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THREE VILLAGES OF NORTHERN NIGERIA

BY

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and Peter Schmidt

Working Paper No. 22

Department of Agricultural Economics
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East Lansing, Michigan 48824

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PREFACE

In 1978 the United States Agency for International Development funded a research project, "Consumption Effects of Economic Policy," which had two principal objectives: 1) to develop methods for measuring the effects of economic policies or events upon the food consumption of rural semi-subsistence households (households that produce large fractions of their own food) and 2) to obtain facts, previously unavailable, that were needed by government officials, planners and anyone concerned with the nutrional well-being of rural households. These facts were to include descriptions of food consumption levels and patterns as well as measures of the changes in food consumption associated with changes in economic variables (prices and incomes). Two sets of data were to be used, one collected in 1974-75 by the Rural Employment Research Project at Njala University College, Sierra Leone (under the direction of Dr. Dunstan S. C. Spencer and Dr. Derek Byerlee),[1] and another collected during the same period by Peter Matlon in three Kano State villages in Northern Nigeria.

The plan was to develop appropriate methods for such studies during the analysis of the Sierra Leone data and to test the methods by applying them to the Kano State information. This paper reports the results of the Kano State test. An adaptation of the method was required because different recall periods were used for different portions of the Kano State sample.

The Sierra Leone research has been presented in a series of seven reports, listed in the references for this paper. They appear there under several authorships: Kolasa (1979), Smith et al. (1979, 1980, 1981a, 1981b), and Strauss et al. (1981a, 1981b).

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[1]Financed by a contract, AID/cds 3625, between the United States Agency for International Development and Michigan State University, and by the Rockefeller Foundation.

Without the work of Peter Matlon this Kano State study would have been impossible. We greatly appreciate his generosity in permitting us to use his data and in devoting time and energy to clarifying our understanding of them. Naturally we retain full responsibility for any errors of interpretation or analysis.

INTRODUCTION

Relatively little is known about the extent to which prices and incomes affect the food consumption of rural households that produce most of their own food. Because they depend primarily upon their own productive efforts it is widely believed that they are comparatively untouched by market forces, and thus partially insulated from the effects of economic change. Yet semi-subsistence households have some contact with the market and the extent of that contact increases during the process of economic development. Thus it becomes important to understand whether and how market forces may affect their consumption patterns. Many students of the problem of hunger appear to believe that rural households should be encouraged to become more rather than less self-sufficient with respect to their own food production. Whether following this advice will raise or lower nutritional levels cannot be determined until we know what effects economic change does have on nutritional adequacy.

One of the reasons we know so little about the food consumption responses of semi-subsistence households is that food consumed from one's own production does not pass through the market. Without market prices to work with, traditional economic models seem inappropriate. We have found, however, in our studies of Sierra Leone, that with appropriate adaptations an economic model is effective.

Perhaps more important has been the lack of adequate data. In the semi-subsistence household production and consumption decisions are intertwined, yet studies of household food consumption rarely provide suitable information about incomes and prices, while studies of production rarely obtain the information needed to examine food intake and nutrient availability. Fortunately in 1974-75 two unusual household production surveys were undertaken, one in

Kano State, Nigeria, by Peter Matlon [1979], and one in Sierra Leone by Spencer and Byerlee [1977]. Both surveys collected data on household expenditures as well as on production activities and sales. With these data our studies of semi-subsistence households became possible.

CHAPTER I

THE DATA

During 1974-75 Peter Matlon conducted a field survey in three villages in Kano State of northern Nigeria. His purpose was to study the determinants of income differences within a traditional society just beginning to experience changes in its production system. Although the study was not planned as a study of food consumption patterns, Matlon collected accurate quantity records for almost all foods likely to enter into household consumption. The villages lay in the Guinea-Savannah ecological zone, had an average of 35 inches of rainfall during the year, and used mainly traditional farming techniques. The three principal crops (millet, sorghum and groundnut) were grown with relatively minor use of improved seed varieties or chemical fertilizer.

The sample consisted of 45 households selected at random in each village. These were divided into a "small" sample of 12 from each village and a "large" sample consisting of the remainder. The small sample was to serve as the basis for a careful study of production relationships, so it was chosen in such a way as to provide an equal number of households in each cell of a four-way stratification matrix in which the stratification variables were (1) the land-to-worker ratio (above or below the mean for the sample) and (2) the use or non-use of both chemical fertilizer and seed dressing during the previous year. [Matlon, 1979, pp. 19-20.]

The small sample households were interviewed two to three times weekly to obtain data on cash consumer expenditures and off-farm earnings and weekly for data on loans and gifts and on input and output sales and purchases. The large sample was interviewed monthly. [Matlon, 1979, p. 21.] As we shall see later, this difference in interview frequency significantly complicated our analysis.

From these data we have developed estimates of the quantities of food available for consumption by the household (which we often refer to for convenience as quantities consumed). However, no data were collected by direct observation of the food served or eaten nor were there any data concerning the distribution of food within the household. What we were able to do was to measure inflows of food into and out of the household in the form of purchases, harvests, sales and other disappearance into non-food uses, and transfers in kind as loans, repayments, gifts or wages. Thus we provide estimates of the quantities of food available to the household.

The total quantity consumed (available for consumption) consists of three parts: food purchased (often called food from the market), the net inflow or outflow of food transfers in kind in the form of loans, repayments, gifts or wages, and food available from home production. The latter component was estimated by the disappearance method--subtracting sales, seed use and losses in storage from the quantities harvested. We had no data on inventories or quantities in storage.

Because the data on expenditures, harvests and sales were collected in quantity terms as well as in value, it was possible to do what cannot be done with so many expenditure surveys: make estimates of the physical quantities of food available for consumption. From these one can proceed to the question of ultimate interest, the nutritional composition of the diet--a question that cannot be dealt with adequately when only data in value terms are available.

The quantity data were collected in local units. To convert them to kilograms we used weight conversions mainly based on careful weighings done by Matlon. For more detail see Whelan (1981, chap. 4).

As the survey obtained no information about the way in which female members of the household spent the profits from their household enterprises,[1] the consumption estimates made here are too low by the amount of any food thus purchased. On the other hand, if the household head failed to report sales of food items within the household to women who processed them for later sale outside, our estimates will be somewhat high.

Table 1 contains the mean values of a number of variables for each sample and for the sum of the two samples.

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[1]This was a Moslem area, so the enumerators obtained information only from the male household head.

TABLE 1

Mean Values of Selected Variables by Sample

Variable	Sample		
	Small	Large	Combined
	Mean	Mean	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
Proportion of Heads Literate	.4	.4	.4
Number of Adult Female Wives	1.7	1.4	1.5
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
Number of Gandu Households	16	45	61
Number of Nuclear Households	17	54	71
Total Number of Households	33	99	132

[1] In numbers unless otherwise specified.

[2] Quantity-weighted average annual prices in Naira per kilogram. One Naira equalled U.S. $1.64 in 1974-75.

[3] In Naira.

CHAPTER II

FOOD CONSUMPTION PATTERNS IN THREE VILLAGES OF KANO STATE

The evening meal in these villages commonly consisted of tuwo (a stiff porridge made from sorghum), a soup or sauce with palm oil base, and a vegetable. The morning meal was likely to be food left from the night before. At noon in the fields the men often ate specially processed millet balls (hura[1]) to be eaten after mixing with nono (soured skimmed milk) purchased from Fulani women. (Whelan [1982, chap. 2] has more detail on meal patterns and practises).

The importance of sorghum, millet, cowpeas, nono, palm oil and sugar cane shows clearly in Tables 2 and 3. Sorghum was by far the dominant cereal in the diet but early millet, next most important quantitatively, played a special role. The annual consumption of sorghum by an average household was 800 to 900 kg, while 85 to 100 kg of early millet were consumed as well as over 100 kg of processed foods based on millet. Early millet, the principal millet consumed, was highly prized because it is the first crop harvested in the agricultural year--the first crop available to ease any "seasonal hunger" which might exist. Every household consumed sorghum and early millet; the percentage consuming late millet was markedly different in the two samples (54 and 91 percent).

The quantities the tables show under "cereal" for sorghum and early millet consumption do not include quantities purchased in processed form from outside the household. All processed foods listed in the table were bought outside the household, so these entries represent net additions to the household diet. Processed foods consumed within the household that processed them are not listed as such in the table; their ingredients already appear in the listings of unprocessed items. The most important processed cereal, hura/fura, was consumed in large amounts by 80 to 90 percent of the households in the sample.

TABLE 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)	PERCENTAGE OF CONSUMPTION AVAILABLE FROM PRODUCTION-2	PERCENTAGE OF PRODUCTION AVAILABLE FOR CONSUMPTION-3	QUANTITY CONSUMED MEAN OVER CONSUMING HOUSEHOLDS (IN KGS)	PERCENTAGE OF ALL HOUSEHOLDS CONSUMING
CEREAL					
EARLY MILLET, GERO	100	100	70	100	100
LATE MILLET, MAIWA	21	100	79	24	91
SORGHUM (GUINEA CORN), DAWA	934	100	68	934	100
MAIZE, MASARA	51	100	92	52	97
RICE, SHINKAFA	22	94	54	30	73
CEREAL PRODUCTS					
MILLET PORRIDGE, TUWO GERO	0	*	*	3	3
MILLET FLOUR, GARI	1	*	*	4	27
THIN PORRIDGE, KOKO/KUNU	14	*	*	28	48
PROCESSED MILLET, HURA/FURA	97	*	*	107	91
SORGHUM PORRIDGE, TUWO DAWA--	1	-	-	20	3
WAINA, NAKIYA	1	*	*	3	36
CORN FLOUR	0	*	*	3	3
RICE (COOKED)	1	*	*	6	24
RICE PORRIDGE, TUWO SHINKAFA	8	*	*	55	15
BREAD, 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,VEG. PRODUCTS,FRUITS					
TOMATOES, TOMATUR	71	24	83	73	97
ONIONS, ALBASA-4	0	-	-	1	36
OKRA, KUBEWA	64	83	84	68	94
PUMPKIN, KABEWA	68	98	90	93	73
CALABASH, KWARYA	18	100	58	84	21
CABBAGE, KABEJI	0	0	0	0	0
FRESH PEPPER	4	40	100	7	64
DRIED PEPPER	10	100	24	12	82
BAOBAB LEAVES, KUKA	0	0	0	1	30
HORSERADISH LEAVES, ZOGALLE	15	91	90	18	82
GAWUTA	5	53	71	9	52

TABLE 2--Continued

COMMODITY	QUANTITY CONSUMED MEAN OVER ALL HOUSEHOLDS(IN KGS)	PERCENTAGE OF CONSUMPTION AVAILABLE FROM PRODUCTION-2	PERCENTAGE OF PRODUCTION AVAILABLE FOR CONSUMPTION-3	QUANTITY CONSUMED MEAN OVER CONSUMING HOUSEHOLDS (IN KGS)	PERCENTAGE OF ALL HOUSEHOLDS CONSUMING
VEGETABLES (OTHERS)-5	37	98	88	40	94
ORANGES, LEMON ZAKI	0	0	0	1	6
MANGOES, MANGHARO	1	0	0	6	15
GUAVA	0	0	0	1	6
LEMON	0	0	0	1	6
LIME	0	0	0	1	6
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	60	20	222	61
HONEY	0	*	*	0	6
SWEETS	0	**	**	0	18
COKE	1	**	**	10	9
TEA	0	**	**	2	6
BEER	0	*	*	0	0
MAGGI CUBES	0	**	**	0	18
GINGER, CITTA	0	**	**	1	15
SPICE, KALKASHI	0	**	**	0	6
CLOVES, KANAMPIRI	0	**	**	0	0

