assets inventory				X		X
C. Other flows						
1. Consumer expenditures	X				X	
2. Cash and kind loans given, red'c., repaid		X			X	
3. Cash and kind gifts given and rec'd.		X			X	
4. Labor migration			X		X	
D. Subjective and retrospective						
1. Price awareness				X		X
2. History of land transfers, fallow, rotations				X		X
3. Storage and wastage				X		X
4. Risk				X		X
5. Government programs				X		X

	Small Sample[1]	Large Sample[1]
	Number of Households	
Village		
Rogo	11	34
Zoza	12	37
Barbeji	12	34

Source: Matlon, 1977, p. 39.

[1]One household was deleted from the small sample for this analysis due to insufficient information. Six households were deleted from the large sample.

in which these estimates were obtained will be discussed later in this chapter, although it must be pointed out here that as a general rule the kilogram estimates obtained from the two samples under consideration differ considerably. This poses difficult methodological problems. There are several reasons for these differences: first, the estimates of quantities produced (harvested) differ because the manner in which yields were estimated varies significantly between the samples. Matlon described the procedure in the following way:

> Actual weights were taken on a sample basis for local units used in harvesting for all small farmers and on a field-specific basis. Thus for a majority of crops (grains, groundnut, cowpeas, peppers, onion) the small sample farmer production weights are based on the farmers'recall of units removed from a specific field times the actual weight of the unit used in harvesting that crop for that field. When a sample weighing for a crop in a particular unit was not available for a specific field of a farmer, I used the average weight recorded for that farmer (for that crop and unit) as derived from his other fields. In rare instances, I lacked unit weights for a specific crop for a given farmer. Then I applied the village average for that crop and unit. As to the large sample, all production weights were estimated using the third method only--that is, average weights for each crop-unit combination (as derived from the small sample weighings) were calculated in each village and applied to the large sample farmers in each respective village. No weighings were taken directly from large sample harvests respectively.[3]

Second, the period of recall varies significantly from one sample to the other with a month-long period of recall characterizing the large sample and a two to seven day period of recall characterizing the small sample. Third, by virtue of the interview frequency, the extent of enumerator contact with the respondent is significantly greater in the small sample than in the large.

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[3]Letter dated November 26, 1980.

However, it was the judgment of this researcher that data which were collected in the large sample contained valuable information which should not be discarded automatically for this reason. It was believed that the extensive nature of information collected in at least twelve monthly interviews throughout the agricultural calendar constituted better data than that upon which many other studies have been based. Considering the purpose of the present analysis in which many aspects of household behavior are to be examined, it is preferable to include the large sample observations in order to expand the number of observations sufficiently enough to permit addressing many more possible factors affecting consumption. The key factors of interest in this research are relationships which are likely to show up even if estimates are likely to be incorrect.

The data contain information on home production, sales, seed use, harvest losses, market purchases, loan repayments, gifts, and wages paid out or received in kind, but there is one element of household food availability which is not contained in these estimates. Women obtain incomes from entrepreneurial activities and generally spend that income freely without either their husband's knowledge and/or permission. Since this study interviewed only the head of each household, information pertaining to food expenditure out of female entrepreneurial income was not obtained.[4] This omission will result in under-reporting of the

[4]Very rough estimates of female entrepreneurial income were made possible because of information collected from the survey about the number of females in the household and the number of occupations in which they were engaged, and because estimates of annual average earnings in those occupations were available from earlier work done by Emmy Simmons. The mean annual household income calculated from female entrepreneurial activity for the small sample was 65.1 Naira. This represents 18 percent of mean total household expenditure (exclusive of female incomes, see Table 5-1), and 26 percent of market expenditure (exclusive of female income, see Table 5-1) for small sample households.

food consumed by the average household, but one can still study factors concerning food procurement and consumption which are subject to the control of husbands and household heads. Clearly these are the major factors affecting the total food availability of the household.

Kilogram Conversions

The original quantity data collected by Matlon were recorded in local units, normally measures of volume. For the major crops, Matlon made accurate harvest weighings of those measures (by commodity) as was mentioned in a previous section. Food items available for purchase in the local market were also weighed to obtain value-weight and weight-unit relationships.

For these and other major items, a table of weights and measures based upon the Matlon measures was used to convert specific volumetric units by commodity into their kilogram equivalent. For some items in which the weight per volume unit changed by season it was more appropriate to use Matlon's monthly retail price records which contained more accurate village-level seasonal weight per volume unit relationships. These two approaches handled the majority of the cases.[5]

Components of Total Food Consumption

This study combines information about food consumption from three different sources: home production, market purchases and all other

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[5]For the estimates of meat available for consumption, a relatively unimportant food item in the diet, weights "by the piece" were determined by first assuming that the average priced piece in our sample was equal in weight to the average piece calculated by Simmons (1980) in the same area. The weights of pieces above and below the mean priced piece were assumed to weigh more and less, respectively, than the average price in the same proportion as their prices were related to the average price per piece.

in-kind food flows. The estimate of the net amount of food consumed from all sources was obtained specifically by simply adding the net amount of food available from each of these sources for each household. Specifically, the amount of food sold, used as seed and lost in storage was subtracted from the quantity of food harvested. Quantities purchased from the market were then added to the net amount available from home production and the net amounts of gifts, wages, loans and loan repayments were also added or subtracted depending upon whether or not this was a net inflow or outflow of food from this combined source.

The total consumption of food i by household h is defined in the following way:

$$q_{ihT} = q_{ihH} + q_{ihM} + q_{ihK}$$

where

q_{ihH} is the amount of food i consumed from home production by household h,

q_{ihM} is the amount of food i consumed by household h which was market purchased, and

q_{ihK} is the net consumption of food i from in-kind sources for household h.

The two sources, q_{ihH} and q_{ihK}, are defined as:

$$q_{ihH} = q_{ihP} - q_{ihS} - q_{ihF} - q_{ihL},$$

$$q_{ihK} = q_{ihG} + q_{ihW} + q_{ihB}$$

where

q_{ihP} is the amount of food i produced by household h,

q_{ihS} is the amount of food i sold by household h,

q_{ihF} is the amount of good i used as seed by household h,

q_{ihL} is the amount of good i belonging to household h which is lost in storage,

q_{ihG} is the net amount of food i received by household h as a gift. It is obtained by subtracting the amount of food i given by household h from the amount of food i received as a gift by household h,

q_{ihW} is the net amount of food i received as wages in kind by household h. It is obtained by subtracting the amount of food i paid out in wages by household h from the amount of food i received in wages by household h, and

q_{ihB} is the net amount of food i received as borrowings (loans) by household h. It is obtained by subtracting loans given and repaid by household h from loans received and repaid to household h.

I will now explain each component of food consumption and point out the methodological problems confronted in deriving these estimates as well as the resolutions which made the definitions meaningful and operational.

Food Retained from Home Production

By food retained from home production, I mean the quantity harvested less whatever is sold, less seed usage, and losses in storage.[6] Certain assumptions had to be employed in order to make this particular estimate

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[6]This figure does not include food gatherings.

meaningful. First, it was assumed that the 1974 harvest was a normal harvest which was representative of Northern Nigerian harvests. Second, it was assumed that the food inventories existing in May of 1974 were equal to the food inventories in existence in May of 1975. Third, it was assumed that the observed food sales figures of pre-harvest 1974 accurately reflected the unobserved sales figures of the 1975 period. The first assumption requires no explanation although the second and third do. I will now discuss each of these two assumptions before describing the procedures followed in order to arrive at final commodity estimates of food retained from home production.

Basic consumption theory tells us that income is a primary determinant of consumption. In a semi-subsistence setting such as the one being examined in Northern Nigeria, incomes are primarily determined by the harvest, although other factors affecting income also are clearly evident. Ideally one would like to study the disposal of this income throughout the course of the "consumption year", namely from harvest to succeeding harvest. However, the Matlon data were not collected during a harvest to harvest period but were collected from a pre-harvest to pre-harvest period instead. The fact that survey information was not collected from the period of May immediately preceding the 1975 harvest until the 1975 harvest period leaves us with approximately nine months of information about how the income derived in the 1974 harvest year was allocated. If the amount of food held in inventory was the same in May 1974 (when the study began) as it was in May 1975 (when the study ended) and if the 1975 pre-harvest sales pattern was similar to the 1974 pre-harvest sales pattern, then consumption information collected during the pre-1974 harvest period could substitute for the information which was not collected from the current and representative consumption year. In making these assumptions, however, one cannot overlook the nature of the 1974 and 1975 harvests, the extent to which they were similar or dissimilar and some influences concerning their possible effect on the data which were collected. The widespread Sahelian drought of 1971-1973 did affect to some extent the study area in at least the year immediately preceding the 1974-1975 survey. As Matlon points out: "Yields of millet and sorghum, the major food grains of the area, are estimated to have been 10-15 percent below mean yields during the preceding (1973-1974) year" (Matlon, 1977, p. 36). Unfortunately, estimates of the amount of harvest shortfall of other crops were not made although it can safely be assumed that all crops produced on non-fadama (non-alluvial) land were affected adversely by the drought.

A beginning and ending food inventory for the survey year was not undertaken as part of the data collection process, although a food inventory was made near the end of the data collection period. This particular factor presents some difficulties which were encountered in a similar situation in the consumption analysis of data collected from Sierra Leone. In order to reflect most accruately the food which is available for actual consumption in the study year, the net change in food stocks from year to year would have to be figured into the household food budget. Since no estimates of actual amounts of food held in storage were available, an assumption was made that beginning and ending food inventories for the survey period were identical in size and composition. This assumption enables us to treat the store of income available in kind in May of 1974 as being equal to that store of income available in kind a year later.

This assumption is important for one other closely related reason as well. Since food disposal patterns are likely to be a function of the size of the inventory, a change in the size of the inventory would most probably result in changed sales amounts and/or in changes in the amount consumed from own retention. The 1974 harvest was below normal with the two possible outcomes being that amounts placed in inventory at the 1974 harvest may have been less than or equal to the amounts placed in storage at the 1975 harvest. (It is unlikely that the amount placed in storage in the bad year was more than in the preceding year.) Either of these two plausible possibilities is compatible with the equal May inventory assumption if, in the likely case of below average additions to harvest inventory in a bad year, disposal levels were reduced between the harvest and pre-harvest (May-August) periods, or in the case of equal net additions to harvest inventory following a bad harvest, if disposal patterns were normal.

In the absence of information to the contrary, the identical May inventory assumption in my judgment seems reasonable. A more complex assumption would be of dubious value in improving the estimates obtained.

The third assumption asserts that the pre-1974 harvest sales are a good proxy for the pre-1975 harvest sales. This assumption may be affected by the equal inventory assumption because differences in inventory amounts may affect the amounts sold during any pre-harvest period. The implications of the previous year's shortfall in production upon pre-harvest sales for at least the two principal components in the diet can perhaps be best understood by turning to an explanation of storage behavior which was offered by Hays (1975) in his study of the marketing of sorghum and millet in Northern Nigeria. He found that "most farmers stated that it was important to have in store more grain than would be consumed during the year in case of a 'bad harvest'. Once it was determined that a normal harvest could be expected, then this extra grain would usually be sold before the new harvest" (Ibid., p. 34). If pre-harvest sales are precisely determined by expectations about an upcoming harvest, then pre-1974 harvest sales would probably have been normal if inventories were normal in May of 1974. If, on the other hand, inventories were below normal in May of 1974 and sales were determined by harvest expectations, then sales patterns would have been normal although sales amounts might have been less than those for the corresponding period in 1975. If Hays' observation holds for this study, then it would appear that the amount of "extra" grain sold in the pre-harvest period of May through August of 1974 would have been less or equal to the long-term average. One could conclude that making an assumption which treats 1974 pre-harvest sales as being roughly equal to pre-harvest 1975 sales would be erroneous if harvest inventory levels were below normal. However, the actual data showed that in some instances, the amount of 1974 observed pre-harvest sales were more significant than one would expect if harvest inventory levels were below normal. Large levels of pre-harvest sales following a period of drought do not constitute proof that they reflect a normal level of pre-harvest sales but neither do they give any strong evidence to reject the hypothesis of equal pre-harvest sales patterns and amounts in the two harvest years. They do allow for the possibility that farmers had successfully avoided using their reserves of food held in storage during the period of drought in order to ensure that an adequate supply was available to gain income when needed to buy consumption items and necessary farm inputs to meet food survival needs. If there were high expectations about a favorable 1974 harvest, as was very likely to be the case, then normal sales levels of crops which had been successfully stored over long periods of time could have been triggered.[7] This could have been possibly by following a food-shortage strategy during the drought period in which levels of food intake were reduced evenly throughout the food shortage period (while still maintaining some food reserves) as opposed to following a strategy in which farmers planned to "use up" what food was held in reserve by the time of the new "good" harvest. This would suggest that no matter how bad the food situation, a premium would be placed upon keeping at least moderate amounts of food in reserve for later food and cash requirement needs. The conclusion which I have drawn from the above information is that food sales of the pre-1974 harvest period are a suitable replacement for the 1975 pre-harvest sales figures.

Aside from the equal sales assumption there is a separate matter concerning sales which might result in the overstatement of estimates of food retained from own production.

In order to obtain an accurate record of what was sold by the farming unit, the following question was asked in the survey: "During the last week (month) have any persons in the pot (household) sold or rented out any of the following farming items: crops, animals and animal products, tools, machinery, seeds, seed dressing, etc.?" This question could have been construed in such a way that the respondents did not include in their answer sales within the household unit. To the extent that sales within the household existed and went unreported, perhaps if the household head sold a certain amount of grain to a wife in order for

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[7]Sorghum and millet evidence long-term storage properties compatible with this assumption.

her to conduct her enterprise, the particular estimates of food available for consumption would be overstated. If such a situation were to exist, the amount available for food consumption would be overstated by an amount equal to the difference between the amount sold internally within the household and the amount of raw ingredients consumed prior to their sale in processed form along with the amount of food which was purchased with the proceeds from these separate enterprise activities.[8] Since it is possible that some food sales within the household did occur, this matter may be of some importance for certain households. Unfortunately there is no way of estimating how important this might be.

This problem discussed above particularly relates to the possible overstatement of the mean quantities of cereals consumed over all households and the mean quantities consumed over all consuming households.

The manner of estimating storage losses also requires a brief discussion. Food consumption from home production is subject to losses in storage. Matlon obtained farmers' estimates for sorghum storage losses in a "normal" production year. These results show that farmers perceive that the most damage to sorghum is cuased by insects and rats, with rot also being the cause of some damage. The estimates of losses for sorghum are perceived by farmers in Zoza, Barbeji and Rogo to be 12.6, 6.8 and 13.9 percent respectively. An overall three village average of 11.1 percent was used for the sorghum losses throughout the entire sample. The estimates of food losses for other crops were based on figures obtained from Postharvest Food Losses in Developing Countries and adjusted

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[8]Market expenditure records included only those purchases reported by the household head.

for the approximate length of storage time for the individual foods under study.

As was mentioned earlier, the estimates of food retained from home production were calculated by first subtracting 1974 post-harvest sales and 1974 pre-harvest sales from crop harvest figures. Next, seed usage from the current harvest year (from August 1974 until May 1975) was subtracted from the net amount of harvest adjusted for storage losses based upon estimated periods of storage. At this juncture a decision had to be made as to whether or not to permit the allowance of estimates which at this point turned out to be negative. The argument which favored truncating these negative estimates to zero was the obvious and intuitive one that the sum of losses, seed use and sales from the current harvest could not exceed the amount harvested. The argument advanced to leave the negative estimates in the data were primarily statistical and, in the final analysis, more persuasive. The principal argument for leaving the negative estimates alone was that this would result in preserving the assumed normal distribution of kilogram estimates of food retained from home production. Since the analysis of these data involves looking at suitable measures of central tendency, dropping the class of negative observations would bias the estimates because there is no way to drop at the same time those unidentifiable observations affected by large positive errors. For the econometric analysis in a later chapter, it is necessary to comply with the assumptions required to estimate minimum variance, linear, unbiased estimators, particularly the assumption of a normal distribution of error terms about the mean value of the dependent variable. Since both negative and positive errors affect the analysis, it is better to leave these errors undisturbed than to edit selectively, in this case, only those clearly identifiable negative cases likely to contain errors. Moreover, to have edited only the negative cases would have indicated the belief that errors occurred only if either estimates of crop sales were too high and/or if the estimates of production were too low. Although Matlon did not design a survey procedure to re-interview farmers to prevent unintentional discrepancies due to farmers' forgetting to provide information concerning sales and/or production, it was felt that errors were due to the fact that many of the kilogram estimates made, particularly those made for the large sample households, were the result of using average conversion factors contained in a table of weights and measures instead of actual weighings made on an individual case by case basis. Therefore, it was decided to allow for the possibility of negative estimates.

To arrive at the final estimate of the quantity of food retained out of own production, one final step was necessary. As was indicated earlier, information on the sales of pre-1975 harvest output was not observed and the decision was made to treat the pre-harvest 1974 sales figures as approximating reasonably well information from the unobserved period. In certain instances, however, this approach caused problems especially in the instances where farmers switched their crops grown from the 1973 harvest to the 1974 harvest. When there were sales in the pre-harvest period but no production in the 1974 harvest, clearly these sales had been made from a previous harvest so they were not regarded as being sold from the 1974 harvest. These data violated the assumption that beginning and ending inventories were equal (unless, of course, an error was made in recording pre-harvest sales when none occurred or in failing to record any 1974 harvest). The treatment followed attempted to preserve the assumption of equal inventory when some alteration in the cropping pattern had apparently occurred. This rather significant change in cropping pattern was not the only type of change detected in the data. Cases also appeared in which 1974 pre-harvest sales were very large in comparison with the 1974 harvest output for that crop in that household. To have subtracted these sales figures as an estimate of 1975 pre-harvest sales would have resulted at times in substantial negative amounts retained from home production due in part to presumed differences in inventory levels in May of each of the two years. These cases were excluded from the analysis.

Food Available from Market Purchases

This study includes estimates of the amounts (in kilograms) of food which was purchased from the retail markets by the sample households throughout the survey year. These estimates were made by converting quantities recorded in volumetric units into kilograms by using average conversion factors and seasonal conversion factors, as appropriate for each commodity.

Market-purchased food estimates do not include the food which was purchased with the profits from female enterprise activities. To the extent that this occurred, these estimates understate the actual amounts bought by the farm household. Processed cereal estimates are likely to be the ones most affected by this omission.

Food Available from Other Sources

A third category of food which may be important to certain households in this study is a category of food which includes kilogram estimates of food gifts, loans, and wages in kind. An estimate of the total quantity of each food available from neither home production nor the market was estimated first by adding estimates of the amount received as food gifts, food loans, repayment to the household in kind of previous in kind loans, and finally, wages received by the household in kind. An estimate of the total amount of each food given away as gifts, loaned out, repaid from previous loans, and paid out in the form of wages was then subtracted from the total amount of non-market, non-home produced food inflow into the household which was calculated in the manner described in the previous sentence. The net result of this operation was the total amount of food in kind available from all other than market and home produced sources. Negative net amounts of food available from other sources was a distinct possibility that seemed perfectly reasonable to expect and these estimates were not of the same concern as were the negative estimates obtained for food retained from home production.

CHAPTER V

FOOD CONSUMPTION PATTERNS IN NORTHERN NIGERIA

Previous Studies

Three major food and nutrition studies during the last 25 years provide useful background information about food consumption and the nutritional situation of farm families in Northern Nigeria--Nicol's 1954 to 1957 study, the Republic of Nigeria's 1965 National Nutrition Survey, and Simmons' 1972 study of Zaria farm households. In addition, Matlon's study of income distribution provided interesting nutritional results using the data set presently being analyzed.

Nicol

Perhaps the first comprehensive work on consumption and nutrition for all of Nigeria was a survey in which two Northern Nigerian Guinea-Savannah villages with similar cropping patterns to those villages found in this study are studied. Nicol studied in a detailed manner the consumption of a relatively small sample of individuals in order to determine "the general adequacy or otherwise of the Nigerian peasants' diet" (Nicol, 1959a, p. 293). Nicol estimated a mean daily food intake for the year by measuring food consumption for ten days on three occasions at different seasons of the year. From this he calculated the mean daily calorie value of the diets of children from 4 to 6 years, from 7 to 9 years, from 10 to 12 years and of males and females over 12 years of age and compared these estimates with the FAO (Food and Agriculture Organization) recommendations (Ibid., pp. 293-294). He found for the year that sorghum and millet provided the bulk of the calories in the diet with a mean daily consumption in one village of 2,154 calories for men (over the age of 12) and 1,742 calories for women (over the age of 12). The other village recorded for sorghum and millet consumption somewhat lower figures of 1,948 and 1,320 calories for men and women respectively (Ibid., p. 297).[1] A simple average of 70.5 percent of the calories for the diet of men in the two Guinea-Savannah locations being derived from sorghum and millet and 67.2 percent of the total calories for women was calculated from these figures.

Nicol observed that in one of the study villages meat was eaten in reasonable quantities, and in the other, sour milk. He also found that the diets in these two Guinea-Savannah locations where the harvest had been "average or better than average" were "satisfactory" and that the calorie value of the diets were better than in areas where yams were the dietary staple (Ibid., p. 303). In the age group from 4 to 12 years it was "the exception rather than the rule for the diets to supply enough calories to meet the suggested requirements" and for this group in the two villages only 83.6 percent of caloric needs were met on the average as opposed to an average figure for adults (over 12 years of age) of 114 percent (Ibid., pp. 300-301).[2]

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[1]Calorie estimate made on the basis of mean daily food intake (in grams) reported by Nicol.

[2]Estimates based on Table 4 in Nicol.

Simmons

Emmy Simmons conducted a household consumption survey in Northern Zaria province from May 1970 to July 1971. She interviewed both males and females in 118 households in three villages about food procurement practices and food preparation and distribution practices (1976a, p. 35). Her work took into account salient economic considerations (food costs and agricultural production information) that were not included in Nicol's work. She obtained this information at the cost of not obtaining information about the intakes of individual age and sex categories as had Nicol and reported her results on the basis of "the intakes of an average person on an average day" (Ibid., p. 1). In conducting the year-long survey of approximately 40 households per village, "each household was interviewed daily for two non-consecutive weeks during the survey year". The interview extended over the full week to allow for "daily variation within a household" and were non-consecutive to "improve the calculation of average annual consumption per household" (Ibid., p. 38). One of the two non-consecutive weeks corresponded roughly to the wet season and to the dry season for each household.

Simmons found that the average consumption of calories varied from 2,458 calories in the April/May period to a low of 1,949 calories in the December/January period. Although the average consumption of calories in one village was 5 percent less than the level needed to ensure that average caloric needs were met, in the sample population as a whole the overall caloric consumption average of 2,264 calories per day exceeded average caloric requirements by 13 percent. The diet consisted mainly of sorghum and millet with 70.2 percent of calorie consumption coming from these two sources. She found that the pattern of meal composition was similar in all three villages and that "most of the staple grains consumed were produced on the family farm, (and that) more than half of the value of all the food consumed each day was purchased with money" (Ibid., p. 35).[3]

Nigerian Nutrition Survey

One component of the 1965 Nigerian National Nutrition Survey was to carry out a seven-day food consumption study in three locations, one of which was in Zaria Province, a province in Northern Nigeria. Forty-six persons in eight farm families were studied during February and March and their calorie intakes per person per day during this period were estimated to be only 63 percent (i.e., 1,377 calories) of requirements (NIH, 1967, p. 59). No detailed information was available about the composition of the diets for those included in the sample.

The Dominance of Sorghum and Millet in the Diet and Inadequate Caloric Consumption

Two of the basic conclusions that can be drawn from these consumption and nutrition studies in Northern Nigeria are that sorghum and millet are clearly the dominant food and calorie sources in the diet and that food consumption for some individuals is likely to fall short of caloric intake requirements.

Nicol's and Simmons' studies were almost identical in the finding that approximately 70 percent of the calories in the diet came from the principal foods, namely sorghum and millet. Although the 1965 Nigerian

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[3]Simmons' three village average was that 87.9 percent of cereal consumption was home-produced.

Nutrition Survey did not report any information about the composition of northern farm household diets, it did contain information about the extent to which food requirements were met. These results and those from Nicol's and Simmons' studies provide some indication about the nature of the caloric shortage. Nicol found that male and female adults on the average consume more than necessary to fulfill caloric needs, whereas all other age and sex groups within the household consumed on the average less than the amount necessary to meet its age and sex group's average caloric requirement. The other two studies reported, however, do not establish the degree to which each age and sex group within the household meets the caloric requirements. The Nigerian Nutrition Study's results show an average consumption of 63 percent of caloric requirements which differs markedly from the figure reported by Simmons of 113 percent. Enough evidence does exist, however, to suggest the hypothesis that average caloric requirements are not met on a year to year basis and that the degree to which caloric needs are met within the household depends in a large part upon one's membership in a particular age and sex category within the household.

Food Consumption and Nutrition in Kano State

Although the studies just cited described food consumption and/or nutrition in the North of Nigeria, no study to my knowledge has studied consumption and/or nutrition in Kano State. Before discussing the results obtained from analyzing Kano State farm households, it is useful to examine some of the initial findings of Matlon which relate to food consumption and nutrition. As will become apparent, one of Matlon's interests in his study was in the relationship which exists between nutrition status and income level. His novel approach provided some interesting information and insights which served in part as a basis for conducting this more detailed consumption study. After examining Matlon's conclusions with these data in the next section, new results will be presented on consumption and caloric consumption in Kano State.

Matlon

Peter Matlon studied food flows and the amounts of calories available to Kano State farm households in different income strata.[4] He did this by first calculating the value of food crop harvests, gifts, retained seeds, and storage losses using detailed kilogram information and weighted mean harvest prices. He valued his estimates of sales of food at the actual prices received. Food purchases (the total amount of cash outlays for food) were recorded over the 12-month period. Once all of these values were calculated, he calculated the net value of food available as consisting of the value of food crop harvests, less the value of sales, or gifts, of retained seed, of storage losses plus the value of food purchases. Once these net values of food were calculated for groups in different income levels, he estimated the calorie purchasing power that these net values of available food would imply, assuming a uniform cost of calories, which he estimated by employing a figure derived by Emmy Simmons in Zaria, Northern Nigeria in 1976 and inflating it by the estimated rate of inflation over the period between the two studies. Once these net values of food available were divided by the estimated uniform cost of calories, an estimate of the calories available on a per capita basis within each income group was estimated. These estimates of the

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[4]See Matlon, 1977, pp. 277-284 for a detailed discussion.

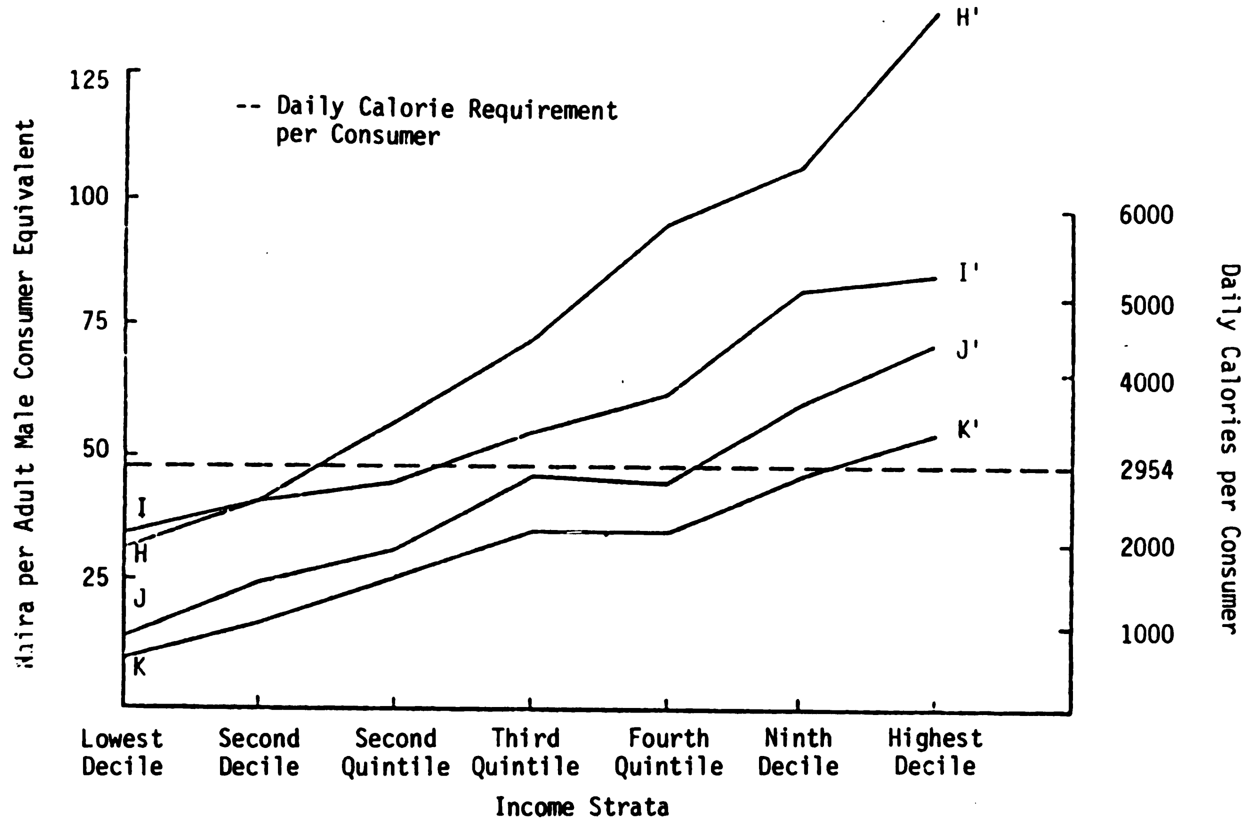
purchasing power of calories by each income group led him to conclude, first, that "domestic food crop production levels among the poorest 40 percent of households were well below the standard necessary to meet the calorie requirement of 2,954 calories per man equivalent"; second, that "even with food purchases, the first and second decile experienced calorie deficits relative to the minimum standard-deficits of approximately 25 and 15 percent, respectively"; and, finally, that "among the poorest 10 percent of households, available food, that is the retained portion of the food crop plus food purchases, exceeded the total value of all crops harvested" (Matlon, 1977, pp. 282-283; See Figure 5-1).

