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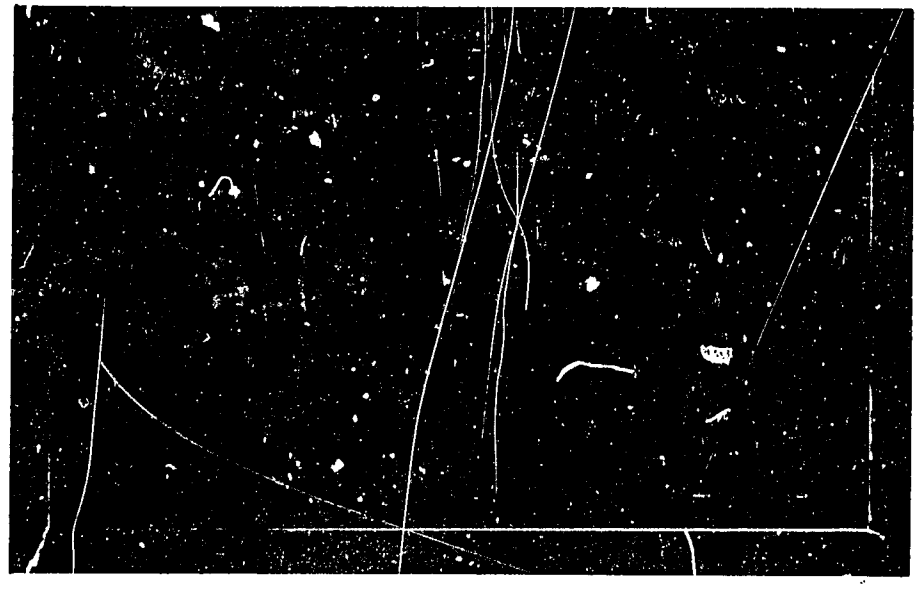

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FOOD FLOWS AND SIMULATIONS: RURAL SIERRA LEONE

By

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

Working Paper No. 19, 1981

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

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PREFACE

This is the seventh in a series of studies of the food consumption behavior of rural households in Sierra Leone. The project, carried out under the direction of Professor Victor E. Smith of the Department of Economics of Michigan State University, has been funded by the United States Agency for International Development (USAID), under Contract No. AID/DSAN-C-0008. Its purposes are to develop methods for analyzing the effects of economic events and policies upon the food consumption of households that produce large fractions of their own food and to measure food consumption levels and the determinants thereof for rural households in Sierra Leone. The data were collected during 1974-75 by the Rural Employment Research Project at Njala University College (financed by a contract, AID/cds 3625, between USAID and Michigan State University, and by the Rockefeller Foundation).

Dr. Dunstan S.C. Spencer and Dr. Derek Byerlee of the Njala Rural Employment Research Team directed the collection of the data. We deeply appreciate the opportunity to use these data and the help that Drs. Spencer and Byerlee, as well as many others, have given us in interpreting the data. In particular we wish to acknowledge assistance from Mrs. Agnes Becker and Mr. Alimami Kargbo, graduate students of Michigan State University, and from Dr. Joseph Tommy, Acting Head of the Department of Agricultural Economics and Extension at Njala University College, Njala, Sierra Leone.

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INTRODUCTION

The nutritional situation in a developing country inevitably reflects the effects of economic changes that occur during development and policies that are adopted to encourage such development. Yet specific information concerning the effects of economic policy on food consumption and the levels of nutrient intake among rural households is extremely limited.

For some time we have been studying the food consumption choices of rural households in Sierra Leone in an effort to increase our understanding of the relationships between food consumption and nutrient availability on the one hand and economic change and economic policy on the other.

Six studies completed to date have been concerned with describing the nutritional situation that prevailed in Sierra Leone in 1978 [Kolasa, 1979], estimating in detail the quantities of food consumed by rural households in that country [Smith et al., 1979, 1980], and deriving estimating equations for use in predicting food consumption responses to changes in various socio-economic variables. Single-equation regressions were presented in Smith et al., 1981, and the results of systems estimation of a household-firm model in Strauss et al., 1981a, 1981b.

All the reports presented so far have been limited to describing the characteristics and behavior of the households in the sample. The present report carries the work three steps further. It presents estimates of per capita consumption for the entire rural population of the area covered by the sample; it uses a Food Accounting Matrix (FAM) in a simplified way to display the flows of food from the rural sector to households outside that sector; and it uses the systems estimation results to derive projections of the effects of certain changes in relative prices upon per capita production, consumption and the flows of food from the rural sector to households outside the sector.