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

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

TABLE 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)	PERCENTAGE OF CONSUMPTION AVAILABLE FROM PRODUCTION-2	PERCENTAGE OF PRODUCTION AVAILABLE FOR CONSUMPTION-3	QUANTITY CONSUMED MEAN OVER CONSUMING HOUSEHOLDS (IN KGS)	PERCENTAGE OF ALL HOUSEHOLDS CONSUMING
CEREAL					
EARLY MILLET, GERO	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
MAINA, 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	92	51	136	30
YAMS, DOYA	1	93	24	38	3
LOCAL POTATOES, DANKALI	10	94	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,VEG. PRODUCTS,FRUITS					
TOMATOES, TUMATUR	65	11	87	85	77
ONIONS, ALBASA-4	2	-	-	6	24
OKRA, KUBEWA	70	65	85	91	87
PUMPKIN, KABEWA	50	35	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

TABLE 3--Continued

COMMODITY	QUANTITY CONSUMED MEAN OVER ALL HOUSEHOLDS(IN KGS)	PERCENTAGE OF CONSUMPTION AVAILABLE FROM PRODUCTION-2	PERCENTAGE OF PRODUCTION AVAILABLE FOR CONSUMPTION-3	QUANTITY CONSUMED MEAN OVER CONSUMING HOUSEHOLDS (IN KGS).	PERCENTAGE OF ALL HOUSEHOLDS CONSUMING
VEGETABLES (OTHERS)-5	22	99	88	41	53
ORANGES, LEMON ZAKI	0	0	0	5	3
MANGOES, MANGNARO	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	95
BUTTER, FAI SHANU	4	*	*	10	38
MILK (EVAPORATED, TINNED)	0	**	**	0	0
MILK	0	*	*	2	5
MISCELLANEOUS					
PALM OIL, MANJA	17	*	*	17	100
GROUNDNUT OIL, MAN KURUWA	2	*	*	4	48
SHEA BUTTER OIL	0	*	*	0	4
SALT, GISHIRI-6	0	0	0	0	1
SUGAR, SUKAR	0	0	0	0	8
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
KANAMPIRI, 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.
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- ESTIMATES OF FOOD RETAINED FROM HOME PRODUCTION NOT USED BECAUSE OF QUESTIONABLE VALIDITY.

Cowpeas were consumed by over 90 percent of the households. They are used most commonly in kosai (a 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) were also popular, purchased by almost every household. A variety of vegetables was consumed, tomatoes, okra, pumpkins and peppers being among the most popular. 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. About half the households consumed sugar cane. For a summary of other students' findings concerning food consumption in northern Nigeria see Whelan [1982, chaps. 2 and 5].

The consumption estimates for onions and groundnuts include only quantities purchased from the market or received in kind. The data on quantities retained from home production were unreliable. Both commodities are produced primarily for sale, but appreciable quantities may also be retained for home consumption.

Likewise, as we have already noted, we have no information about foods purchased by women from the proceeds of their household enterprises. Whelan [1982, chap. 4] estimates the mean annual household income earned from female entrepreneurial activity as 65.1 Naira for the small sample. This represents 18 percent of the mean total household expenditure (exclusive of female income) for that sample.

The second column in Tables 2 and 3 reports (as a percentage) the ratio of the sum over all households of the quantities available for consumption from their own production to the sum over all households of the total quantities consumed. We programmed the computer to set a maximum of 1.00 on this

ratio, although in principle it could exceed unity. (The numerator includes food paid out in kind as wages, loans or loan repayments, or as gifts, so for some households it could exceed the quantities actually consumed.[1] For the sample as a whole, however, this possibility is not important, for the net outflow of such payments in kind is likely to be small.

On the average, almost all the cereal grain consumed was produced by the consuming household. In the large sample (but not in the small one) rice was an exception, only 52 percent of consumption being available from own production. The other items available in large part out of own production were cassava, yams, local potatoes (dankali), cowpeas, bambara nuts, pumpkin, calabash and dried peppers. For the most important items in the diet, the majority of the food consumed was produced by the consuming household.

Although the average household produced all or a major part of its own consumption of the foods just mentioned, it also produced some for the market. The third column in Tables 2 and 3 lists the percentage of production retained (available for home consumption or for gifts, loans and wage payments). These percentages are large, but almost invariably less than 100. Some 25 percent of the sorghum produced and some 30 percent of the millet are not consumed within the household. Even though many crops may be grown primarily for use by the family itself, excesses are produced that can be sold. Therefore, when we examine the economic factors that affect consumption decisions we must regard the price for which a food could be sold as an opportunity cost incurred whenever that food is retained for home consumption.

Comparison of Tables 2 and 3 reveals that the two samples give generally consistent pictures of the consumption pattern, but there are often large

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[1] The items comprising the numerator were calculated by subtracting sales, seed use and storage losses from the quantities harvested, but out-payments in kind such as those just listed were not subtracted.

differences with respect to individual items. With respect to expenditures, the samples do not agree nearly as well as they do with respect to household characteristics (Table 1). Although other factors were involved [Whelan, 1982, chaps. 4 and 5], the principal reason for the difference seems to be that the recall period was from two to seven days in the small samples and one month in the large. This creates a strong presumption that where differences exist the small sample results are the more reliable.

From the estimates of quantities of foods consumed by individual households that we have developed we can calculate the total calories available for each household and express that figure as calories per adult male consumer equivalent [Whelan, 1982, chap. 5]. When those figures are classified by levels of household expenditure per consumer equivalent we obtain the following results for the small sample:

Fraction of Income Distribution (Percentiles)	Mean Calories Available per Consumer Equivalent (Per Day)	Mean Annual Household Expenditure per Consumer Equivalent (Naira)
0-10	1572	30
10-20	1997	40
20-40	2371	50
40-60	2777	64
60-80	3591	85
80-90	4078	110
90-100	4384	167

When we take account of family size and composition families in the lowest third of the income distribution appear to be suffering from deficient caloric intake. Households in the lowest decile are in desperate straits. As incomes rise, however, the situation improves, providing income rises faster than the number of adult male consumer equivalents. However, this tabular analysis takes no account of relative prices or of other important variables. It attributes to the ratio of expenditure to consumer equivalents what is

actually the result of the action of other variables as well, as we shall see when we examine the multiple regression results.

The figures presented in this chapter provide a realistic picture of food consumption patterns in three rural villages in Kano State , although it is probable that they underestimate somewhat the total quantity of food (and of calories) available. Better estimates could be developed if more and better data could be collected, but those data would be costly to obtain. When funds are limited we must make the best use possible of such data as are available.

CHAPTER III

THE MODEL

To examine the relationship between the quantities of food commodities consumed and the economic and other variables that determine those quantities we apply the single-equation methods developed in the Sierra Leone study.[1] The procedure was far more complicated in this case, however, because of differences between the two parts of the sample with respect to the recall periods used and other aspects of the data collection process.

Perhaps the widespread belief that the consumption of a household that produces most of its own food is largely independent of market forces prevails because such food passes through no market, so there are no market prices to which consumption decisions are obviously related. On second thought, however, we realize that there are opportunity costs, whether or not a market exists, and the economist, at least, is likely to feel that if the opportunity costs were known we should find that the household responds to them when making its choices. The crucial element in any attempt to analyze the economic determinants of consumer choice among semi-subsistence or subsistence households is to identify an appropriate measure of opportunity costs for food produced for one's own consumption. The most important single feature of the methods developed in the Sierra Leone study is their use of the selling price of any commodity produced as the opportunity cost of whatever quantity

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[1] Fruitful as the systems equation estimation of a household-firm model was in the Sierra Leone study, it was far too complicated and expensive, in both time and money, for application a second time with these data.

of that commodity is retained for home consumption. This is a lower bound; the true opportunity cost may be higher, and it is likely to be if all that is produced is retained at home.[1] In such a case the opportunity cost is the sales value of the most valuable product or collection of products that could have been produced with the same resources had they been used to produce for the market rather than for the home. In the absence of technical information about the physical substitutions possible between this and other products, the sales prices of those other products may serve as proxies in the regressions equations. If internal opportunity costs are so high as to preclude providing all one's own consumption of a certain food, buying from the market remains an alternative. In the market the opportunity cost is the price paid for the food, and the economist is again on familiar ground.

The single-equation method as used in the Sierra Leone studies took consumption per household as the dependent variable rather than consumption per capita or per consumer equivalent. In addition to the usual economic variables (prices and total expenditure--a proxy for income), the independent variables included measures of household characteristics and variables relating to production patterns and market orientation.

Expenditure, as we use it here, is not simply expenditure in cash, but cash expenditure plus the value of consumption in kind. We define it shortly in more detail. In the Sierra Leone study we used total household expenditure as a measure of the capacity for consumption that the household possesses, and we do the same here, for similar reasons. While consumption theory normally refers to income in defining the budget constraint, doing so requires including saving and borrowing in the list of goods among which income is

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[1] Our purpose is not to measure the subjective welfare associated with the consumption of the commodity, but to examine the relationship between consumption choices and available objective measures of the situation in which those choices must be made.

to be allocated. We are not interested here in the choice between saving and consumption, but in the allocation of expenditures to the individual foods that comprise the aggregate food component of total expenditures. Incomes vary more from year to year and from household to household than do expenditures; total expenditure is a closer approximation to the concept of "permanent income," which is more relevant for a study of normal levels of allocations to food consumption than actual income with its burden of transitory elements. Furthermore, total expenditure usually correlates more closely with individual consumption choices than does income (as it should, for total expenditure is the sum of all individual expenditures). We expect greater predictive power when a regression uses total expenditure as a right-hand side variable than when it uses income.

In the present study we define total expenditure as the value of all consumption goods and services purchased from the market (including taxes, licenses and school fees) plus, at farm-gate prices, the value of food available for consumption from home production (except for groundnuts and onions, as we have said) and of net receipts in kind of gifts, loans or wage payments. It does not include the value of non-food production consumed at home (presumably minor), or the value of production from the enterprises engaged in by the female members of the household.[1] Nor do we include food purchased from the proceeds of the womens' enterprises in our data on food consumption.

The dependent variable in each commodity regression is the total quantity of the food consumed by the household during the year, measured in kilograms. This differs somewhat from the quantity variable used in the Sierra Leone studies [Smith, et al., 1981a, pp. 10-11]. As total consumption consists of goods from all sources--the market, home production, and all other (net gifts, loans or wages received in kind), we use an average of market

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[1] The omission is unfortunate, but unavoidable. Female entrepreneurial activity may constitute as much as 18 percent of total household income

and farm-gate (sales) prices as its price.[1] The price averages are quantity weighted, calculated as the sum of the values of market expenditure and of consumption from home production, divided by the total quantity consumed from those two sources. [Whelan, 1981, chap. 6.]