The Household Unit of Analysis

Before discussing household food consumption results obtained in this study, it is important to clarify what is meant by the basic unit of analysis as defined by Matlon, namely the household. The data were collected for this study according to an operational definition of a household as consisting of those "persons eating from the same pot" (Ibid., p. 44). This is the most common unit of analysis in rural economic surveys conducted among the Hausa. However, the definition of the basic unit of observation presents some problem (Ibid., pp. 43-44). The problems do not occur for "nuclear" household (49 percent of the sample) characterized by one male head of the household who exercises the production and consumption decision-making activities of the household. The problems arise in dealing with the non-nuclear, or gandu, household which are comprised of more than one male adult per household or where the decision-making responsibilities need not be

Figure 5-1

Mean Annual Levels of Crop Harvest and Available Food per Consumer by Income Strata in Naira and Approximate Daily Calorie Equivalents, Large Sample[1]



HH' = Total harvest value   II' = Available food (KK' + food purchases)
JJ' = Food crop harvest   KK' = Retained food (JJ' - sales, fits, storage losses & seed)

[1]Average values have been calculated for each income strata as the quotient of the value of each food flow within the strata divided by the total number of consumer man-equivalents in the respective income strata.

Source: Matlon, 1977, pp. 279-281.

concentrated with any one individual.[5] In the gandu household, adult males have the right to farm their own fields over which they have complete autonomy in planting and disposal decision making. Given this decentralization of power, the interviewee might not know everything related to the household's production and consumption activities. To what extent this factor may prejudice the results of this study is unknown.

Aside from the subject of household classification, two other important questions must be asked: to what extent does either of these two types of household (i.e., nuclear or gandu) remain constant in size over the course of this study, and second, to what extent do food-sharing arrangements exist for each of these two household types? Although this study provides no direct evidence to answer the first question, it is assumed that household membership remains the same throughout the survey year. Although this assumption is clearly not absolutely correct,[6] it is hoped that any changes in household membership which occur over the survey year are not significant enough to bias the regression results. Since the primary focus of this study is upon the determinants of food consumption, this definition of household size based upon one interview is satisfactory. The effect of changes in household size over the course of the study would affect any description of per capita or per consumer

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[5]The Dictionary of the Hausa Language (Abraham, 1962) defines gandu as simply "a large farm".

[6]The 1979 World Bank Atlas cites a population growth rate as 2.6 percent for Nigeria in the 1970-77 period. Changes are not being made in the existing data being analyzed to allow for the possibility of some "normal" rate of population growth such as the one cited in the World Bank Atlas. This is an approximation of what might happen to family size over the survey year.

equivalent food consumption, but since the study is principally interested in factors influencing food consumption at the household level, the omission of more precise family size and composition information covering the course of the study does not pose serious problems for the analysis. Sufficient detail about important household characteristics, including household size and composition, allows for the determination of the effect of variables of different relative sizes upon food consumption.

Food sharing arrangements on the other hand are believed to be commonplace in Hausa society and take on two forms: gifts and meal sharing. Although this study was able to obtain information on outright gifts, the extent of meal sharing and its effect upon these results is not known.

Household Food Consumption

This study confirms some of the findings discussed earlier in this chapter, particularly those having to do with the importance of sorghum and millet in the diet. Moreover, there are several important reasons why this study contributes significantly to knowledge about consumption in Northern Nigeria and to knowledge concerning the estimation of food consumption in a semi-subsistence setting of an LDC. The data are more up-to-date, cover a longer time period than any previous consumption and nutrition study in Northern Nigeria, and contain sufficient detail to enable research into the determinants of food consumption and caloric availability from some new and different points of view.

To introduce the two tables which follow it is useful to point out the differences in the data collection process used in the two samples. Both the small and the large sample data were collected over the May 1974 through May 1975 period but at different time intervals. The small sample household were interviewed far more frequently than the large sample households and the period of recall for the small sample households was seldom beyond a week. In addition, the small sample harvest kilogram weights were almost entirely obtained in a manner which allowed for weight variations to occur by farmer's field or by farm even though the commodity, unit and quantity remained unchanged. This was not the case for the large sample harvest kilogram weight estimates. Since the period of recall was shorter for small sample households and since the manner of obtaining kilograms harvest weight estimates was believed to be more precise for the small sample, the small sample results are believed by the author to be more accurate from a descriptive point of view. It is possible, of course, that frequent interviews may bias the data because the responent becomes eager to please an interviewer. Such a possibility, however, seems much less important than either duration of the recall period or estimation of harvest weights. A comparison of the mean results for important variables from each sample is found in Table 5-1.

The reader will recall that the evening and breakfast meals contain primarily sorghum or millet porridge, (i.e., tuwo dawa or tuwo gero) palm oil and a vegetable and the noon meal primarily consists of processed millet balls (i.e., fura/hura and soured milk i.e., nono). The importance of all of these foods in the diet is indicated in the figures contained in Tables 5-2 and 5-3. Sorghum is the dominant cereal by far in the diet with early millet also playing an important role. Early millet is the dominant form of millet consumed and it is highly prized because it is the first crop harvested in the agricultural year and the first

Table 5-1

Mean Values of Selected Variables by Sample

Variable	Sample: Small Mean	Large Mean	Combined Mean
Household Characteristics[1]			
Household size	7.2	6.7	6.8
Children, under 5 years	1.0	1.0	1.0
Children, 5-9 years	1.0	1.0	1.0
Boys, 10-15 years	.4	.7	.6
Girls, 10-15 years	.4	.3	.4
Men , 16-49 years	1.5	1.3	1.3
Women, 16-49 years	2.0	1.7	1.8
Men over 49 years	.4	.3	.3
Women over 49 years	.5	.3	.3
Age of Head	44.4	39.6	40.8
Percent of heads literate	.4	.4	.4
Number of adult female wives	1.7	1.4	1.5
Caloric Requirements/Day/Household	17,484	16,014	16,141
Prices[2]			
Sorghum	.08	.08	.08
Early Millet	.08	.08	.08
Late Millet	.05	.05	.05
Maize	.10	.10	.10
Rice	.07	.07	.07
Cowpeas	.04	.04	.04
Palm Oil	.44	.44	.44
Tomatoes	.05	.05	.05
Nono	.11	.11	.11
Expenditures/Year/Household[3]			
Value of subsistence consumption	112.2	84.5	91.4
Market expenditure	246.6	209.0	218.4
Total expenditure	358.8	293.5	309.8
Matlon's Estimate of Income[4]/ Year/Household	418.7	347.7	365.48
Number of Gandu Households	16	45	61
Number of Nuclear Households	17	54	71
Total Number of Households[5]	33	99	132

[1]In numbers unless otherwise specified.

[2]Quantity-weighted average annual prices in Naira per kilogram (see the discussion of prices in Chapter VI). One Naira = U.S. $1.64 in 1974-75.

[3]In Naira.

[4]Net household income is defined as the total value in Naira of farm production, less the imputed cost of or actual expenditures on seed, cuttings, fertilizers and hired non-household farm labor, less actual expenditures on land, plus receipts from off-farm occupations, less reductions in inventories of items being traded.

[5]Excludes one small sample household.

Table 5-2
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)	% of Consumption Available from Production[2]	% of Production Available for Consumption[3]	Quantity Consumed Mean Over Consuming Households (in KGS)	% 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, Burodi	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, Vegetable Products, Fruits					
Tomatoes, Tumatur	71	24	83	73	97
Onions, Albasa[4]	0	-	-	1	36
Okra, Kubewa	64	83	84	68	94
Pumpkin, Kabewa	88	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	53	71	9	52
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 amounts consumed were based only on purchases and in-kind flows. Estimates of food retained from home production were not used because of questionable validity.

Table 5-3
Mean Amount Available for Annual Household Consumption from All Sources by Commodity--Large Sample, Kano, Northern Nigeria[1]

Commodity	Quantity Consumed Mean Over All Households (in KGS)	% of Consumption Available from Production[2]	% of Production Available for Consumption[3]	Quantity Consumed Mean Over Consuming Households (in KGS)	% of All Households Consuming
Cereal					
Early Millet, Gero	85	91	64	85	100
Late Millet, Maiwa	19	100	65	35	54
Sorghum (Guinea Corn), Dawa	839	92	78	839	100
Maize, Masara	19	96	69	27	68
Rice, Shinkafa	27	52	43	58	46
Cereal Products					
Millet Porridge, Tuwo Gero	0	*	*	0	0
Millet Flour, Gari	1	*	*	11	6
Thin Porridge, Koko/Kunu	25	*	*	84	30
Processed Millet, Hura/Fura	120	*	*	152	79
Sorghum Porridge, Tuwo Dawa[4]	5	*	*	42	11
Waina, Nakiya	1	*	*	5	17
Corn Flour	0	*	*	0	0
Rice (Cooked)	0	*	*	11	4
Rice Porridge, Tuwo Shinkafa	0	*	*	3	1
Bread, Burodi	0	*	*	4	8
Biscuits	0	*	*	4	1
Starchy Roots and Tubers					
Cassava, Rogo	40	82	51	136	30
Yams, Doya	1	93	24	38	3
Local Potatoes, Dankali	10	84	77	50	20
Cassava (Cooked)	6	*	*	20	33
Cassava (Flour), Garin Rogo	1	*	*	14	7
Legumes, Legume Products, Nuts					
Cowpeas, Wake	43	94	80	43	99
Groundnuts, Gyada[4]	0	-	-	1	8
Bambara Nuts, Gurjiya	3	100	89	55	5
Locust Beans, Kalwa	6	5	86	20	28
Cowpea Cake, Kosai	1	*	*	2	33
Cowpea Dumpling, Dan Wake	1	*	*	5	11
Groundnut Cake, Kuli Kuli	9	*	*	15	57
Groundnuts (Fried)	0	*	*	0	0
Locust Bean Cake, Daddawa	20	*	*	21	95
Kolanut, Goro	5	*	*	7	76
Vegetables, Vegetable Products, Fruits					
Tomatoes, Tumatur	65	11	87	85	77
Onions, Albasa[4]	2	-	-	6	24
Okra, Kubewa	70	65	85	81	87
Pumpkin, Kabewa	50	95	89	126	40
Calabash, Kwarya	22	100	90	216	10
Cabbage, Kabeji	0	100	63	1	1
Fresh Pepper	6	44	83	11	52
Dried Pepper	11	100	21	17	65
Baobab Leaves, Kuka	1	0	100	4	32
Horseradish Leaves, Zogalle	2	40	79	6	41
Gawuta	5	79	65	27	17
Vegetables (Others)[5]	22	99	88	41	53
Oranges, Lemon Zaki	0	0	0	5	3
Mangoes, Mangwaro	2	54	90	9	18
Guava	0	0	0	1	1
Lemon	0	0	0	0	0
Lime	0	0	0	0	0
Pawpaw	0	100	100	14	3
Banana	0	0	0	2	1
Tamarind	0	0	0	0	0
Meat, Fish, Milk Products					
Fish	0	*	*	0	0
Meat (Unspecified), Nama	32	*	*	32	100
Roasted Meat, Tsire	2	*	*	5	29
Eggs	0	*	*	0	1
Soured Milk, Nono	94	*	*	98	96
Butter, Mai Shanu	4	*	*	10	38
Milk (Evaporated, Tinned)	0	**	**	0	0
Milk	0	*	*	2	5
Miscellaneous					
Palm Oil, Manja	17	*	*	17	100
Groundnut Oil, Man Ruruwa	2	*	*	4	48
Shea Butter Oil	0	*	*	0	4
Salt, Gishiri[6]	0	0	0	0	0
Sugar, Sukar	0	0	0	0	0
Sugar Cane, Rake	153	54	33	349	44
Honey	0	*	*	0	0
Sweets	0	**	**	0	8
Coke	0	**	**	0	0
Tea	0	**	**	3	2
Beer	0	*	*	2	1
Maggi Cubes	0	**	**	2	3
Ginger, Citta	1	**	**	13	5
Spice, Kalkashi	0	**	**	4	3
[illegible], Cloves	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]Estimate 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 amount consumed were based only on purchases and in-kind flows. Estimates of food retained from home production were not used because of questionable validity.

crop able to ease any "seasonal hunger" which might exist. The role of late millet is less clear. Every household consumed sorghum and early millet and half or more consumed late millet.

Since this study uses the disappearance method to estimate the amount of cereals which are retained from home production and since there was no recorded information about the amount and form of final cereal consumption, the problems of double-counting of estimates did not arise. For cereal products in particular the quantities consumed reported in these two tables represent consumption from all sources other than home production. These cereal product consumption records are incomplete, however, because information concerning food purchases out of income earned by female entrepreneurs was not collected. The most important cereal product in the diet, fura/hura (a processed millet ball) is consumed extensively in both samples, both in terms of the mean quantity consumed over all households and in the percentage of households consuming in the sample.

Cowpeas are consumed by over 90 percent of the households and they are used most commonly in kosai (fried batter of cowpea flour, sometimes spiced with onions or hot peppers) and dan wake (boiled cowpea dumplings), two widely consumed snacks in the area. Daddawa (locust bean cakes) are also popular, purchased by almost every household. Tomatoes are the most widely consumed vegetable according to the small sample results. Almost every household purchased some high protein food source, either meat or nono (soured milk), the latter being mixed with fura/hura. Likewise, almost every diet included palm oil, used in preparing the morning and evening meals as well as many of the processed foods produced by female entrepreneurs.

Percentage of Consumption Retained from Household Production

The percentages of consumption retained from household production which are listed in column two were calculated as the ratio (expressed as a percentage) of the sum over all households of the quantities available for consumption from own production for each household to the sum over all households of all quantities consumed. The computer placed a ceiling of 100 upon these calculations, even though in principle these percentages could have exceeded 100. The presence of extremely high percentages, and in particular 100, does not imply that households did not purchase any of that food from the retail market, as might appear to be the case. The sum of all quantities consumed often included negative amounts of consumption from in-kind receipts, because gifts given, loans made and wages paid out in kind exceeded gifts, loans and wages received in kind, and these negative quantities could completely offset the positive contribution to consumption which could be attributed to food purchases.

Almost all the cereal grains consumed are produced by the consuming household. The large sample results indicate that rice is an exception with only 52 percent of consumption being available from own production. The other items consumed in large part out of own production are cassava, yams, local potatoes, cowpeas, bambara nuts, pumpkin, calabash and dried peppers. These results indicate that for the most important items in the diet, at least the majority of food consumed is produced by the same farm households.

Percentage of Production Retained for Household Consumption

The question addressed in the previous section dealt with how important the quantities of home produced foods are in the total diet compared to quantities of the same foods consumed from other sources. This section addresses the different question about how much of output that is produced on the farm is ultimately consumed by the producing household.

Most of the cereal grains produced are consumed within the producing household, with rice being an exception. For cereals other than rice the proportion of production not consumed by the producing household ranges from 8 percent for maize (in the small sample) to 36 percent for early millet (in the large sample). These excesses over own consumption are available for other purposes, primarily sales.

The amount of grain marketed is influenced by several factors. All crops could be sold to ease cash constraints arising out of household requirements, however, early millet is more likely to be sold to ease a seasonal cash constraint experienced by the farm household. Longhurst (1979, p. 14) states that sorghum is more profitable to produce than the crops traditionally viewed as cash crops, because producers have more control over the timing of sales. This is true not only because sorghum need not be sold to a government purchaser but because sorghum has favorable long-term storage properties. Polly Hill, an anthropologist, has suggested (1968, p. 246) that farmers might be ashamed to admit to being grain sellers (from their own production), although Matlon later found no evidence of this in this sample.

Comparison of Estimates of Calories Available per Consumer Equivalent by Income Groups Using Food Estimates

As was discussed earlier in this chapter, Matlon estimated the level of calories available to consumers at various income levels in the large sample by dividing the total value of food available by a uniform cost of calories measure. Since he did not obtain his estimates of calories available directly, it was possible to compare the estimates which he obtained using his method with calorie estimates obtained by a method which examined directly the calorie content of foods which were actually available for consumption. Moreover, since Matlon's estimates suggest that consumers in the lower income strata do not have enough calories available to meet daily recommended caloric intakes, it seemed sensible to examine further whether or not this was the case by calculating for the large sample new estimates based on a direct method of obtaining caloric estimates of consumption.

Obtaining these estimates requires translating into nutrients the amounts of different foods available to the household which are expressed in kilograms. A nutrient availability matrix can be defined by the following equation:

$$E = Q - R$$

where

E is an ixh matrix of i foods with e_{ih} being the element which is the edible portion of the i^{th} fppd available to household h,

Q is an ixh matrix of i foods with q_{ih} being the element which represents the amount of food i available to household h, and

R is an ixh refuse matrix of i foods with r_{ih} being the refuse associated with the i^{th} food for household h.

Then let

$$A = C \cdot E$$

where

A is a 1xh caloric availability vector with element a_{ih} being the amount of total calories available to household h, and

C is a 1xi calorie composition matrix with C_{1i} being the amount of calories contained in food commodity i.

The matrix A then must be divided by some measure of household size in order to provide a measure of the amount of calories available to individual household members. Since households do not have identical age-sex profiles it would be somewhat misleading to measure consumption on a per individual (i.e., per capita) basis by simply dividing A by the number of individuals living in the household. Rather, it is preferable to use a scale such as a consumer equivalent scale which takes into account the fact that the consumption needs of household members are different. The consumer equivalent scale which was selected for use at this stage of the analysis was the one which was used by Matlon. This scale is presented in Table 5-4. As Matlon points out "these coefficients reflect very closely the relative standard calorie requirements of each age and sex group suggested by the FAO (Food and Agriculture Organization of the United Nations)" (Matlon, 1977, p. 61).

Figure 5-2 makes a comparison between Matlon's method and the caloric availability method just discussed. Comparisons were made using the large sample households. Line AA' represents the new estimate of the mean level of calories available to consumers at various income levels. These estimates are uniformally lower than those made by Matlon represented by the line II'. The fundamental difference in level which

Table 5-4

Coefficients Applied to Estimate the Number of Adult Male Consumer-Equivalents per Household[1]

	Age			
	0-4	5-9	10-15	16+
Male	.2	.5	.75	1.0
Female	.2	.5	.7	.75

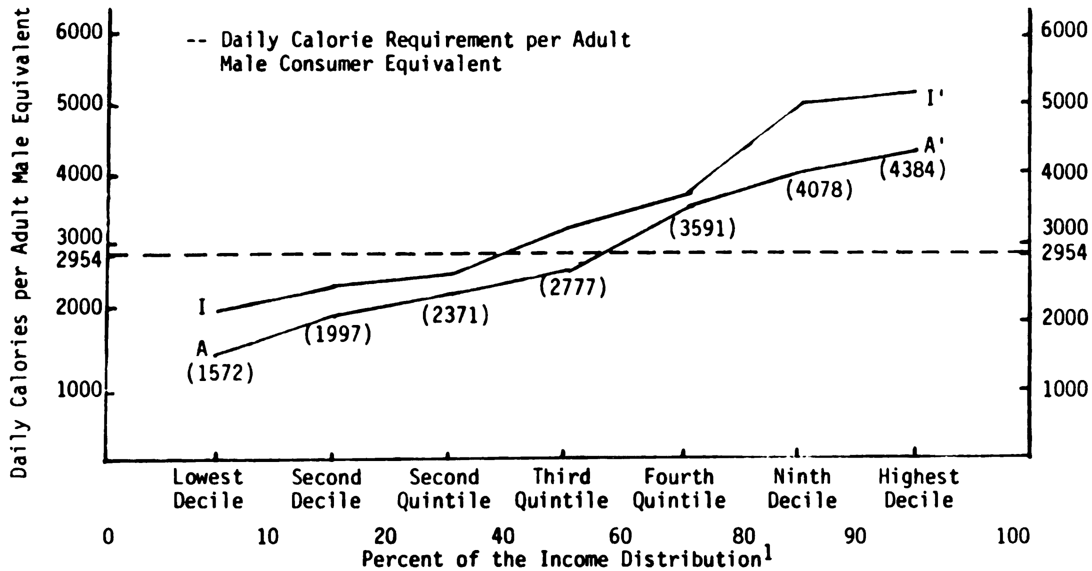
[1]Source: Matlon, 1977, p. 61.

exists between the two lines may be explained to some extent by the manner in which they were derived and in the components of consumption they represent. Aside from the differences in method which have been discussed, it is important to point out also that Matlon's estimates do not include estimates of certain food flows into or out of the household. His estimates do not take into account wages received and paid out in kind from the household, loans paid out and received in kind or loan repayments paid out and received in kind. Moreover, his definition of retained food, which subtracts out gifts paid out in kind, does not appear to be offset by the inflow of food gifts into the total available food component. Although there is no reason to suppose that these flows constitute the bulk of consumption, they may become very important to household consuming food at close to subsistence levels.

Apart from these differences, the two lines are actually quite similar. Three features are immediately apparent. First, it indicates that approximately the lowest 60 percent of the income scale do not consume a sufficient amount of calories to meet caloric needs on a per adult

Figure 5-2

Calories Available for Consumption per Consumer by Income Strata in Naira by Actual Food Estimates and by Using a Uniform Cost of Calorie Figure



[1]Classified by Naira per adult male consumer equivalent. These were calculated here to be ₦30 for the lowest decile, N40 for the second decile, ₦50 for the second quintile, ₦64 for the third quintile, ₦85 for the fourth quintile, ₦110 for the ninth decile and ₦167 for the highest decile.

II' - Average values have been calculated for each decile and quintile of the income distribution as the quotient of the total value of available food within the strata, i.e., food purchases plus food harvested less food sales, gifts, storage losses and seed, divided by the total number of adult male consumer equivalents in the respective income strate and by ₦.0442.

AA' - Average values have been calculated for each decile and quintile of the income distribution as the quotient of the total amount of calories available per adult male consumer equivalent for all of the households in the income strata divided by the number of households in the income strata. The amount of calories available per adult male consumer equivalent for each household is equal to the calorie equivalent of food purchases plus food harvested less food sales, losses in storage and seed, and then adjusted for net inflows or outflows of calories from loans and wages in kind divided by the number of adult male consumer equivalents. Calorie intake levels are represented in parentheses.

male consumer equivalent basis. The caloric need level assumed by Matlon to be 2954 calories per day is again used as the standard recommended intake level.[7] Second, these estimates indicate that caloric availability per consumer shows a strong positive relationship with income. Third, consumers in the highest income decile consume almost three times the number of calories as those in the lowest income decile, meeting one and one-half times their recommended level of calorie consumption. In contrast the consumers in the lowest income decile consume approximately one-half of their recommended level of calorie consumption.

It is apparent that the uniform cost of calories figure used by Matlon was associated with calorie estimates which were consistently higher than those calorie figures obtained using actual amounts available. Since these latter amounts represent what was actually available for consumption, they are functions of the actual costs for the foods consumed and not of their estimated costs. If the uniform cost of calories used by Matlon were somewhat higher however, then the results which he obtained would have been lower and would have conformed more closely to the results obtained using actual food estimates. Moreover, if one considers only the slope of these lines and not their absolute levels, then it is worth noting how surprisingly well the results obtained from the approach using a uniform cost of calories compares with the results obtained from the approach which does not make such a restrictive assumption about the cost of calories at various income levels.

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[7]Matlon used an average daily per capita requirement of 2009 calories. Converted to consumer man equivalents a daily requirement of 2954 calories per consumer was estimated (Ibid., p. 280).

The percentages of recommended caloric intake levels which are met were also compared. This approach differs from that employed in Figures 5-1 and 5-2 in that these recommended levels are based on average household intake levels by village. The results in Table 5-5 are obtained by first taking the mean quantities of all foods available in consuming households in Table 5-2 and 5-3, converting these figures into their caloric equivalent and adding these converted figures for all foods. These two figures, one for each sample, were then expressed as a percent of mean daily recommended household caloric intake levels for each village and for all villages combined for both the large and the small samples.

The individual household caloric requirements levels were based upon recommendations given in the 1977 Food and Agriculture Report entitled Handbook on Human Nutritional Requirements. Since age and sex specific information about household membership was collected the total caloric needs for each household was obtained first by multiplying the number of people in each of these age and sex specific categories by the caloric intake levels appropriate for each age and sex specific category and then simply adding these results. Suggested caloric intake levels for each of these age and sex categories are presented in Table 5-6.

It is interesting to note that the average percent of recommended intake levels met in each sample indicates a widespread shortfall of caloric availability relative to village level average household requirements and that the percent of recommended levels met by average village households is in exactly the opposite order when the large and the small sample results are compared.

Table 5-5

Mean Daily Household Recommended Caloric Intake Levels and Consumption for Farm Households in Kano State, Northern Nigeria (1974-1975)

Sample	Village	Mean Recommended Caloric Intake Levels per Household[1] (in Calories)	Mean Amount Available per Household[2] (in Calories)	Mean Amount Available as % of Recommended Caloric Intake Levels (per Household)
Large	Zoza	13,434	11,770	88
	Barbeji	15,567	11,770	76
	Rogo	19,273	11,770	61
	All Villages	16,014	11,770	74
Small	Zoza	18,693	13,934	75
	Barbeji	17,374	13,934	80
	Rogo	16,275	13,934	86
	All Villages	17,484	13,934	80

[1] Calculations were based upon individual household requirements which were calculated by using detailed available age and sex composition information for each household and caloric intake levels for each of these age and sex categories as obtained from the Food and Agricultural Organization's Handbook on Human Nutritional Requirements (See Table 5-6).

[2] Mean total amounts of every individual food consumed by households in the large and small sample (Tables 5-2 and 5-3) were converted into their caloric equivalent by using the Food and Agricultural Organization's Food Composition Table for Use in Africa (1968). Total amounts were calculated as the amount purchased plus food harvested less food sold and lost in storage and then adjusted for net inflows or outflows from loans and wages in kind. Mean amounts for all villages combined are used for village specific mean amounts which were not calculated.

Table 5-6

Individual Daily Caloric Requirements Levels by Age and Sex-Specific Category[1]

Age	Sex	
	Male	Female
Younger than 5	1346	1346
5 or older and younger than 10	2046	2046
10 or older and younger than 16	3300	2904
16 or older and younger than 20	3070	2310
20 or older and younger than 50	3090	2125
50 or older	2850	2068

[1]Taken from the Handbook on Human Nutritional Requirements of the FAO (1974). Adjustments were made to fit the age and sex specific categories of the study households. This was done because Table 1 in the Handbook on Human Nutritional Requirements lists the energy needs of age and sex categories different from the age and sex categories available in this research. For example, the energy needs of children under five are represented in Table 1 in three groups: under one, between the ages of one and three and between the ages of four and six. In order to calculate the requirement for the group used in this study "younger than five" a new requirement was calculated by using a simple weighting procedure with each year in the new age bracket receiving an equal weight. This calculation for the children under five group was as follows:

Ages	Weight	x Requirements		
Less than 1	.2	820	=	164
1 or older and less than 2	.2	1360	=	272
2 or older and less than 3	.2	1360	=	272
3 or older and less than 4	.2	1360	=	272
4 or older and less than 5	.2	1830	=	366
				1346

Calculations for the other age and sex specific categories were calculated in a similar manner.