CHAPTER I

PER CAPITA CONSUMPTION IN THE RURAL POPULATION

Up to this point we have made no attempt to describe food consumption patterns for the rural population as a whole. We have concentrated upon the characteristics of the households in the sample, for our primary goal was to understand how individual households adjust their consumption to differences in their characteristics and situations. We should also like to know how the total rural population responds to changes in factors affecting food consumption, but to make such as estimate we must adjust for the fact that the sample contains a smaller proportion of the rural population in some geographical areas than in others.

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

Estimation Procedure

Within each zone the households included in the sample were selected by two-stage random sampling: first three census enumeration areas were chosen at random and then twelve households, also at random, within each enumeration area. For more detail see Smith et al., 1979, pp. 18-21.

The data were collected by households, the numbers of households being roughly equal in each enumeration area. Estimates of the rural population in each ecological zone (resource region) [Spencer and Byerlee, 1977, Table 3.1, p. 10] were available to users of the data, but there were no figures on the rural population in each enumeration area or the number of households in each zone. Consequently, we use a ratio estimator (consumption per capita) to derive figures for the rural population as a whole. We assume the populations in each enumeration area to be essentially equal within a given ecological zone.

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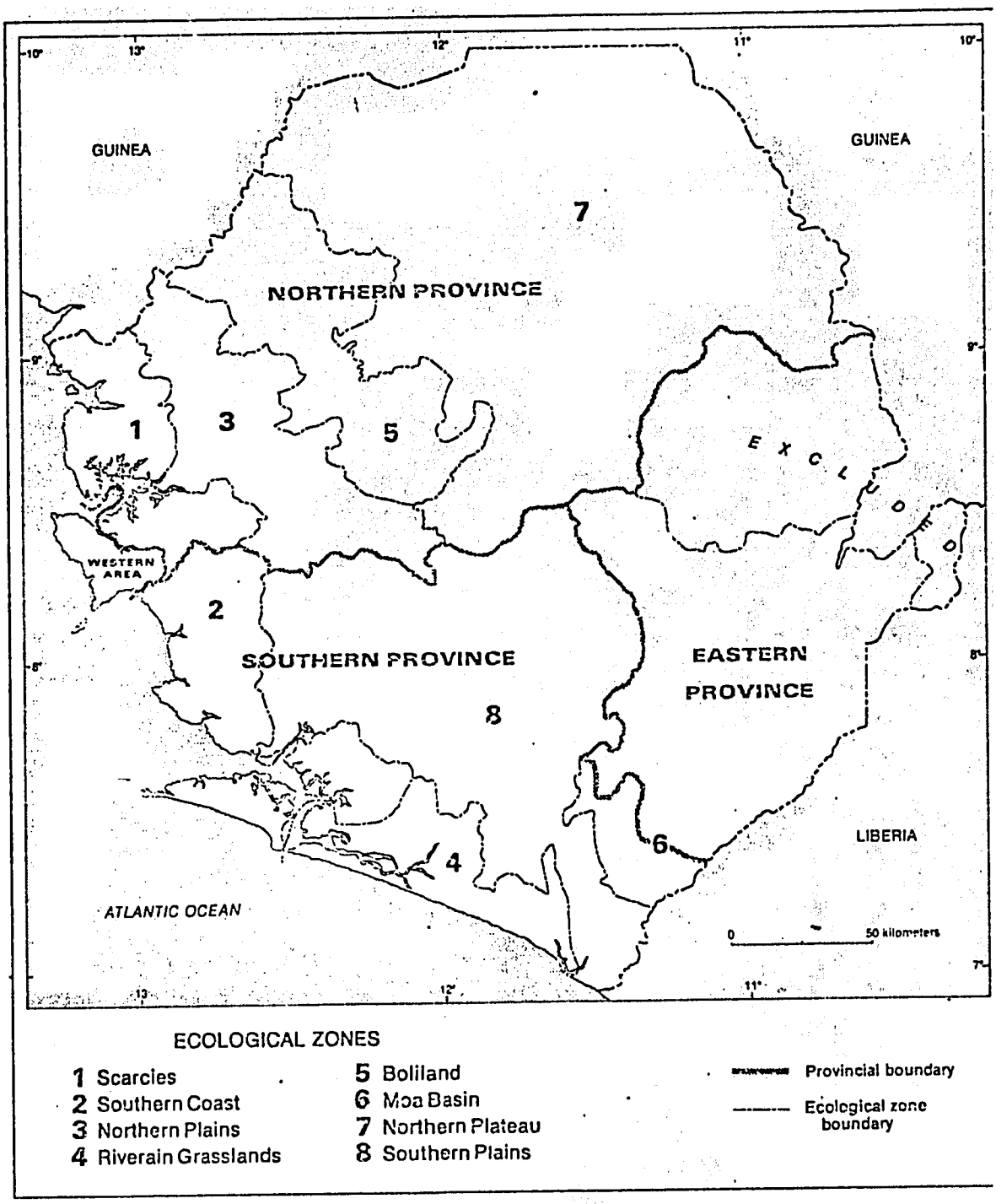