Pursuing our purpose of testing the method developed in the Sierra Leone studies, we use the same regression form here, although the set of variables differs somewhat. The regression is arithmetically linear, except for one quadratic term in expenditure. The function is homogeneous of zero degree in prices and expenditure.

The underlying model is

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

where

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

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

P is a vector of relevant prices,

C_h is a vector of characteristics for household h,

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

and

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

The functional form is

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

The intercept term, α_i, is the coefficient of the own-price term (i.e., P_i/P_i); the latter does not appear explicitly in this formulation. As a consequence, the size of the own-price elasticity is not readily apparent. The influence of

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[1] We have no prices for goods received in kind, and would doubt their validity if we did have them.

own-price upon the quantity consumed operates through the relative price and expenditure variables.

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

Table 4 lists the variables used in the present study.[1] The price and expenditure variables require no further explanation. Variables beginning with S and ending with AP or AN are source variables. SLMAP, for instance, is the share of the late millet consumed that is available from one's own production. If the variable ends in AN it is the share of consumption that is obtained in kind from sources other than home production: the excess of in-kind gifts received over those given, of in-kind wages received over those paid out and of loans received in kind over such loans repaid or extended to others. At

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[1] Table 4 includes only variables included in one or more of the regressions to be presented in Chapter IV. Additional variables were examined but discarded during the variable selection process. Some were dropped because of multicollinearity and some because the criteria by which we selected our regressions usually resulted in our retaining no more than ten variables. (See page 28.) For instance, one source variable ending in AP and one in AN were available for each regression if the food was sometimes produced at home, but in most cases only one of them proved useful in the final set of equations.

TABLE 4

Variables Used

I. Commodity-Specific Variables

A. DEPENDENT

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

B. INDEPENDENT

Commodity	Variable Name	Meaning
Sorghum	PRPS	Price ratio of palm oil to sorghum
	TEXPR	Total expenditure divided by the price of sorghum
	SSAN	Share of sorghum received in kind but not from home production
Early Millet	PRSEM	Price ratio of sorghum to early millet
	TEXPR	Total expenditure divided by the price of early millet
	TEXPRSQ	TEXPR squared
	SEMAN	Share of early millet received in kind but not from home production
Late Millet	PREMLM	Price ratio of early millet to late millet
	TEXPR	Total expenditure divided by the price of late millet
	TEXPRSQ	TEXPR squared
	SLMAP	Share of late millet from own production
Maize	TEXPR	Total expenditure divided by the price of maize
	TEXPRSQ	TEXPR squared
Rice	SRAP	Share of rice from own production
	SRAN	Share of rice received in kind from other sources
Cowpeas	PRWMC	Price ratio of weighted millet to cowpeas
	PRSC	Price ratio of sorghum to cowpeas
	TEXPR	Total expenditure divided by the price of cowpeas
	SCAP	Share of cowpeas from own production
	SCAN	Share of cowpeas received in kind from other sources
Palm Oil	PRSP	Price ratio of sorghum to palm oil
	TEXPR	Total expenditure divided by the price of palm oil
Tomatoes	TEXPRSQ	The square of total expenditure divided by the squared price of tomatoes
	STAN	Share of tomatoes received in kind but not from home production

TABLE 4--Continued

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 any other non-Hausa ethnic group (=1; =0 otherwise)
FUL	Binary variables for Fulani ethnic group (=1; =0 otherwise)
SHOG	The value of groundnuts harvested as a share of the value of total food crops harvested.
SSHO	Total food crop sales as a share of the value of total food crops harvested.

times we may call this the share coming from or made available from off-farm non-market sources. The "AN" is a mnemonic for "available from non-market" sources. These are off-farm sources in the sense that they are not from home production; they are non-market sources in the sense that the goods are not purchased in commodity markets. Of course wages and loans involve transactions in labor and credit markets, whether in kind or in money, and gift exchanges may sometimes constitute implicit or concealed market transactions. The source variables vary from commodity to commodity as well as across households.

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

Two market orientation variables, SSHO and SHOG, are included to test the hypothesis that food availability declines as the extent of market participation increases. The second of these, the value of groundnut production as a percentage of the value of total food crop harvests, is particularly relevant to the so-called "groundnut strategy," producing heavily for the market in order to be able to buy more food than the same resources could have provided through home production. Cf. Matlon [1979, pp. 89-91]. SHOG relates the harvest value of a major cash crop, groundnuts, to the harvest value of all food 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 large fractions of its output of crops other than groundnuts. The market orientation variables vary across households, but are the same for all foods consumed by a given household.

The household characteristic variables relate to household type, size and composition, characteristics of the household head, and ethnic background.

Households are classified as either nuclear or extended (gandu). In general, gandu units are households which include two or more male adults, often married, with their wives and children. [Matlon, 1979, pp. 57-59.] For detail concerning other variables see Whelan [1981, chap. 6].

The price variables are average prices for each village, so each one can assume no more than three values. With so few values for each variable, we cannot be optimistic about the chance of obtaining many statistically significant price coefficients. The probability is high that there will be multicollinearity among the price variables or between some of the price variables and any other variable that assumes only three values.

Moreover, there may be fairly strong responses to price variation within each village that we cannot detect because all intra-village variation has been replaced by a village average. In addition, it is impossible to differentiate between price and any other variable which is constant within the village; price will pick up all such effects. Thus effects properly assigned to one variable may be attributed to others, or one variable may serve as a proxy for others, and be assigned more influence than it alone possesses. In particular one or more of the price variables may pick up some of the influence of locational or other variables that are not price-related, but are associated with other differences among the villages.

CHAPTER IV

COMBINING THE SAMPLES

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

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

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

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

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

The first step in this process, choosing an appropriate regression for the small sample data, required us to choose a small number of variables from a much larger set (some 27 potential variables for each commodity). To do this we used a computer routine, the "All Possible Subsets Regression," from the Biomedical Computer Programs (BMDP) package. This routine determines 1) a regression that minimizes C_p (an estimate of total squared error that takes account of both bias and the variance of the predicted values) and

2) a regression that maximizes $\bar{R}^2$.[1] It also prints out other regressions with near-minimum C_p or near-maximum $\bar{R}^2$.

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

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

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

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

CHAPTER V

THE COMMODITY REGRESSIONS

The commodities selected for analysis comprise the most important foods in the diet. Of the nine foods chosen five were cereals: sorghum, early millet, late millet, maize and rice. The four other foods were cowpeas, palm oil, nono (soured skimmed milk) and tomatoes. The five cereals alone provided approximately 75-80 percent of the calories in the diet, sorghum being the dominant cereal. Early millet, the first crop harvested in the agricultural cycle, has a unique role, so it was distinguished from late millet, harvested much later. Palm oil was selected as an important source of vitamin A, cowpeas and nono as important protein sources, and tomatoes as an important vegetable.

The regression results are based upon equations for consuming households only. Table 5 shows that most of these commodities were consumed by almost all households. Where this was not the case some bias is introduced by excluding non-consumers, but including them could also lead to bias. See Smith et al. [1981a, pp. 35-36].

The Commodity Equations

Sorghum

Table 6 (p. 34) has the regressions for the staple, sorghum. The variables chosen for the original model were of course less satisfactory when used with the large sample data set. However, the variances of the disturbance terms did not differ significantly between the two regressions, so the third regression in Table 6 (for the "Combined Samples") was calculated without weighting. This pooled result, of course, constrained the parameters to be the same from both samples, but upon applying the Chow test it appeared that we had to reject the hypothesis that parameter values were the same in both samples. Therefore

TABLE 5

Percentage of Households Consuming, Small Sample, Large Sample and Combined Samples, Kano State, Nigeria--1974-1975[1]

	Percent of All Households Consuming Small Sample	Percent of All Households Consuming Large Sample	Percent 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

[1]Estimates for all commodities based upon the total number of households in each sample: 33 for the small sample, 99 for the large sample and 132 for the combined sample.

SSD and the interaction terms were added to the original model. For sorghum, the coefficient of every one of the new terms proved to be significant, so all were retained, yielding the "Final Model-Combined Samples" (Table 6). In this Final Model the prediction for a household in the small sample uses the observed value of each independent variable twice, once with its coefficient from the first page of the table and once with the coefficients of the small sample adjustment terms given on the second page of the table. Thus any coefficient in the small sample predicting equation is simply the sum of two components from the Final Model-Combined Samples. That sum, listed in Table 6 as the "Small Sample Component, is identical in this case to the coefficient in the regression for the "Small Sample-Original Model," on the first line of Table 6. Similarly, the "Large Sample Component" is identical with the entries in the "Final Model-Combined Samples" for terms without the small sample dummy, and with the entries for the "Large Sample-Original Model." No entries in the Final Model are equal to those in the "Combined Samples" regression. In that regression the coefficients were constrained to be the same for both samples; in the Final Model each sample is permitted its own set of coefficients.

This identity between the Large and Small Sample components of the Final Model and the coefficients of the Original Model when fitted to each sample separately gives us a clear picture of what happens when the two data sets are combined by using the Final Model, but this is a special case. Only when SSD and every interaction term is included in the Final Model will the coefficients of the Small and Large Sample components of that model be identical will those of the Original Model fitted separately to each sample. Had even one of the parameters in the Final Model been constrained to be the same for both data sets, the identity between the Final and Original Model results would have broken down, for other parameters as well as for the one required to be the same for both data sets.

TABLE 6

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

Equation	Number of Consuming Households	$\bar{R}^2$	R^2	Intercept	INDEPENDENT VARIABLES[2]								
					Price[3]	Expenditure[3]		Household Characteristics				Market Relationship		Source
					PRPS	TEXPR	TEXPRSQ	HHS	IAT	MAD	HHAGE	SHOG	SSHO	SSAN
Small Sample-[4] Original Model	33	.87	.91	*** 2775.3 (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	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	132	.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	132	.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 4.

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

[4] C_p equals 5.7.

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

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

TABLE 6--Continued

Equation	INDEPENDENT VARIABLES										
	Intercept Shift	Price[3]	Expenditure[3]		Household Characteristics				Market Relationship		Source
	SSD	PRPSDI	TEXPRDI	TEXPRSQDI	HHSDI	IATDI	MADDI	HHAGEDI	SHOGDI	SSHODI	SSANDI
Combined Samples	*** 3585.0 (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)

As a predicting equation, which results should we use? The Small Sample Component, because we believe those data to be more reliable. If we wanted to predict the observed values for households in the large sample, clearly the Large Sample Component would be preferred, but that is not our purpose. We want to predict what such households actually consume, not what was reported to be consumed. Nothing in the data suggests that large sample households are indeed different from the small sample households, aside from whatever effects the stratification in the small sample may have. We believe the observed differences in behavior must be attributed to the less satisfactory methods of measurement of the dependent variable that were used for the large sample.

With respect to sorghum, nothing was gained by including the large sample data. Our final result leaves us with exactly what we would have had by using the Original Model with the small sample--except the knowledge that in this case the large sample data could not help us any. For most other commodities, however, the large sample data did furnish useful information.