Table 5-7

Percent of Daily Household Recommended Caloric Intake Levels Derived from All Foods by Village and Income Level for Selected Farms in Kano State, Northern Nigeria (1974-1975) (Large Sample)[1]

Village	Household Income Level (by Decile)	Percent of Total Recommended Caloric Intake Levels Met on an Individual Household Basis
Zoza	Lowest	69
	Highest	218
Barbeji	Lowest	48
	Highest	170
Rogo	Lowest	57
	Highest	167
All Villages	Lowest	61
	Highest	208

[1]Calculations of Recommended Caloric Intake Levels were calculated by using detailed available age and sex composition information for each household and caloric intake levels for each of these age and sex categories as obtained from the Food and Agricultural Organization's Handbook on Human Nutritional Requirements. Mean total amounts of each food consumed by households were converted into their caloric equivalent by using the Food and Agriculture Organization's Food Composition Table for Use in Africa (1968).

Table 5-7 provides a more detailed descriptive breakdown for the large sample by comparing the percent of recommended caloric intake levels met on an individual household basis when households are grouped by village as well as by the highest and lowest income deciles within villages. Upon examining the percent of total recommended caloric intake levels met on an individual household basis for the lowest and highest income levels the evidence suggested that low income households in each village experience inadequate levels of calorie consumption and that high income households experience satisfactory levels of caloric consumption. The entire group of large sample households in the lowest income decile meet on the average only 61 percent of their recommended daily calorie intake level, whereas the highest income households on the average meet 208 percent of their recommended calorie consumption levels. High income households meet their recommended caloric intake levels on the average three and one-half times above the level at which low income households fail to meet their recommended caloric consumption levels.

The evidence presented in this section supports the conclusion that lower income households do experience low levels of calorie consumption both in absolute and relative terms. It must be pointed out, however, that a portion of consumption which might raise these levels somewhat, namely that related to female earnings and their associated purchases, was not included in this analysis. The subject of calorie consumption levels will be addressed again and in greater detail in Chapter IX when calorie regression equations will be estimated using both large and small sample data.

CHAPTER VI

THE FUNCTIONAL FORM, VARIABLES AND PROCEDURE FOLLOWED IN THE SINGLE-EQUATION FOOD COMMODITY ANALYSIS

This chapter will address the following issues: the functional form of the equations used, the variables chosen for consideration and the variable selection procedure. The following chapter will discuss the results obtained from the single-equation consumption equations.

The Functional Form

Various functional forms were possible but several selection criteria quickly narrowed the search. The first was that the form allow for the possibility of negative estimates of consumption. The second was that the form had to be flexible enough to allow for the estimation of elasticities which vary with income. The third criterion was that the form preserve the theoretical property of zero homogeneity of prices and income.

It was important in this study to allow for the possibility of negative estimates of food consumption, and therefore of the dependent variable, for two very essential reasons. First, since the study begins with an assumption that <u>some</u> food inventories exist, it is possible for some households to have negative consumption estimates over the period studied if food sales and other in-kind outflows are greater than all of the available food inflows into the household (i.e., harvest, purchases, gifts received, etc.). This is unlikely to occur with major food items but not out of the realm of possibility. Secondly, a normal distribution of measurement errors might result in some low, possibly negative, consumption estimates. As was discussed in the section on the estimate of food retained from home production in Chapter IV, a statistical bias would occur if editing removed all cases of negative estimates. This position can best be explained by stating that there is no absolute assurance that the negative estimates are caused by measurement errors, and, even if they were, there is no way to identify and remove positive measurement errors. To remove only negative measurement errors, even if correctly identified, would alter the assumed normal shape of the distribution of errors. Furthermore, in analyzing food consumption by the sources by which it enters the household (Chapter VIII), we expect negative consumption figures for food which is exchanged either as a gift, loan, or wage paid in ind, whenever the total amount of gifts, loans and wages paid out exceed the total amount of gifts, loans and wages received. Since a source equation with these components was to be estimated for sorghum, the capacity to handle negative figures was important. For these reasons, functional forms which treated the dependent variable logarithmically were not selected for this analysis.

The second requirement, which necessitated choosing a functional form which would not result in constant elasticities, was that the Engel function within the overall equation be non-linear. Functional forms which treated the independent variables logarithmically were therefore not selected for this analysis.

A form was selected which satisfied the zero homogeneity in prices and income requirement as well as the two others. The form was arithmetically linear in relative prices and expenditure (income) with the addition of one quadratic expenditure (income) term. The basic model from which this specific functional form is derived is:

$$q_{ih} = f(Y_h, P, C_h, S_h, M_h) \qquad (6.1.1)$$

where

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

Y_h is the total expenditure (income) of household h during the year,

P is a vector of 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 stated explicitly is:

$$q_{ih} = \alpha_i + \sum_{j\neq i} \alpha_j (P_j/P_i) + \beta_1 (Y_h/P_i) + \beta_2 (Y_h/P_i)^2 + \sum_n \gamma_n C_{hn} + \sum_m \lambda_m S_{hm} + \sum_o \mu_o M_{ho} \qquad (6.1.2)$$

The intercept term, α_i, is the coefficient of the own-price term (i.e., P_i/P_i) which does not appear explicitly in this formulation. As a consequence, the size of the own-price elasticity is not readily apparent as it is with such forms as, for example, the log-log. The influence of own-price upon the quantity consumed occurs through the relative price and expenditure variables and the constant term.

Conventional Demand Variables

Expenditure

Two measures of income that could be employed in this analysis are net household income and current total expenditure. Current total expenditure is selected as the better measure to use for the income variable in the following analysis because it conforms more closely to the economic theory of consumption behavior. It is regarded as a better approximation of the unobservable 'permanent income' which Friedman (1957) argues is the true determinant of 'permanent consumption'.[1] There are several reasons for this. Using a total expenditure measure avoids having to derive a savings component, which should be included in a measure of net current income. Also, it does not have the same deficiency as net current income which does not include any measure of the household's wealth. Brown and Deaton (1972, p. 172) point out the problem of including savings in the measurement of income (which is even more difficult in LDCs) and the misleading nature of an income measure which does not take into account the fact that household wealth is in general positively correlated with current income. Therefore, they recommend treating "the income variable as though it were identical with total expenditure on consumer goods and services" (Ibid.). Total household consumption expenditure is commonly used by many researchers (see, for example, Timmer and Alderman, 1979). It is defined in detail in Table 6-1. It includes cash expenditures as well as the value of subsistence consumption at farm gate prices and the value of the net amount of food gifts received by the household.

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[1]Friedman uses the terms 'permanent income' and 'permanent consumption' as the concepts relevant to theoretical analysis (pp. 10-11). Duesenberry proposes a different hypothesis, that consumption is not dependent on the absolute level of current income alone but must also take into account "current income relative to past income" (Duesenberry, J., 1969, p. 91). If this hypothesis were true, total expenditure would be preferred to net current income as an appropriate measure of consumption.

Table 6-1

Definition of Expenditure

I. Cash Component

The total expenditure by the household upon:

- Food and Drink
- Cloth and Clothing
- Home Construction and Maintenance
- Fuel and Light
- Household Goods
- Ceremonies and Gifts
- Taxes, Licenses and School Fees
- Other Miscellaneous Items (e.g., soap, pomade)

II. Implied Value Component

The following food components valued at local farm-gate prices:

- Net Amount of Food Available from Own Production
  (i.e., domestic production less sales less seed use less estimated storage loss)
- Net Amount of Food Gifts
  (i.e., gifts received less gifts given)
- Net Amount of Wages in Kind
  (i.e., kind payments received less kind payments to others)
- Net Amount of Loans in Kind (either borrowed or repaid)
  (i.e., loans in kind received less loans in kind extended)

Prices

All prices are derived so that exogeneity is maintained. Prices are annual quantity weighted village level prices, assumed to be exogenous to the household. Unfortunately, it was not possible to calculate a meaningful non-food price because the necessary data were not collected.

Several important criteria had to be satisfied in calculating the retail prices. First, these prices had to be calculated in the same way for all the foods for which retail prices were needed. Second, prices based upon observations from as many different points in time as possible were preferred in order to avoid some of the possible bias introduced if the estimated prices were collected at unrepresentative times.[2] The retail prices which were implicit in the farmer's recollection of amounts paid and quantities purchased satisfied these dual criteria. These retail prices were obtained by dividing the total annual expenditure upon each commodity within each village by the total quantity (in kilograms) purchased within that village during the year. The market price of the i^{th} good is defined as follows:

$$P_i^m = \frac{\sum_{jk} P_{ijk}^m \cdot q_{ijk}^m}{\sum_{jk} q_{ijk}^m}$$

where P_{ijk} is the price paid by the j^{th} household in the k^{th} transaction for the purchase of q_i.

The farm gate prices were also calculated as quantity weighted prices with the farm gate price of the i^{th} good defined as follows:

$$P_i^f = \frac{\sum_{jk} P_{ijk}^f \cdot q_{ijk}^f}{\sum_{jk} q_{ijk}^f}$$

The quantity-weighted overall prices for each of the i commodities were calculated in the following manner:

$$P_i^a = \frac{\sum_{jk} P_{ijk}^f \, q_{ijk}^f + \sum_{jk} P_{jk}^m \, q_{ijk}^m}{\sum_{jk} q_{ijk}^f + \sum_{jk} q_{ijk}^m}$$

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[2]This ruled out using the retail prices which were calculated by Peter Matlon. His retail prices were not available for all foods purchased and they were based upon observations obtained in each village at one point each month.

with the numerator representing the sum of the values of the amount of q_i retained from home production for food consumption and the value of the amount of q_i purchased from the market. The denominator is the total kilogram estimate of q_i consumed from own production and market purchases by household j throughout the year.

Household Characteristics

The following household characteristics were examined in this study: type, size and composition, characteristics of the head, and ethnic background.

Household type, discussed in a previous section, was classified into either nuclear or gandu households. As Matlon states "Gandu households cover a range of domestic arrangements which defy any single definition. Most generally, gandu units can be characterized as households which include two or more male adults, often married, with their wives and children (Matlon, 1977, p. 44). Household type is specified in the analysis with a binary variable.

The household size and composition variables were HHS for household size and IAT, YCH, OCH, MAD, WAD, and OAD for household composition. IAT represents the number of infants and toddlers of both sexes from birth to age four inclusive. YCH is the variable for the number of young children of both sexes from ages five through nine. The variable for the number of older children of both sexes from ages 10 through 15 is OCH. OAD is the last non-sex-specific variable used; it represents the number of adults residing within the household who are over age 50. The last two household composition variables, MAD and WAD, are sex-specific. MAD represents the number of male adults between the ages of 16 through

49 and WAD represents the total number of wives of all adult males living with the household between the ages of 16 and 49. This leaves the number of female adults who are not wives of one of the adult males unrepresented by a variable. If this were included, the numerical value of the household composition variables when added would equal the numerical value of the variable HHS.[3] Since one purpose of the analysis was to use the size and composition variables together so as to detect whether size or composition or both influenced the composition of important foods, the following procedure was followed. If a household composition variable was to be examined with HHS also being included as a variable in the equation, then net additions to family composition, when added to the values of all the other household composition variables, could not exceed the value of HHS. In order to accomplish this and to avoid the problem of perfect multicollinearity, a composition variable therefore had to be omitted. As a result, the interpretation of any unit increase in a household composition variable for this analysis has to take into account the fact that the number of adult non-wives, the unspecified variable in the equation, has to offset directly the unit increase so that household size remains unchanged.

Two variables were included to measure what effect characteristics of the household head might have upon food consumption. HHAGE is a continuous variable which measures the age of the household head and LITERAT is a binary variable which indicates whether the household head is literate (in either Hausa or Arabic) or not.

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[3]If all household characteristic variables were included along with HHS, then the household characteristics variables would have been a perfect linear combination of HHS. With perfect multicollinearity matrix inversion is impossible and the regression parameters cannot be estimated.

Two ethnic variables are specified: FUL and MAOTH. FUL represents Fulani tribal membership whereas MAOTH represents Maguzawa or any other non-Hausa tribal membership. The overwhelming proportion of households in this study are Hausa. Hausa membership is indicated whenever both the binary variables FUL and MAOTH are set equal to zero.

Production and Market-Side Variables

In addition to the conventional variables used in demand analysis, there are some variables new to consumption analysis which will examine questions of particular importance for semi-subsistence households. These new variables which this study suggests as being important ones to examine in the consumption context of semi-subsistence households can be classified into two types: consumption source variables and market-orientation variables. The former variables will vary from commodity to commodity as well as from household to household, whereas the latter variables will vary only from household to household.

Share of Consumption Available from Own Production

The first of the two source variables which will be examined is the share of consumption (of specific foods) available from own production. This variable attempts to examine the extent to which household consumption is influenced by the household's activities as a firm, or if you will, by the supply side of the household's behavior. The variable is constructed for each food by dividing the total amount of food consumption by the amount of that food which is retained from home production.[4] The variable attempts to represent the extent to which a household

[4]These two terms have been defined in Chapter IV in the section "Components of Total Food Consumption".

relies directly upon its own food production as a source of consumption and the extent to which this direct reliance upon internal food supply is associated with the consumption level of that commodity.

One important question to address in using such a variable is the extent to which this source variable is or is not an exogenous influence upon consumption. The reader will note that for the single-equation total regressions which appear in the following Chapter, the dependent variable total consumption (in kilograms) of a food commodity by household, will be identical to the denominator of both of the source variables. This relationship between the variables violates one of the fundamental assumptions of ordinary least squares estimators, namely that the random variables are distributed independently of the error term (i.e., $E(X_{it}U_t) = 0$). As a result of including these source variables, there is a contemporaneous correlation and the parameter estimates no longer remain unbiased. However, alternative estimators with desirable small-sample properties cannot in general be determined (Kennedy, 1979, p. 94). Some bias is therefore introduced as a worthwhile price for being able to test the hypothesis that an increase in the share of food consumed which comes from home production is significantly associated with food consumption in a positive way. It should be pointed out, however, that this variable may be relatively constant through time and reflect the household's preference towards the different food sources from which its food can be obtained.[5] Whether or not this hypothesis were rejected, the variable, although still not exogenous in an econometric sense, is nevertheless an important preference variable to

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[5]This hypothesis could be tested if time series information were available.

include in food consumption analysis of semi-subsistence farm households.

Share of Consumption Available from Off-Farm Non-Market Sources

One of the categories of food consumption contains food from all sources other than one's own farm and the food market. These sources are gifts, loans and wages paid in kind. Although loans and wages are obtained from separate markets, the principal market is the food market. The reference made through this study to off-farm non-market souces will be a reference to these net amounts of gifts, loans and wages received in kind. As was mentioned earlier, this category may be important for certain foods and for certain households.

From this category the share of consumption available from off-farm non-market sources variable is derived by dividing the net amount received from these sources by the total amount consumed. However, as was the case with the share of consumption available from own production variable previously discussed, the distribution of the independent variable is not entirely independent of the error term, therefore resulting in biased parameter estimates. Nevertheless this variable can test a similar hypothesis to the one tested by the home production source variable, namely whether or not households which primarily obtain most of their food from off-farm non-market sources are significantly better off nutritionally than those that do not.

Market Orientation Variables

The two variables discussed in the previous two sections are variables which will not only vary among households, but will vary among food commodities as well. The market orientation share variables are household specific but will not vary when different foods are studied. These variables are designed to reflect the degree to which households as firms market their output as opposed to the degree to which households purchase their food. The total value of sales as a percentage of the total value of harvest output, SSHO, and the value of groundnut production as a percentage of the value of total harvest output, SHOG, are the two market orientation variables used in this analysis.

The first variable compares total sales and harvest values for each household in order to determine how heavily market oriented a household happens to be. As this variable increases, the degree of market involvement also increases. When this variable varies across households, it provides one useful test of the hypothesis that food availability declines as the extent of market participation increases. The second market orientation variable, the value of groundnut production as a percentage of the value of total harvest output, is another variable which tests the same hypothesis, but in a slightly different way. This variable, which compares harvest values within each household, relates the harvest value of the most important cash crop, groundnuts, to the harvest value of all crops. Presumably households for which this variable is large are more market oriented than others, but a market oriented household could also be one that sells a large fraction of its output of crops other than groundnuts.

Combining the Large and Small Sample Data

A fundamental question in undertaking this analysis was whether to analyze the large and small samples separately or as one combined sample. The number of observations in the small sample were too few to permit including as many independent variables in the regression equations as desired. The large sample contained enough observations to do so, but it seemed likely that the dependent variables might be less reliable than those from the small sample. Consequently it was decided to use both samples, but, since the quality of the dependent variable for the small sample was felt to be better than that from the large sample, to handle them in such a way as to use the large sample to supplement the small sample observations (even though this imposed restrictions on the number of variables employed). The procedure followed for each food studied will be explained shortly.

The original model was selected using small sample data. It was then re-estimated using large sample data and the variances of the two disturbance terms (i.e., mean square errors) were compared. This F-test for equality of variances was used to detect heteroskedacity due to overall sample differences. This was a preliminary test to determine how the samples could be combined for the purpose of testing the overall equality of parameters between the two samples. If heteroskedasticity due to sample differences was found, then the samples were combined with a weight attached to each sample equal to the standard error of the appropriate sample regression.

The next step was to test the hypothesis that the coefficients of the two samples were equal by conducting an F-test for the stability of coefficients, often referred to in econometric literature as the Chow test. The standard Chow test assumes equal variances for each equation and an adjustment had to be made in the test whenever heteroskedasticity was detected. The adjusted formula for this test was:

$$F = \frac{\left(\text{RRSS weighted} - \left(\frac{1}{\sigma^2_{LS}}\, RSS_{LS} + \frac{1}{\sigma^2_{LS}}\, RSS_{SS}\right)\right)/(k+1)}{\left(\frac{1}{\sigma^2_{LS}}\, RSS_{LS} + \frac{1}{\sigma^2_{SS}}\, RSS_{SS}\right)/(n_{LS}+n_{SS}-2k-2)}$$

which has an F distribution with k+1 and $n_{LS}+n_{SS}-2k-2$ degrees of freedom where the subscript LS denotes large sample and SS denotes small sample.

If the hypothesis of equality for all the coefficients between the same equations, but run on different samples, was not rejected, then the small and large sample data were simply pooled for that particular commodity and the original model specification left unaltered. When the hypothesis of equality was rejected, the following variables were created to allow for variation to occur between the sample parameters being estimated. First the intercept was allowed to shift between samples by specifying in the combined equation model a binary variable designating sample. In addition, slope interaction terms were created for each of the independent variables being examined, such that significant differences in slope parameter estimates between samples could be tested. Creating these new variables doubled the number of parameters to be estimated.

For cases in which new variables were added to account for slope and intercept differences between samples, the regression run on the combined samples was examined carefully and the statistically insignificant[6] slope and intercept interaction terms were dropped for the final

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[6]At the .10 level.

regression run[7]. Another F-test was then calculated for each of these cases to test the hypothesis that the equation with the insignificant interaction terms removed was not significantly different from the equation with all the interaction terms included. Since this hypothesis was never rejected whenever this test was made, the final model included as interaction terms only those which were statistically significant at the .10 level.

Variables Included in the Final Model

Two important issues will be addressed in this section, the first being the matter of what stage or stages in the sample combining process should the variables be selected for the final model and secondly, what procedure should be followed in actually selecting those variables.

The first equation is a difficult one to resolve given the nature of the differences which exist between the two samples. There appears to be no scientific basis for answering the question. The judgment made was that the small sample data, felt to be descriptively superior to the large sample data, should be used as a basis for selecting the initial set of variables. If in a large number of cases the Chow test gave evidence of there being no statistically significant differences between the parameters estimated by the separate samples, then there was a basis for re-formulating the model to allow for the possibility of new and perhaps different variables showing up due to the threefold increase in sample size. Moreover, such a model re-formulation might permit certain relationships evidenced from the small sample regressions to become even stronger. However, the overwhelming evidence obtained from the Chow

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[7] If all the interaction terms were significantly different from zero, then the final regression included all the interaction terms.

tests indicated that model re-formulation was inappropriate. As a result, the variables chosen for the final models were those which were obtained from the original small sample model.

A selection process along with certain selection criteria had to be established to select from among the wide range of variables of potential importance to this analysis. The selection criteria established included a C_p, $\bar{R}^2$ and t-statistics criteria which will be discussed in the next few paragraphs. The selection process for satisfying these criteria used a standard computer program from Biomedical Data Package (BMDP)[8] entitled "All Possible Subsets Regression."

The C_p criterion selected those equations which provided the lowest total squared error of the n fitted observations for any given regression model.[9] It is defined as being equal to the following:

$$C_p = \frac{SSE_p}{\hat{\sigma}^2} + 2p - n$$

where p is the number of terms retained in a particular equation; SSE_p is equal to the sum of squared errors of the particular equation run with p terms; $\hat{\sigma}^2$ is the estimate of the variance of the disturbance term when all of the variables are present; and n is the number of observations. C_p is useful because it is an estimator of a standardized function of the total squared error which contains both a bias and a random error (i.e., variance) component:

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[8]See Dixon, N. and Brown, H. (eds.), 1979.

[9]For a statistical discussion of all the possible subsets approach and the selection criteria employed, see Neter and Wasserman, 1974, pp. 375-382. The notation used here is from this source.

$$\Gamma_p = \frac{1}{\sigma^2}\left[\sum_{i=1}^{n}(V_i - n_i)^2 + \sum_{i=1}^{n}\sigma^2(\hat{Y}_i)\right]$$

where

V_i = $E(Y_i)$ according to the true regression relation,

n_i = $E(Y_i)$ according to the fitted model,

$\sigma^2(\hat{Y}_i)$ = the variance of the fitted value, and

σ^2 = the true error variance.

The alternative selection criterion which was also employed was the $\bar{R}^2$ criterion. This measure is preferable to R^2 (which has a weakness--the fact that as you continue to add variables R^2 will always increase), because it adjusts it to take into account the loss of degrees of freedom as more explanatory variables are introduced into the model. The equation for $\bar{R}^2$ is:

$$\bar{R}^2 = 1 - \frac{n-1}{n-k-1}(1 - R^2)$$

where k is the number of regressors.[10] $\bar{R}^2$ will be maximized whenever the variance about the line (i.e., σ_u^2) is minimized since another way of defining $\bar{R}^2$ is the following:

$$\bar{R}^2 = 1 - \frac{\sigma_u^2}{\sigma_y^2}$$

with σ_y^2 being the variance of the regression line based on the mean prediction value of the dependent variable.

Both the "best" regressions from the C_p and $\bar{R}^2$ approach were examined in order to assist in the selection of the variables to use in the models.

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[10] See Maddala, 1977, pp. 120-122, for a discussion of this measure.

The models chosen were among those with the lowest C_ps and highest $\bar{R}^2$s (selected by the computer routine) which included variables believed essential to the analysis, in particular real price and income terms. In addition, models which included as many as possible highly statistically significant variables were selected from among the initial set of low C_p and high $\bar{R}^2$ equations selected by the computer. Although a uniform decision rule would have been possible, such as the one to select the model with the highest $\bar{R}^2$ or the lowest C_p, it seemed imprudent not to take into account more information that was available about the equations. There was a tendency, however, to select models from among the set with the highest $\bar{R}^2$s for two reasons. First, equations with more statistically significant variables were chosen by the maximizing $\bar{R}^2$ criterion. This was true because variables with t-statistics exceeding one would raise $\bar{R}^2$, whereas only variables with ratios (in absolute value) greater than or equal to the square root of two would lower C_p. Second, the $\bar{R}^2$ criterion fit better with the view that some of the variables being tested were experimental and not necessarily essential for the proper specification of each model.

CHAPTER VII

SINGLE-EQUATION FOOD COMMODITY ANALYSIS

Commodity Selection

The commodities which were selected for regression analysis were those which were considered to be important foods in the diet. Of the nine foods chosen, five were cereals, namely sorghum, early millet, late millet, maize and rice. The four other foods selected were: cowpeas, palm oil, nono and tomatoes. Although other additional foods could have been studied, it was felt that those selected constituted the basis of the diet. The five cereals alone constituted approximately 75-80 percent of the calories contained in the diet with sorghum being the dominant cereal and with early millet having a unique role. Since early millet is the first crop harvested in the agricultural cycle, it was distinguished from late millet which is harvested much later in the agricultural cycle. Palm oil was selected as an important source of vitamin A, cowpeas and nono as important protein sources, and tomatoes as a principal vitamin source.

Consuming Households

These regression results are based upon equations for consuming households only. However, as Table 7-1 indicates, except for rice, late millet and tomatoes the consuming households constitute virtually the entire sample. This is even more the case for the small sample than for

Table 7-1

Percent of All Households Consuming, Small Sample, Large Sample and Combined Samples, Kano State, Nigeria - 1974-1975*

	% of All Households Consuming Small Sample	% of All Households Consuming Large Sample	% of All Households Consuming Combined Sample
Sorghum	100	100	100
Early Millet	100	100	100
Late Millet	91	54	63
Maize	97	68	75
Rice	73	46	52
Cowpeas	91	98	95
Palm Oil	97	98	97
Nono	97	94	94
Tomatoes	97	75	80

*Estimates for all commodities based upon the total number of households in each sample: 34 for the small sample, 99 for the large sample and 133 for the combined sample.

the combined samples. Where there are significant numbers of non-consuming households, the model used does not accurately describe the behavior of all of the households represented in the sample. This research focuses on the factors which influence the amounts that consuming households consume instead of what factors influence the decision to consume or not to consume. Although the latter is an interesting and important matter to address and one that can be done using sophisticated econometric estimation techniques, principally Tobit analysis, this study concentrates upon the importance of market orientation and the source from which consumed foods come, both of which contain important implications for the economic development process.

Price Variables

Village level food commodity prices were used in this analysis to measure the effect of changes in real prices upon the consumption of individual foods. As was discussed in the previous chapter, these individual commodity prices were actual annual average quantity-weighted prices based upon farm gate sales prices and implicit retail purchase prices. Non-food prices could not be calculated from the data sets which were available.

There were three important reasons for expressing the commodity price variables used in the regression analysis as a ratio of the nominal prices of two food commodities. First, doing so allows us to measure real price relationships which are less sensitive over time to general changes in the price level. Second, each price variable fitted in the regressions is a relationship between two commodities in which the price of one is measured in terms of its relative purchasing power vis à vis the other. For example, a price variable which is the ratio of the price of palm oil to the price of sorghum is a variable which reflects the purchasing power of sorghum in terms of palm oil, or the real price of palm oil measured in terms of sorghum. This is an attractive feature for this analysis because much of that which is sold is essentially done so in order to acquire an item which can be purchased from the market. The ratio of nominal prices establishes a barter relationship between the two goods and specifying the price variables in this way should remind the reader that real price relationships are what is of importance to the consuming unit. A third reason for expressing the price variables this way is in order to preserve the theoretical property of zero homogeneity in which a doubling of prices and incomes leaves unaltered the quantity of food demanded for any given consumer.

Similarly, the income variables are measured in terms of the household's power to purchase the dependent variable because income is divided by the nominal price of the commodity being examined. As a result, simple changes in the nominal price of the dependent variable affect all of the price and income variables specified in the regression equation because these variables are all measured in real terms. In the sorghum example just given, a change in the nominal price of sorghum affects both its exchange relationship with palm oil and its exchange relationship with all other commodities as well. This altered exchange relationship of sorghum and all other commodities is contained in the expenditure variables which change due to a change in the nominal price of sorghum.

Village level prices were used in this attempt to measure real price and expenditure relationships. Consequently, it is possible that factors associated with the locational differences among the villages are included in the measured real price and income relationships. As a result it is not surprising that quite often price does not appear to be an important factor influencing the consumption of a particular food. Even if village effects could have been successfully removed from these real price relationships by the inclusion of a binary variable to designate village,[1] it is unlikely that many more statistically significant

[1]A high degree of multicollinearity between the price and village variables prevented estimating both of these sets of variables.

price variables would have appeared in the regressions which follow because only three observations were available for each commodity.