Figure 1

Sierra Leone: Ecological Zones

The procedure is to estimate the per capita consumption level in each of the eight ecological or resource region zones, to weight each zonal estimate by the proportion of the total rural population found within that zone, and to combine these weighted consumption ratios into a single per capita consumption ratio for the whole rural population. For proofs see the technical note to this chapter.

Within enumeration area i (i = 1, 2, 3) of any zone we estimate $\hat{R}_i$, the per capita consumption of a specific good, according to the following formula:

$$(1) \quad \hat{R}_i = \frac{\sum_j y_{ij}}{\sum_j x_{ij}},$$

where $\sum_j y_{ij}$ is the total consumption of the good by the sample households in Enumeration Area i (EA i) and $\sum_j x_{ij}$ is the total number of people in the sample in EA i.

As we take the populations of the enumeration areas as substantially equal within any ecological zone, we estimate the per capita consumption for zone h, $\hat{R}_h$, as the unweighted average of the $\hat{R}_i$:

$$(2) \quad \hat{R}_h = (\sum_i \hat{R}_i)/n$$

where n is the number of enumeration areas for which we have data in the zone.

The per capita consumption estimate for the entire rural sector, $\hat{R}$, is the weighted average over h of the $\hat{R}_h$, where the weights are the rural populations of each zone. Thus,

$$(3) \quad \hat{R} = (\Sigma N_h \hat{R}_h)/\Sigma N_h, \text{ where } N_n \text{ is the rural population of zone h.}$$

As the households comprising the sample were drawn by a two-stage sampling procedure, the usual formulas for estimating the standard errors of these estimated mean consumption figures are inappropriate. To estimate the standard errors we first estimate the variance of $\hat{R}_{ih}$, the estimated mean

consumption ratio in enumeration area i of zone h. We then estimate the variance of the mean consumption ratio for zone h as a whole ($\hat{R}_h$), and finally the variance of the estimate $\hat{R}$ for the entire population. For proofs see the technical note.

In any enumeration area i, the variance of $\hat{R}_i$ may be estimated by

$$(4)\quad s_{2i}^2 = [(1 - {}^{n}i/N_i)/\bar{x}_i^2 n_i][\sum_{j=1}^{n_i} (y_{ij} - \hat{R}_i x_{ij})^2/(n_i - 1)],$$

where n_i is the number of households in the sample in EA i, and N_i is the total number of enumeration areas in the sample in EA i.

Second we estimate the variance within the zone. Zonal variance is composed of two parts. The first component measures the variability among enumeration areas, S_1^2; the second the variability within them, S_2^2. Mathematically this is stated as follows,

$$(5)\quad S^2(\hat{R}_h) = \frac{1}{n}[(1 - {}^{n}/K)\, S_1^2 + ({}^{n}/K)\, S_2^2]$$

where

$$(5.1)\quad S_1^2 = \sum_{i=1}^{n} (\hat{R}_{ih} - \hat{R}_h)^2 / (n-1)$$

and

$$(5.2)\quad S_2^2 = (1/n) \sum_i s_{2i}^2, \text{ within any given zone, h.}$$

K is the total number of enumeration areas in the zone.

The estimated variance of $\hat{R}$, the estimated overall consumption rate for all zones, is given by

$$(6)\quad S^2(\hat{R}) = (\Sigma N_h^2\ S^2(\hat{R}_h))/(\Sigma N_h)^2.$$

Complications can arise if, as happened when our data were being collected, the planned sampling procedure could not be carried out completely. Because of enumerator failure or dishonesty, all households had to be dropped in three enumeration areas. Other households had to be dropped because of

missed interviews, deaths or movement from the village; in still other cases households were lost because essential data were missing or some figures were obviously inconsistent or erroneous. [Smith et al., 1980, pp. 9-11.] As a consequence there were two ecological zones in which only one enumeration area was represented and two enumeration areas in which there was only one household.

Where the enumeration area contained only one household we were unable to estimate the area variance because the denominator of the variance formula (4) contains the term $n_i - 1$, which becomes zero when n_i is equal to one. In these cases we simply eliminated that enumeration area, accepting the variances in the remaining enumeration areas of the zone as estimates of the missing variance.