The sorghum regression provides an excellent fit for the small sample data. At the mean values of the independent variables (as calculated from the combined samples) the purchasing power of household expenditure was equivalent to 3895.4 kg of sorghum; predicted household consumption of sorghum was 778 kg per year (20 percent of total expenditures).

Predicted sorghum consumption per household varies as follows with the level of total expenditure, assuming that the values of all other independent variables are constant:

Total Expenditure (measured in kg of sorghum it could purchase)	Predicted Sorghum Consumption of Household (kg)	Predicted Consumption as Percentage of Total Expenditure
1900	1255	66
2900	957	33
3895	778	20
4900	714	15

Predicted sorghum consumption constitutes 33 percent of the value of all expenditure for the "average" household we have been discussing at an expenditure level of 2900 kg, 15 percent at a level of 4900 kg, and smaller and smaller percentages as total expenditure rises.

The expenditure relationship is highly significant and negative for households with real expenditure levels (in terms of power to purchase sorghum) of 4932 kg and below. (That level is 27 percent above the mean real expenditure figure for the combined samples.) At the mean of the two samples the marginal increment of sorghum consumption is 12 kg for each added hundred kilograms of real expenditure. One more kilogram of purchasing power lowers sorghum consumption by nearly one-eighth kilogram. Below an expenditure level of 4932 kg (measured in power to purchase sorghum) all marginal changes in sorghum consumption are negative; as expenditures rise the marginal changes decrease in absolute amount:

Total Expenditure (kg of sorghum)	Marginal Change in Sorghum Consumption (kg per kg increase in total expenditure level)
1900	-.36
2900	-.24
3900	-.12
4932	-.00

Above 4932 kg marginal changes are positive and rising. From the total consumption figures previously given we may note that a rise in expenditure from 2900 to 3900 decreases sorghum consumption by 179 kg or 19 percent of the predicted consumption at the 2900 expenditure level.

Evidently sorghum is an inferior food for well over half the households even though (or perhaps because) it is by far the most important single food consumed.[1] It is a normal good only for households at the upper end of the expenditure distribution. Perhaps this should not surprise us.

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[1] In Pakistan low income farm laborers who receive their wages in rice are

Surely potatoes, rye bread and corn meal have been inferior goods in certain economies and at certain levels of living, but each of them is a normal good for most people in an economy as well off as ours.

Of course, expenditure is not likely to vary as much as it does in the tabulations we have just given unless there are changes in the other independent variables as well. Expenditure is not in fact independent of the other variables; in particular it is strongly correlated with HHS, household size. If low-expenditure households are usually smaller than average, observed sorghum consumption may be either smaller or larger than average, for it is the overall result of two sets of forces which may oppose each other.

For instance, the lower the level of expenditure, the more sorghum is consumed if household size and all the other independent variables remain the same, for the less there is to spend per person, the more the household must rely upon sorghum. But if household size decreases by one person, with no change in either of the two age-sex variables in the regression, less sorghum will be consumed at a given expenditure level. A smaller household is under less pressure to consume large quantities of sorghum to meet its food needs. This shows in the sorghum regression. A one-person decrease in HHS, the numbers of infants and toddlers and of male adults remaining unchanged, is associated with a reduction in household sorghum consumption of 266 kg. If both HHS and expenditure are below average, sorghum consumption may fall, even though the expenditure effect alone would increase it. If the expenditure differential between two households were to dominate a one-person difference in size the expenditure difference would have to be well over 1000 kg for a comparison with a household spending 3900 kg per year (the mean expenditure level for the combined sample).

For a complete understanding of this matter we must examine production as well as consumption relationships--in particular the relationship between

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[1] (continued from p. 7)
C.H. Shah, in his study of 1376 families in Kerala State, India, concluded that among low-income families meeting food preferences took precedence

household size and composition and the total expenditure level. To describe the full effect of a change in household size on consumption we must be able to show the effect through expenditure as well as the effect of a change in household size at a given expenditure level.

Changes in the age-sex variables also have measurable effects. An extra infant-and-toddler (IAT), HHS constant, is associated with reduced sorghum consumption. An infant or toddler undoubtedly consumes less than the larger person he replaces if household size is constant.

The regression also shows that an extra adult male in a household of fixed size is associated with less sorghum consumption. The mechanisms here are more complicated. One more male in a household of fixed size means one less person in some age and sex class other than infants and toddlers. One possibility is that the household will have fewer females and therefore may eat less sorghum because the women prepare the sorghum for consumption and less of their labor time is available in the household. Sorghum and millet are normally stored unthreshed, in the bundle, so every few days small amounts of the grain must be threshed. Another possibility is that the negative coefficient of MAD occurs because sorghum is an inferior good and more attention is given to pleasing the male palate than the palates of other members of the household.

If both household size and the number of male adults increase by one the net effect on sorghum consumption is small: -76 kg, comprised of +266 from the HHS variable and -342 from the MAD variable. Still other relationships with age-sex variables must exist that can only be detected with a larger sample.

The only price variables in the sorghum regression are those for palm oil and for sorghum itself. The real price of palm oil (in terms of sorghum) has been retained in this regression, but its coefficient does not differ significantly

from zero. The sign of the cross-price relationship as it exists in this sample is negative. This is consistent with complementarity in consumption between palm oil and sorghum, but of course is not evidence that such a relationship really exists in the population.

Because all price and expenditure variables are expressed in terms of the price of sorghum, there is no explicit own-price variable in the regression. The price of sorghum enters as the denominator of each price and expenditure variable. Own-price elasticities will be given toward the end of this chapter.

Sorghum consumption has a strong negative association with patterns of production and sale that increase the share of the total value of food crop output that is available in terms of money. Other things equal, households that produce more for the market consume less sorghum than others.

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.

In this case SSD and many of the interaction terms were statistically insignificant in the model for the combined sample with complete interaction. See Table 7 (p. 42). Thus they were removed from the Final Model, constraining the coefficients of the variables to which they had applied to be the same for both samples. As a result, the parameters for the intercept, price and expenditure terms of the large and small sample components are identical, as well as for IAT and OAD. Where the coefficient can vary between samples, that for the small sample component is no longer identical with its counterpart in the original model applied to small sample data. (The special

conditions of the sorghum case do not apply here.) For early millet there is information in the large sample that affects the small sample component of the final model. That small sample component, as we have said, is our predicting equation.

Among other things, being able to make some use of the large sample data increases the significance level of the small positive relationship with real expenditure--expenditure measured in terms of the power to purchase early millet. (But it also renders statistically insignificant the relationships with OCH, OAD and the price of sorghum that we would have found acceptable if we had looked only at the small sample data.)

Non-Moslem Hausa and non-Hausa households (MAOTH) consume more early millet than others in similar situations. Perhaps such households are somewhat outside the usual socio-cultural support network of the village and thus must depend more upon the early millet crop to end the lean months of the year. The households that obtain larger shares of their early millet from sources other than the market or their own production consume less than otherwise similar households at the same expenditure level. Other things equal, households dependent upon charity, loans and wages in kind eat less early millet than the others do.

Late Millet

Almost no useful information was obtained from the late millet regressions (although we would have been quite well pleased if we had looked only at the small sample data). See Table 8. For late millet the variances of the disturbances about the original model regression differed significantly between samples, so the original model was fitted to the combined samples as a weighted regression. (For this purpose the intercept term was replaced by CONST, set equal to 1, which then, in the weighted form of the observations, took on the

TABLE 7

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	33	.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	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	132	.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	132	.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 (7.3.5)	132	.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 (-1.20)	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 4 .

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

[4] C_p equals 3.65.

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

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

TABLE 7--Continued

Equation	INDEPENDENT VARIABLES										
	Intercept Shift	Price	Expenditure		Household Characteristics						Source
	SSD	PRSEMDI	TEXPRDI	TEXPRSQDI	HHSDI	IATDI	OCHDI	WADDI	MAOTHDI	OADDI	SEMANDI
Complete Interaction	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)
Limited Interaction					*** 21.5 (3.2)		** -43.2 (-1.97)	*** -71.3 (-3.27)	*** 159.8 (2.82)		*** -69.1 (-2.82)

TABLE 8

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	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	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)	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 4.

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

[4] C_p equals .89.

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

values $1/\sigma_S$ and $1/\sigma_L$, where σ_S and σ_L are the standard deviations about the regression lines for the two samples.) This weighted regression became the final model because the hypothesis that comparable parameters were equal in value in the two samples was not rejected upon using the Chow test. Membership in the Fulani ethnic group was the only statistically significant variable in the final equation.

Maize

Maize, not consumed in large amounts in these Kano State villages in 1974-75, is a crop of considerable policy interest. Maize production has been encouraged in Nigeria for some years and the World Bank now has a maize production program under way.

The results in Table 9 suggest that maize will be well accepted in Northern Nigeria, for maize consumption rises with real expenditure. Fulani households eat less and gandu households eat more maize than others. Market oriented households also are comparatively heavy maize consumers.

If maize production (and consumption) should become important in Northern Nigeria, long-run benefits may accrue because of the remarkable success plant breeders have had in improving maize productivity by hybridization. No such breakthrough seem to have been made for sorghum and millet. However, there is far to go before maize will become an important item in the Kano State diet. Even in our small sample households, although they consumed far more maize than those in the large sample, maize consumption by the average household was only 6.5 percent of its sorghum consumption (Tables 2 and 3).

Rice

The Chow test applied to the two weighted regressions using the original model indicated rejection of the hypothesis that comparable coefficients were equal in value in the two samples. However, the interaction term coefficients

TABLE 9

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	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	67	.30	.37	* 24.6 (1.7)	*** .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	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	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	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 4.

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

[4] C_p equals -3.02.

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

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

TABLE 9--Continued

Equation	INDEPENDENT VARIABLES							
	Intercept Shift	Expenditure[3]	Household Characteristics					Market
	SSD	TEXPRSQDI	HHSDI	OCHDI	FULDI	HHAGEDI	GANDDI	SSHODI
Complete Interaction	** 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)
Limited Interaction	32.8 (1.27)		*** -14.92 (3.48)	*** 41.9 (3.23)	*** -72.5 (2.69)		*** 72.9 (2.65)	*** 160.5 (2.75)

TABLE 10

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

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4 .

[3] C_p equals 4.68.

[4] Each parameter is obtained from the regression just preceding as the sum of the parameters for the terms with and without the DI suffix.

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

TABLE 10--Continued

Equation	INDEPENDENT VARIABLES										
	Household Characteristics								Market	Source	
	CONSTDI	HHSDI	IATDI	YCHDI	OCHDI	FULDI	LITERATDI	GANDDI	SHOGDI	SRAPDI	SRANDI
Complete Interaction	-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)
Limited Interaction				-68.7 *** (-7.90)						33.3 *** (2.88)	

were significant for only two variables (Table 10), so the small and large sample components of the final model are much alike (but different from the small sample version of the original model). The predictive power of the regression is excellent, as indicated by the R^2 of the Final Model. Unfortunately, no price or expenditure variable was statistically significant.