Because a wide array of potentially relevant relative prices was possible, the model selection process began with a pool of these and other variables. However, a high degree of multicollinearity often existed between two or more of these price variables for an individual commodity which prevented the estimation of equations for that commodity. When this occurred, as in almost every case it did, some selection of the most promising price variable was made in order to enable the model selection process to continue. Only these price variables eventually selected appear in Table 7-2. Other variables which are used in the regression tables that follow can also be found in Table 7-2.

Single-Equation Models--Cereals

The small sample was the superior data set available for use in this analysis because of the data collection and measurement methods which were followed for this sample. Observations were collected far more frequently from this sample's households and because of its small size (34 households) compared to the large sample (99 households), more exact measurement techniques could be used to obtain accurate kilogram weights of crops. Fortunately, the small sample did contain enough observations to test many independent variables which were believed to be potentially important as well as to test various single-equation total consumption models. However, when the large sample data could be relied upon to give equally accurate results, an expanded sample which included both large sample and small sample data was used to select the appropriate single-equation total consumption regression models which follow.

Table 7-2

Variables Used in the Regression Analyses

I. Commodity Specific Variables

A. DEPENDENT

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

B. INDEPENDENT

Commodity	Variable Name	Meaning[1]
Sorghum	PRPS	Price ratio of palm oil to sorghum[2]
	TEXPR	Total expenditure (income) divided by the price of sorghum
	SSAN	Share of sorghum available from off-farm non-market sources
Early Millet	PRSEM	Price ratio of sorghum to early millet[2]
	TEXPR	Total expenditure (income) divided by the price of early millet
	TEXPRSQ	TEXPR squared
	SEMAN	Share of early millet available from off-farm non-market sources
Late Millet	PREMLM	Price ratio of early millet to late millet[2]
	TEXPR	Total expenditure (income) divided by the price of late millet
	TEXPRSQ	TEXPR squared
	SLMAP	Share of late millet available from own production
Maize	TEXRP	Total expenditure (income) divided by the price of maize
	TEXPRSQ	TEXPR squared
Rice	SRAP	Share of rice available from own production
	SRAN	Share of rice available from off-farm non-market sources
Cowpeas	PRWMC	Price ratio of weighted millet to cowpeas[2]
	PRSC	Price ratio of sorghum to cowpeas
	TEXPR	Total expenditure (income) divided by the price of cowpeas
	SCAP	Share of cowpeas available from own production
	SCAN	Share of cowpeas available from off-farm non-market sources
Palm Oil	PRSP	Price ratio of sorghum to palm oil[2]
	TEXPR	Total expenditure (income) divided by the price of palm oil
Tomatoes	TEXPRSQ	Total expenditure (income) divided by the price of tomatoes squared
	STAN	Share of tomatoes available from off-farm non-market sources

II. Non-Commodity Specific Independent Variables

Variable Name	Meaning
GAND	Binary variable for gandu 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
HHAGE	Age of household head
LITERAT	Binary variable for literate household head (= 1; = 0 otherwise)
MAOTH	Non-Moslem Hausa (Maguzawa) and other non-Hausa ethnic group (= 1; = 0 otherwise)
FUL	Binary variables for Fulani ethnic group (= 1; = 0 otherwise)
SHOG	The value over all households of the groundnuts harvested divided by the value of all food crops harvested (cereals, groundnuts, onions, pappers and other foods)
SSHO	The value over all households of all food crops sold, likewise divided by the value of all food crops harvested (by the same figure used for SHOG)

[1]Table 7-2 includes only variables included in one or more of the regressions to be presented in Chapter IV. Additional variables were examined in the variable selection process but discarded for one of two principal reasons. Some were dropped because of multicollinearity and some were dropped because the equation which best satisfied the selection criteria rarely included every variable. For instance, one source variable ending in AP and one in AN were available for each regression for a food sometimes produced at home, but in most cases only one of them proved useful in the final set of equations.

[2]All prices are expressed as the price of a given good relative to the price of the dependent variable. These prices represent those which were selected for their potential explanatory power and economic relevance. Due to the limitations imposed by a high degree of multicollinearity between price variables, other potentially relevant price variables had to be omitted.

Sorghum

After first discussing the specific method by which the final sorghum model was chosen as well as the implications of this choice, I will turn to a discussion of the results obtained in examining the most important food commodity among our sample households.

The original model was chosen from the small sample data as being the one which best satisfied the original selection criteria which were established: high $\bar{R}^2$, low C_p, and significant t-statistics especially for price and income variables. Equation 7.3.1 in Table 7-3 possessed most of these criteria, with the exception of having an insignificant relative price variable, and was therefore selected to be the original model. The original model was then re-calculated using only the large sample data. This equation, equation 7.3.2, provided a quick check to see if the same variables when run on the large sample showed evidence of being unsatisfactory explanatory variables of large sample total household sorghum consumption. Upon examination this appeared to be the case. It also provided the means by which a test of the equality of the population variances for the two samples could be tested. This test was conducted by comparing the variances of the disturbance terms of equations 7.3.1 and 7.3.2 so that unequal error variances, i.e., heteroskedasticity caused by sample differences, could be detected if present. Heteroskedasticity was suspected due to the considerable differences between the recall periods of the two samples and between measurement procedures. Heteroskedasticity due to sample differences was not detected from equations 7.3.1 and 7.3.2 and therefore the original model using the pooled samples, equation 7.3.3, could be calculated without having to weight for unequal error variances.

Table 7-3
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	TEXPRSG	HHS	IAT	MAD	HHAGE	SHOG	SSHO	SSAN
Small Sample-[4] Original Model (7.3.1)	34	.87	.91	*** 2775.3 (3.86)	-45.2 (-.65)	*** -.58 (-4.94)	*** .588 E-4 (6.75)	*** 266.1 (5.48)	*** -321.6 (-3.08)	*** -342.0 (-2.82)	* -17.1 (-2.04)	** -1742.8 (-2.77)	*** -1031.7 (-3.03)	** 193.3 (2.45)
Large Sample- Original Model (7.3.2)	99	.62	.66	** -809.7 (-1.99)	** 109.5 (2.42)	*** .19 (3.14)	-.649 E-7 (-.01)	** 30.5 (2.03)	-22.9 (-.47)	38.9 (.70)	6.5 (1.52)	-379.3 (-1.61)	-319.1 (-1.39)	-144.6 (-1.16)
Combined Samples (7.3.3)	133	.63	.66	18.59 (.04)	69.4 (1.5)	-.01 (-.18)	*** .19 E-4 (3.57)	*** 54.22 (3.1)	-61.0 (-1.18)	28.4 (.49)	1.6 (.37)	** -652.6 (-2.51)	** -466.6 (-2.13)	93.3 (.18)
Final Model-														
Combined Samples (7.3.4)	133	.76	.80	* -809.7 (-1.94)	** 109.5 (2.36)	*** .19 (3.07)	-.65 E-7 (-.01)	** 30.5 (1.98)	-22.9 (-.46)	38.9 (.68)	6.5 (1.48)	-379.3 (-1.57)	-319.1 (-1.35)	-144.6 (-1.14)
Small Sample[5] Component				*** 2775.3 (3.86)	-45.2 (-.65)	*** -.58 (-4.94)	*** .588 E-4 (6.75)	*** 266.1 (5.48)	*** -321.6 (-3.08)	*** -342.0 (-2.82)	* -17.1 (-2.04)	** -1742.8 (-2.77)	*** -1031.7 (-3.03)	** 193.3 (2.45)
Large Sample Component				* -809.7 (-1.94)	** 109.5 (2.42)	*** .19 (3.07)	-.65 E-7 (-.01)	** 30.5 (1.98)	-22.9 (-.46)	38.9 (.68)	6.5 (1.48)	-379.3 (-1.57)	-319.1 (-1.35)	-144.6 (-1.14)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 7-2.

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

[4] Cp equals 5.7.

[5] Each parameter is obtained from 7.3.4 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. For example, the coefficient for PRPS in the combined sample final model is equal to 109.5 + (-154.7). The intercept is simply the intercept from equation 7.3.4 plus the parameter from the variable SSD.

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

Table 7-3 (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
(7.3.4) (Cont'd)	*** 3585.0 (4.6)	** -154.7 (-1.96)	*** -.77 (-6.21)	*** .59 E-4 (6.24)	*** 235.6 (5.01)	*** -298.7 (2.77)	*** -380.9 (-3.05)	*** -23.6 (-2.67)	** -1363.42 (-2.19)	* -712.6 (-1.82)	** 337.9 (2.31)

This version of the original model along with the two equations run on each of the samples separately provided a test of whether for all variables in the regression model the pairwise comparisons of the equality of parameter estimates for each variable across equations revealed no instance in which the parameter estimates for one or more variables were significantly different. This F-test, also referred to as a Chow test, indicated that when compared across equations one or more variables were found to have statistically different parameter estimates. The null hypothesis of equality between the regression coefficient of each sample for every coefficient in the model had to be rejected. Consequently, the results obtained in equation 7.3.3 from simply pooling the two sample data sets together would have been misleading if used as the final model, because the parameters it contained were constrained to be the same for both samples. Therefore, a new model was estimated, equation 7.3.4, which contained twice as many variables as the original model. The new variables were introduced in order to identify which variable or variables out of the entire set of variables had significantly different parameter estimates across equations, as well as the magnitudes of these differences. Each of the new variables introduced in 7.3.4 either allowed for the intercept to shift between the samples (the variable SSD) or allowed for slope differences to exist between samples for the same variable (the variables having DI suffix). Including these eleven new variables in the reformulated model enabled me to identify explicitly which of all the possible parameters were those found implicitly in the Chow test to be significantly different between samples. The results of this search indicated that for sorghum the coefficient of each variable, including the intercept term, differed significantly between the large and the small samples. Had any of the eleven new interaction variables not been significantly different from zero, the conclusion could have been drawn that the two sample parameters for that variable could be constrained to be equal in the final model. Since this was not the case for sorghum, the final model became equation 7.3.4.

The final model was broken down into its two versions, a small sample component and a large sample component. The parameters and t-statistics of the large sample component are those calculated for the combined samples regression of the final model. If a household is in the large sample, none of the shift variables applies, so what remains of the combined samples regression is the large sample component.

The intercept parameter of the small sample component was calculated by adding the intercept parameter calculated for the combined samples equation to the intercept shift parameter required to adjust for the small sample component. Similarly, the slope parameters of the small sample component were calculated by adding the slope parameters calculated from the small sample base equation (the first ten variables) to the slope parameters required to adjust the slope parameters for the small sample component (the last ten variables). The t-statistics for these newly calculated small sample component parameters were calculated in the following way:

$$t = \frac{\hat{\beta}i + \hat{\beta}i'}{\sqrt{var\ \partial + var\lambda + 2\ cov\ (\partial)(\lambda)}}$$

where $\hat{\beta i}$ is the estimate of the parameter of variable i,

$\beta i'$ is the estimate of the parameter of the associated interaction variable i,

∂ is the variable i, and

λ is the associated interaction variable i.

In Tables 7-6, 7-8 and 7-10 no t-statistic was calculated for the intercept term of the small sample component because the computer program did not calculate the necessary covariance between the combined sample intercept and SSD.

It will be noted here that for sorghum the method just described for calculating the small sample component parameters and their associated t-statistics provides the identical result to that obtained from the small sample original model. Each and every parameter and t-statistic when compared between equation 7.3.1 and the small sample component of 7.3.4 is identical because there were no parameters constrained in equation 7.3.4 to be equal. If one or more of the parameters had been constrained to be equal between samples than the parameters and t-statistics calculated for the small sample component of equation 7.3.4 would not generally have been the same as those for equation 7.3.1.

The large sample component's parameters and t-statistics were simply those parameters and t-statistics calculated for the large sample base equation. These too were identical to the parameters and t-statistics found in equation 7.3.2 because no equality of parameter constraint was imposed upon the final model. The final sorghum model provided essentially two sets of results, one set for each of the two samples. Since it was believed that the two samples were representative of the same population, the decision was made to select one single set of coefficients to use in indicating the food consumption behavior of the population. With this decision having been made, the next decision concerned selecting the model component which best represented the true behavior of the population. The choice was made to follow a procedure which interpreted for sorghum and all other commodities as well only the small sample component coefficients from the final model because of the superior characteristics of the small sample data outlined earlier. Large sample findings were used as additional information when they supported the findings from the small sample. When these results from the separate samples differed significantly, the large sample results were judged inferior.

Absolutely no information from the large sample was useful in the case of sorghum. $\bar{R}^2$ and R^2 for the final combined model, equation 7.3.4, are less than those for equation 7.3.1. Of course the parameters from the small sample component of equation 7.3.4 are identical with those in equation 7.3.1, so $\bar{R}^2$ and R^2 for the small sample component (not calculated here) are the same as they were for equation 7.3.1.

Had the results of equation 7.3.4 shown that certain interaction terms were not significantly different from zero, thereby indicating that the null hypothesis of equal parameters for each sample could not be rejected, then large sample data would have been used by virtue of their inclusion in the combined sample in obtaining the small sample component results. This would have occurred insofar as that the large and small sample parameters, being constrained to be the same, would most certainly have been different from those estimated by using the small sample separately. For most of the commodities which will be examined in this chapter, with the exception of sorghum, some information from the large sample is useful in determining a model which best explains the consumption behavior of consuming households.

The four sorghum regressions presented in Table 7-3 provide some interesting insights into the determinants of sorghum demand at the farm level. The sign on the relative price of palm oil to sorghum variable in the small sample component of equation 7.3.4 is as expected. The quantity of sorghum demanded appears to be inversely related to the price of palm oil, as one would expect given their role as complements in the diet, although the coefficient is not significantly different from zero at the .10 level.

The income and income squared terms provide evidence of a very strong relationship between the level of income and the quantity of sorghum demanded by rural Nigerian families. As income increases, the amount of sorghum consumed falls slightly at a decreasing rate.

The effect that household size has on the quantity of sorghum consumed is not surprising. Given the same real income, larger households eat more sorghum than smaller households. The variables IAT, MAD, and HHAGE represent three household characteristics' variables which are inversely related to the amount of sorghum consumed. The coefficient of the infants and toddlers and male adult variables represent the negative effect upon sorghum availability whenever either category increases in a household of a given size. To interpret either variable properly the effect of an increase in its size must be interpreted while holding all the other household size and composition variables explicitly contained in the equation constant. Moreover, in interpreting either IAT or MAD, the only variables which can vary, therefore, are those household size and composition variables not contained in the regression equation, specifically YCH, OCH, WAD, NWAD[2] and OAD. Therefore an increase in size due to the presence of an additional person in this infant and toddler category will result in a decrease in size of any of these household composition groups. A shift in family composition of this sort will result in a significant fall in the level of consumption simply because infants and toddlers consume less sorghum than a household member from any of these other groups. Similarly, if MAD increases, then a shift in household composition by a decrease in either YCH, OCH, WAD, NWAD or OAD must occur. This shift in household consumption is also associated with a significant drop in the level of sorghum consumption. This may be because older children have larger appetites for sorghum than do adult males. A final household characteristic variable, the age of the household head, is inversely related to sorghum consumption, although this relationship is only significant at the .10 level.

One of the principal hypotheses to test is whether an increase in the level of market activity by the household is likely to reduce food consumption. The variables SHOG, the share of harvest output which is comprised of groundnuts, and SSHO, the value of total sales as a percent of total harvest output, are the two variables which test this hypothesis. The small sample sorghum equation shows that for either variable, there is strong evidence that sorghum consumption is negatively related to the degree of the household's marketing orientation.

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[2]NWAD is a variable which was not included in any of the regression equations. It represents adult females who are non-wives. To have included this variable would have resulted in perfect multicollinearity since the sum of the household composition variables for any household would have been an exact linear combination of the household size variable, HHS.

The coefficient for SSAN indicates that households with a higher proportion of total sorghum consumption coming from gifts, loans or wages paid in sorghum in kind consume more sorghum altogether.

The Small Sample Component of the final sorghum model, equation 7.3.4, is the relevant model to use in predicting household consumption for a rural northern Nigerian household of any ethnic background given income, household characteristics, market orientation and food source information.

A more complete model of sorghum consumption, which will be developed in Chapter VIII, will attempt to explain more than what can be explained using the simple model of total sorghum consumption presented here. The new model will examine separately the importance of the same factors influencing the consumption of sorghum but from different sources.

Early Millet

Early millet, consumed by every household, is the second most heavily consumed cereal among both large and small sample households. Since it is the first crop harvested in the agricultural year, its importance is enhanced because it provides relief from the hungry season.

The final early millet model, equation 7.4.5, was derived in the same manner as was the final model for sorghum examined in the previous section with one principal exception. Whereas the sorghum model contained interaction variables every one of which was statistically significant. The early millet combined sample equation 7.4.4 contained many insignificant interaction terms. Since these insignificant terms indicated that the small sample and large sample parameter estimates were not significantly different, these insignificant interaction terms were removed to constrain the final model to have the same parameter for these variables. As can be seen by comparing the parameters for the small and large sample component of equation 7.4.5, the parameter estimates for the final model are indeed the same for those variables which did not have statistically significant interaction terms in equation 7.4.4.

Equation 7.4.5 in Table 7-4 shows that there is no significant difference between the two samples in the important variables, PRSEM, TEXPR, and TEXPRSQ. One relationship established is that consumption increases gradually at a decreasing rate with higher levels of income. Income affects early millet consumption very slightly, but in a positive manner and a significantly positive non-linear relationship is established.

Household size has a strong positive association with early millet consumption, as is expected given the fact that the household consumption of large households would, on the average, be expected to be larger than household consumption of smaller households. Although there is a significant difference between the two samples as to the effect of HHS upon early millet consumption, the influence upon early millet consumption by HHS is significant at the .01 level or better in the small sample component of equation 7.4.5. The variable representing adult wives, WAD, shows the greatest difference when a comparison is made between samples. The relationship which is seen in the small sample is strongly negative which can be explained by the fact that an increase in the membership of the WAD household composition category is associated with a drop in either the number of young children, male adults, or adult females who are non-wives. From the small sample component of

Table 7-4
Single-Equation Total Early Millet 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						Source
					PRSEM	TEXPR	TEXPRSQ	HHS	IAT	OCH	WAD	OAD	MAOTH	SEMAN
Small Sample-[4] Original Model (7.4.1)	34	.51	.66	65.1 (.77)	* -111.6 (-1.79)	.0295 (1.65)	** .115 E-5 (-2.07)	*** 37.6 (4.14)	-23.7 (-1.27)	** -53.4 (-2.34)	*** -64.0 (-3.35)	** -43.6 (-2.07)	*** 175.6 (3.31)	** -54.5 (-2.27)
Large Sample- Original Model (7.4.2)	99	.19	.27	-21.9 (-.43)	-13.3 (-.37)	.03 (1.60)	* -.334 E-5 (-1.72)	9.2 (1.58)	-11.6 (-.94)	4.8 (.53)	13.2 (1.04)	-9.6 (-.74)	-9.6 (-.33)	7.7 (1.23)
Combined Samples (7.4.3)	133	.17	.24	51.2 (1.18)	-34.2 (-1.06)	.002 (.20)	-.423 E-6 (.59)	*** 14.3 (2.81)	-14.5 (-1.33)	-2.5 (-.29)	.51 (.05)	-16.2 (1.42)	32.2 (1.21)	5.1 (.80)
Combined Sample With Complete Interaction (7.4.4)	133	.29	.40	-21.9 (-.44)	-13.3 (-.38)	.030 (1.62)	* -.334 E-5 (-1.74)	9.2 (1.6)	-11.6 (-.95)	4.8 (.54)	13.2 (1.05)	-9.6 (-.75)	-9.6 (-.34)	7.7 (1.25)
Final Model-														
Combined Samples with Limited Interaction (7.4.5)	133	.29	.37	12.4 (.30)	-34.4 (-1.14)	** .021 (2.0)	*** -.217 E-5 (-2.68)	** 9.9 (1.99)	-12.26 (-1.20)	4.4 (.52)	15.1 (1.25)	-18.8 (-1.74)	-8.9 (-.31)	7.0 (1.14)
Small Sample[5] Component				12.4 (.30)	-34.4 (-1.14)	** .021 (2.0)	*** -.217 E-5 (-2.68)	*** 31.4 (4.47)	-12.26 (-1.20)	-38.8 (-1.78)	*** -56.2 (-2.97)	-18.8 (-1.74)	*** 150.9 (3.06)	** -62.1 (2.62)
Large Sample Component				12.4 (.30)	-34.4 (-1.14)	** .021 (2.0)	*** -.217 E-5 (-2.68)	** 9.9 (1.99)	-12.26 (-1.2)	4.4 (.52)	15.1 (1.25)	-18.8 (-1.74)	-8.9 (-.31)	7.0 (1.14)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 7-2.

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

[4] Cp equals 3.65.

[5] Each parameter is obtained from 7.4.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. The intercept is simply the intercept from equation 7.4.5 plus the parameter from the variable SSD.

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

Table 7-4 (Continued)

Equation	INDEPENDENT VARIABLES										
	Intercept Shift	Price	Expenditure		Household Characteristics						Source
	SSD	PRSEMDI	TEXPRDI	TEXPRSQDI	HHSDI	IATDI	OCHDI	WADDI	MAOTHDI	OADDI	SEMANDI
(7.4.4) (Cont'd)	87.0 (.86)	-98.3 (-1.32)	-.0001 (-.00)	.962 E-5 (.43)	*** 28.45 (2.56)	-12.09 (-.52)	** -58.18 (-2.28)	*** -77.3 (-3.26)	*** 185.18 (2.96)	33.9 (-1.33)	** -62.3 (2.4)
(7.4.5) (Cont'd)					*** 21.5 (3.2)		** -43.2 (-1.97)	*** -71.3 (-3.27)	*** 159.8 (2.82)		*** -69.1 (-2.82)

equation 7.4.5, it appears that membership in either the Maguzawa or other non-Moslem Hausa and non-Fulani tribes significantly increases the amount of early millet consumed. If one views early millet consumption as being influenced to some extent by the amount of cereals held in storage at the end of the agricultural year, then one might surmise that those relying heavily on early millet are those whose stores are lowest at the end of the agricultural year, who are therefore the most vulnerable to seasonal shortfalls. Although an alternative explanation could be given that these tribal households simply prefer early millet to sorghum or some other cereal, this argument can be dismissed because by far the majority of households in MAOTH are those who are Hausa, but non-practicing Moslems. There would be no apparent reason for suspecting that Hausas and non-Moslem Hausa should have markedly different preferences for cereals, and therefore the difference in tastes argument is deficient. Membership in non-Moslem or non-Fulani tribes may, however, place the household beyond the socio-cultural support network that the village may have, thereby rendering these households more dependent upon their own stores during the lean consumption months of the year. To the extent that these households have to rely on their own food reserves, they may draw down their reserves more quickly and experience greater need for an early crop to provide food relief.

When the share of early millet consumption coming from non-market and non-home production sources rises, the amount of early millet consumed declines significantly. Those dependent upon charity, loans and wages in kind eat less than other households at the same real income level.

Late Millet

The late millet final model, equation 7.5.3 in Table 7-5, was derived from the combined samples and made special use of the small and large sample equations 7.5.1 and 7.5.2. Since the test of the equality of the variances of the disturbance terms for equation 7.5.1 and 7.5.2 indicated that unequal error variances existed between the samples, weighting of each sample by the appropriate standard error of the regression equation, either from 7.5.1 for the small sample or from 7.5.2 from the large sample, was necessary to derive a satisfactory final model and to conduct the Chow test. The combined sample data set was used to fit an equation which weighted both sides of the equation to which the data were being fitted. Unless the intercept term fitted to each of the sample data sets took this weighting into account, the intercept from the combined data set would have been calculated incorrectly. As a result, the computer program suppressed the calculation of an unweighted intercept term and the variable CONST was defined and included in the regression equation 7.5.3. CONST was defined as being equal to one so that it could be weighted by the standard error of the appropriate regression line for the appropriate sample observation. The estimated parameter for the variable CONST could then be treated as the properly weighted intercept term for equation 7.5.3, since the variable itself, when multiplied by the estimated parameter, would be identical to the estimated parameter itself. Thus, CONST allowed for proper sample weighting and provided at the same time an estimate of the combined sample intercept term. A similar weighting procedure was also used for the rice and tomatoes models because of unequal error variances between the small and large samples.

Table 7-5

Single-Equation Total Late Millet 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
					CONST	PREMLM	TEXPRSQ	IAT	OCH	MAD	FUL	SHOG	SSHO	SLMAP
Small Sample-[4] Original Model (7.5.1)	30	.40	.58	*** -217.7 (-3.38)		*** 91.1 (3.27)	.197 E-6 (1.42)	-6.9 (-1.14)	-10.0 (-1.37)	7.8 (1.02)	*** 86.3 (4.08)	*** 202.7 (3.74)	37.14 (1.13)	** 6.8 (2.04)
Large Sample- Original Model (7.5.2)	53	.02	.19	-95.42 (1.39)		54.5 (1.98)	-.104 E-6 (-.71)	4.2 (.51)	.44 (.07)	3.0 (.25)	1.3 (.06)	-51.5 (-.94)	-74.0 (-.78)	65.1 (1.08)
Final Model- Combined Samples (Weighted) (7.5.3)	83	.28	.37	-	-12.2 (-.37)	27.6 (1.58)	-.56 E-6 (-.15)	-1.4 (-.25)	-.93 (-.18)	-3.97 (-.60)	* 26.84 (1.81)	12.0 (.35)	-10.0 (-.32)	2.4 (.74)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 7-2.

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

[4] Cp equals .89.

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

The Chow test of equality between the small sample parameters of equation 7.5.1 and the large sample parameters of equation 7.5.2 indicated that the null hypothesis of equality of every sample parameter between the samples could not be rejected. Consequently, there was no need to specify an alternative final model to equation 7.5.3 because it could be concluded from the Chow test that no significant interaction terms could be found.

The final model chosen provides little information which can be used in understanding factors influencing the consumption of late millet. The coefficients of every variable except FUL indicate that the hypothesis that the effect of each variable upon consumption of late millet being equal to zero cannot be rejected. FUL is the only variable in 7.5.3 about which some statement of relationship can be firmly established at the .10 level of significance. If the household happens to be a Fulani household, the chances are greater that more late millet will be consumed. This may reflect a greater preference for late millet by Fulani households.

It was hoped that these late millet equations in Table 7-5 would help to provide a better explanation of what factors influence late millet availability, but the results were disappointing. The role that millet plays in the diet cannot be adequately answered by use of these regressions.

Maize

Maize is a crop which is the subject of great current policy interest in Northern Nigeria. The results in Table 7-6 shed light upon the factors which influence maize consumption by Northern Nigerian households.

Table 7-6

Single-Equation Total Maize 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]						
					Expenditure[3]	Household Characteristics					Market
					TEXPRSQ	HHS	OCH	FUL	HHAGE	GAND	SSHO
Small Sample-[4] Original Model (7.6.1)	32	.33	.48	129.03* (1.70)	.784 E-6* (1.91)	-15.4** (-2.43)	31.3 (1.61)	-68.2** (-2.17)	-1.6 (-1.02)	85.6** (2.08)	93.0 (1.57)
Large Sample-Original Model (7.6.2)	67	.30	.37	24.6* (1.70)	.488 E-6*** (4.75)	.673 (.50)	-7.6*** (-2.75)	7.9 (.70)	.093 (.26)	-4.1 (-.49)	-49.1 (-1.74)
Combined Samples (7.6.3)	99	.15	.21	42.9* (1.82)	.381 E-6** (2.46)	-2.6 (-1.14)	-.616 (-.13)	-21.9 (-1.4)	-.498 (-.89)	24.3* (1.81)	76.53** (2.60)
Combined Samples with Complete Interaction (7.6.4)	99	.38	.48	23.4 (1.05)	.488 E-6*** (2.94)	.673 (.31)	-7.55 (-1.70)	7.9 (.43)	.093 (.16)	-4.1 (-.30)	-49.1 (-1.08)
Final Model-											
Combined Samples with Limited Interaction (7.6.5)	99	.37	.46	39.6* (1.86)	.565 E-6*** (4.02)	.58 (.27)	-7.0 (-1.58)	8.2 (.44)	-.3 (-.62)	-3.3 (-.25)	-55.1 (-1.23)
Small Sample[5] Component				72.4	.565 E-6*** (4.02)	-14.34*** (3.80)	34.88*** (2.87)	-64.3*** (3.25)	-.3 (-.62)	69.6*** (2.86)	105.4*** (2.89)
Large Sample Component				39.6* (1.86)	.565 E-6*** (4.02)	.58 (.27)	-7.0 (-1.58)	8.2 (.44)	-.3 (-.62)	-3.3 (-.25)	-55.1 (-1.23)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 7-2.