Likewise, we were unable to estimate the complete zonal variance for the two zones that had data from only one enumeration area each. In that situation it was impossible to calculate the variance between enumeration areas. (In equation 5.1, $n - 1$ in the denominator becomes zero when $n = 1$.) Lacking a complete estimate of the variance for these two ecological zones we accepted the mean variance of the remaining six zones as our best estimate of the variance for the entire rural population. Thus the summation in equation 6 is over only six zones.

Population Estimates

Table 1 contains population estimates of per capita consumption, per capita consumption from home production and per capita production, for the rural population of the eight ecological zones for which we have data from the 1974-75 African Rural Employment Survey. Multiplying these per capita figures by 2,042,100 yields aggregate figures for the 1974-75 rural population.[1]

We present the information for 24 commodity groups, with one exception defined as in Table 3.2 of Smith et al., 1980 [p. 32]. We replace the three cate gories of fish in the earlier table by a single category which represents both fresh and dried fish. The dried fish have been converted to fresh fish equivalents by multiplying the dried fish weight by 1.613. We omit "Cassava Products," for the cassava root included in those products is also included under "Cassava." We also omit "Meals" and add "Palm Kernel," important in

[1] If we make the reasonable assumption that capital increases in proportion to population, we can use current population figures to derive estimates of currrent aggregates. Land is not as yet a major limiting factor in Sierra Leone.

However, the 1974-75 season was not entirely normal. [See Spencer and Byerlee, 1977, p. 54.]

TABLE 1

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

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

TABLE 1--Continued

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

[a]Standard errors are given in parentheses.

[b]The Northern Plateau.

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

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

[e]In fresh fish equivalents. Dried fish weights were converted to their fresh weight equivalent by multiplying by 1.513. Production figures are for fresh fish only.

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

production, but not consumed in significant amounts. The entries in parentheses in the table are the standard errors of the mean consumption or production values listed immediately above them.

Some of the standard errors of the per capita total consumption figures for the major foods (for all eight zones) run up to 20 to 25 percent of the estimate -- not bad, considering the size of the sample and the problems inherent in using the disappearance method and data collected in local quantity units. Not surprisingly they run higher for quantities consumed from home production (up to 29 and 36 percent for rice and cassava respectively). The standard errors on per capita production figures for major commodities are a bit better than for consumption from home production, except for palm kernel. That figure exceeds the value of the estimate. Fortunately, we are not especially interested in palm kernel production.

Comparing the population estimates of per capita consumption for all eight zones with the per capita consumption figures that describe the sample [Smith et al., 1980, Table 3.2, p. 32], shows close correspondence. The figures do not agree entirely, of course, because some zones with small populations provided relatively large proportions of the sample. When the per capita consumption rates of the several zones are weighted by the populations of those zones, the weighting reduces the influence of the zones with relatively small populations. There are also minor differences because two households included in the earlier sample were excluded here for lack of data on their non-food expenditures.

The principal differences between the per capita figures for the sample and the estimates for the population occur for cassava, cereals other than rice, and alcoholic beverages (almost entirely palm wine). The population estimate for cassava root consumption (22 kg per capita) is less than half of the figure for the sample (52 kg). One zone with very high consumption (the Riverain Grasslands) accounts for 16 percent of the sample households but has only three percent of the total rural population, while three zones with low consumption ratios provide only 30 percent of the sample but have 61 percent of the population. See Table 2 for population figures by zones.

For cereals other than rice the population estimate is ten kilograms per capita, while the mean consumption of the sample households is 18. Here the reported consumption in zone 7, the Northern Plateau, is zero. That zone, although it provides only 3.6 percent of the sample households, contains 24 percent of the total rural population.

TABLE 2

ESTIMATED RURAL POPULATION BY ECOLOGICAL ZONES, SIERRA LEONE, 1974-1975

Ecological Zones	Rural Population
1. Scarcies	156,900
2. Southern Coast	94,900
3. Northern Plains	277,600
4. Riverain Grasslands	56,600
5. Boliland	172,200
6. Moa Basin	466,200
7. Northern Plateau	495,500
8. Southern Plains	322,200
Sierra Leone	2,042,100

SOURCE: Spencer and Byerlee, 1977, Table 3.1, p. 10.

With alcoholic beverages the same weighting phenomenon has the reverse effect. Per capita consumption in zone 7 is 147 kg, but as there are only five households from zone y in the sample, this has little effect upon the average for the sample (18 kg). But given a population weight of 24 percent the high consumption rate in zone 7 raises the population average to 44 kg.