Fulani households eat more rice than others. Production of either groundnuts or rice (both grown largely for sale) is associated with high rice consumption.

Cowpeas

Here for the first time the data reveal significant cross-price relationships: cowpea consumption is positively associated with the relative price of millet[1] and negatively associated with the relative price of sorghum (Table 11, p. 52). In a single-equation model of this sort we cannot be sure whether the signs of these coefficients represent consumption relationships, production relations, or both. As successful cowpea production usually implies intercropping in Nigeria, the possibility of a production connection cannot be neglected. A positive relationship between cowpea production and home consumption exists in the data, but it is not statistically significant.

Cowpea consumption is also positively associated with groundnut production and negatively associated with the share of the total food crop harvest sold in the market. Given the share of the total food crop harvest composed of groundnuts, the larger the marketed share of the harvest the fewer cowpeas are consumed. But given the marketed share of the total food crop harvest, the greater the share of groundnuts in that harvest the more cowpeas are consumed. Households which produce more groundnuts (presumably for sale) and sell less of other food crops consume more cowpeas,

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

whereas households which produce fewer groundnuts and more of other food crops for sale consume fewer cowpeas. There are interrelationships here that deserve further study.

Cowpea consumption has a highly significant positive relationship to total real household expenditure.

Palm Oil

Palm oil is the first of three commodities to be examined that are largely or wholly purchased from the market. Palm oil consumption is positively associated with real household expenditures and with the relative price of sorghum (Table 12). If the price of sorghum is high in terms of palm oil, the sale of a given quantity of sorghum allows a household to buy more palm oil.

Nono

Nono (soured skimmed milk), is produced largely by Fulani women. The nono consumed in our sample is entirely from the market. We have no data on the quantities produced by the household. (See Table 13, p. 56.)

No price or expenditure variable was statistically significant for nono, but household characteristics and market sales as a share of the total value of food harvests were strongly so. The small sample component of the final model promises to be an excellent predicting equation, being much like the small sample version of the original model, which had an R^2 of 0.89.

Fulani households and market oriented households (SSHO) consume more nono than others. Given the household size, the addition of a member of any of the age-sex groups included in the regression must be accompanied by a reduction in the number of adult females who are not wives (NWAD); the net effect is to reduce nono consumption. Perhaps the presence of an additional adult female non-wife is associated with more income from female enterprises, with some of

TABLE 11

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

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

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4 .

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

[4] C_p equals 9.85.

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

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

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

TABLE 11--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
Complete Interaction	*** -488.1 (-3.05)	*** 252.5 (2.47)	*** -127.7 (-2.55)	*** .476 E-2 (2.50)	*** 17.1 (3.46)	-16.2 (-1.37)	** -22.98 (-2.29)	** -22.7 (-2.01)	*** 89.9 (3.32)	25.0 (1.11)	*** 392.2 (3.36)	*** -277.9 (-4.63)	96.03 (1.01)	124.5 (1.36)
Limited Interaction	*** -314.4 (-2.71)	** 213.4 (2.18)	** -109.7 (-2.27)	*** .496 E-2 (2.83)	*** 11.7 (3.18)		** -20.1 (-2.12)	** -21.8 (-1.97)	*** 79.3 (2.99)		*** 328.9 (3.06)	*** -260.3 (-4.54)		

TABLE 12

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-Original Model[4]	32	.70	.76	-9.9	***	***	***	***	*	***							
				(-1.27)	130.311 (3.40)	.213 E-1 (5.18)	-3.8 (-5.13)	5.3 (3.06)	3.5 (1.95)	7.0 (3.34)							
Large Sample-Original Model	97	.29	.33	*	***	**		*									
				-11.8 (-1.84)	119.4 (3.50)	.784 E-3 (2.34)	.34 (.62)	-2.4 (-1.72)	-2.1 (-1.24)	2.9 (1.39)							
Combined Samples	129	.33	.36	**	***	***				***							
				-13.13 (-2.43)	127.8 (4.52)	.106 E-1 (3.69)	-.612 (-1.27)	-.492 (-.41)	-.318 (-.23)	4.3 (2.52)							
Combined Samples with Complete Interaction	129	.40	.46	**	***	***		*					**	***	***	*	
				-11.8 (-1.96)	119.4 (3.72)	.784 E-2 (2.49)	.344 (.66)	-2.4 (-1.83)	-2.1 (-1.31)	2.9 (1.48)	1.9 (.15)	10.9 (.18)	.013 (2.08)	-4.1 (-3.63)	7.7 (2.84)	5.6 (1.91)	4.1 (1.17)
Final Model-																	
Combined Samples with Limited Interaction	129	.40	.45	**	***	***				***			***	***	***	**	
				-11.2 (-2.16)	121.6 (4.46)	.753 E-2 (2.48)	.116 (.23)	-2.04 (-1.57)	-2.4 (-1.48)	4.4 (2.70)			151 E-1 (2.61)	-3.4 (-3.45)	6.7 (2.66)	5.9 (2.03)	
Small Sample[5] Component				**	***	***	***	**		***							
				-11.2 (-2.16)	121.6 (4.46)	.226 E-1 (4.30)	-3.28 (3.59)	4.66 (2.10)	3.5 (1.46)	4.4 (2.70)							
Large Sample Component				**	***	***				***							
				-11.2 (-2.16)	121.6 (4.46)	.753 E-2 (2.48)	.116 (.23)	-2.04 (-1.57)	-2.4 (-1.48)	4.4 (2.7)							

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4.

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

[4] C_p equals 1.63.

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

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

that income being spent on nono and captured in the reports of market purchases that were obtained in the survey interviews.

Tomatoes

The small sample component of the final model reveals a highly significant but small positive consumption response to real expenditure levels, the latter being measured in terms of power to purchase tomatoes. The positive effect of the relative price of sorghum is statistically insignificant when we take advantage of the information available from the large sample. Fulani households eat fewer tomatoes than others similarly situated; households that produce relatively large quantities of groundnuts consume more tomatoes than others. (See Table 14, p. 58.)

Among the last four commodities we found significant positive cross-price responses between the relative price of sorghum and the consumption of palm oil and between the relative price of millet and the consumption of cowpeas. We also found a significant negative relationship between the relative price of sorghum and the consumption of cowpeas. Cowpeas, palm oil and tomato consumption rise with household expenditure levels (measured as the power to purchase the relevant commodity). Market orientation has a positive effect on the consumption of tomatoes and of nono, but no demonstrable effect on the consumption of palm oil, which is also a food obtained from the market.

Elasticities

To interpret the magnitude of price and expenditure responses it is usually best to express them as elasticities. This is important for cross-commodity comparisons and still more so when the price and expenditure variables are given as relative prices or expenditure and the denominator of the ratio

TABLE 13

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	32	.84	.89	*** -120.229	*** 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	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	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	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	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 (8.35)	*** 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)

[1] t-statistics are in parentheses.

[2] Variables are defined in Table 4.

[3] C_p equals 8.01.

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

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

TABLE 13--Continued

Equation	INDEPENDENT VARIABLES									
	Intercept Shift	Household Characteristics								Market
	SSD	HHSDI	IATDI	YCHDI	OCHDI	MADDI	WADDI	OADDI	FULDI	SSHODI
Complete Interaction	*** -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)
Limited Interaction	*** -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)	

TABLE 14

Single-Equation Total Tomato 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	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	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)	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	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	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)	-15.7 (-.55)	*** 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 Tables 4.

[3] C_p equals 7.99.

[4] Each parameter is obtained from the regression just preceding as the sum of the parameters for the terms with and without the DI suffix.

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

TABLE 14--Continued

Equation	INDEPENDENT VARIABLES											
		Price	Expenditure	Household Characteristics							Market	Source
	CONSTDI	PRSTDI	TEXPRSQDI	HHSDI	IATDI	YCHDI	OCHDI	OADDI	FULDI	LITERATDI	SHOGDI	STANDI
Complete Interaction	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)
Limited Interaction			* .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)			

is different in each regression. Furthermore, in the regressions we have been using the own-price response does not appear in the form of a single coefficient. In this section we present price and expenditure elasticities calculated from the regressions in Tables 6 to 14 above.

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

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

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

$$\text{Cross-Price:} \quad \frac{\partial q_i}{\partial p_j} \cdot \frac{p_j}{q_i} = \frac{a_j}{q_i}\frac{p_j}{p_i}$$

where: q_i is the predicted consumption of the dependent variable,

p_i is the price of the dependent variable,

p_j is the price of commodity $j \neq i$,

a_i is the intercept term for the prediction equation,

b_2 is the parameter estimate for the quadratic expenditure term,

y is total expenditure

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

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

All elasticities were calculated at mean values of the independent variables, using the large and small samples combined. The combined samples were used to determine the values of the independent variables because the large sample measurements of most independent variables were comparable in quality to those from the small sample and combining the two samples quadrupled the number of observations.

The elasticities apply only to consuming households.

In using the elasticities we must remember two things. First, the price variables are village prices. Consequently some village-to-village differences may have been picked up by one or more of the price variables, so that what we have may not be pure price or expenditure elasticities, but may include some response to unidentified differences among villages. This problem would diminish of course if the sample used covered a larger number of villages.

Secondly, and of far more fundamental importance, we must remember that these elasticities are not derived from structural demand regressions appropriate for the explanation of demand behavior when all goods are purchased from the market and incomes are given in money and unaffected by the nature of the consumption decision. In semi-subsistence households a decision as to what to consume often requires a decision to produce or not to produce a given crop; it affects the form and may affect the magnitude of household income. Consumption decisions affect both consumption and production sides of household activities; they respond both to consumption and production prices. If food A is consumed only from home production, and none is sold,[1] the decision to consume is a decision to produce, but it may be affected either by the prices of alternative foods obtainable from the market or the sales prices of alternative products that could have been produced with the same resources. If a single-equation regression such as ours detects a cross-price relationship between the consumption of A and some other price it could be either the production or the consumption relationship that is revealed, or a combination of the two.

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[1] Maize, in the sample, nearly meets these conditions. Only eight percent of production was sold (Table 2).

In the more general case, in which food A is consumed partly from home production and partly from the market, and can also be sold, it is still true that both production (supply-side) and consumption (demand-side) relationships are involved in the consumption decision. Production decisions at planting time are designed to make possible a given set of consumption actions; both production and consumption decisions are based on the same set of expected prices. After the harvests are in, prices may be different than had been expected, so consumption decisions may be revised, but the adjustments made must still be within a framework created by production plans and outcomes. In short, consumption actions are the net result of both supply-side and demand-side responses to prices and other variables.

The single-equation regressions that we are using capture these net responses, but they do not separate the production and consumption components or distinguish between them. From demand theory we expect a rise in the price of A to discourage its consumption; from production theory we expect the same increase in price to expand its production. But this will be at the expense of resources that could have been used to produce foods to consume instead of A, so their opportunity cost has risen, thus offsetting, at least in part, the adverse effect of the higher price of A on the consumption of A. Moreover, if the output of A expands, the amount of A available at the low farm gate price is larger, so the actual opportunity cost may fall for that part of consumption that had been obtained from the market. The regressions we have measure the net effect of the entire complex of relationships. They provide us with consumption elasticities, but these are not pure demand elasticities, for production responses also affect their magnitudes. Indeed, where home production is a limiting factor in the consumption of a particular commodity, the production response to a rise in the sales price may actually bring about an increase in consumption--the supply response dominates.