[3] Expenditure variable has been divided by the price of the dependent variable.

[4] Cp equals -3.02.

[5] Each parameter is obtained from 7.6.5 by adding the parameters for the term with a DI suffix to the parameter for the associated term without this suffix. The intercept is simply the intercept from equation 7.6.5 plus the parameter from the variable SSD.

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

Table 7-6 (Continued)

Equation	INDEPENDENT VARIABLES							
	Intercept Shift	Expenditure[3]	Household Characteristics					Market
	SSD	TEXPRSQDI	HHSDI	OCHDI	FULDI	HHAGEDI	GANDDI	SSHODI
(7.6.4) (Cont'd)	** 104.4 (1.96)	.296 E-6 (.96)	*** -16.03 (-3.53)	*** 38.8 (2.97)	*** -76.18 (-2.82)	-1.7 (-1.47)	*** 89.7 (3.08)	** 142.2 (2.41)
(7.6.5) (Cont'd)	32.8 (1.27)		*** -14.92 (3.48)	*** 41.9 (3.23)	*** -72.5 (2.69)		*** 72.9 (2.65)	*** 160.5 (2.75)

Equation 7.6.5 provides some further evidence that the results obtained from the small and large sample data sets are markedly different. In some respects, however, the two samples provide estimates consistent with each other. Of the two variables for which the differences between the large and small samples are not significant (i.e., TEXPRSQ and HHAGE), the one of interest is the positive and statistically significant income squared term. Maize consumption increases at an increasing rate as income rises, ceteris paribus.

Surprisingly, larger households consume less maize than smaller ones, regardless of household type. Why smaller households consume more maize is not evident. Households of the same size which happen to be gandu eat more maize than nuclear households of equivalent size. The results show that the consumption of maize is positively related to the proportion of older children in the household. As was suggested in the sorghum equation, older children do eat more than male adults, and in this case, more than any adult, young child or infant or toddler. Fulani households consume significantly less maize than do Hausa, Maguzawa or households of other ethnic backgrounds.

Households which have sales as a high proportion of harvest output tend to consume more maize. This can perhaps be explained by the fact that households likely to accept the risks associated with market involvement (e.g., wide price fluctuation) are also likely to accept the risk of introducing maize into their cropping mixtures. To the extent that these risks are undertaken, one reward is apparently having more maize available for consumption.

Rice

Rice consumption appears in equation 7.7.5 in Table 7-7 to be similar for large and small sample households in almost all respects.

The sign on the HHS variable is positive as was expected and the coefficient on this term is significant at the .01 level. The signs on the IAT, YCH, and OCH variables are negative and are likely to reflect the replacement in the household of any older person by a member of either of these three household composition groups. These associations are significant at the .01 level. Fulani households consume significantly more rice than do Hausa, Maguzawa or other households. Households whose heads are literate consume significantly less rice than do households whose heads are illiterate. This is the first indication that literacy has any effect upon food consumption. Households headed by the better educated farmers on the average eat less rice than others.

For the first time evidence is found in this study that a heavier groundnut production orientation by the household is associated with greater consumption of the food under consideration.[3] People that produce groundnuts (for sale) eat more rice than others, perhaps because a larger part of their income is received in the form of money. An increase in the amount of rice available from own production relative to other sources is positively related to greater rice consumption levels of that crop and is significant at the .01 level.

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[3]The small sample equation for late millet (equation 7.5.1 in Table 7-5) did show a significant relationship between the groundnut production orientation of the household and higher household levels of late millet consumption. However, when the large sample information was included, the coefficient of SHOG became insignificant.

Table 7-7

Single-Equation Total Rice 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]										
					Household Characteristics								Market	Source	
					CONST	HHS	IAT	YCH	OCH	FUL	LITERAT	GAND	SHOG	SRAP	SRAN
Small Sample-[3] Original Model (7.7.1)	24	.92	.96	136.182*** (-5.25)		24.1*** (10.31)	-28.4*** (-6.08)	-35.3*** (-6.97)	-34.6*** (-6.06)	116.1*** (9.27)	-29.6*** (-3.25)	-19.5 (-1.52)	124.0*** (2.92)	55.7*** (6.32)	-14.4*** (-3.50)
Large Sample- Original Model (7.7.2)	45	.36	.50	-75.6** (-2.53)		21.2** (2.47)	-9.0 (-.49)	19.6 (1.34)	-26.0* (-1.93)	39.1 (.89)	-26.4 (-.93)	-40.2 (-1.22)	63.5 (1.00)	14.4 (1.62)	-33.3 (-.66)
Combined Samples (Weighted) (7.7.3)				-	-76.5*** (-2.85)	20.4*** (6.49)	-29.0*** (-4.34)	-20.8*** (-3.19)	-27.1*** (-3.51)	88.2*** (5.44)	-32.2** (-2.45)	-14.4 (-.85)	53.6 (1.17)	20.8** (2.29)	-12.1* (-1.88)
Combined Samples with Complete Interaction (7.7.4)	69	.84	.89	-	-75.6** (-2.48)	21.2** (2.43)	-9.0 (-.48)	19.6 (1.32)	-26.0* (-1.89)	39.1 (.87)	-26.4 (-.92)	-40.2 (-1.19)	-63.5 (.98)	14.4 (1.59)	-33.3 (-.65)
Final Model-															
Combined Samples with Limited Interaction (7.7.5)	69	.84	.87	-	-114.3*** (-5.85)	23.1*** (10.47)	-26.8*** (-5.78)	33.6*** (4.0)	-33.7*** (-6.25)	104.9*** (9.20)	-33.4*** (-3.68)	-19.7 (-1.66)	93.6*** (2.87)	18.3** (2.18)	-14.2*** (-3.19)
Small Sample[4] Component				-	-114.3*** (-5.85)	23.1*** (10.47)	-26.8*** (-5.78)	-35.1*** (7.19)	-33.7*** (-6.25)	104.9*** (9.20)	-33.4*** (-3.68)	-19.7 (-1.66)	93.6*** (2.87)	51.6*** (5.75)	-14.2*** (-3.19)
Large Sample Component				-	-114.3*** (-5.85)	23.1*** (10.47)	-26.8*** (-5.78)	33.6*** (4.0)	-33.7*** (-6.25)	104.9*** (9.20)	-33.4*** (-3.68)	-19.7 (-1.66)	93.6*** (2.87)	18.3** (2.18)	-14.2*** (-3.19)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 7-2.

[3] Cp equals 4.68.

[4] Each parameter is obtained from 7.7.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. The intercept is simply the intercept from equation 7.7.5 plus the parameter from the variable SSD.

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

Table 7-7 (Continued)

Equation	INDEPENDENT VARIABLES										
	Household Characteristics								Market	Source	
	CONSTDI	HHSDI	IATDI	YCHDI	OCHDI	FULDI	LITERATDI	GANDDI	SHOGDI	SRAPDI	SRANDI
(7.7.4) (Cont'd)	-64.8 (-1.58)	3.4 (.38)	-19.9 (-1.03)	*** -54.6 (-3.47)	-9.9 (-.66)	75.9 (1.63)	-5.1 (-.17)	18.7 (.52)	65.3 (.83)	*** 43.9 (3.25)	17.9 (.35)
(7.7.5) (Cont'd)				*** -68.7 (-7.90)						*** 33.3 (2.88)	

Whether or not the total effect of the substituion of a primarily market crop for a primarily subsistence crop improves or worsens the overall diet cannot be determined by examining commodities individually. This question will be addressed later in the household calorie regression analysis.

The variable SRAP, whose coefficient varies significantly between samples, indicates that those households which produce more rice eat more rice than those which obtain a greater share of rice consumption from other than home produced or market sources. Households with the higher shares of rice consumption coming from off-farm non-market sources consume less rice than others.

Principal Factors Affecting Cereal Consumption

It was not surprising to find that real prices did not appear to be significant factors influencing the consumption of cereals since only three prices could be calculated for each commodity and since locational characteristics were probably included in these price variables.

The influence of real income upon cereal consumption was not altogether surprising. The consumption of early millet showed the expected positive Engel relationship, approaching a saturation level as real incomes increased. Sorghum, the most important food in the diet, showed consumption reducing with increased real expenditure, although at a diminishing rate. Maize was found to be the most responsive to real income changes with maize consumption rising at an increasing rate with higher real income levels. Real income appeared not to influence rice consumption at all. Rice is unique in that it is a crop produced on fadama land, only a small fraction of the hectarage available in the area and it is likely to be sold, given the fact that it competes for this land with other crops grown primarily for cash income. These two characteristics distinguish it from the other four cereals, which are grown on the more abundant dry land soils and primarily for home consumption.

Household size and characteristic variables do influence the consumption of cereals. No discernible and strong pattern of these influences upon cereal consumption emerged from the final models for these five cereals, although the presence of children in the households, infants and toddlers in particular, led to reduced consumption levels for some cereals. The results almost always indicate that household size is significant and more often than not that larger households consume more of certain cereals than do smaller households given the same real incomes. Household size has no effect at all on consumption of late millet; for maize, increases in household size lead to actual declines in the amount of maize consumed by households in the sample. Of the two household head characteristic variables, HHAGE shows up as having a significant and negative influence upon the consumption of sorghum. The general finding is, however, that the age of the household head does not significantly influence the availability of the five cereals. Whether the household head is or is not literate also does not appear to be a factor determining cereal availability with the sole exception of rice.

One cannot conclude from these findings that the more market-oriented the household's production activities are, the lower will be its consumption of all or even most cereals. However, total cereal consumption is likely to be lower among households which are more market-oriented because of the strong negative association between market involvement and sorghum consumption. This could imply that the group of households which pursued a groundnut strategy were those households which consumed smaller amounts of sorghum.

The importance of food charity, food loans and wages paid in kind was observed in the analysis of the consumption of cereals among the sample households. This finding along with the importance of the home production source upon rice consumption suggests that source is indeed an important factor associated with the consumption of certain cereals, particularly sorghum and early millet.

Single-Equation Models -- Non-Cereals

Cowpeas

The price ratio of millet[4] to cowpeas variable, PRWMC, is positively associated with the consumption of cowpeas and is significant at the .05 level for the small sample version of equation 7.8.5 in Table 7-8. When millet prices are high in terms of cowpeas households consume more cowpeas. Since this real price of millet in terms of cowpeas is lowest in the village with the most cash-oriented cropping pattern, Rogo,[5] and highest in the least cash-oriented village, Zoza, this provides an indication that households in the less cash-oriented villages consume more

[4]The price of millet is a quantity weighted average price of early millet and late millet. Its principal component is early millet.

[5]See Matlon, 1977, pp. 34-35, for a discussion of the characteristics of the three villages.

Table 7-8

Single-Equation Total Cowpeas 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]		Expenditure[3]	Household Characteristics						Market		Source	
					PRWMC	PRSC	TEXPR	HHS	IAT	YCH	OCH	FUL	LITERAT	SHOG	SSHO	SCAP	SCAN
Small Sample-[4] Original Model (7.8.1)	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 (7.8.2)	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 (7.8.3)	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 (7.8.4)	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 (7.8.5)	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 7-2.

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

[4] Cp equals 9.85.

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

[6] Each parameter is obtained from 7.8.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. This intercept is simply the intercept from equation 7.8.5 plus the parameter from the variable SSD.

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

Table 7-8 (Continued)

Equation	INDEPENDENT VARIABLES														
	Intercept Shift	Price[3]		Expenditure[3]	Household Characteristics						Market		Source	
	SSD	PRWMCDI	PRSCDI	TEXPRDI	HHSDI	IATDI	YCHDI	OCHDI	FULDI	LITERATDI	SHOGDI	SSHODI	SCAPDI	SCANDI
(7.8.4) (Cont'd)	*** -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)
(7.8.5) (Cont'd)	*** -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)		

cowpeas, ceteris paribus. The relative price of sorghum to cowpeas, PRSC, is negatively associated with cowpeas consumption. This relationship, which is highly significant, may indicate that sorghum and cowpeas are complements in the diet, that when sorghum prices are high, households produce and eat more sorghum and fewer cowpeas, or that some other less obvious relationship exists.

The income variable, TEXPR, indicates that there is a very strong and positive but small association between income and cowpea consumption. Although there is a significant difference between the small and large sample estimates with respect to income, the basic relationship found in the small sample also appears in the large sample. TEXPR is very highly significant in both the small and large sample components of equation 7.8.5 and indicates that consumption of cowpeas increases at a constant rate with increasing income.

Among the household characteristics variables found to be significant in equation 7.8.5 household size and older children were the most significant. HHS shows a positive and significant relationship (at the .01 level), as was observed in several of the preceding cereal models. IAT, YCH, and OCH on the other hand are negatively associated with household consumption of cowpeas as would be expected given the fact that households with more children consume less cowpeas than households with more adults, ceteris paribus. These three variables are statistically significant at the .05 level or better. Fulani households consume significantly higher amounts of cowpeas than households of other ethnic groups. This relationship is significant at the .01 level.

The two market orientation variables, SHOG and SSHO, are significant at the .01 level in the small sample version of equation 7.8.5. The interesting point here is that the results appear, at least initially, to provide contradictory evidence. As the share of harvest output comprised of groundnuts increases, while holding the total value of sales as a share of the total value of harvest output constant, the amount of cowpeas consumed increases. Conversely, as the ratio of the total value of sales to the total value of harvest output increases, whild holding the share of harvest output that is comprised of groundnuts constant, the amount of cowpeas consumed falls. Households which produce more groundnuts for sale and sell less of other cash crops consume more cowpeas, whereas households which produce the same amount of groundnuts and more of other cash crops for sale consume less cowpeas. This would suggest that households which emphasize principally groundnuts among the range of cash crops, consume more cowpeas than households which are generally more market-oriented selling other crops than groundnuts. This negative impact upon the consumption of cowpeas of an increase in SSHO is one case in which the more market-oriented households consume less of a particular food. Sorghum was another, but maize consumption rose with market orientation.

Palm Oil

Palm oil is the first of several commodities that is largely or entirely purchased from the market. The variable PRSP in the final palm oil model, equation 7.9.5, indicates that as the price ratio of sorghum to palm oil increases, the amount of palm oil consumed increases. This relationship is different from zero at the .01 level of significance for both the large and small sample households. Where palm oil is inexpensive in terms of sorghum, households buy more palm oil. This is not surprising, especially if they sell sorghum in order to buy palm oil.

Table 7-9

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 (7.9.1)	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 (7.9.2)	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 (7.9.3)	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 (7.9.4)	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 (7.9.5)	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 7-2.

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

[4]Cp equals 1.63.

[5]Each parameter is obtained from 7.9.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term with this suffix. The intercept is simply the intercept from equation 7.9.5 plus the parameter from the variable SSD.

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

The real expenditure variable, TEXPR, is also significantly different from zero for both samples at the .01 level of significance. In both samples it is positively associated with palm oil consumption, although a significant difference exists between the two sample estimates.

The household characteristic variables specified in the final model are all significant in the small sample version at the .05 level of significance or better except for WAD. The large sample OAD variable is the only household characteristics variable which supports the small sample findings concerning the influence of household characteristics upon palm oil consumption. The small sample version shows that given total household expenditure an increase in household size, explained by increases in either IAT, OCH, MAD or NWAD household composition groups, is associated with a reduction in palm oil consumption. The same increase in size, if it occurs in the form of an increase in YCH or OAD, is associated with greater palm oil consumption.

This local substitute[6] can be produced locally and perhaps is more widely produced by these larger households. The addition of either young child or an older adult is associated with an increase in the amount of palm oil consumed. A possible explanation of this is that young children are often sent by the household heads to purchase items from the market, one of which is palm oil, and their presence in the household is likely to facilitate obtaining this item, especially given the fact that men are occupied with farm work and most Moslem women are in seclusion, kulle. Older female adults, included in the variable OAD, are not bound

[6]Groundnut oil is consumed by 79 percent of the small sample households. To a far lesser extent shea butter oil is another substitute.

by the same Moslem regulations, and are therefore able to go to the market and engage in palm oil purchasing.

Nono

Nono, like palm oil, is primarily a purchased food. (The sample provides no information about the production of nono.) The model which best satisfied the selection criteria did not include in the original model (equation 7.10.1 in Table 7-10) any price or expenditure variables.

Except for SSHO, only household characteristics reveal important influences upon nono consumption. It is not surprising to find that Fulani households consume more nono than households from other ethnic backgrounds, but it is surprising that Fulani households purchase more nono, given the fact that they are its primary producers in the area. It is possible that Fulani households purchase more nono simply to supplement the nono already available at times when the household's quantity demanded exceeds the quantity the household is able to supply. All the other household size and composition variables indicate that the consumption of nono rises when an adult non-wife female is added to the household, and the consumption of nono falls whenever any household group other than adult non-wife female increases in size, while the adult non-wife female category decreases in size so as to preserve a constant household size.

The positive and strongly significant relationship which appears for the marketing orientation variable, SSHO, is what was expected given the fact that the nono consumption observed here was bought with money which would obviously be more available in households which were more cash-oriented.

Table 7-10

Single-Equation Total Nono[#] 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]								
					Household Characteristics								Market
					HHS	IAT	YCH	OCH	MAD	WAD	OAD	FUL	SSHO
Small Sample-[3] Original Model (7.10.1)	32	.84	.89	*** -120.229 (-3.39)	*** 106.5 (6.99)	** -145.9 (-6.47)	*** -67.7 (-3.78)	*** -131.5 (-5.62)	*** -77.1 (-3.10)	*** -69.1 (-3.81)	** -62.6 (-2.68)	*** 227.0 (6.88)	*** 179.5 (3.02)
Large Sample-Original Model (7.10.2)	93	.04	.14	*** 67.7 (2.99)	* -29.4 (-1.93)	24.9 (1.26)	** 35.9 (2.09)	** 33.5 (1.97)	** 46.7 (2.00)	27.0 (1.36)	29.1 (1.47)	-18.1 (-.64)	** 107.8 (2.17)
Combined Samples (7.10.3)	125	.18	.24	37.1 (1.60)	** 29.3 (2.14)	*** -49.8 (-2.67)	-18.4 (-1.14)	* -29.0 (-1.81)	-9.96 (-.48)	** -35.9 (-2.10)	-7.5 (-.38)	*** 72.5 (2.57)	*** 141.9 (2.94)
Combined Samples with Complete Interaction (7.10.4)	125	.53	.60	*** 67.7 (3.06)	** -29.4 (-1.97)	24.9 (1.29)	** 35.9 (2.14)	** 33.5 (2.01)	** 46.7 (2.05)	27.0 (1.39)	29.1 (1.50)	-18.1 (-.66)	** 107.8 (2.22)
Final Model-													
Combined Samples with Limited Interaction (7.10.5)	125	.53	.60	*** 64.7 (2.96)	** -29.3 (-1.96)	24.4 (1.27)	** 34.5 (2.07)	** 34.1 (2.05)	** 46.6 (2.05)	26.7 (1.37)	28.4 (1.47)	-18.0 (-.65)	*** 133.2 (3.43)
Small Sample[4] Component				-111.5	*** 105. (6.29)	*** -142.7 (-5.83)	*** -65.5 (-3.36)	*** -128.5 (-5.04)	*** -73.5 (-2.72)	*** -68.6 (-3.45)	** -62.7 (-2.44)	*** 229.4 (6.35)	*** 133.2 (3.43)
Large Sample Component				*** 64.7 (2.96)	** -29.3 (-1.96)	24.4 (1.27)	** 34.5 (2.07)	** 34.1 (2.05)	** 46.6 (2.05)	26.7 (1.37)	28.4 (1.47)	-18.0 (-.65)	*** 133.2 (3.43)

[#] Nono is a milk product often mixed with cereal products, e.g., hura/fura.

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 7-2.

[3] Cp equals 8.01.

[4] Each parameter is obtained from 7.10.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. The intercept is simply the intercept from equation 7.10.5 plus the parameter from the variable SSD.

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

Table 7-10 (Continued)

Equation	INDEPENDENT VARIABLES									
	Intercept Shift	Household Characteristics								Market
	SSD	HHSDI	IATDI	YCHDI	OCHDI	MADDI	WADDI	OADDI	FULDI	SSHODI
7.10.4 (Cont'd)	*** -187.9 (-4.19)	*** 135.9 (6.06)	*** -170.8 (-5.44)	*** -103.6 (-4.01)	*** -165.1 (-5.38)	*** -123.8 (-3.48)	*** -96.2 (-3.45)	*** -91.7 (-2.85)	*** 245.122 (5.38)	71.7 (.88)
7.10.5 (Cont'd)	*** -176.2 (-4.11)	*** 134.3 (6.01)	*** -167.1 (-5.37)	*** -99.99 (-3.92)	*** -162.6 (-5.33)	*** -120.1 (-3.40)	*** -95.3 (-3.42)	*** -91.1 (-2.83)	*** 247.4 (5.45)	

Tomatoes

The squared real income term is significant and positive in the small and large sample versions of equation 7.11.5 in Table 7-11 but has an extremely small association with tomato consumption. As TEXPRSQ rises there is first a gradual rise in the tomato consumption level with consumption levels increasing at an increasing rate at higher income levels.

The signs on all the household composition variables are the reverse of what they were for cowpeas and for most of the cereals. As was the case with palm oil, the sign on the HHS variable was also negative. Every household characteristic variable included in the final model was significantly different from zero at the .01 level. IAT, YCH, OCH, OAD and LITERAT all have a positive effect upon the consumption of tomatoes, whereas being a member of a Fulani household is associated with significantly reduced levels of tomato consumption.

The marketing orientation variable, SHOG, indicates that households with a greater groundnut production orientation consume greater amounts of tomatoes and the source variable, STAN, indicates that households which consume the larger shares of their tomatoes from off-farm non-market sources consume greater amounts of tomatoes overall.

Principal Factors Affecting Non-Cereal Consumption

The four non-cereals examined in the previous pages are all, with the exception of cowpeas, commodities largely or entirely purchased from the market. Cowpeas more closely resemble the cereals in that most of what is consumed is produced by the consuming household.

Table 7-11

Single-Equation Total Tomatoes 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	Expenditure	Household Characteristics							Market	Source
					CONST	PRST	TEXPRSQ	HHS	IAT	YCH	OCH	OAD	FUL	LITERAT	SHOG	STAN
Small Sample-[3] Original Model (7.11.1)	32	.84	.90	-76.6** (-2.38)		21.1** (2.36)	.619 E-4*** (7.64)	-23.4*** (-5.82)	42.9*** (5.42)	44.4*** (5.21)	56.3*** (5.00)	33.4*** (3.32)	-93.4*** (-5.24)	42.5** (2.58)	188.5** (2.21)	75.9** (2.57)
Large Sample Original Model (7.11.2)	74	.38	.47	-42.1* (-1.88)		21.0** (2.02)	.901 E-5 (.80)	5.75 (1.01)	10.1 (.85)	-1.7 (-.18)	-8.2 (-1.09)	15.6 (1.18)	-17.7 (-.70)	23.6 (1.39)	68.4 (1.32)	-90.5 (-.95)
Combined Samples (Weighted) (7.11.3)	106	.75	.78	-	-36.3* (-1.94)	31.3*** (4.37)	.457 E-1*** (5.32)	-8.7** (-2.46)	33.6*** (4.38)	14.7** (2.13)	14.6** (2.28)	11.4 (1.29)	-56.0 (-3.33)	28.9** (2.34)	45.6 (1.03)	-6.7 (-.26)
Combined Samples with Complete Interaction (7.11.4)	106	.75	.81	-	-29.1 (-.93)	15.4 (1.17)	.903 E-7 (.85)	5.4 (.82)	8.9 (.66)	-.67 (.06)	-8.0 (.92)	18.0 (1.13)	-20.7 (-.69)	25.7 (1.30)	62.5 (1.01)	-91.7 (-.82)
Final Model-																
Combined Samples with Limited Interaction (7.11.5)	106	.76	.80	-	-3.7 (-.17)	4.8 (.52)	.163 E-6* (1.79)	-.81 (-.16)	13.9 (1.10)	7.0 (.68)	-4.1 (-.50)	29.6*** (3.14)	- .55 (5.28)	37.8*** (3.07)	79.7* (1.65)	50.7* (1.76)
Small Sample[4] Component					-3.7 (-.17)	4.8 (.52)	.375 E-6*** (4.53)	-19.7*** (4.38)	47.7*** (5.04)	38.2*** (3.98)	55.9*** (4.26)	29.6*** (3.14)	-121.6*** (5.28)	37.8*** (3.07)	79.7* (1.65)	50.7* (1.76)
Large Sample Component					-3.7 (-.17)	4.8 (.52)	.163 E-6* (1.79)	-.81 (-.16)	13.9 (1.10)	7.0 (.68)	-4.1 (-.50)	29.6*** (3.14)	-15.7 (-.55)	37.8*** (3.07)	79.7* (1.65)	50.7* (1.76)

[1] t-statistics are in parenthesis.

[2] Variables are defined in Table 7-2.

[3] Cp equals 7.99.

[4] Each parameter is obtained from 7.11.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. The intercept is simply the intercept from equation 7.11.5 plus the parameter from the variable SSD.

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

Table 7-11 (Continued)

Equation	INDEPENDENT VARIABLES											
		Price	Expenditure	Household Characteristics							Market	Source
	CONSTDI	PRSTDI	TEXPRSQDI	HHSDI	IATDI	YCHDI	OCHDI	OADDI	FULDI	LITERATDI	SHOGDI	STANDI
(7.11.4) (Cont'd)	29.5 (.61)	-23.5 (-1.17)	** .361 E-6 (2.44)	*** -29.7 (-3.5)	*** 41.0 (2.45)	*** 46.7 (2.89)	*** 72.6 (4.37)	20.5 (1.01)	*** -110.0 (-2.88)	24.3 (.86)	81.4 (.67)	167.7 (1.42)
(7.11.5) (Cont'd)			* .212 E-6 (1.92)	*** -18.9 (-3.64)	** 33.8 (2.20)	** 31.2 (2.38)	*** 60.0 (4.07)		*** -105.9 (-2.88)			

Real prices are important factors influencing cowpea and palm oil consumption but the data provide no support for such a statement about nono and tomato consumption.

Real income evidences a positive linear effect upon cowpeas and palm oil consumption, but no apparent influence upon nono consumption at all. Real income is associated with tomato consumption in a positive non-linear way.

Household characteristics are particularly important in determining household consumption levels of nono. No common pattern emerged between household characteristics and consumption for these four commodities as a group.

Three of the non-cereals are obtained primarily from the market. For two of these three (nono and tomatoes) the market orientation variables show positive association between the level of consumption and market orientation. Neither of the marketing orientation variables was significant in the palm oil final model and the two marketing orientation variables indicated directly opposite effects upon cowpea consumption.

Elasticities

The equations which have just been discussed in the previous nine tables do not present price and expenditure relations which can be interpreted easily. Since all of these price and expenditure terms are expressed in terms of the relative price of the dependent variable, it is very difficult to see readily what the money expenditure and own-price relationships are. Although I have attempted to indicate that price and expenditure relationships are important, I have not attempted to interpret these effects carefully until now. Table 7-12 presents own-price expenditure and cross-price elasticities for the nine commodities being studied.

Table 7-12

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

Commodity	Elasticity Type		
	Own-Price	Expenditure	Cross-Price
Sorghum	.92	-.61	-.31 (with palm oil)
Early Millet	.18	.18	-.37 (with sorghum)
Late Millet	-1.16	-.02	1.19 (with early millet)
Maize	-.33	.37	--
Rice	.00	--	--
Cowpeas	-5.52	2.43	11.36 (with millet) -8.38 (with sorghum)
Palm Oil	-2.03	.86	1.16 (with sorghum)
Nono	.00	--	--
Tomatoes	.24	.08	.17 (with sorghum)

-- no information

The formulas for the own-price, total expenditure and cross-price elasticities are as follows:

Own-price: $$\frac{\partial q_i}{\partial p_i} \cdot \frac{p_i}{q_i} = -1 + \frac{[a_i - b_2 (y/p_i)^2 + g]}{q_i}$$

Expenditure: $$\frac{\partial q_i}{\partial y} \cdot \frac{y}{q_i} = [b_1 + 2b_2 (y/p_i)] \frac{y}{p_i q_i}$$

Cross-price: $$\frac{\partial q_i}{\partial p_j} \cdot \frac{p_i}{q_i} = \frac{a_j}{q_i} \frac{p_j}{p_i}$$

where q_i is the predicted consumption of the dependent variables,

p_i is the price of the dependent variable,

p_j is the price of commodity other than the dependent variable,

a_i is the intercept term for the prediction equation,

b_2 is the parameter estimate of the quadratic expenditure term,

y is expenditure (income),

g is the total predicted consumption of q_i minus that portion of consumption which results from the intercept and the price and expenditure terms, and

a_j is the parameter estimate of the relative price term p_j/p_i.