The negative entries for banana, plantain and avocado largely result from the heavy weight given to a negative per capita consumption figure of .76 kg in zone 7. In estimating the home production component of consumption we subtracted reported sales from reported production. When, as in this case, only small quantities of the commodity are involved, a modest error in reporting either sales or consumption can result in a negative estimate of their difference.

Table 1 also contains estimates of per capita consumption and production rates based on zones 1-6 plus zone 8 of the area sampled. Although zone 7, the Northern Plateau, contains nearly one-fourth of the entire rural population

of Sierra Leone (495,500 of the 2,042,100 in the eight zones that were sampled),[1] the sample for zone 7 contains only five Limba households, all from one enumeration area. These five households hardly constitute an adequate basis for making predictions about either the consumption or production responses of the some 70,000 households in the Northern Plateau. Therefore in Table 1 we also present per capita production and consumption ratios for the rural population exclusive of the Northern Plateau. We can make useful statements about this major fraction of the rural population, but attempting to extend those statements to cover the whole rural population we believe to be unwise. Consequently, in the work that is to follow we limit ourselves to estimates for the rural population exclusive of the Northern Plateau (zone 7).

A study of Table 1 shows that per capita consumption levels for most commodities remain about the same whether or not zone 7 is included. In most respects the five households in zone 7 behave quite like those in the rest of rural Sierra Leone. But the question is not whether the zone 7 households in the sample are like the rest of the households in Sierra Leone; the question is whether the households in zone 7 that are <u>not</u> in the sample behave like the rest of the households in Sierra Leone. If one is willing to assume that, he may estimate aggregates for the entire rural population by using the per capita figures exclusive of zone 7 and applying them to the entire population.

The principal differences between the per capita estimates with and without zone 7 households are for alcoholic beverages and cassava. These are explained by the fact that annual cassava root consumption in the zone 7 households (only 7 kg per capita) is far below the average for the other zones, while the consumption rate for alcoholic beverages, as noted above, is far greater. "Other cereals" consumption rises when zone 7 is excluded, because the five households in that zone reported no consumption in this group. Likewise, when zone 7 households are excluded per capita consumption rises for "other fruits," kolanut, salt and other condiments, and vegetables, as well as for certain other foods.

[1]Zone 7 is roughly the eastern half or two-thirds of the Northern Province (Figure 1). Its westernmost portion consists of the following chiefdoms: Tambakha, Sela-Limba, Sanda Loko, Magbaiamba, Pendembu-Gowahun, Safroko Limba, Paki Masabong, Kafe Simiria, Tane and Bonkolenken. All chiefdoms east of those are in the Northern Province. [Sierra Leone. Surveys and Land Department, 1970].

Table 1 also gives figures for production and the quantities consumed from home production (by the household producing the food). Excluding zone 7, the average rural household produces 75 percent of the rice it consumes, 50 percent of its palm oil and 83 percent of the alcoholic beverages consumed, but only 16 percent of the fish.

For the rural population excluding zone 7 the principal outputs (in kilograms per capita) are palm kernel (313 kg),[1] rice (207 kg), fish (76 kg), vegetables (33 kg) and cassava root (22 kg). Including the five Limba households from the Northern Plateau lowers per capita production figures for fish, vegetables, palm kernel and rice, but raises the figure for alcoholic beverages (essentially palm wine) from 10 to 44 kg. Palm wine provides the five households in zone 7 with almost one-sixth as many calories as does rice.

For the entire rural population covered (seven zones), per capita daily calorie availability was 2011 calories (Table 3),[2] with the 39 percent of the population that lives in the North consuming slightly less.[3] Note that the part of the Eastern Province that was sampled is here included with the Southern Province.

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

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

Similar tabulations of the dietary sources of other nutrients could also be prepared from our data. Sometimes a food consumed in relatively small quantities is vitally important for a particular nutrient.

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

Some 3000 hectares of oil palm trees are in estates associated with oil processing plants [Snodgrass et al., 1980, p. 127].

[2]Our estimate of calories from fish is somewhat high; the conversion factor used for dried fish seems to have been intended for fish dried more thoroughly than is usually the case in Sierra Leone.

The estimate of total calories could have been adjusted for wages paid or received in kind, but we did not do so.

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

TABLE 3

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

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

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

Technical Note:

Estimation of Per Capita Consumption

by James H. Stapleton

Since sampling is independent from zone to zone, we first discuss the estimation of per capita consumption of a commodity within a zone, then later combine these estimates for an overall estimate across zones.