That these regressions measure the net effects of both supply and demand decisions is consistent with our objectives, for this is just what we want, if we are interested in the nutritional effects of economic change upon rural households. Of course, as scientists we would prefer to isolate the mechanisms at work, to give us a better understanding of the processes involved. For this purpose we should require a more complicated model (a simultaneous equations model) that would keep production and consumption responses separate. Such a model was developed, and used in our Sierra Leone study [Strauss et al., 1981a, 1981b], but such models are far more expensive to develop and use than the single-equation models used here.[1]

Table 15 contains price and expenditure elasticities for the nine commodities studied. In calculating them we used all relevant coefficients in the regression equation chosen, whether or not the coefficient differed significantly from zero.[2] Each elasticity was calculated from the Small Sample Component, except for late millet, where we used the Final Model--Combined Samples (Weighted).

Four of the own-price elasticities are based upon expenditure and intercept coefficients that are statistically significant; in the other five cases at least one of these coefficients is not significant at the ten percent level. (We did not calculate significance levels for the elasticities themselves.) We discuss

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[1] We need to explore the possibility of developing simultaneous equation models simpler than that used for Sierra Leone, models that would cost less in time and money but still give insight into underlying mechanisms that our single-equation models cannot provide.

[2] To have replaced insignificant coefficients by zero would have been to derive the elasticity from a different predicting equation than the one presented.

TABLE 15

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

COMMODITY	ELASTICITY		
	OWN-PRICE	EXPENDITURE	CROSS-PRICE
Sorghum	.92	-.61	-.31[a] (with palm oil)
Early Millet	.18[b]	.18	-.37[a] (with sorghum)
Late Millet	-1.16[c]	-.02[c]	1.19[a] (with early millet)
Maize	-.33	.37	--
Rice	--	--	--
Cowpeas	-5.52	2.43	11.36 (with millet) -8.38 (with sorghum)
Palm Oil	-2.03	.86	1.16 (with sorghum)
Nono	--	--	--
Tomatoes	.24[b]	.08	.17[a] (with sorghum)

--The regression equation does not contain the information needed for calculating this elasticity.

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

[b]Based on a statistically insignificant intercept coefficient.

[c]Based on statistically insignificant expenditure and intercept coefficients.

here only the elasticities based upon quantities that are statistically significant.

The data reveal large negative own-price elasticities for cowpeas and palm oil. Cowpeas are almost entirely produced at home; palm oil is obtained from the market. About 25 percent of cowpea production, on the average, is for the market (or for gifts or payments in kind). There is a small negative elasticity (0.33) for maize, which again is primarily produced at home. For sorghum the own-price elasticity (0.92) is positive! (We return to this shortly.)

Expenditure elasticities are appreciable for three commodities: positive for cowpeas and palm oil and negative for sorghum. The regressions contained no information from which expenditure elasticities can be calculated for rice or nono.

Most cross-price elasticities are either based on statistically insignificant coefficients or cannot be calculated because the relevant coefficients are not in the regressions. As we had only three observations on each price, this is not surprising. For the two foods for which cross-price elasticities are based on significant coefficients the relationships are strong. Higher prices for sorghum are associated with greater consumption of palm oil and less consumption of cowpeas; higher millet prices are associated with greater cowpea consumption. The latter relationship is consistent with either the conventional substitution relationship on the demand side between millet and cowpeas or a complementarity relationship on the supply side--or both.[1]

The relationships with sorghum are more complicated. The negative cross-price elasticity for cowpeas with respect to the price of sorghum indicates that they are substitutes, not complements, in consumption (because the sorghum own-price elasticity is positive high sorghum prices lead to more sorghum and fewer cowpeas in the diet). Should one choose to regard the cowpea regression

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[1] Cowpeas are normally grown in a mixture containing millet and sorghum, and sometimes groundnuts [Whelan, 1982, Chapter 2].

as dominated by production relationships, the negative cross-price elasticity with sorghum would imply that sorghum and cowpeas were substitutes in production. If it is technically possible for cowpeas to be simultaneously a substitute for sorghum and a complement of (early) millet, the supply-side relationships may be dominating the cowpea regression.

If the own-price response of sorghum consumption is positive, as the data indicate, higher sorghum prices are associated with greater consumption of sorghum and more palm oil as well. One might conclude that palm oil and sorghum are complements in consumption, even though the sign of the cross-price elasticity is the same as that between millet and cowpeas.[1] When the household consumes more sorghum the marginal utility of palm oil is greater.

However, this interpretation of complementarity is for a situation in which income is fixed in money; one's power to purchase palm oil (though not one's inclination to do so) is unaffected by the price of sorghum. Our case is different. Some 25-30 percent of sorghum output is sold for money to be used to buy other goods, including palm oil. A rise in the price of sorghum is an increase in one's power to purchase other goods. Exchanging sorghum for palm oil through the market provides more palm oil per kilogram of sorghum than before (the price of palm oil in sorghum has fallen). One may buy more palm oil, not because he has more sorghum to eat it with (its marginal utility has risen), but because a given sale of sorghum obtains more palm oil in exchange (its real price has fallen).

Of the elasticities likely to be useful for policy questions (those for cowpeas, palm oil and sorghum), the own-price and expenditure elasticities for sorghum are the most interesting. Sorghum is the principal food in the diet. At 0.08 Naira per kg, mean household consumption in the small sample, 934 kg,

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[1] Palm oil is a principal ingredient in the sauce normally served with sorghum [Whelan, 1982, Chapter 2].

represents 21 percent of mean total expenditure by sample households. (See Tables 1 and 2.) As we have seen (page 36), at lower expenditure levels the share devoted to sorghum would be even greater. The data show sorghum to be an inferior good. At the same time its own-price elasticity is positive; the higher the price the more is consumed. If we could be sure that our sorghum regression were the true structural relation for the demand curve we should declare sorghum to be a Giffen good--often described, but never before detected in empirical data. Sorghum in these Kano State villages meets the conditions: it is an inferior good that represents a large fraction of the total value of consumption. To be sure, the standard theoretical derivation is for the case where income is fixed in money, and a household spends so much on an inferior good (say sorghum) that the impoverishing effect of a rise in the price of sorghum dominates the substitution effect. Consequently the household buys more sorghum at a high price than at a low one. In the present case we use expenditure as a proxy for income, but this is not an important matter. More important is the fact that in semi-subsistence households expenditure (income) is not fixed in terms of money. Moreover, in our Kano State villages most of the sorghum consumed is produced at home, not bought in the market. Yet there is an analogous mechanism operating. The data show that if two households have equal money expenditures and are alike with respect to all the other variables included in the sorghum regression, except that the price of sorghum is higher for household A than for B, we would expect A to consume more sorghum than B. Now if money expenditures are equal for the two households they cannot be producing the same sets of goods. Expenditure in this study is defined essentially as the value of output less sales plus purchases in the market. Aside from gifts and loans we may take market purchases as limited by receipts from sales. If both households produced identical sets of outputs, the expenditure (income) of A would be greater than that of B, for

the same output of sorghum is worth more for A than for B. Thus equal expenditures for both imply that A is producing less sorghum (certainly less of some good or goods). The same money income is associated with the ownership of a smaller collection of physical goods by the household confronted by the higher price of sorghum. In this sense a kind of impoverishment is associated with a higher price of sorghum for the semi-subsistence household as well as for the household that receives an income in money and buys its sorghum in the market. Thus it need not be surprising that in our sample a higher price of sorghum is associated with greater sorghum consumption at a given level of money income.

Of course the observable event for the semi-subsistence household in the real world is not the Giffen case, for a rise in the price of sorghum increases the money value of expenditure. But having fitted the regression, we may derive the effect of a price change holding money income constant or a change in money income holding prices constant (as was done in calculating the elasticities reported in Table 15).

To predict the complete effect of a change in the price of sorghum for a semi-subsistence household we must remember that a change in the price of sorghum implies a change in the expenditure variable. In our sample the sorghum produced, valued at its average price, amounts to about one-third of average total expenditure. Thus, with no change in production levels, a one percent increase in the price of sorghum increases total expenditure by 1/3 of one percent. The joint effect of these two changes is to increase sorghum consumption by 7/10 of 1 percent. Given the expenditure elasticity (-0.6), the expenditure change by itself would reduce sorghum consumption by 0.33 X 0.6 = 0.2 percent; the price change, by itself, would increase sorghum consumption by 0.9 percent; the sum of the two is 0.7 percent. The regression as fitted allows us to measure these two effects of a rise in sorghum prices as though they occurred separately (subject to the proviso that having the dependent variable as a

component of total expenditure does not bias the regression coefficients too greatly).[1]

Other explanations of the positive own-price elasticity for sorghum are possible. Between 1/4 and 1/3 of the sorghum produced is sold. Standard offer curve analysis tells us that if we think of the production pattern as given, a rise in the price of sorghum in terms of all other goods leads to an increase in the quantity of sorghum retained for one's own use whenever the demand for other goods in terms of sorghum in inelastic. In addition, the usual supply-side response to a higher sorghum price will lead to increasing the amount of sorghum included in the production pattern, perhaps at the expense of home production of some other foods. These approaches, however, provide no explanation for the fact that the income elasticity of demand for sorghum is negative.

Conclusion

This experiment with the use of single-equation regressions to analyze the food consumption of semi-subsistence households has shown that even a small sample, carefully handled, can give statistically significant results if the data have been carefully collected and the recall period is short enough.[2] Estimating consumption by the disappearance method gave useful results, not as precise as direct observation of quantities eaten, but far less expensive. Inability to obtain data concerning female enterprises, however, made a complete picture of food consumption choices impossible.

The data gave clear indications of the effects of household characteristics on consumption. Specifying household size and composition by a set of age-sex classes was more informative than expressing the dependent variable

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[1] It is possible that the price variable acts as a proxy for village, and that its coefficient measures the effect of some unspecified village characteristic that is unrelated to price. It would be a mistake, however, to assume this too easily.

[2] Two to seven days worked out well; one month was clearly too long.

as either consumption per capita or consumption per consumer equivalent would have been. No weighting system could have provided a single index of household composition as sensitive to variations in composition as the use of the individual variables. And even if we were determined to use a single average, no single weighting scheme exists that would be clearly preferable to all others or satisfactory for all purposes. Which categories are significant varies from commodity to commodity; different commodities respond in different ways to individual components of the set of variables.

Statistically significant consumption-expenditure responses existed for six of the nine foods studied. Most were positive, as one would expect. The only exception was sorghum, which is an inferior good for well over half the households in the combined sample. It is a normal good only for households toward the upper end of the expenditure distribution. Of course at the higher expenditure levels the diet is already appreciably more varied than it was at the lower levels.

Even though the price series used provided only one observation for each of the three villages being studied, statistically significant price responses were found for four foods, sorghum, cowpeas, palm oil and maize. Negative own-price elasticities are large for palm oil and cowpeas; that for maize is small.