All of the elasticities were calculated using mean values for the consuming households from the large and small sample combined. The author felt that it was appropriate to select mean values of the independent variables from the combined sample in order to calculate predictions of consumption for the consuming population because the combined sample data offered the best profile of the mean consuming household in the population. The independent variable measurements for both samples were of similar quality with respect to village prices and household characteristics. Other independent variables, however, particularly those derived from production estimates,[7] are judged to be of superior quality in the small sample, which has lower measurement errors. The equation from which the elasticities were computed was the equation felt to be most representative of the population as a whole. For that reason the small sample components were used from the final models for sorghum, early millet, maize, rice, cowpeas, palm oil, nono and tomatoes plus equation 7.5.3 for late millet.

These elasticities must be interpreted with caution for three critical reasons. First, many of these elasticities were calculated using statistically insignificant real price and income terms, and therefore the degree of reliance upon these elasticities will vary depending upon the quality of the regression from which they were calculated. However, sorghum, cowpea and palm oil have own-price, expenditure and cross-price elasticities calculated from equations with many highly significant variables. Fortunately, these are extremely important commodities. On the other hand, the rice and nono final equations contain many significant variables but no price or expenditure terms at all. The quality of the maize expenditure elasticity is high, given the fact that the expenditure variable is highly significant, and the own-price elasticity can also be calculated because the price relationship enters the maize equation through the real expenditure term. The early millet expenditure elasticity was calculated from an equation with more insignificant terms than the previous equations discussed, but its expenditure variable is significant. No significant price terms enter into

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[7]Expenditure, expenditure squared, the market and source variables are derived from production estimates.

the calculation of early millet price elasticities although, again, the real expenditure term embodies own-price information. Finally, the late millet elasticities are of little interest because they were calculated from an equation which possesses price and expenditure terms, but only terms that are insignificant.

Second, the price variables, derived as annual village level prices, may incorporate some village level differences not captured by other independent variables. If they do, these price variables are not pure price variables and their inclusion in the elasticity formula leads to the calculation of a form of regional elasticity.

Third, the elasticities are not strictly speaking demand elasticities because of the inclusion of information concerning the production side of the household, information also relevant in determining consumption patterns. Economic theory suggests that the quanity supplied of a product should increase when the price of that product increases. Theory also suggests the opposite effect of a price increase upon the quantity demanded. When price changes affect both the quantity supplied and the quantity demanded, theory suggests certain responses. For example, a price increase would result, under normal circumstances, in selling more and consuming less. However, that result is based upon the assumption that buying and selling prices are the same, which is not the case if the household produces a part of its own food. Responsiveness to a price change can be either as a change in production or in consumption, or in both. In semi-subsistence areas the distinction between changes in production and consumption is blurred because most of what is produced by the farm household is consumed by the household. That is to say, price changes cause responses in both production and consumption and what are conventionally thought of as supply elasticities may be for the most part demand elasticities or vice versa.

In models of supply response to price changes lagged prices are used, whereas in studies of the demand response to price changes current prices are used. To the extent that current prices are used demand responses are likely to be measured, except that in this semi-subsistence setting consumption and production decisions are first made jointly at planting-time when the price for food at the time of future consumption is unknown. If households are able to forecast reasonably well the price of food for the upcoming consumption year, then consumption decisions will undergo only slight changes when the success of the current harvest is known. If prices do undergo only slight changes, then current prices clearly do measure supply responses as well as demand responses. However, even when prices fluctuate widely depending upon the success of the harvest and therefore the forecast price and actual prices are substantially different, food consumption responses to actual prices still reflect to a large extent the supply outcome of the current year's harvest. Consequently an interpretation of the elasticities will be in terms of whether or not the supply or the demand effect is dominant, recognizing that for several of these commodities an increase in production brings with it an increase in consumption and an increase in consumption comes about through an increase in production. The important point to mention in this context is that although traditional demand elasticities may be useful in measuring consumption in urban areas of LDC's, elasticities which capture both supply <u>and</u> demand changes are the relevant elasticities to study in measuring consumption by semi-subsistence rural households.

The own-price and expenditure elasticities for sorghum are .92 and -.61 as can be seen from Table 7-12. The positive own-price elasticity implies that the supply response to a price change dominates the demand response. It may also reflect the fact that areas where the consumption of sorghum is more widespread are areas in which the price of sorghum is generally higher. The negative expenditure elasticity indicates that sorghum is an inferior good. The cross-price elasticity of -.31 of sorghum with respect to palm oil indicates that palm oil and sorghum are complements. Knowledge of the dietary patterns confirms this fact.

The own-price elasticity of early millet is also positive. This indicates that early millet as well as sorghum have greater supply responses to price changes than they do demand responses. In the case of early millet a high price may indicate low food inventories because of the poor harvest which occurred in the previous year. It may be the low inventories that prompt large plantings of early millet, and therefore larger current consumption, rather than the price received for its sale. The expenditure elasticity for early millet is, however, positive, reflecting the fact that early millet is a normal good. This confirms what seems intuitively obvious in light of early millet's contribution to the diet. The negative cross-price elasticity of early millet with sorghum indicates perhaps a production response. When a high relative price for sorghum is expected, some resources may be shifted from early millet to sorghum, perhaps by increasing the density of sorghum in the cropping mixture.

The own-price elasticities were non-positive for the other cereals and cowpeas. Although the rice equation used resulted in an own-price elasticity of zero because no price, expenditure or intercept term appeared in the equation, late millet, maize and cowpeas reveal a situation in which consumption was inversely related to price. The own-price elasticity for cowpeas was extremely strong, indicating great responsiveness to price among consuming households with the mean characteristics of the sample. Late millet also evidenced less strong negative own-price elasticity, but substantial. The own-price elasticity picture which emerges from these five cereals and cowpeas is that the most important cereals evidencing demand effects, or it may simply be that cowpeas, maize and late millet are more often sold in response to a good market price. The own-price effect of cowpeas showed significant price responsiveness due perhaps to the attraction of marketing cowpeas. Cowpea production might increase with increases in cowpea prices but most of these production increases might be marketed instead of consumed and consumption be reduced.

The expenditure elasticities for maize and cowpeas evidence the same result found with early millet, but the effect of income upon cowpea consumption is very large (an elasticity of 2.43). The expenditure elasticity for maize indicates the scope for improved maize consumption with increasing incomes as well.

The cross-price elasticities for early millet and cowpeas seem sensible. A 1 percent increase in the price of late millet results in a 1.19 percent increase in the consumption of early millet, indicating as expected that these two forms of millet are substitutes. The cross-price elasticities of cowpeas with respect to millet and of cowpeas with respect to sorghum provide some additional interesting insights. If the price of cowpeas increases by 1 percent, then the consumption of millet increases by 11.36 percent, indicating that a rather large shift towards the consumption of millet occurs, whereas the same price change for cowpeas makes it more worthwhile to consume less sorghum, perhaps by allocating more resources to the production (and possibly, sale) of cowpeas.

Palm oil and nono show strong negative price responsiveness. These strong demand effects are not surprising insofar as that the sample households do not produce palm oil and only Fulani households in the sample produce nono. Tomatoes on the other hand evidence the opposite effect, with many of the sample households being producers of tomatoes. For tomatoes, the supply effects are dominant. The sign on the expenditure elasticities for palm oil and tomatoes are positive as was expected.

Supply as well as demand effects are evident in response to price changes. The supply effects appear to be strongest for the two most important cereals, namely sorghum and early millet. Since production equations were not fitted in this study, it is difficult to maintain positively that these are supply responses. Higher prices do not always lead to reduced consumption of items of importance in the diet; consumption may rise along with production in response to higher prices. However, the variable which attempted to capture this effect, consumption out of own production as a share of the total consumption appeared only once as a significant explanatory variable.[8]

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[8]SRAP, the share of rice consumed which was home-produced, was significant at the .01 level in equation 7.7.5 for rice.

CHAPTER VIII

SORGHUM CONSUMPTION BY SOURCE USING A SINGULAR SYSTEM

Among the important research questions which need to be addressed in this study is the extent to which low-income rural households which primarily produce food consume adequate amounts of it. Stating it in a slightly different manner, does it really matter whether or not a farm household produces its own food, if it is interested in having an adequate level of food intake?

There are several ways of obtaining answers to this question. First, the question can be answered whether or not the households which tend to produce large amounts of food tend to consume large amounts of food. This question can be answered by means of a single-equation analysis of total consumption of different foods where the relationship between an independent variable, representing the production orientation of a household, and the dependent variable, representing total consumption of a food, can be measured. In the multiple regression analysis of the preceeding chapter an attempt was made to answer this question for important food items in Northern Nigeria. There is, however, another way of approaching the same question which entails examining characteristics of households which consume large amounts of food from their own harvest output. The relationship which provides an answer to this question and which can be examined conveniently concerns households which produce foods primarily destined for home consumption and the level of consumption by those households of particular foods which are home produced.

The distinction between whether households consume more in total of a particular food or whether they consume more of the actual harvest output of the food requires, however, that some attention be paid to whether increases in food consumption come from home production, market purchases, in-kind flows or from all of these sources combined. In this chapter a method of analysis will be used to make these source distinctions and to identify within this framework the characteristics of households which consume large amounts of sorghum from the market, from home production and from in kind flows. This technique will make it possible to answer the question whether or not households which produce foods primarily for internal consumption are households which consume large amounts of sorghum from home consumption.

The analytical method used in this chapter does not preclude obtaining estimates of relationships pertaining to the total consumption of an individual food, in this case sorghum, but in fact supplements it with additional information. For this reason I consider the approach followed here to be of even greater value in more fully understanding sorghum consumption than the single equation total consumption approach employed earlier. This deeper understanding will be obtained by means of studying the demand for sorghum from different sources which will make it possible to determine which food sources dominate the total single-equation results and which variables are significant in the demand for sorghum from each source.

A Singular System of Sorghum Consumption

The estimation procedure for sorghum consumption by source is the one used for estimating a system of equations with a singular disturbance covariance matrix.[1] The equations which will be used in this system are the following:

S_{hH} is the consumption of sorghum from own production for household h,[2]

S_{hM} is the consumption of sorghum which has been purchased from the market for household h,

S_{hK} is the consumption of sorghum from gifts, loans, and wages in kind for household h, and

$S_{hT} = S_{hH} + S_{hM} + S_{hK}$ is total sorghum consumption for household h.

Each of these four equations is a function of a set of independent variables, X_{ih}, which can be assumed to be the same for all four equations. The variables from the final sorghum model in Table 7-2 will be the variables included in these four equations. Although theory does

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[1]For a discussion of this see: Judge, Griffiths, Hill and Lee, 1980, pp. 275-278.

[2]As the reader will recall from Chapter IV the components of total food consumption were defined in terms of q_{ihH}, q_{ihM} and q_{ihK}, where q_{ihH} referred to the amount of food i consumed from home production by household h. This variable was defined as being equal to the amount of food i produced by household h, less the amount of food i which the household sold, used as seed, and lost in the storage. An alternative definition could have also entailed subtracting from q_{ihH} the amount of food i which the household loaned, repaid as debt, paid out as wages or gave away. However, this was not done since q_{ihK} was defined to be the net amount of food i received in kind by household h and included in its calculation the amount of food i which the household loaned, paid as debt, paid out as wages and gave away.

In this chapter $q_{ihH} = S_{hH}$, since $q_i = S$. Therefore, the amount of sorghum loaned out, paid as debt, paid as wages and given away is not subtracted from the amount of sorghum which is defined here as being available from home production.

suggest that the factors which influence the demand for a good are likely to be the same whether the item demanded be from the market or from home production, there is reason to question whether the demand for a good from other in-kind sources, namely gifts, loans, and wages received, is likely to be determined in the same way. Traditional economic theory says little about this issue other than that in the case of gifts, the consumer will consume a free good until its marginal utility is equal to zero. Nevertheless, it was thought useful to model consumption from all sources, including S_K, in order to determine whether the variables suggested by economic theory for the demand from other sources might provide some guidance in understanding this component of consumption.

The system of sorghum consumption to be estimated is:

$$S_{hT} = \alpha_1 + \beta_1 X_{ih} + \varepsilon_1$$
$$S_{hH} = \alpha_2 + \beta_2 X_{ih} + \varepsilon_2$$
$$S_{hM} = \alpha_3 + \beta_3 X_{ih} + \varepsilon_3$$
$$S_{hK} = \alpha_4 + \beta_4 X_{ih} + \varepsilon_4$$

where X_{ih} is the set of independent variables for each household h,

$\beta_1 = \beta_2 + \beta_3 + \beta_4$, and

$\varepsilon_1 = \varepsilon_2 + \varepsilon_3 + \varepsilon_4$.

This system of four equations is linearly dependent because the independent variables are identical throughout the system and the error terms are correlated across equations.[3] The covariance matrix of the disturbances, being singular, cannot be inverted, so one of the equations must be dropped in order to estimate the system. The choice of the regression to drop will not affect the results obtained because of the parameter

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[3]The error terms are, however, not correlated across observations.

restriction on the beta coefficients. Each equation in the system can be estimated separately by using Ordinary Least Squares. This procedure is analagous to Zellner's Seemingly Unrelated Regression Case except that in this case the identical nature of the explanatory variables and the presence of a singular disturbance covariance matrix render it unnecessary to estimate all the equations in the system. One of the equations can be dropped before estimating the parameters of the other equations by Ordinary Least Squares. As a check the omitted equation can be fitted to ensure that the parameter estimates across equations add up while providing at the same time the R^2, $\bar{R}^2$ and t-statistics for this equation.

Farm Gate and Retail Prices for the Sorghum System Model

The single equation total consumption equations calculated in the previous chapter employed prices which were averages of farm gate and retail prices, weighted by the importance that each price played in the consumption of the particular food being discussed. Here the prices which reflect the opportunity costs faced by the sorghum consuming households, namely the farm gate and retail prices, can be used directly in these source equations. As was mentioned earlier, price used for sorghum purchased at home is the amount foregone by not selling the product at the farm gate level, whereas the price used for sorghum purchased from the market is the retail purchase price. Since sorghum which is received either in the form of a gift, loan or wage paid in-kind will be treated as having an opportunity cost equal to the farm gate price, the purchase price for these types of off-farm receipts in-kind in this analysis is the farm gate price. It should be pointed out again that these acquisition and salvage prices are not being used for the purpose of attempting to value household consumption as would be done perhaps in a study with different objectives. These prices reflect instead simply the opportunity costs of food under the given set of assumptions that foods consumed from different sources should be valued according to their value in exchange not in terms of their value in use.

When one observes that sorghum is consumed from home production, market purchase and from off-farm in-kind sources and that the price paid for sorghum from one source, i.e., the market purchase source, is different from the price paid for sorghum from the other two, then the following economic argument suggests that the sorghum consumed from these three principal sources must possess certain economic differences which cause it to satisfy the utility of the consuming household in different ways. If one were to assume first that sorghum from one source was the same as sorghum from a different source, then economic theory would suggest that the marginal utility of sorghum from that source would be equal to the marginal utility of consumption from the other source, and that only sorghum from the relatively inexpensive source would be consumed, since the exact same item would otherwise be consumed from another source at a higher price. However, the consumption of sorghum occurs among these households from all three sources and not simply the cheaper one. This observed fact about the consumption behavior of the study households and the associated theory just presented lead to the conclusion that sorghum consumed from different sources are separate economic goods possessing certain form, time and place differences which cause them to satisfy the utility of the consuming household in different ways.

That sorghum consumed from different sources satisfies different time, form and place characteristics of utility is apparent. One example of differences in time utility between sorghum from different sources is that consumption of sorghum from own production may be greatest during the harvest period when the own-production source is plentiful and that the consumption of sorghum as gifts and loans in-kind may be greatest when the amount of sorghum available from home and market sources is negligible (or even non-existent). Differences in form utility may simply be that certain varieties of sorghum are preferred for home consumption.[4] Differences in place utility are, of course, embodied in the source distinction employed in this analysis.

Bearing this in mind, it would be more appropriate for the sorghum singular system analysis to be undertaken with different prices being used to reflect differences in sorghum types. In the specific case of sorghum, the choice was made to replace the average quantity-weighted average price used in Table 7-2 with the farm gate price of sorghum. The price and expenditure variables are again expressed in real terms all being relative to the farm gate price of sorghum. The price of palm oil used is the retail price of palm oil since only a retail price for palm oil exists in this study. The selection of the price variable followed the same procedure mentioned in Chapter VII, with the exception of replacing an average price by a farm gate price, and was to some extent arbitrary as can be seen from the preceeding discussion. In addition,

[4]Since sorghum was aggregated across variety at an early stage of the analysis the distinction between different varieties, with different physical characteristics was not preserved. An intensive examination of the different varieties of sorghum produced, bought and sold might suggest that certain varieties are more preferred for home consumption than others, and some varieties are produced primarily for sale.

constraints imposed by the method itself and the limited number of observations available made the selection of prices arbitrary for another reason as well. As has also been pointed out, the method used in this chapter imposes the constraint that every right hand side variable in each equation be the same. The astute reader will notice that only one equation, 8.1.1, employs a price which is its own real price. For 8.1.2 and 8.1.4 the relevant own prices should be expressed in terms of the retail price of sorghum and the average of the farm gate and retail price of sorghum, respectively, instead of simply the farm gate price of sorghum. However, to have included these two new prices, the price ratio of the retail price of palm oil to the retail price of sorghum and the price ratio of the retail price of palm oil to the average of the farm gate and retail price of sorghum, would have necessitated increasing the number of right hand side variables by two. Since the degrees of freedom permitted by the small sample were few, adding these two extra variables would have made it difficult to obtain meaningful relationships for other important variables. Nevertheless, it is possible that the inclusion of other real prices of sorghum may have resulted in being able to measure more accurately the effect of price upon sorghum consumption from different sources.

Small Sample Selection

The final model in Table 7-3 provided a very interesting result. Since each variable specified with a DI suffix was statistically significant at the .10 level or better, each of the small sample component parameters of the final model was identical to the small sample original model, equation 7.3.1. The parameter estimates were significantly different for the large and small samples and inclusion of the large sample data did not improve the estimates obtained by using only the small sample data. Since it was believed that the small sample provided the more reliable data, the small sample alone was used to analyze the consumption of sorghum from different sources.

Sorghum Consumption by Source for All Sorghum Consuming Households -- Small Sample

Before examining the components of consumption by source for all sorghum consuming households, it would be worthwhile to point out that the final sorghum model from Chapter VII, equation 7.2.4, provides another reason for undertaking the following analysis in addition to those mentioned at the beginning of the chapter. The source variable SSAN, the share of sorghum available from neither home production nor from the market, was statistically significant at the .05 level in the small sample component of the final model. This provided a clear indication that the source from which sorghum was obtained for consumption was an important factor associated with the overall level of sorghum consumed by small sample households. However helpful this variable was in detecting (initially) the importance of source upon sorghum consumption, it did not suggest any reasons why households with a greater share of sorghum consumption from off-farm in-kind receipts, ceteris paribus, might consume more sorghum. This can be done by measuring explicitly the factors associated with the consumption of absolute quantities of sorghum from different sources as is done in this and the following sections.

Equations 8.1.1, 8.1.2 and 8.1.4 in Table 8-1 were the three equations fitted to all sorghum consuming households in the small sample. Equation 8.1.3, the market source equation, was derived from the parameters estimated in the three other equations by subtracting the sum of the parameters in equations 8.1.1 and 8.1.2 from the parameters estimated in equation 8.1.4. No attempt will be made to interpret the results of this market source equation in Table 8-1 because half of the sorghum consuming households are non-purchasers of sorghum. This was not the case with sorghum consumption from the two other sources reported in equations 8.1.1 and 8.1.2. Since the proportion of non-purchasers to consumers of sorghum is so high, the distribution of observations upon which the parameter estimates are made is weighted by a disproportionate number of observations at zero. This skewing of the distribution violates the assumption that the residuals are normally distributed, yet this assumption is needed to make meaningful confidence-interval statements and to apply tests of significance. However, the least squares parameters still possess minimum variance among all estimators and they are still unbiased. Since tests of significance cannot be applied to these market consumption estimators with any degree of confidence, the t-statistics for equation 8.1.3 were left unreported.

Another point worth mentioning at the outset is that the total sorghum consumption final model presented as equation 7.3.4 in Table 7-2 is a different model than equation 8.1.4 presented in Table 8-1. First, as has just been discussed, the price and expenditure terms are now expressed in terms of the farm gate price of sorghum instead of the price of sorghum calculated for use in Chapter VII. Second, since a source variable was used in Chapter VII to capture the effects upon

Table 8-1

Singular System of Sorghum Consumption Regressions by Source for All Sorghum Consuming Households, Small Sample, Kano State, Nigeria, 1974-1975[1]

Equation	Number of Households	$\bar{R}^2$	R^2	Intercept	INDEPENDENT VARIABLES[2]								
					Price[3]	Expenditure[3]		Household Characteristics				Market Relationship	
					PRPSFG	TEXPR	TEXPRSQ	HHS	IAT	MAD	HHAGE	SHOG	SSHO
Home Production (8.1.1)	34	.69	.78	*** 2686.04 (2.74)	-60.8 (-.60)	*** -.362 (-2.77)	*** .239 E-4 (3.18)	*** 330.3 (4.61)	*** -448.0 (-2.91)	** -492.5 (-2.58)	-8.2 (-.70)	*** -2749.5 (-2.68)	-844.8 (-1.60)
Off-Farm Non-Market (8.1.2)	34	.12	.36	1061.2 (1.57)	-70.61 (-1.01)	*** -.253 (-2.80)	*** .163 E-4 (3.14)	25.7 (.52)	-74.2 (-.70)	-226.0 (-1.71)	.55 (.07)	799.1 (1.13)	249.7 (.68)
Market[4] (8.1.3)				207.66	2.31	-.005	-.001 E-4	13.1	28.9	39.1	-4.25	308.7	-55.2
Total-All Sorghum Consuming (8.1.4)	34	.56	.68	*** 3954.9 (3.13)	-129.1 (-.99)	*** -.62 (-3.69)	*** .401 E-4 (4.14)	*** 369.1 (4.00)	*** -551.1 (-2.77)	*** -757.6 (-3.08)	-11.9 (-.78)	-1641.7 (-1.24)	-650.3 (-.95)

[1]t-statistics are in parentheses.

[2]Variables are defined in Table VII.1 except PRPSFG. PRPSFG is the price ratio of the retail price of palm oil to the farm gate price of sorghum.

[3]Each expenditure and price variable has been divided by the farm gate price of sorghum.

[4]Parameters from this equation were calculated by subtracting the sum of the parameters from equations 8.1.1 and 8.1.2 from the parameters in equation 8.1.4. For example, for PRPSFG -112.7 - (-60.8 + (-70.61)) = 10.71.

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

consumption of gaining one's sorghum from different sources, this variable must be dropped as an independent variable when source is modeled explicitly into the analysis by virtue of each separate source equation. Therefore, the variable SSAN is the variable which will be dropped from equation 7.3.4 in fitting equation 8.1.4.

A comparison of equations 7.3.4 and 8.1.4 confirms what was expected in light of the above discussion. Perhaps the most significant finding from the changes made in equation 7.3.4 is that the non-sorghum specific marketing orientation variables, SHOG and SSHO, lose the statistical significance that they had when their parameters were estimated using the combined data sets in equation 7.3.4.[5] Moreover, when one compares the explanatory power of equation 8.1.4 and the small sample original model, equation 7.3.1,[6] it becomes apparent immediately that the explanatory power falls considerably from an $\bar{R}^2$ of .87 to .56 when the source variable SSAN is dropped and when the average price of sorghum is replaced by the farm gate price of sorghum. The signs, and significance levels of the price, expenditure and household characteristic terms are approximately the same in these two equations with the exception of HHAGE which become statistically insignificant at the .10 level for equation 8.1.4. Both equations show positive levels of

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[5]These overall marketing variables are independent of the dependent variables (unlike the source variable SSAN) because they measure the composite market activity of the household and not the household's market activity, vis-a-vis, sorghum per se.

[6]Recall that the small sample component of the final model (equation 7.2.4) gave the identical results to that obtained from the small sample original model (equation 7.2.1). Since the discussion here concerns only estimation differences given identical samples equation 7.2.1 must be used in the comparison with 8.1.4 in lieu of 7.2.4.

sorghum consumption occurring in response to income changes at income levels which lie within the income range of sample incomes and which are two standard deviations from the mean income level of the small sample households.

Table 8-1 provides the first estimates made of consumption of sorghum by the three major sources, home production, off-farm in-kind receipts and market purchase. These estimates were made for all sorghum-consuming households. Sorghum consumption from home production, equation 8.1.1, gives the best fit of the three equations estimated in Table 8-1. Although its effects clearly dominate the total equation, equation 8.1.4, some additional information of interest can be obtained from the off-farm non-market equation, equation 8.1.2. Real expenditure appears to have the same (negative) influence upon sorghum consumption either from the home produced source of from the off-farm in-kind source and in the case of this latter source, it appears to be the only significant factor which influences sorghum consumption. For these two source equations the consumption of sorghum increases in response to real income changes for households with real incomes approximately two standard deviations above the mean income level of the sample. The market source sorghum equation, equation 8.1.3, is unlike the other two source equations in that it does not show any sorghum consumption increase at all for households with real incomes within the range of real incomes which exist in the sample.

One hypothesis to test with respect to income is that the level of consumption from this source falls as income rises. The results found in equation 8.1.2 lend support to this hypothesis insofar as that it cannot be rejected at the .01 level of significance. If gifts are the most important component of this category, then wealthier households receive more sorghum gifts than poorer ones. On the other hand, if loans or wages in-kind are the most important component, then it would imply that wealthier households need to rely less on these types of in-kind receipts than lower income households do.

In addition to real income, certain household characteristics and market relationship variables provide evidence of statistically significant relationships with the consumption of sorghum from own-produced sources (equation 8.1.1). However, these same household characteristic variables do not indicate any significantly non-zero relationship at all with the consumption of sorghum from gifts, loands and wages in-kind. The value of groundnuts as a share of the total value of harvest output is not a statistically significant explanatory variable useful in explaining sorghum consumption from this same off-farm non-market source, whereas it is useful in explaining sorghum consumption from home production. This latter variable indicates the not so surprising conclusion that households which produce more groundnuts for sale and thereby replace other cash crops sold with these groundnuts (so as to keep SSHO constant) are likely to consume less sorghum from home production. This suggests that groundnut producers produce less sorghum and, by virtue of the sign on SHOG in equation 8.1.3, consume more sorghum from the market and other off-farm sources instead.

Singular Systems for Market Purchasing and Non-Purchasing Sorghum Consuming Households

An interesting hypothesis to test in the analysis of sorghum consumption by source is whether households which resort to market purchases for at least some part of sorghum consumption behave in the same way as households which do not resort to market purchases for sorghum at all. In order to test this hypothesis, an F-test was calculated using equations representing total sorghum consumption from only sorghum purchasing households, total consumption of sorghum from only non-sorghum-purchasing households and total consumption of sorghum among all sorghum consuming households together. The F-test revealed a significant difference did exist between the sorghum-purchasing and non-sorghum-purchasing households at the .10 level of significance. For that reason the analysis will, from here on, take into account the significant differences which exist between these two groups.

Once the distinction is made between these two sorghum consuming groups, one can see from Table 8-2 several differences between the two groups become immediately apparent. The model used is better suited to predict the consumption of non-sorghum purchasing households, having an $\bar{R}^2$ of .71 compared to an $\bar{R}^2$ of .48 for the sorghum-purchasing group.