Estimation Within a Zone:

Let the enumeration areas be $A_1, A_2, \ldots, A_K$ with total consumptions of the commodity of interest in the populations $Y_1, Y_2, \ldots, Y_K$. Suppose each enumeration area has the same population P.

Let the N_i households in area A_i have consumptions $Y_{i1}, Y_{i2}, \ldots, Y_{iN_i}$ and household sizes $X_{i1}, X_{i2}, \ldots, X_{iN_i}$. Then

$$Y_i = \sum_j Y_{ij} \text{ and } P = P_i = \sum_j X_{ij}$$

for each i. We wish to estimate the mean consumption per person

$$(\sum_i Y_i)/PK = (\sum R_i)/K = \bar{R}$$

for

$R_i = Y_i/P$ = mean consumption in enumeration area i.

In this study n enumeration areas were chosen at random without replacement, and from each chosen enumeration area A_i, n_i households were chosen at random. That is, the sampling design was two stage sampling with enumeration areas as primary units, households as secondary units. Let y_{ij} and x_{ij} be the consumption and size of the jth chosen household in the ith chosen enumeration area. Let

$$\hat{R}_i = (\sum_i y_{ij})/(\sum_j x_{ij}) \text{ and } \hat{R} = (\sum_i \hat{R}_i)/n.$$

Under the super-population model that the $\angle_{ij} - y_{ij}/x_{ij}$ are independent with equal variances, $\hat{R}$ has minimum variance among linear unbiased estimators of $\bar{R}$. (See Cochran, p. 158).

For given primary unit i, $\hat{R}_i$ is a ratio estimator with approximate expected value R_i and approximate variance

$$\sigma_{2i}^2 = [(1-n_i/N_i)/\bar{x}_i^2 n_i][\sum_j (y_{ij}-R_i x_{ij})^2/(N_i-1)]$$

σ_{2i}^2 may be estimated by

$$s_{2i}^2 = [(1-n_i^2/N_i)/\bar{x}_i^2 n_i][\sum_{j=1}^{n_i} (y_{ij}-\hat{R}_i x_{ij})^2/(n_i-1)]$$

(See Cochran, pages 153-5.)

The numbers of households in the chosen enumeration areas were known only roughly. However, the sampling fraction n_i/N_i, is close to zero, so that the factor $(1-n_i/N_i)$ above may be omitted.

We are now in position to apply Theorems 11.1 and 11.2 of Cochran (pages 300-3). Let $\hat{Y}_i = \hat{R}_i$, $Y_i = R_i$, $w'_{is} = K/n$ if area i is in the sample, 0 otherwise.

Then Theorem 11.1 states that

$$\mathrm{Var}(\sum_1^n w'_{is} \hat{Y}_i) = \mathrm{Var}((K/n)\sum_1^n \hat{R}_i)$$

$$= (K/n)^2[\mathrm{Var}(\sum_1^n \hat{R}_i) + (n/K)\sum_1^n \sigma_{2i}^2],$$

so that

$$\mathrm{Var}(\hat{R}) = (1/n)[(1-n/K)\sigma_{\hat{R}}^2 + \bar{\sigma}^2]$$

where

$$\sigma_{\hat{R}}^2 = \sum_1^K (R_i - \bar{R})^2/(K-1) \text{ and } \bar{\sigma}^2 = \sum_1^K \sigma_{2i}^2/K$$

Theorem 11.2 states that an unbiased estimator of $Var(\hat{R})$ can be constructed from an unbiased estimator of $\sigma_{\hat{R}}^2$ for one-stage sampling by inserting $\hat{R}_i$ in place of R_i in $\sigma_{\hat{R}}^2$, and by adding the term

$$(1/K)^2 \sum w'_{is} s_{2i}^2 = (1/nK) \sum_1^n s_{2i}^2$$

Thus, an unbiased estimator of $Var(\hat{R})$ is

$$(*) \qquad S^2(\hat{R}) = (1/n)[(1-n/K)S_1^2 + (n/K)S_2^2]$$

where

$$S_1^2 = \sum_1^n (\hat{R}_i - \hat{R})^2/(n-1)$$

and

$$S_2^2 = (1/n)\sum_i s_{2i}^2$$

$S^2(\hat{R})$ is only asymptotically unbiased, of course, since each $\hat{R}_i$ is asymptotically unbiased for R_i, and each s_{2i}^2 is asymptotically unbiased for σ_{2i}^2. The number of households sampled in each chosen area is such that the bias should be reasonably small.

The constant K was known only approximately. However, as seen in (*), unless S_2^2 is substantially larger than S_1^2 (and such was not the case), K plays relatively little role in the determination of $S^2(\hat{R})$.