At the mean of the combined samples sorghum has a positive own-price elasticity of 0.92 and a negative expenditure elasticity of -0.61. At a given level of money expenditure, sorghum consumption rises as the average price of sorghum rises. Sorghum is evidently a Giffen good.

Three strong cross-price relationships are also revealed by the data. A high price for sorghum has a positive effect on palm oil consumption and a negative effect on cowpea consumption; a high price of millet has a positive effect on cowpea consumption.

It is clear from the data that consumption may be strongly price-responsive for foods consumed primarily from one's own production (cowpeas and sorghum, for instance) as well as for foods purchased from the market (palm oil). These semi-subsistence farmers adapt to market forces.

Production patterns and attitudes toward the market also have measurable effects on consumption behavior, but the effects differ from food to food. Households consume more rice or cowpeas if they produce a large fraction of that consumption themselves. Households that sell a large share of their food crops (in value terms) eat more maize and nono than others, but less sorghum and cowpeas. If groundnut production accounts for a relatively large share of the value of total food crop output, the household consumes more tomatoes, rice and cowpeas, but less sorghum. Market orientation matters, but from these data it is impossible to say in general that it is either positively or negatively related to the quality of the diet.

CHAPTER VI

CALORIES AVAILABLE

The regression analysis of Chapter V added much to our understanding of the factors determining household consumption of major foods in Kano State, but more important than the consumption of individual foods is the nutritional adequacy of the diet as a whole. For each household in the sample we have made estimates of the annual consumption of all foods in the diet (see Chapter II),[1] so we can estimate the nutritional composition of the diet for each household simply by multiplying the quantity of each food consumed by its nutrient content. Budgetary limitations restrict us to doing this for calories only. In much of the world, of course, the most pressing of the nutritional problems is that of caloric availability. In northern Nigeria the evidence suggests that calories and vitamin A are the nutrients most likely to be seriously deficient [Smith, 1975, pp. 161-2, 263-267].

The single-equation regression model provides an efficient way of analyzing economic and other determinants of the caloric content of the diet as a whole. Although it does not identify the food choices that are made, it does relate the net outcome of those choices to the factors affecting them. We experimented with two models, one almost identical in form to those used for commodity predictions, and one that used a new variable, HHREQ (the daily caloric requirement of each family), in lieu of some household composition variables. The best version of the latter model used HHREQ instead of HHS and the age-sex variables and yielded a value of 0.82 for $\bar{R}^2$--very good, but not as good as the $\bar{R}^2$ value of 0.87 obtained from the model which used HHS and age-sex composition variables instead of HHREQ. The equation with the age-sex variables also

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[1] Except for groundnuts, onions and items purchased with the profits of the women's enterprises.

measures differences in the effects of the various age-sex classes upon total calorie consumption.

The results presented in this chapter are from the model with HHS and the age-sex variables. Variables were selected for the calorie model by the same procedure used for the commodity regressions--consideration of the values of C_p and $\bar{R}^2$ for all possible subsets of the variables in the available pool. The variables available for that pool were the same as those available for the sorghum regression that was discussed at length in the previous chapter, except that the source variables for individual commodities were replaced by source variables for calories: SKAP, the share of total calories coming from home production, and SKAN, the share coming neither from home production nor market purchases.

The selection process led to a small sample original model which minimized C_p (Table 16, p. 76). Not surprisingly, it turned out to be much like the model for sorghum (Table 6). Of course the share of calories obtained from sources other than home production or market purchases appeared instead of its counterpart, SSAN. However, three variables in the sorghum equation do not appear in the calorie equation (the price of palm oil, HHAGE and SSHO, the marketed share of the value of harvested food crop output). Only the latter of these was important in the sorghum equation. The calorie equation has one variable, YCH, that does not appear in the sorghum equation; it is significant at the ten percent level.

At the mean values of the combined samples predicted caloric availability per household per day is 10,581 calories. As was the case with sorghum, total calorie consumption decreases with increasing expenditure levels for households at the mean of the combined sample (TEXP in terms of sorghum = 3895 kg) and below. The declining range ends appreciably sooner than it did for the sorghum regression--at an expenditure level of 4239 kg rather than at 4932 kg. The

predicted values by expenditure levels are given here:

Total Expenditure (kg of sorghum)	Predicted Calories Available per Household per Day
1900	13,700
2900	11,600
3895	10,600
4239	10,500
4900	10,600

Not only is the minimum reached at a lower expenditure level than it was for sorghum, but the rate of decline is also lower. An increase in expenditure from 2900 to 3900 kg reduces calorie availability by nine percent; sorghum consumption decreased by 19 percent over the same range. Both of these differences from the sorghum pattern are to be expected. Sorghum consumption declines because, as expenditure levels rise, households consume more of other things, including such foods as cowpeas and palm oil. The foods being substituted for sorghum are more expensive sources of calories, but they do provide partial replacement of the calories lost when less sorghum is purchased.

To note that caloric availability decreases as expenditure levels rise for households that are otherwise identical and are located near and below the mean of the sample is not equivalent to saying that households with lower expenditures consume more calories than others, for generally speaking households with lower expenditures differ from others in many other ways as well. In particular, low-expenditure households are likely to be smaller than average and smaller households, given no change in the levels of the three age-sex variables that appear in the calorie regression, consume fewer calories. Increases in household size caused by increases in the number of infants and toddlers, young children or male adults on the other hand, are associated with lower

TABLE 16

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

Equation	Number of Households	$\bar{R}^2$	R^2	Intercept	INDEPENDENT VARIABLES[2]							
					Expenditure[3]		Household Characteristics				Market Relationship	Source
					TEXPR	TEXPRSQ	HHS	IAT	YCH	MAD	SHOG	SKAN
				***	***	***	***	***	*	***	***	***
Small Sample-[4] Original Model	34	.87	.90	18000.6	-4.6	.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	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	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	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	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	-4.90	.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	2.51	.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)

[1] t-statistics are in parentheses.

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

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

[4] C_p is 3.35.

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

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

TABLE 16--Continued

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

consumption of calories. If, when all variables are accounted for, fewer calories are in fact available for low-expenditure households than for others, the calorie regression tells us that near and below the mean of the expenditure distribution this result is not to be attributed to the lower expenditure level in itself, but to the differences in the values of the other variables that affect caloric availability. Above an expenditure level of 4239 kg the expenditure variable itself has a positive effect.

As we have seen, the price of sorghum is related to caloric intake through its effect on the real value of expenditure. No other price variable appears in the calorie regression, although there may be significant price relationships that would be revealed if the sample were large enough.

The regression provides valuable information about another question of great importance to nutritionists and economists. Are rural households better fed when they produce primarily for their own consumption or when they produce for the market? If we may take the caloric content of the diet as a useful measure of its quality our calorie regression states that one form of producing for the market, the production of groundnuts, is negatively associated with the adequacy of the diet.[1] The larger the share of total food crop output that consists of groundnuts, the fewer calories are available for the household, at any given level of expenditure and of the other relevant variables. It is not clear whether this is simply because producing for the market has an adverse effect on the quality of the diet or because those whose diets would be worse for other reasons are those who produce relatively more groundnuts. Households that emphasize groundnuts production may be those that feel under pressure from inadequate resources. Land holdings may be small, for instance, in relation to the size and composition of the household. Such a household may be able to

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[1] But we must remember that our data do not include the consumption of home-produced groundnuts and onions or of items purchased with the proceeds of women's enterprises.

attain a level of income because it produces groundnuts that it could not otherwise reach, but still consume fewer calories than others at that expenditure level because a larger proportion of its sorghum and other foods must be obtained at relatively high market prices rather than at the lower farm gate prices that represent the opportunity costs to those who produce their own food. The household that is forced to produce a considerable quantity of groundnuts in order to attain a given expenditure level may well consume less sorghum than the household that can attain the same expenditure level by producing more sorghum and fewer groundnuts.

The source variable, SKAN, is significant and positively associated with caloric availability. Households that receive relatively large amounts of gifts in kind, wages in kind, or loans or loan repayments made in kind consume more calories than those that do not. This is not surprising, but whether such receipts are associated with poverty or with being well enough off to be the recipient of loan repayments cannot be determined without further study.

For many purposes the price and income relationships implicit in the calorie regression will be more useful if they are expressed as elasticities. At the mean values of the independent variables for the combined sample, the expenditure elasticity of calorie availability is -0.15 and the price elasticity with respect to the price of sorghum is +0.15. Given the form of the regression and the absence of any other price variable, these two elasticities must be equal, but opposite in sign. A ten percent increase in the level of expenditure, other things equal, reduces calorie availability by 1.5 percent; a ten percent increase in the price of sorghum (which lowers real income) increases calorie availability by 1.5 percent. These elasticities will be larger in absolute amounts as expenditure levels are smaller. At expenditure levels above 4239 kg the expenditure elasticity becomes positive and the sorghum price elasticity negative.

The most important aspect of these elasticities is that they are small: for policy purposes changes in income or in the price of sorghum do not have important effects on calorie availability. The most interesting aspect is their signs. Until expenditures reach levels somewhat above the mean for the combined samples, the general response to higher spending capacity is to add variety to the diet by increasing the consumption of cowpeas, palm oil, maize, etc., and to do this even at the sacrifice of some calories that the household could have obtained had it consumed larger quantities of sorghum than it did in fact choose to do. Evidently in the lower income strata there is strong preference for higher quality foods even at a higher cost per calorie. An expenditure of 0.01 Naira on sorghum, an item not usually obtained from the market, provides 428 calories. The same expenditure on palm oil, purchased primarily from the market, provides only 198 calories. Yet as incomes rise in these strata, sorghum consumption falls and palm oil consumption rises, the values of the other variables remaining the same.

CHAPTER VII

CONCLUSION

Sorghum and millet were quantitatively the most important foods consumed by the households in these Kano State villages. Some 800 to 900 kg of sorghum were consumed per year by the average household, along with 85 to 100 kg of early millet and over 100 kg of processed foods based on millet. Cowpeas, nono and palm oil were also important, as well as sugar cane and a wide variety of vegetables. Palm oil consumption amounted to only some 20 kg, but the oil is a major source of vitamin A and a highly concentrated source of calories.

Except for the palm oil, nono and sugar cane, the consumption of most of the major foods came largely from the household's own production. In addition, the average household produced an appreciable excess of most of the foods it produced, an excess available for sale or for use in making gifts, loans or wage payments in kind. Still, quantities retained for home use or payments in kind constituted two-thirds or more of production for most food items.

These consumption estimates do not include groundnuts or onions consumed from home production. Apparently such quantities may be appreciable, but these products are produced primarily for the market and our data did not provide reliable estimates of quantities retained for home consumption. Perhaps more important is the fact that the survey collected no information about food purchased from the proceeds of enterprises engaged in by the women of the household, or about the magnitude of those proceeds. One of the most important of such enterprises is the processing and distribution of food products. A rough estimate of the amount earned in this way places it at ₦ 65 per year for the average household--18 percent of the mean total expenditure (exclusive of female income) of the small sample households. Given these limitations, our findings probably underestimate the quantities of food (and calories) available for household consumption.