The real income and income squared terms, TEXPR and TEXPRSQ, were significantly different from zero for only the non-sorghum-purchasing group. It is apparent from examining equation 8.2.3 that the income relationship among the non-sorghum-purchasing households is what dominates the relationship observed for all sorghum-consuming households, both in equations 8.2.3 and 7.3.4. Since income does not appear to be a significant factor influencing the consumption of sorghum for

Table 8-2

Total Sorghum Consumption Regressions for Households Purchasing Sorghum from the Market and for Non-Sorghum Purchasing Households, Small Sample, 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	
					PRPSFG	TEXPR	TEXPRSQ	HHS	IAT	MAD	HHAGE	SHOG	SSHO
Sorghum Purchasing (8.2.1)	18	.48	.76	2067.7 (1.93)	-171.6 (-1.26)	.097 (.58)	-.414 E-5 (-.44)	89.1 (.81)	-49.6 (-.26)	-195.5 (-.84)	1.6 (.14)	-1148.0 (-1.17)	-779.0 (-.76)
Non-Sorghum Purchasing (8.2.2)	16	.71	.88	4147.8 (2.02)	-322.5 (-1.45)	*** -1.192 (-3.42)	*** .808 E-4 (4.09)	** 307.7 (2.33)	-40.0 (-.09)	-638.7 (-1.35)	27.6 (.76)	2783.4 (.87)	-990.4 (-.82)
All Sorghum Consuming (8.2.3)	34	.56	.68	*** 3954.9 (3.13)	-129.1 (-.99)	*** -.62 (-3.69)	*** .401 E-4 (4.14)	*** 369.1 (4.00)	*** -551.1 (-2.77)	*** -757.6 (-3.08)	-11.9 (-.78)	-1641.7 (-1.24)	-650.3 (-.95)

[1] t-statistics are in parentheses.

[2] Variables, except PRPSFG, are defined in Table VII.1. PRPSFG is the price ratio of the retail price of palm oil to the farm gate price of sorghum.

[3] Each price and expenditure variable has been divided by the farm gate price of sorghum.

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

sorghum-purchasing households. A simple explanation why is simply that the households comprising the sorghum purchasing groups are an extremely heterogeneous group of households.

Market-Purchasing Sorghum Consuming Households

Table 8-3 presents the source equations derived from the sorghum purchasing group examined in Table 7-2. The t-statistics for the market equation have meaning here, unlike in equation 8.1.3, because the zero market purchase observations have all been removed. Although the market equation 8.3.2 was the omitted equation from the singular system and the parameters derived in the same way as in the other singular systems, the market equation was fitted to gain measures of $\bar{R}^2$ and R^2. As it were, this was useful to do because the negative $\bar{R}^2$ reported on the market equation indicated that one could predict market consumption with a smaller variance if the prediction were the mean consumption from the market instead of the consumption from this regression equation. This stands out in sharp contrast to the total consumption from home production model which has an $\bar{R}^2$ of .66, much higher than the $\bar{R}^2$ obtained by using the equation for sorghum consumption from all sources.

The total harvest value of groundnuts as a share of the total value of output variable shows a significantly negative relationship with consumption from home production. This relationship provides the rather interesting insight that households which purchase sorghum and increase their share of groundnuts in production consume less sorghum from home production, although not from all sources together. The sign reverses when one examines the influence of SHOG upon market consumption,

Table 8-3

Singular System of Sorghum Consumption Regressions by Source for Households Purchasing Sorghum from the Market, Small Sample, Kano State, Nigeria, 1974-1975[1]

Equation	Number of Households	$\bar{R}^2$	R^2	Intercept	INDEPENDENT VARIABLES[2]								
					Price[3]	Expenditure[3]		Household Characteristics				Market Relationship	
					PRPSFG	TEXPR	TEXPRSQ	HHS	IAT	MAD	HHAGE	SHOG	SSHO
Home Production (8.3.1)	18	.66	.84	1287.6 (1.44)	-113.2 (-1.0)	.150 (1.08)	-.711 E-5 (-.91)	50.5 (.55)	49.5 (.31)	-96.1 (-.50)	8.8 (.92)	-1737.0* (-2.12)	-1164.0 (-1.33)
Market (8.3.2)	18	-.23	.42	582.0 (1.38)	-60.0 (-1.12)	.015 (.23)	-.107 E-5 (-.29)	23.9 (.55)	-70.7 (-.94)	-68.3 (-.75)	-4.8 (-1.07)	555.6 (1.44)	331.6 (.80)
Off-Farm Non-Market (8.3.3)	18	.21	.63	197.9 (1.21)	1.7 (.08)	-.068** (-2.67)	.404 E-5** (2.83)	14.7 (.87)	-28.4 (-.97)	-31.0 (-.87)	-2.4 (-1.37)	33.0 (.22)	33.3 (.21)
Total-All Sources (8.3.4)	18	.48	.76	2067.7 (1.93)	-171.6 (-1.26)	.097 (.58)	-.414 E-5 (-.44)	89.1 (.81)	-49.6 (-.26)	-195.5 (-.84)	1.6 (.14)	-1148.0 (-1.17)	-779.0 (-.76)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table VII.1 except PRPSFG. PRPSFG is the price ratio of the retail price of palm oil to the farm gate price of sorghum.

[3] Each expenditure and price variable has been divided by the farm gate price of sorghum.

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

indicating that the more marketing oriented households are ones that consume more from the market source. This follows logically from the influence observed in equation 8.4.1 of SHOG upon home consumption, namely that the more groundnut-oriented the production strategy is of the household the less is sorghum consumed from home production and the more is sorghum consumed from the market. The coefficients of the other marketing orientation variable, the value of sales as a share of the total value of harvest, are consistent with the same pattern of behavior, but are not statistically different from zero.

Looking at consumption by source also reveals a significant relationship of income upon the consumption of sorghum from off-farm nonmarket sources. The relationship which developed is the same as the one discussed in the context of equation 8.1.2 in Table 8-1, namely that with incremental increases in income the quantity of sorghum consumed from gifts, loans or wages paid in-kind diminishes initially. This confirms the same hypothesis which was tested for all sorghum consuming households, namely that consumption from gifts, loans and wages paid in-kind becomes less important the wealthier is the household. This relationship holds throughout the sample range of real incomes. This observed relationship cannot be discerned by examining the total consumption of sorghum without paying any attention to source.

There are three major findings which result from examining the consumption of sorghum by source for sorghum purchasing households. First, the consumption of sorghum from all sources equation disguises the fact that the same model can better explain the consumption of sorghum from home production. The total consumption regression also disguises the second and third major finding which concern the importance of income and the market relationship of the household in explaining the consumption of sorghum from the off-farm non-market and home production sources, respectively. For those who purchase sorghum, the higher income households clearly rely less upon sorghum gifts, loans and wages in-kind than do lower income households and more groundnut production-oriented households tend to consume less sorghum from home production, yet more sorghum from the market.

The prediction of sorghum consumption by sorghum purchasing households can be obtained by using the total consumption equation, each of the source equations, or the best-predicting equation of the entire group of equations estimated in Table 8-3. Since the home production source equation does a better job of predicting home production consumption than the others do of predicting market consumption, off-farm non-market consumption or total consumption, respectively, it has particular appeal. However, using this predicting equation would perhaps not accurately represent the consumption of low income households which rely heavily upon off-farm non-market sources of sorghum.

Non-Purchasing Sorghum Consuming Households

Table 8-4 contains the equations which examine sorghum consumption by source for those sorghum-consuming households which do not purchase sorghum from the market. The singular system which is presented in Table 8-4 contains only two source equations since the market source equation does not exist for this type of household. Although it was unnecessary to estimate both source equations and the total equation, all were estimated so that the associated $\overline{R}^2$ and R^2 could be obtained for

Table 8-4
Singular System of Sorghum Consumption Regressions by Source for Non-Sorghum-Purchasing Households, Small Sample, Kano State, Nigeria, 1974-1975[1]

Equation	Number of Households	$\bar{R}^2$	R^2	Intercept	INDEPENDENT VARIABLES[2]								
					Price[3]	Expenditure[3]		Household Characteristics				Market Relationship	
					PRPSFG	TEXPR	TEXPRSQ	HHS	IAT	MAD	HHAGE	SHOG	SSHO
Home Production (8.4.1)	16	.87	.95	2254.4 (1.92)	11.2 (.09)	** -.498 (-2.49)	** .365 E-4 (3.22)	*** 305.5 (4.03)	-278.9 (-1.14)	-410.9 (-1.52)	-9.5 (-.45)	-183.9 (-.10)	** -1892.9 (-2.75)
Off-Farm Non-Market (8.4.2)	16	.56	.83	1893.4 (1.93)	** -333.7 (-3.14)	*** -.694 (-4.16)	*** .443 E-4 (4.70)	2.2 (.03)	238.9 (1.17)	-227.8 (-1.01)	37.1 (2.12)	2967.3 (1.94)	902.6 (1.57)
Total-All Sources (8.4.3)	16	.71	.88	4147.8 (2.02)	-322.5 (-1.45)	*** -1.192 (-3.42)	*** .808 E-4 (4.09)	* 307.7 (2.33)	-40.0 (-.09)	-638.7 (-1.35)	27.6 (.76)	2783.4 (.87)	-990.4 (-.82)

[1]t-statistics are in parentheses.

[2]Variables are defined in Table VII.1 except PRPSFG. PRPSFG is the price ratio of the retail price of palm oil to the farm gate price of sorghum.

[3]Each expenditure and price variable has been divided by the farm gate price of sorghum.

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

each of the source and total equations. It is immediately apparent from examining Table 8-4 that the home production source equation, equation 8.4.1, has greater power in explaining and predicting sorghum consumption from own production than the total equation, equation 8.4.3, does in explaining and predicting consumption from all sources. The model chosen is least suited to explain the consumption of sorghum from off-farm non-market sources.

The home production source and the off-farm non-market source equations look quite similar when the effect of income upon the consumption from each source is examined. This negative influence upon consumption is significantly different from zero for each of the two sources. Among non-purchasing household, income affects consumption from both sources in the same way and approximately in the same magnitude, whereas among sorghum purchasing household income only affects sorghum consumption from off-farm non-market sources, but not sorghum consumption from home production. The similarity of the effect of income upon the consumption of sorghum from off-farm non-market sources for both the sorghum purchasing and non-sorghum-purchasing households is striking. The households with higher income that do not purchase sorghum from the market are households which also rely less heavily upon sorghum received either as gifts, loans or wages received in-kind. This relationship holds true throughout the entire range of observed small sample real incomes.

The real price of palm oil in terms of sorghum, which is expressed as the ratio of the retail price of palm oil to the farm gate price of sorghum, has not been found to be important until now. A very strong relationship without any apparent explanation emerges between this real price and the consumption of sorghum among non-sorghum purchasers of sorghum from off-farm non-market sources.

The one household characteristic variable which influences sorghum consumption among either group of households is household size. For non-sorghum purchasing households at a given real income, larger households consume more sorghum from home production.

The marketing orientation variable, SSHO, appears significant in the home production source equation. This implies that households whose market orientation increases, while holding the share of groundnuts which they produce constant, consume less sorghum from home production because their resources are more heavily concentrated upon the production of cash crops. What would be expected from this finding is that more market oriented non-sorghum purchasing households either tend to eat less sorghum or that if they consume more sorghum, it is from sorghum obtained through the off-farm, non-market sources as gifts, loans and wages paid in-kind. The results from equations 8.4.2 and 8.4.3 do not confirm the hypothesis that these households consume less sorghum overall or that consumption of sorghum from gifts, loans or wages in-kind increases as the marketing orientation of the households increase. It is interesting to note further as a point of comparison with the results obtained from equation 8.3.1 in Table 8-3, that the groundnut-producing orientation of the household does not influence the consumption of sorghum from home production by non-market purchasing sorghum consumers, whereas it does for those households which are more apt to purchase at least some sorghum from the market.

If one compares the effect of marketing orientation upon the consumption of sorghum by both groups from sources other than home production, one finds that these variables do not appear to have any association with sorghum consumption from any other source. Although the effects of SHOG and SSHO are not significantly different from zero, for the market and off-farm non-market source equations, they do serve to explain why the total consumption equations (equations 8.3.4 and 8.4.3) do not show any significant effect of market orientation upon consumption when in fact marketing orientation does play an important role in determining the availability of sorghum for either set of households which rely primarily on home production for the sorghum which they consume. It is interesting to note that these same comments apply when the two sorghum consuming household groups are combined into one. These same results can be seen in equations 8.1.1 and 8.1.4 and the constrast there is somewhat sharper because the marketing orientation variable, SHOG, has a higher level of significance in the home production equation 8.1.1 than does either SHOG in equation 8.3.1 or SSHO in equation 8.4.1. Ignoring any distinction of consumption by source would have resulted perhaps in not detecting these relationships.

Income Elasticities by Source

Source income elasticities were calculated in the same manner as total income elasticities were in Chapter VII. These elasticities are presented in Table 8-5 and were calculated from equations which appear in this chapter. The first column of elasticities are calculated from the respective source equations in Table 8-3, the second column of elasticities from Table 8-4 and the third column of elasticities from the respective source equations in Table 8-1. These elasticities reveal

Table 8-5

Expenditure Elasticities by Source for Sorghum Consuming Households, Small Sample, Kano State, Nigeria, 1974-75

Source	Sorghum Purchasing Households	Non-Sorghum Purchasing Households	All Households
Home Production	.53	.32	-.23
Market	.04	N.A.*	.10
Off-Farm In-Kind	.79	.01	.30

*Not applicable

the fact that considerable differences in elasticities[7] exist between the different sources for either the sorghum purchasing households, the non-sorghum purchasing households or all sorghum consuming households combined.

The results presented in Table 8-5 indicate that the expenditure elasticities for sorghum consumption from all sources are substantially higher for sorghum purchasing households than for sorghum non-purchasers. For purchasing households the off-farm in-kind source shows the greatest responsiveness to income changes.

The Importance of Food Consumption by Source

This chapter has examined the argument that it is important to distinguish between the different sources of food consumption in order to determine how changes in policy variables or other explanatory variables

[7]Calculated at mean levels of the independent variables.

influence food consumption. Although the examination of total consumption for all sources is mandatory in understanding the effect of policy changes, the policy changes themselves occur primarily through either one or a combination of sources. For policy changes to be effective, an understanding of how such policy changes affect the consumption of food from different sources is necessary for complete understanding of the effect that such changes have upon aggregate household consumption levels.

The demand for sorghum was examined for both sorghum purchasing and non-sorghum purchasing households for each of the primary sources of sorghum consumption, namely, home production, market purchase and off-farm non-market sources. This analysis has pointed out an important way in which sorghum-purchasing households and non-sorghum purchasing households behave differently. For one thing the groundnut production orientation of a household has little effect upon the consumption of sorghum from home production for non-sorghum purchasers. On the other hand, these small sample findings establish the fact that the groundnut producing pattern of households which do purchase sorghum from the market does indeed influence the amount of sorghum consumed from home production. Since this analysis holds real income constant, the above findings pertain to households irrespective of income. For households with both low incomes and a noticeable emphasis on groundnut production, consumption of sorghum still comes in large part from home production, although the consumption of sorghum from the market is a large share of the total sorghum consumption for certain households.

The analysis has also pointed out an important way in which real income influences the consumption of sorghum by source, irrespective of whether or not the household purchased sorghum from the market. An interesting finding worth noting is that income is negatively associated with the consumption of sorghum from the off-farm non-market source for each of the consuming groups. This statistically significant negative relationship between sorghum consumption and income explains in large part the income relationship found in equation 8.4.3 and in the small model component of the final sorghum model in Table 7-3. The conclusion which can be drawn from this is that the consumption of sorghum from gifts, loans and wages paid in-kind is related to income and that this source contains important information useful in explaining sorghum consumption.

CHAPTER IX

AN ANALYSIS OF HOUSEHOLD CALORIC CONSUMPTION

This chapter continues the analysis of caloric consumption which was treated descriptively in Chapter V. In particular, it builds upon the findings associated with households which fell into different income strata based upon an income per adult male consumer equivalent criteria for the households. The evidence presented there supported the conclusion that on a per adult male consumer equivalent basis lower income households do experience low levels of caloric consumption both in absolute and relative terms. This chapter will examine what specific factors determine actual levels of total household caloric intake.

Single Equation Total Calorie Consumption Model

Two calorie consumption models were examined, one which was similar in form to the single-equation total consumption by commodity regressions discussed in Chapter VII, and one that replaced some or all of the household characteristics variables with a household-specific calorie requirement variable. This was done to test the null hypothesis that a household calorie requirement variable is not significantly different from detailed household size and composition variables used in explaining caloric consumption.

The first model was chosen from among all possible regression subsets by using the same model selection procedure and criteria employed in selecting the single-equation small sample commodity models in Chapter VII. The reader will recall from the discussion in Chapter VII that the household characteristics and market orientation variables were the same for each equation and that real price, real income and source variables changed from commodity to commodity in the models employed in Chapter VII. The same distinction applies here with the household characteristics and market orientation variables being the same as in Chapter VII but the real price, real income and source variables being different from those used in Chapter VII. In the total calorie models presented in Table 9-1 the real price and income variables are expressed in terms of the average price of sorghum.[1]

The price ratio of palm oil to sorghum (PRPS), the price ratio of weighted millet to sorghum (PRWMS), and the price ratio of cowpeas to sorghum (PRCS) were the original price variables placed in the variable selection pool. PRPS and PRCS were then dropped due to a problem with multi-collinearity leaving only PRWMS as the only price variable entering into the final variable selection pool. The source variables which entered the final variable selection pool were the share of total calories coming from home production, SKAP, and the share of total calories coming from neither home production nor market sources, SKAN. The household characteristics variables and the marketing orientation variables (SHOG and SSHO) were the same as in previous chapters. The

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[1]The principal reason for avoiding the use of a so-called price of calories is that is is more useful for policy purposes to see how calorie consumption levels change in response to changes in real prices and real incomes. Use of a fictitious price of calories is of less practical value because it is unbelievable and not directly subject to policy changes. Furthermore, if an appropriate measure of the real price of calories were found it would be likely to change as a result of policy changes.

Table 9-1

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] TEXPR	TEXPRSQ	Household Characteristics HHS	IAY	YCH	MAD	Market Relationship SHOG	Source SKAN
Small Sample-[4] Original Model (9.1.1)	34	.87	.90	18000.6***	-4.6***	.543 E-3***	2872.5***	-4052.5***	-1661.9*	-3866.7***	-19230.5***	5121.4***
				(4.51)	(-3.64)	(5.62)	(5.00)	(-3.50)	(-1.72)	(2.90)	(-2.87)	(4.46)
Large Sample-Original Model (9.1.2)	99	.71	.73	2540.9*	2.6***	.484 E-4	557.6***	-185.5	-395.7	77.8	-7843.3***	3014.9*
				(1.91)	(4.42)	(-1.01)	(3.09)	(-.39)	(-.93)	(.15)	(-4.26)	(1.75)
Combined Samples (9.1.3)	133	.69	.71	6227.9***	.499	.154 E-3***	932.5***	-915.3*	-1118.7**	7.0	-9471.2***	4772.5***
				(4.04)	(.79)	(2.96)	(4.45)	(-1.76)	(-2.37)	(.01)	(-4.28)	(4.95)
Combined Samples with Complete Interaction (9.1.4)	133	.80	.83	2540.9*	2.56***	-.491 E-4	557.6***	-185.5	-395.7	77.8	-7843.3***	3014.9*
				(1.79)	(4.15)	(-.95)	(2.90)	(-.37)	(-.87)	(.14)	(-4.0)	(1.64)
Final Model-												
Combined Samples with Limited Interaction (9.1.5)	133	.80	.82	2749.7*	2.51***	-.426 E-4	598.9***	-113.7	-650.1*	-48.8	-7743.3***	4627.4***
				(1.95)	(4.05)	(-.82)	(3.36)	(-.23)	(-1.65)	(-.09)	(-3.93)	(5.41)
Small Sample[5] Component				18135.7	-4.92***	.578 E-3***	2626.9***	-3793.8***	-650.1*	-3832.9***	-17457.8***	4627.4***
					(4.66)	(7.36)	(5.91)	(3.96)	(-1.65)	(3.46)	(3.17)	(5.41)
Large Sample Component				274.9*	2.5***	-.426 E-4	598.9***	-113.7	-650.1*	-48.8	-7743.3***	4627.4***
				(1.95)	(4.05)	(-.82)	(3.36)	(-.23)	(-1.65)	(-.09)	(-3.93)	(5.41)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table VII.1 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 9.1.5 by adding the parameter for the term with a DI suffix to the parameter for the associated term without this suffix. For example, the coefficient for TEXPR is equal to 2.5 + (-7.4). The intercept is simply the intercept from equation 9.1.5 plus the parameter from the variable SSD.

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

Table 9-1 (Continued)

Equation	INDEPENDENT VARIABLES								
	Intercept Shift	Expenditure[3]		Household Characteristics				Market	Source
	SSD	TEXPRDI	TEXPRSQDI	HHSDI	IATDI	YCHDI	MADDI	SHOGDI	SKANDI
(9.1.4) (Cont'd)	*** 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)
(9.1.5) (Cont'd)	*** 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)	

dependent variable that is being measured is the daily per household consumption level measured in terms of calories.

The model selected had the lowest C_p, had one of the highest $\overline{R}^2$ of all possible regression subsets, and had each variable statistically significant at least at the .10 level. This model, equation 9.1.1 in Table 9-1, provides very good results with high explanatory and predictive power. The variables selected do describe quite well the calorie consumption patterns of small sample households.

The second calorie consumption model which was examined is one in which the household variables selected in the original model, namely HHS, IAT, YCH and MAD, are replaced by HHREQ, a variable which is considered to be an alternative to household size as well as to age and sex-specific household composition variables. This model was calculated in two ways, first by replacing only the household composition variables[2] with HHREQ, and then by replacing the household composition variables and HHS with the variable HHREQ. These two equations were tested individually against the original model, equation 9.1.1.

The $\overline{R}^2$ for the equation which replaced only household composition variables with HHREQ was .81 and the other model (which replaced household composition variables and HHS with HHREQ) had an $\overline{R}^2$ of .82 compared to an $\overline{R}^2$ of .87 for equation 9.1.1. This can be explained by the fact that HHS, IAT, YCH, and MAD are all statistically significant in equation 9.1.1. HHREQ when used without either the household composition variables or HHSIZE is statistically significant at the .01 level as is

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[2]IAT, YCH and MAD.

HHS in equation 9.1.1 However, when HHREQ is used in conjuction with HHS as simply a substitute for the household characteristic variables it is supposed to measure, the t statistics on both variables become insignificant because of the high degree of multicollinearity which exists between HHREQ and HHSIZE.[3] It is apparent that HHREQ is not a satisfactory replacement in the model for either the household composition variables, HHS, or both and that even though it is calculated on the basis of detailed household size composition information, it is not a satisfactory replacement in the model for these variables. HHREQ is actually a substitute variable for HHS, but it is more restrictive than HHS in that it explains only the specific influence of caloric needs upon household calorie consumption, whereas HHS would be more flexible and appropriate in examining the consumption of proteins and/or other nutrients as well as energy. The two alternative models to equation 9.1.1 were therefore rejected and equation 9.1.1 became the basis for further household calorie analysis.

Having decided that the original model was superior, the analysis was extended to the large sample data. The original model was re-estimated using the larger sample data and a test of the equality of variances about the mean was made using equations 9.1.1 and 9.1.2. The F test at the .05 level of significance showed no indication of heteroskedasticity caused by sample differences. An unweighted combined sample equation was then calculated using the original model variables so that a Chow test could be made. The Chow test of the hypothesis that the large and small sample values of the regression coefficient were

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[3]The correlation coefficient for HHS and HHREQ is .95.

equal for each coefficient had to be rejected. Therefore, complete interaction between samples was allowed by the construction of an intercept shift variable and a variable allowing changes in the slope of each regression parameter between the large and small sample equation (9.1.4). The final model was then calculated by dropping from this equation those interaction terms which were not significantly different from zero, namely YCHDI and SKANDI. The small and large sample components of equation 9.1.5 were then derived in the same manner as they were for the final models presented in Chapter III.

The small sample component provides evidence that the consumption of calories by households decrease at a decreasing rate as real expenditures increase and eventually becomes positive beyond an income level of ₦339. This result is similar to the response of sorghum consumers to increases in income found in Table 7-3, which is not surprising given that approximately 80 percent of caloric consumption comes from cereals, sorghum in particular. It is clear from Table 9-1 that the effect of income on the consumption of calories is significantly different from zero and that is is significantly non-linear.

It is useful to determine over what range of actual real expenditures a marginal increase in income results in a marginal decline in caloric consumption. If the partial derivative of calorie consumption with respect to real expenditure is calculated and then set equal to zero, this value will indicate the minimum point at which incremental changes in calorie consumption in response to real expenditure switch from being negative to positive. For these data, such a point occurs at a real expenditure level of ₦339, slightly above the regression mean real expenditure level of ₦314.[4]

No price variable appears explicitly in the single-equation total caloric consumption model. The average price of sorghum enters, of course, as the deflator of the expenditure terms, but no other price has a statistically significant effect on caloric intake.

If the small sample mean values for household size and for the price of sorghum (drawn from Table 5-1) are used to examine the impact of changes in nominal expenditure upon caloric consumption, holding all other factors constant, the predicted per capita daily caloric consumption falls 223 calories per person per day from 1319 to 1086 as nominal household income rises from ₦200 to ₦300 per annum.[5] It rises 27 calories per person per day to 1123 as income rises to ₦400 per annum and it rises 278 calories per person per day to 1401 as income rises to ₦500 per annum. These changes in calorie consumption in the ₦200-₦300 range where calorie consumption falls represent 9 percent of the mean amount of calories available per person in the small sample.[6]

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[4]Recall that TEXPR for the calorie regression is equal to total expenditure expressed in nominal terms divided by the appropriate village-level price of sorghum. These mean values are not the same as those using the sample mean average price values from Table 5-1 because a three-village average price is used in the calculation of TEXPR.

[5]The mean total expenditure for the small sample is ₦358.8. Mean household size is 7.2. Average sorghum price is ₦.08 per kilogram.

[6]This is calculated by dividing 223 by the average per capita level of caloric consumption for the small sample of 2428 calories. This level is obtained by dividing 17,484 calories consumed per household by an average household size of 7.2 (see Table 5-1). If 13,934 calories consumed per household as reported in Table 5-5 is preferred, this translates into 11 percent of the mean amount of calories available per male adult consumer equivalent.

In view of the fact that it was only possible to measure village level prices for each commodity, there was insufficient variation in the three village prices to account for changes in the dependent variable.

The household characteristics which proved to be useful for the total calorie consumption models in Table 9-1 are the same as those in the sorghum models except that YCH replaces HHAGE. The signs and significance levels are identical for the variables HHS, IAT and MAD in the sorghum and calorie models. The small sample component of equation 9.1.5 provides evidence that at a given expenditure level, an increase in household size attributed to an increase in the number of older children, female adults[7] or older adults in the household will consume more calories. On the other hand, if an increase in the number of infants, toddlers, young children or male adults occurs in a household of a given size and real income, then a decrease in calories consumed will occur. The first three of these groups consume less calories than older children, female adults or older adults. It is not so clear why male adults should be negatively associated with calorie consumption, although they may consume fewer calories than "older" children.

The market relationship variable, SHOG, shows a strong negative association with the consumption of calories. This particular variable provides corroborating evidence that those households which consume the least number of calories are those which are heavily oriented towards the production and sale of groundnuts.

The source variable, the share of calories available from neither home production nor from the market indicates that the households which derive large shares of calories from either food gifts, loans or wages received in-kind at a given expenditure level, are households which

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[7]Both wives and non-wives.

consume more calories. This relationship is statistically significant at the .01 level. If the household receives "free" calories, as when contained in food gifts, then this result is hardly surprising. Calories from loans are not free, yet if two households have the same real expenditures but household A has financed more of them by borrowing food than has B, one would expect A to consume more food. Similarly, if a larger part of A's expenditures consists of wages received in the form of food, A might well eat more than B, if B receives his wages in money. At the commodity level the share of food available from off-farm non-market sources was important for only two commodities, sorghum and early millet. It had a positive effect upon sorghum consumption but a negative one on early millet. The sorghum effect appears to be the dominant factor explaining the sign on SKAN. The results from equation 9.1.5 indicate that if one is interested in the calorie content of food available to the household, then attention must also be paid to those sources of food in the diet which are primarily non-market and do not come from the household's farm output.

Calorie Elasticities

The price and income elasticities were calculated at mean sample values for the combined samples using the small sample component of equation 9.1.5. The elasticity of calorie consumption with respect to the price of sorghum is .15 and the elasticity of calorie consumption with respect to real income is -.15.