Combining Estimators Across Zones

Let the zones be indexed by h, with $h = 1,2,\ldots,N$. Let R_h be the population consumption ratio and let $\hat{R}_h$ be its estimator for zone h. Let $S^2(\hat{R}_h)$ be the estimator of the variance of $\hat{R}_h$ defined above. (There seems little danger that these new meanings for these symbols will lead to confusion).

We wish to estimate the overall consumption rate

$$R = (\sum N_h R_h)/(\sum N_h)$$

where N_h = population of zone h.

The estimator

$$\hat{R} = (\sum N_h \hat{R}_h)/\sum N_h$$

is asymptotically (as numbers of households sampled increases) unbiased for R. An asymptotically unbiased estimator of its variance is then

$$S^2(\hat{R}) = (\sum N_h{}^2 S^2(\hat{R}_h))/(\sum N_h)^2.$$

Reference:

Cochran, W.G. (1977). Sampling Techniques. John Wiley and Sons. New York.

CHAPTER II

FOOD FLOWS

The Food Accounting Matrix

It will improve our understanding of food production and consumption patterns if we organize such information as that just presented into a food accounting matrix which shows the flow of food from the household that produces it into the market or into direct consumption and from the market into consumption by other rural households or by households in the nonrural sector. [Cf. Hay, 1978, pp. 251-255.] In our variant of this procedure we do not attempt to study food flows within the whole of Sierra Leone, but simply flows within the rural sector and the consequences of rural production and consumption activities for food outflows to other sectors. We limit ourselves to information available from our study of rural households: the total consumption of such households, the quantities consumed from their own production, the quantities produced by such households, and the quantities made available to the market.[1] In our model we consider four types of accounts: production, market, rural households, and all other. Our data do not permit us to take account of processing activities as such, of specific marketing institutions, or of the role of government. Nor shall we be able to present information about changes in stocks or food losses in transportation or in storage.

Figure 2 contains a schematic version of the basic structure. The total quantities produced, marketed, consumed by rural households and available as a net marketable surplus for sale outside the rural sector are given at the bottom and far right of the table. Reading down each column

[1]The conventional food accounting matrix (more generally, the social accounting matrix) makes use of national income accounts or other such aggregate data. It provides a valuable means of developing a consistent picture of production or income flows within a nation. [See Pyatt and Round, 1977]. In contrast, our model relies exclusively upon micro-level information obtained from individual households.

Acquisitions → / Disposals ↓		Production Accounts	Appropriation Accounts			Total
			Market	Rural Households	All Other	
		1	2	3	4	5
Production Accounts	1	Used as seed		Consumed	Available for sale outside rural sector[a]	Produced
Appropriation Accounts: Market	2	Sold to (received by) market				Marketed
Appropriation Accounts: Rural Households	3	Consumed from home production	Sold to (purchased by) rural households			Consumed
Appropriation Accounts: All Other	4		Available for sale outside rural sector[a]			Net marketable surplus[a]
Total	5	Produced	Marketed	Consumed	Net marketable surplus[a]	

[a]This category, calculated as a residual, also includes losses in transportation or storage, any net outflow of gifts or loans given or repaid over gifts or loans received, and changes in inventories.

Figure 2

SCHEMATIC FOOD ACCOUNTING MATRIX FOR RURAL HOUSEHOLDS IN SIERRA LEONE

in the body of the table the entries record the disposal of physical quantities. The monetary values of these quantities constitute the receipts (in value terms) of the units whose accounts each column presents.

Column 1 in Figure 2 shows how the production of any commodity is disposed of or used. Rice, for instance, is used for seed, some is sold to the market and some is consumed within the household that produces it. The total quantity sold to the market is the quantity marketed, disposed of as column 2 indicates. Some is sold to rural households (which buy part of their rice from the market) and the remainder is available for sale outside the rural sector, except to the extent that some disappears as a result of losses in transportation and in storage and some is either added to or subtracted from inventories. Our data do not permit us to separate such losses or inventory changes from the quantities available for sale outside the rural sector. The third column records how households dispose of food. They consume it (which produces energy used in production), give or lend it to other households, or lose a portion of it. We have not separated gifts and loans from household consumption (the figure would be negligible for rural households as a whole), but we have adjusted the consumption figures for losses in storage. We have not adjusted the consumption figures for household wastage and losses in good preparation.

The fourth column shows the excess of the total output of rice over the quantity consumed by rural households and the quantity used as seed. It shows the net marketable surplus of rice, which originates in the production sector. This figure, calculated as a residual, also includes changes in inventories, losses in transportation or storage, and any excess of gifts or loans given or repaid over gifts or loans received.