Even though we were constrained to work with a very small sample, the data provided clear evidence that the consumption patters of these semisubsistence farmers respond to such economic forces as incomes and prices. The price series contained only three observations apiece, one for each of the villages, so we could not reasonably expect to detect all the price responses that actually exist. Furthermore, a price variable may in some cases have picked up the influence of location or other characteristics of the village to which the price corresponds.

Even given these limitations consumption showed itself to be strongly price-responsive for some foods consumed primarily from own production (cowpeas and sorghum, for instance), as well as for palm oil, a food obtained only from the market. The data revealed a number of statistically significant own-price and cross-price relationships, and a larger number of significant expenditure relationships.

Cowpea and palm oil consumption respond positively to higher levels of household expenditure and negatively to increases in their own prices; there are strong cross-price relationships with millet and sorghum. The responses of sorghum consumption are the most interesting as well as the most important. At the mean of the combined samples sorghum appears to be a Giffen good, with an expenditure elasticity of -0.61 and an own-price elasticity of +0.92. Because the value of sorghum consumption constitutes more than 20 percent of total expenditure for households in the lower half of the combined samples, the income effect of a rise in the price of sorghum is strong. Above a real expenditure level of 4932 kg (measured in power to purchase sorghum), sorghum is a normal good, but below that figure a higher level of household income, other variables held constant, is associated with reduced sorghum consumption. As sorghum consumption falls, however, the consumption of maize, palm oil and cowpeas

increases. At these expenditure levels the average household prefers to take improvements in its economic well being at least partly in the form of cowpeas, palm oil and maize. It will give up some sorghum to do so.

As for the positive price elasticity of sorghum, this is the result of its negative expenditure elasticity and a negative cross-elasticity (-0.31) with the price of palm oil. Except for households with real expenditures above 4932 kg, a higher price for sorghum is associated with more rather than less sorghum in the consumption pattern.

Household characteristics and attitudes toward the market also affect consumption choices. Many statistically significant relationships appeared in these categories--but no simple answer to the question whether production for the market affects the diet adversely. Households selling a large share of their food crop output eat more maize and nono than other households, but less sorghum and cowpeas; those that produce a larger proportion of groundnuts than others consume above-average amounts of rice and cowpeas, but below-average amounts of sorghum; those that produce a large share of the rice or cowpeas they consume eat more of those two crops than others do. Market orientation and production patterns matter, but no simple statement about the effect on the diet would be a trustworthy guide to action. It does appear, however, that the more market oriented households, other things equal, eat less sorghum, the major food in the diet. At the same time they eat larger quantities of most other foods--and probably also of groundnuts, though our data did not permit us to examine the latter case.

The total effect on consumption of changes in the relevant variables is best indicated by the behavior of total calories. As we saw in Chapter II, a simple tabulation of the small sample data showed that caloric availability per consumer equivalent increased with expenditure per consumer equivalent. But

that tabulation took no account of relative prices or of any of the other variables that are important along with expenditure and prices in determining what people consume. Unless one isolates the influence of these other variables one is likely to attribute to income (expenditure) what is actually the result of other determinants.

When the effects of other variables are recognized the influence of expenditure in itself is quite different than it appeared to be in the tabular analysis. Holding other variables constant, we see from the calorie regression that our estimate of total caloric availability per household behaves much like sorghum consumption, declining as expenditure levels rise for households below (or moderately above) the mean expenditure level for the combined samples. The percentage decline is smaller than for sorghum, for increased consumption of cowpeas, palm oil, and other foods partially offsets the fall in sorghum consumption. At the mean values for the combined sample, the expenditure elasticity is -0.15 and the elasticity with respect to the price of sorghum is +0.15. At expenditure levels above 4239 kg the expenditure elasticity becomes positive and the price elasticity negative. All other variables held constant, if households are below the mean of the combined samples (or not too far above it), those with the higher expenditure levels choose the more varied diets, losing something in caloric content, but probably gaining something in terms of protein (from cowpeas) and vitamin A (from palm oil). The effect on caloric availability is small, however; at the mean of the combined samples, a ten percent rise in expenditure level corresponds to only a 1.5 percent decrease in calories. Furthermore, as we have noted, our calorie series does not include calories from groundnuts or from any foods female members of the household may buy with the proceeds of their own enterprises. Given the fact that decreases in sorghum consumption may be partially offset by increases in groundnuts eaten, in addition to the increases

in other foods, it is reasonable to conclude that increases in expenditure (or in the price of sorghum, for that matter) have negligible effects upon total calorie consumption even though over more than half the income distribution the households favored by higher expenditure levels alter their consumption pattern in favor of more cowpeas, palm oil, etc. -- and perhaps groundnuts -- at the expense of some of the sorghum that would otherwise have been eaten.

Although the share of food crop output sold was negatively related to the quantity of sorghum consumed, no statistically significant relationship was found between this variable and total calorie availability. The share of food crop output that consisted of groundnuts, however, was negatively related to total calories, as it was to sorghum consumption. Of course the negative relationship to total calories may persist simply because groundnuts were not included when estimating our calorie series. Groundnut consumption may increase as sorghum consumption declines, but, having no satisfactory data on groundnut consumption, we cannot examine that.

Before turning to the policy implications of these results we must remind ourselves of their limitations. First, the sample was small; on the other hand, significance levels for most of the coefficients were highly satisfactory. Second, the data do not include the consumption of groundnuts, onions and foods purchased by females from the earnings of their own enterprises. Third, the total expenditure variable is not given to the household, but is affected by the decisions of the households concerning what it produces and consumes. Thus some endogeneity is present, and endogeneity leads to biased estimates of the parameters. Fourth, this is a cross-section study that included only three villages. There were only three observations in any price series, a factor which contributes to multicollinearity. Moreover, one or more of the price variables (or perhaps some of the other variables) could have become a proxy

for differences among the villages that affected behavior but were not adequately represented by the variables in the model. Access to transportation facilities, differences in land-labor ratios, or differences in the amount of inventory-building (the result of differences in the harvest of the previous year) could all be important variables, and might have had effects that in these regressions are being reflected in the coefficients of other variables.

These limitations could be removed, of course, by additional research: a larger sample, more villages, reliable data on stocks in storage, the inclusion of female incomes and expenditures therefrom, more accurate information concerning groundnuts, and the use of data from different points in time as well as from different points in space. All these would improve the quality of our information. However, in the absence of new data such as are described here we must make the best use we can of the data that are already available.

Even if no comprehensive additional study can be carried out, it is important that there be careful investigation into the role of groundnut production and consumption and the relationship of groundnut production to the economic status of the household, its land-labor ratio or other relevant variables. Groundnut production clearly plays an important role in the household economy for many families in these villages, but the exact nature of that role is not yet clear. Households that produce relatively more groundnuts consume less sorghum, but is it because they produce less sorghum, or consume more groundnuts, or (having a larger fraction of their income available in money) spend more on foods (such as palm oil) or other goods obtained through the market. Or perhaps the households that produce more groundnuts do so because their limited resources (of land, for instance) make it impossible to obtain as much sorghum from their own production as they can by producing for the market and exchanging groundnuts for sorghum. Knowing the mechanism is important here, but further study on this point will be required to be identify it properly.

What policy measures are appropriate, given all this? The instinctive reaction of the economist, given that incomes are low and deficient caloric intake is a problem, is to recommend measures to increase incomes in general and, in particular, to improve productivity for the staple food. But in these Kano State villages an uncritical application of such policies may make nutritional problems worse rather than better. Because high sorghum prices, lower income and low reliance on the market are associated with above-average consumption of the basic food, sorghum, when all other variables are held constant (except for families somewhat above the mean expenditure level for the combined samples), normal economic development policies, directed toward greater output, higher incomes and more production for the market, may harm the nutritional status of most households. The data suggest that there is danger of this. Certainly there should be careful surveillance of the situation.

On the other hand, it is clear that the reduction in sorghum consumption that occurs when a household's capacity to purchase sorghum increases does so because households prefer to add other foods to their diets as soon as they are able to do so without excessive loss of calories. And indeed there may be no such loss. Although our regression shows that some decrease takes place, groundnuts and food purchased from the proceeds of the women's enterprises were not included in our consumption data.

Moreover, except for families at the upper end of the distribution, high sorghum consumption is a measure of the difficulty of the family situation. The evidence is that as soon as they become able families attempt to reduce sorghum consumption in favor of greater consumption of other goods. We can hardly recommend the perpetuation of poverty as a means of improving family welfare unless we regard improved caloric availability as more important than all the alternative forms of consumption that the household itself holds important.

Consequently measures to improve household incomes are in order, even if they involve more dependence on the market,[1] but the emphasis in programs directed toward improvements in productivity should be on foods that are sought after in greater amounts as income rise -- cowpeas and maize, for instance. Improvements in production methods and varieties for sorghum would also yield benefits, but the mechanism would involve lower prices and less consumption of sorghum, and release of resources from sorghum production to the production of other things. Furthermore, the normal growth of incomes to be expected from economic development will shift the demand curve for sorghum to the left. The difficult transitional problems that develop when supply curves are shifting to the right and demand curves to the left could be avoided if resources shifted in response to improved opportunities in the production of alternative crops (including groundnuts or other crops for which there may be external markets), rather than because they were being squeezed out of sorghum production.

Improvements in transportation and marketing can help by lowering the price of palm oil or other foods advantageously obtained from other areas and by improving farm gate prices and export outlets for groundnuts, cowpeas, and other crops, but especially for sorghum. Sorghum and millet from the north can play important nutritional roles in the rest of Nigeria, for they are valuable sources of protein, particularly of the two amino acids, methionine and cystine, that have been found to be the limiting amino acids in the Nigerian diet [Smith, 1975, pp. 279-80]. Except for sorghum, of course, we must remember that high farm gate prices improve farm incomes but have a negative effect on consumption from a given income.

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[1] Greater production for the market is a favorable factor with respect to the consumption of maize, rice, nono and tomatoes.

Clearly population control measures are also in order; calories per consumer equivalent, not calories per household, are what matter for adequate nutrition.

The Federal Government of Nigeria, in cooperation with the World Bank, has recently instituted a Food Production Plan designed to reduce the country's food deficit, improve the standard of living of smallholder farmers and create a more modern, market oriented agriculture with increased regional specialization. Such a program could be effective in providing the wider range of consumption alternatives that lower-income households appear to desire in these Kano State villages, if adequate attention is paid to moderating the unfamiliar risks associated with market orientation and the possible increase in risk from uncertain rainfall associated with increasing the production of crops that may be less suited to the area than sorghum and millet. Greater regional specialization may expand the external market for sorghum and millet, thus providing alternative uses for those crops as income increases reduce the quantity of sorghum locally consumed. Greater maize production would give the Kano State villagers access to the exceptional improvements in the yields of maize that have been occurring for some years. No such break-throughs have occurred as yet in the production of sorghum and millet. In general, production improvements that lower the costs of desired alternatives to sorghum will permit low-income households to move toward the more varied diets they desire with less sacrifice in terms of the caloric adequacy of their diets. The program seems well designed, but continued surveillance of energy intake levels in northern Nigeria should be instituted to make sure that the possible adverse effects for the least well-off households do not occur.

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