This income elasticity of -.15 indicates that there is the need to provide some explanation of the calorie-income relationships, particularly because the elasticity figures range from being negative among low income categories to being positive for high income groups.

For households in the lower income strata this gives rise to the explanation that there is a strong preference for higher quality foods which have higher costs per calorie.[8] If such a preference for high quality and high cost sources of calories exists among the low income groups, then some substitution away from low cost per calorie food sources, such as the primarily home produced sorghum at 199 calories per ₦.01, to high cost per calorie food sources, such as palm oil which is primarily purchased from the retail market at 429 calories per ₦.01, may result in a declining level of caloric consumption.[9] This is consistent with the income relationships found in Table 7-3 and 7-9 for these two commodities. This explanation is also consistent with what is known about certain low-income households in the study. A number of these households purchase foods from the market, which are relatively more expensive per calorie than home produced foods.

In the middle income range the calorie-income elasticity switches from being negative to being positive and in the high income range the

[8]It is an empirical question whether or not this occurs at all income levels as opposed to simply at low income levels. Although one might expect this at all income levels, the empirical information with which I am familiar indicates that this is not so. In a study of 1376 families undertaken in Kerala, India, by C. H. Shah, he finds that "If food preference gets precedence over nutritional needs, the marginal cost would exceed the average cost. We observe this at lower income levels and the opposite at higher income levels" (Shah, 1978, p. 6).

[9]A simple numerical example should suffice in explaining how this might occur. If a food item "A" with a caloric value of 200 calories is bought for ₦.05, then ₦.01 will buy, in effect, 40 calories of food "A". If on the other hand, food "B" with a caloric value of 50 calories can also be bought for ₦.05, then ₦.01 will buy only 10 calories, if food "B" is chosen. If the consumer's income were then to double from ₦.05 to ₦.10, and if the consumer were at the same time to switch from the consumption of food "A" to food "B", then caloric consumption would fall from 200 calories (of food "A") to 100 calories (of food "B") because food with a higher price per calorie food is now preferred.

elasticity increases throughout. This elasticity in the high income range is somewhat surprising in that there is no indication that it approaches an upper bound. There are several reasons why this might be so. First, it might be that for the range of observed incomes for the small sample the consumption of calories does not reach that saturation level that one might generally expect to observe. Second, it may be that the omission of income and consumption information resulting from the activities of female entrepreneurs within the household may understate income, so this saturation level would not be observed even though it was actually occurring. Third, the small number of high income observations available in the small sample data set may account for some misrepresentation of what is the actual pattern of behavior. High income households may also be putting a larger percentage of their crop into storage than the others. Perhaps 1974-1975 was an unusually good year for them. Fourth, it is possible that the real incomes of those households in the high income level are understated insofar as that an "average" price of sorghum used in the real income calculation is higher than the farm gate purchase price of sorghum, which is more than likely the appropriate price to use for these households, which consume most of their sorghum from home production. It is possible that by raising these income estimates to their proper level, the quadratic term estimated for these household would not result in a rising income-calorie elasticity even in the higher income categories.

There are several other explanations which might account for the calorie income elasticities observed for the small sample households. First, the income variable used in the elasticity calculation is measured in real as opposed to nominal terms. Since the price variable is obtained from three distinct geographical points, it possibly contains some village-specific information which might be more appropriately measured through a binary variable representing village. Therefore, if the representation of income expressed in real terms embodies more than simply a relationship between total expenditure and the price of sorghum, then the regression coefficients for all the real income terms in Table 9-1 and the income elasticities calculated from these equations, in particular the one calculated above, do not measure precisely what they are intended to measure. Second, the decision was made to measure the income of households in terms of the purchasing power of sorghum at the farm level. Therefore, the income elasticity mentioned above should properly be interpreted as the percent change in the household level of consumption of calories due to a 1 percent change in the household's purchasing power of sorghum. If income had been measured in terms of its purchasing power of some other food item, then the measure of real income and the calorie elasticity obtained would have been different. The measure of real income employed was judged to be the best and the decision was made not to re-estimate the equations in Table 9-1 by using some other real income measure.

The principal conclusions drawn here are that low income households most likely experience a fall in calorie consumption as incomes rise because of two interrelated reasons. First, these households have a preference for high quality sources of calories and the substitution from low price per calorie foods to high price per calorie foods results in some fall in total calorie consumption. Second, closely related to the point just made, these households experience falling consumption levels because they do consume some expensive retail foods as well as lower priced home produced foods. For the high income households on the other hand, it is possible that a saturation level is approached, although not observed among these households in the sample, because these incomes used in the analysis are underestimated.

However contradictory they might appear, these income-caloric consumption results are not in contradiction with the descriptive findings pertaining to caloric consumption discussed in Chapter V that on a per adult male consumer equivalent basis lower income households do experience low absolute and relative levels of caloric consumption. In addition to the fact that the large sample data are used in the analysis of Chapter V whereas the small sample data are used in the analysis of this chapter, another important reason is that the analysis in this chapter concerns factors associated with actual levels of total household caloric intake as opposed to levels of household caloric intake expressed on a per adult male consumer equivalent basis. Household size and family composition variables were used in the analysis of this chapter and were not pre-imposed upon the specification of the dependent variable. The measurement of the effect of income upon a different dependent variable, namely daily household caloric consumption per adult male consumer equivalent, need not necessarily give evidence of the same negative income-caloric consumption relationship for low income groups found in this chapter. This points out the importance of recognizing that a more complete understanding of consumption relationships might best be accomplished by examining levels of total household consumption as well as some other consumer-weighted levels of household consumption as has been done in this research.

CHAPTER X

RESEARCH FINDINGS, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Background and Methods

This consumption study of 133 semi-subsistence farm households was carried out in the Guinea-Savannah ecological zone of Northern Nigeria in Kano State. It was designed to assist policy makers in understanding the linkages which exist between economic policies followed in the course of the economic development process and the nutritional welfare of rural farm households. In a more general sense, it attempts to understand the determinants of food consumption in households which can either grow the food they consume, purchase it from the market, or receive it from several other off-farm non-market sources, particularly as gifts, loans or wages paid in-kind.

A discussion of the factors affecting production revealed that the area is one in which traditional farming systems have evolved in order to minimize crop losses caused either by low levels of rainfall, uneven distribution of rainfall throughout the growing period, and/or uncertain dates of onset and termination of the rains. A review of the literature concerning the prevailing household consumption practices in Northern Nigeria indicate that the most widely produced crops, namely sorghum and millet, account for 70-80 percent of the caloric consumption of individuals in this semi-arid region. The overall health picture which emerges for this area is one in which the children appear to be the most vulnerable to dietary inadequacies, in particular a shortage of calorie and protein intakes, and disease. There is conflicting evidence concerning the existence of a hungry season during which households experience a general shortfall in the amount of calories consumed.

The data used in this analysis were field survey data collected by Peter Matlon from May, 1974 to May, 1975 for the purpose of examining the size distribution, structure and determinants of personal income among farmers in the North of Nigeria. This period corresponded roughly to the preparation period for the 1974 harvest until the preparation period prior to the 1975 harvest. This necessitated making several assumptions so that the collected large and small sample data covering one agricultural production year, yet observed as consumption data from two consumption years, could be treated as representative of the one consumption year (i.e., from the 1974 harvest until the end of the 1975 preharvest period).

The influence of consumption goals upon production goals, and ultimately production upon consumption was presented to show the interdependence between these two spheres of household activity. The particular goal of food security pursued by farm households was discussed although not specified explicitly in the mathematical model of farm household food consumption behavior. This model, which was developed to take into account the fact that households can obtain food from a number of different sources, was based upon the simple theoretical assumptions of a household utility function which is maximized subject to a budget and a production function constraint.

The information which was collected from the household was obtained from male household heads and did not take into account that some food consumption occurs as the result of female entrepreneurial activity. Nevertheless, since the male is the dominant member of the family in terms of his direct involvement in food production, food sales, food purchases and food storage, a great deal of useful information relevant to the determinants of consumption were obtained without the inclusion of female entrepreneurial incomes. However, this resulted in some under-reporting of food consumption.

Food commodity consumption by household was classified into three major components, namely food retained from home production, food from market purchases and food from other off-farm non-market sources, notably gifts, loans and wages paid in-kind. The first component was calculated by subtracting food sales, seed usage and storage losses from food quantities harvested and was dependent upon the following three assumptions: the 1974 harvest was normal and representative of other production years, the food inventories in May of 1974 and May of 1975 were equal and the food sales of the pre-1974 harvest period were a suitable replacement for the 1975 pre-harvest sales figures.

The functional form chosen for the single-equation total regressions satisfied three essential requirements: allowance for the possibility of negative estimates of food consumption, flexibility sufficient enough to allow income elasticities to vary with income and thirdly, preservation of the theoretical property of zero homogeneity of prices and income. The form selected was arithmetically linear in relative prices and income with the addition of one quadratic term in real income. Total expenditure, comprised of the total value of cash expenditures plus the value of subsistence consumption at farm gate prices, was the proxy variable used for income and quantity-weighted retail, farm gate and overall prices were derived for use in the regression analysis. Variables denoting household size, composition, household ethnic affiliation and household type were the principal variables depicting household characteristics used in the regression analysis. Two other sets of variables believed important were introduced, namely market-orientation and food source (share) variables. Ordinary least squares was the estimation techniques used which yielded minimum variance, though not unbiased, estimators. When the endogenous source variables were removed for the singular system analysis which followed later in the study, the unbiased character of the new ordinary least squares estimators was preserved. The procedure followed to arrive at a final model of consumption to describe for each commodity used the small sample as the primary data set with the large sample data set supplementing whenever the two sample results were in agreement. The variables which were chosen for the final model were the variables selected for the original models according to the selection criteria of having a low C_p, a high $\overline{R}^2$ and significant t statistics on variables selected for the model, particularly for the real price and income variables. Since these selection criteria were at times mutually exclusive, there was a tendency to select equations which had particularly high $\overline{R}^2$s.

Research Findings

The findings of this study are based upon two principal analyses, the first being the estimation of mean consumption characteristics of the two samples in Chapter V and the other being the food commodity and calorie regression analysis found in Chapters VII, VIII, and IX.

The first important descriptive finding taken from Chapter V in Tables 5-2 and 5-3 is that sorghum and millet are consumed by every household in the small and large sample and that consumption levels of these foods are higher than of any other food consumed by the sample households. This evidence supports the findings of other authors that sorghum and millet are the main staples in the diets of rural Northern Nigerians.

The second finding of the descriptive analysis was that for these most important foods the primary source of consumption is home production and most of what is produced is consumed.

The third finding was that most of the sample means of household characteristics and expenditure variables were found to be higher in the small sample than in the large sample. The fact that small sample mean values calculated in Chapter V tended to be larger than large sample means can be explained either by differences in sample characteristics, for example, household size and composition, or by differences in data collection methods. It was concluded that the differences in many of the consumption relationships examined were more likely explained by the markedly different data collection and measurement procedures employed for the two samples than simply by variation within the range of sampling error. The principal conclusion drawn from this finding was that since the small sample data set contained information collected over shorter time intervals and by the use of a more precise method to estimate the weights of crops (most of which would ultimately be consumed), the analytical results of the remainder of the study should be based primarily on relationships evident using the small sample data. However, it was felt that the large sample household data set did contain information which was useful to analyze since the key factors of interest in this research were not dependent upon correct estimates of actual quantities consumed, but instead concerned important relationships useful in understanding consumption behavior.

A fourth set of findings result from a comparison made between two estimates of calorie consumption per consumer by income strata derived by different means. Estimates of calories available per adult male consumer equivalent derived from records of food availability showed important similarities with estimates made by Matlon in which he divided the total value of available food by a uniform cost of calories in order to gain an approximation of caloric consumption. Both approaches lead to the conclusion that a large number of households drawn from the large sample, particularly those at the lower end of the income distribution, have inadequate levels of calories available on a per adult male consumer equivalent basis to meet recommended levels of caloric intake. These findings need to be fiewed in light of the fact that neither of the two approaches utilized data on income derived from female enterprises nor did the actual records of food availability contain estimates of groundnut consumption due to the questionable validity of that portion of the data. Nonetheless, both approaches provide evidence of a positive association between income level and calorie consumption per consumer as well as sizeable differences in consumption levels at opposite ends of the income spectrum. Consumption estimates based upon food availability records were consistently lower than estimates based upon the total value of available food-uniform cost of calorie approach but represented a more precise means by which to examine consumption levels.

Other evidence from the large and small samples yields another set of findings that the average household in each village does not consume a sufficient number of calories to achieve recommended caloric intake levels and that on an individual household basis households in the lowest income decile in each village experience insufficient levels of caloric consumption. The contrast with the consumption levels of households in the highest income decile is striking and points out the consumption implications of sizable income differentials.

The research findings from the single-equation food commodity analysis can be categorized according to the five types of independent variables used in the analysis, namely price, expenditure, household characteristics, market relationship and source.

The price variables used in this study were expressed in real terms as the ratio of two nominal prices in order to preserve the theoretical property of zero homogeneity in prices and income, to lessen the sensitivity to nominal price changes, i.e. inflation, and to express prices in terms of their values in exchange. The influence of prices upon food consumption was found in this study to be insignificant in the case of most foods, with the principal exception being sorghum, cowpeas, and palm oil. However, this is due largely to the nature of the data used and does not signify that the basic price-consumption relationships are in fact insignificant. Although it might be argued that the absence of one or more significant price variables is an indication that the household is not at all sensitive to price changes, perhaps because it produces its own food, this argument does not receive support here. This hypothesis of the lack of price responsiveness could be tested only if enough price variation existed in the data. However, in view of the fact that it was only possible to measure village level prices for each commodity, there was insufficient variation in the three village prices to account for changes in the dependent variable. Moreover, the fact that locational differences are also possibly included in these price variables might also explain their lack of significance in this study.

Some interesting findings did appear, however, when price elasticities were calculated. These elasticities reveal that supply as well as demand responses are evident from price changes and suggest that the supply effects are strongest for the two most important cereals, namely sorghum and early millet. This indicates the possibility that price increases for these items will result in supply increases which more than offset demand decreases, thereby increasing overall levels of sorghum and early millet consumption.

It is interesting to note in contrast to the two primarily home-produced foods mentioned above that the food which is primarily purchased from the market, namely palm oil, has an own price elasticity which resembles that which might be expected from consumption expenditure studies based upon market expenditures.

The cowpea own-price elasticity is the only unmentioned own-price elasticity calculated from an equation with all highly signficant variables, particularly price and income variables. Its extremely high negative price elasticity gives rise to the suggestion that cowpea consumption is reduced sharply as cowpea prices increase perhaps because of the attractive option to sell what might otherwise be consumed.

As has been suggested above, however, it is possible that the price variable also reflects locational differences. Cowpeas and palm oil serve as cases in point. The empirical results from this study indicate that cowpeas, which are largely consumed out of own production, are more likely to be consumed in villages which emphasize the production of food crops, whereas palm oil, which is entirely purchased, is more likely to be purchased in more market-oriented villages. This suggests that households living in more cash-oriented locations are more likely to purchase food items exclusively available through the market.

Another set of findings pertaining to the importance of income upon the consumption of cereals and non-cereals was evident in this study. The results indicate that as the income of farm households rises the amount consumed by households of sorghum, falls slightly at a decreasing rate. Increases in early millet, maize and cowpeas consumption occur as real incomes increase, while the results obtained in this study indicate that late millet is an inferior food. The data do not show a significant relationship between rice consumption and real income whereas two of the three items which are largely or entirely purchased from the market, namely palm oil and tomatoes, exhibit a positive relationship between real income and consumption. All of the consumption income relationships mentioned above with the exception of rice are highly significant statistically.

Among the noteworthy findings showing the effect of household characteristics upon consumption, the results for cereals indicate that larger households often consume more of certain cereals than do smaller households, given the same real incomes, and that presence of children in the households, infants and toddlers in particular, lead to the reduction in consumption by households for some cereals. The age of the household head or whether he is literate do not appear at all related to cereal consumption. No clearly discernible pattern emerged between food consumption and household characteristics for any of the non-cereal foods although HHAGE[2] sometimes shows up as being an important factor.

Among the principal objectives of this research, one was to test the hypothesis that farm households with a market production emphasis consumed more than other farmers with a greater emphasis upon production for home consumption. The results from the single equation analysis support the hypothesis that a greater cash production orientation was associated with higher levels of maize, rice, nono and tomato consumption and lower levels of sorghum consumption. The production orientation of the farm household has no discernible association with palm oil, early millet, or late millet consumption. The results obtained for cowpeas are inconclusive on this issue.

Perhaps the most important finding of the study is that food consumption relationships cannot be adequately understood unless careful attention is paid to the source through which food enters into household consumption. The study examined the importance of source in two ways, namely through a single-equation approach specifying source as an independent variable and through a singular system of equations in which each equation is estimated to represent the relationship between the amount consumed from each source and the same set of independent variables[3] likely to affect those consumption levels.

The single equation consumption regressions estimated for the two primary cereals in the diet, sorghum and early millet, showed that source was an important factor influencing food consumption, although

[2]Age of the household head.

[3]Exclusive of source variables.

as expected, source appeared to have different effects upon consumption of these and other commodities.

The singular system analysis made of the determinants of the consumption of sorghum from its three principal sources revealed that the same exogenous factors influence the consumption of sorghum by source in very different ways and that an analysis of total consumption with all sources aggregated into one conceals important relationships which only become apparent when the source distinction is maintained. Although the single-equation total consumption regressions indicate when source might be important, they do not indicate any particular factors which might perhaps explain why they are important.

The source analysis of sorghum was carried out for all sorghum consuming households, those which purchase sorghum from the market and those which do not purchase sorghum from the market. The three major findings which result from examining the consumption of sorghum by source for sorghum purchasing households are first, that the total sorghum consumption equation does not explain the variation in total sorghum consumption as well as the home production source equation explains the variation in the consumption of sorghum from home production; second, that higher income households clearly rely less upon sorghum gifts, loans and wages in-kind than do lower income households, and third, that the more groundnut production-oriented households tend to consume less sorghum from home production, yet more sorghum from the market than by those less groundnut production-oriented.

The first major finding in the sorghum system of equations for non-sorghum purchasers was the same as the finding above, namely that the model can better explain consumption of sorghum from home production than the consumption of sorghum from all sources. For the non-sorghum purchasing households income increases result in the same lowered sorghum consumption from home production. The third finding for the non-purchasing sorghum households is that households which have a more cash-oriented production emphasis are households which consume less sorghum from home production.

A final point worth noting about this source distinction is that although the sorghum single-equation regressions indicated that sorghum consumption fell as the households pursued a more cash-oriented production emphasis, the singular system results provided the explanation that this was so because the households (either sorghum purchasing or non-purchasing) consumed less sorghum out of own production. This suggests that as resources shift from the production of primarily food crops to cash crops, consumption of those food crops will fall principally because less of those crops are produced. This result is not at all surprising, particularly for sorghum, in view of the fact discussed in Chapter V that such a large proportion of what is produced is consumed. Since for many other foods as well a large share of what is produced is consumed, the singular system approach is a convenient method for testing the hypothesis that a more cash-oriented production focus among farm households will result in a decline in the consumption out of own production of primarily home produced foods. Even where this hypothesis is supported, an increase in the consumption of this food from other sources may still occur, as was shown to be the case with sorghum.

A separate single equation analysis of factors associated with household calorie consumption resulted in some important findings pertaining to the effects of income, production orientation and source upon household caloric consumption. The results show that the caloric consumption of small sample households fell as income increased for households in the lower income groups. Middle income households showed only very slight changes in caloric consumption and high income households in the small sample had steadily increasing caloric consumption levels. Several conclusions were drawn from these facts. First, low income households most likely experience a drop in calorie consumption because they have a strong preference for high quality sources of calories and/or because they consume some of their primary foods, including staples, at the relatively higher priced retail level. The high income households on the other hand do not appear to approach a saturation level in consumption possibly because the income estimates used throughout the study do not include an estimate of female income.

The income-caloric consumption relationships found in the single-equation analysis, particularly for households with relatively and absolutely low income levels, do not contradict the descriptive findings discussed earlier about a positive association between income and caloric consumption at all income levels. The caloric consumption levels used in the descriptive analysis in Chapter V were expressed for households on a per adult male equivalent basis, whereas in the single-equation analysis these levels were of total household caloric consumption. Therefore it can be concluded that income is positively associated (for the small sample) with total household caloric intake and (for the large

sample) with per male adult household caloric intake for all but the low income households. For these low income households the income-total household caloric consumption levels relationship (for the small sample) is negative whereas the income-per adult male equivalent caloric consumption level relationship (for the large sample) is positive. Differences between the two samples used and between the two consumption levels used account to some extent for the differences just noted. However, on balance the results show a degree of similarity, although differences at the low income levels point out the important of examining these relationships from several perspectives.

The calorie analysis also shows that households which are more cash-oriented, in terms of their production of groundnuts, are households which consume less calories overall. The source of decline does not come from the in-kind source component because the coefficient obtained from the share of calories derived from in-kind receipts variable was positive and highly significant.

Another interesting finding from the calorie consumption analysis is that a household calorie requirement variable is significantly inferior to using detailed household size and composition variables in explaining caloric consumption.

Conclusions and Policy Implications

The review of the research findings leads to several conclusions, some of which have important policy implications and some of which pertain to future research. The latter set will be discussed in the next section.

In order to place the policy implications in proper perspective I will briefly review the current agricultural setting of Nigeria. Nigeria has recently been experiencing a rate of growth of food output of 1 percent along with large scale migration from rural to urban areas. This migration had undoubtedly been fueled by the attraction of areas where there has been a large influx of oil wealth. In response to the problem of lagging food output the Federal Government has recently initiated a Food Production Plan (1981-1985) which is designed "to increase Nigeria's agricultural production, to ease the country's increasingly serious food deficit, and to improve the standard of living of the smallholder farmers" (World Bank, 1981). This $13.5 billion program designed with help from the World Bank is designed to achieve self-sufficiency in food crops by 1985. The Plan's strategy and program for agricultural development has as a long-term objective "to transform agriculture from its present low technology, semi-subsistence character to a more modern, market oriented one, based on greater regional specialization" (World Bank, 1974, p. 81).

If the Federal Government of Nigeria seriously wishes to improve the level of living of farm households at the same time that it expands agricultural output commensurate with domestic needs, then government policy makers must not only carefully design specific policies which address these problems but also guard against non-agricultural policies which nullify the advances made by the agricultural specific policies. Economic policies which do not specifically attempt to strengthen the agricultural sector through either a production, marketing and/or consumption focus are likely, nevertheless, to have an impact upon

consumption as well primarily through their price and income effect. By examining aggregate consumption by food and disaggregated consumption by source, as is done in this analysis using a three source distinction, the impact of price and real income changes which result from economic policies can be thoroughly examined. This analysis has attempted to show that in order to understand better the impact that these price and income changes have upon consumption, one should examine food consumption by disaggregated source. To do otherwise is to risk overlooking one means of identifying how different segments of rural society are likely to be affected by these price and income effects. As has been shown in this analysis, for example, households that rely on the consumption of sorghum from home production will experience a different consumption increase from real income increases than those that rely on the consumption of sorghum from the retail market.

The evidence from the sorghum analysis concerning cash crop orientation also has some policy implications. It appears that households which produce more cash crops are households which consume less sorghum, mainly because most of what is produced of non-cash crops is consumed. This suggests that policies which encourage the production of cash crops, through favorable internal pricing policies for example, are likely to lead to a greater reliance upon the retail market and other in-kind sources for sorghum and other foods. There is, however, no basis for concluding that an increased cash production orientation will lead to a lower consumption of all individual cereals, however, even though the total consumption of calories may fall. The World Bank's present strategy of attempting to "support services and physical infrastructure for farms . . . to help increase the production of food crops and the incomes of smallholder farm families living in Kano State" (World Bank, 1981, p. 103) will be effective as long as the production of a diversity of cereal crops and cash crops is advocated. The production of maize should be included in this mix because of its potential for considerable output increases over time, its complementary labor requirements with those of other traditional crops, and because as this study shows, its consumption rises with real income and is not reduced as farm households adopt a more cash-oriented production strategy.

It appears that in a highly risk-prone environment such as that of Northern Nigeria, where farmers have responded in part through crop diversification, an overemphasis upon expanding the production of either a single cash or food crop, could increase yield and price uncertainties and would be unlikely to fit with the traditional risk-reducing farming system strategies which farmers have adopted.

Recommendations for Further Research

There are seven topics I would recommend for future research. First, a relatively simple and straightforward single-equation estimation technique can be used to analyze important consumption questions. Analyzing consumption by source improves the single equation total consumption parameter regressions, because removing the source variables from the analysis renders the new parameter estimates unbiased estimates of the "true" parameter estimates. These studies should also deal with integrated aspects of household production-consumption behavior and should be of sufficient duration to collect production and consumption data for the entire annual production and consumption cycles. These studies would be enhanced also if the following factors were measured: sales of food internal to the family, expenditure upon food out of female income earned in small business activity and beginning and ending food inventories.

A second topic is the important methodological study which could be undertaken to analyze in more detail what the data needs are for consumption studies of semi-subsistence household-firms, and ways in which the quality of the appropriate data could be increased. Given that budgets are likely to be limited, surveys need to obtain data frequently enough to ensure that high quality information is obtained. When information of such varying types is collected, there is no reason to suppose that all types of information should be collected at the same interval.

The third suggestion concerns examining in somewhat more depth the in-kind receipts category so that the importance of its components, namely gifts, loans and wages in-kind, can be examined further. These different source distinctions may be important for certain categories of households, particularly those which are the most nutritionally vulnerably.

A fourth topic would be to examine the calorie consumption of households in more depth than has been done in this study. This analysis could separate households into two groups, those meeting household caloric requirements and those falling short of these requirements. Each separate analysis would provide more information about the effect of source on the total caloric consumption of farm families nutritionally at risk. In addition it would be useful to categorize households by some variables, such as nuclear or gandu households, or by ethnic group. Questions of per capita and per consumer equivalent consumption could be undertaken in this type of study despite the theoretical limitations in doing so. The nutrient analysis could be expanded to include protein and perhaps other nutrients.

A fifth topic would be to examine the flow of food, calories and other nutrients to and from the household during the consumption year to establish whether or not significantly noticeable periods of food shortage exist throughout the year. The data which were collected for this study would only permit an analysis of food flows, and not food consumption, because of inadequate information concerning food storage. If food storage stock information were available concerning withdrawals and additions, then study of seasonal food consumption would be possible. The importance of this type of study would be obvious if policy interventions could be planned which would attempt to provide assistance to households which are critically short of food and calories at certain times of the year.

A sixth important topic to study would be to examine separately the significance of cash and in-kind sources of income upon consumption and household caloric intake. If data could be obtained on the sources of income from on-farm activities, off-farm agricultural activities, off-farm non-agricultural activities and female entrepreneurial income, it would be worthwhile to explore the influence of these income sources upon food and calorie consumption.

A seventh topic which is closely related to the above, would be to distinguish households on the basis of income level and conduct an analysis of the food consumption strategy of households in different income groups. For example, if households in the low income categories pursue a "groundnut strategy" which is different than the one followed by upper income households in terms of food acquisition, then variables similar to the marketing orientation variables used in this analysis might prove insightful. Within this approach, a subsistence potential ratio variable could be constructed. This variables would identify households, which because of an inadequate land base, would be unable to produce enough food crops for home consumption commensurate with household caloric needs. These households might pursue a strategy which was markedly different from households whose land base was sufficient to pursue a non-market food self-sufficiency approach. This could also be linked to the development of a model which attempted to explain why households purchase food.

There are several other important research areas of considerable potential. Virtually nothing is known about the actual decision-making process of Northern Nigerian farm households. There is clearly much more theoretical work of a disciplinary nature that can be done in the area of household-firm modeling that would be useful. In particular, the incorporation of the dimension of risk and uncertainty into the theoretical structure would be worthwhile for furthering our understanding of the behavior of semi-subsistence household-firms. Since this analysis has only examined the consumption patterns of consuming households, it would be a logical next step to study characteristics of the sample households which lead to a higher probability of consumption of individual foods. Lastly, a more detailed examination of the intra-household distribution of food would also reveal consumption and nutritional problems not evident in the household level analysis. Ways of ensuring the dietary adequacy for all family members would follow.

If we could learn more about just who the malnourished happen to be and more about their characteristics, then we will be able to make a contribution to the economics that really matters, namely "the economics of being poor". I hope this research can be considered a contribution towards achieving that goal.

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