We must point out that the rural households regarded as consumers under the heading "Appropriation Accounts" are the identical households whose production activities are recorded in the production accounts. We follow the traditional practice of separating production and consumption activities in the food accounting matrix (FAM), but we must not forget that in rural Sierra Leone these are simply different aspects of the activities of the same set of rural households.

We have not followed the traditional practice of including an accumulation section. Our data do not permit us to determine whether food inventories are being increased or decreased. In any case, the role of capital accumulation or decumulation is peripheral to our principal interest.

Reading across the rows we see the acquisitions by the agents associated with each group of accounts. Thus in row 1 the total product of food production enterprises is ultimately acquired by: the production enterprises themselves, for use as seed; rural households, for consumption; and "all others." Rural households, of course, represent the consumption side of the production enterprises; they provide the energy required for production in exchange for the food they consume. The net marketable surplus is acquired by households or agents outside the rural sector; its value, of course, accrues to the households that constitute the production enterprises and furnishes them the means to obtain the other food or non-food commodities they require.

The marketing sector receives the quantity it markets from the production sector. Rural households receive the quantity they consume in part as consumption from home production and in part in the form of purchases from the marketing sector. All other sectors, of course, receive the quantities available for sale outside the rural sector.

A Food Accounting Matrix for Rural Sierra Leone

Table 4 contains a food accounting matrix (FAM) for the rural population of seven ecological zones in Sierra Leone in 1974/75. The entries are kilograms per capita. They may be converted into aggregate figures by multiplying each entry by the estimated rural population for seven zones (1,546,600 in 1974/75). We present estimates for only seven of the eight zones sampled because the consumption sample in the omitted zone (the Northern Plateau resource region) contained only five households, all of them Limba households in a single enumeration area. This is clearly not an adequate basis from which to project production and consumption patterns for the 495,500 persons living in the rural areas of that zone. However, if one wishes to use them, Table 1 contains per capita figures derived from all eight ecological zones. Alternatively, if one wishes to assume that the quarter of the rural population living in the Northern Plateau resource region can be adequately represented by the population of the remainder of the regions, the data in Table 4 can be converted into aggregates simply by multiplying by 2,420,100, the estimated total rural population of the sampled area of Sierra Leone at that time. We know, however, that production and consumption patterns in the Northern Plateau region differ appreciably in some respects from those in the remainder of rural Sierra Leone. Unfortunately, our sample does not contain enough households from that region to allow us to be specific about the differences.

In Table 4 the 24 commodity groups listed in Table 1 have been combined into nine categories.[1] Six of the nine are identical with the categories used in Table 1. "Other cereals" in that table has been divided here into

[1] If more detail is wished the reader may construct an FAM with 24 commodity classes by using the data as given in Table 1.

PER CAPITA FOOD AND CALORIE FLOWS IN RURAL SIERRA LEONE,[a] 1974/75
(Food in kilograms per year; calories in calories per day)

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

[a]Not including the Northern Plateau.

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

TABLE 4 --Continued

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

sorghum, the principal component, and all other cereals except rice. "All other" here includes some agricultural products not ordinarily used as food. The principal one is palm kernel. The first eight classes in Table 4 include all foods consumed by at least 66 percent of the households in the sample, except for salt, Maggi cubes, onions, and peppers and chillies. They also include alcoholic beverages and the new "other cereals" group (cereals other than rice or sorghum), although no single component of the latter is consumed by more than 36 percent of all households.

From column 1, row 37, of Table 4 we discover that rice production per capita in the rural population of the seven zones amounted to 207 kilograms in the 1974/75 season. In row 1 of column 1 (cell 11) is recorded the seed used per capita, 37 kilograms. We assume that the same amount is to be withheld from the current crop for next year's planting. From the harvest of 207 kilograms, 103 were made available to the market (cell 10,1) and 66 were consumed in the household that produced them. Rural households, however, also, buy an appreciable portion of the rice they consume, as we see from row 19. Cell 19,10 shows that 22 kilograms of rice per capita were purchased from the market during the 1974/75 season, for a total household consumption of 88 kg per capita (cell 19,37). On the average, rural households buy one-fourth of their consumption of rice but sell nearly five times as much as they buy.[1] As the rural sector furnished 103 kg of rice per capita to the market and purchased only 22 kg from the market, it provided a net marketable surplus

[1]It is commonly believed that most purchases of rice are financed by credit, and occur because household stocks have become exhausted. The resultant debt is repaid after harvest, when rice is sold or exchanged at reasonably low prices. [Snodgrass et al., 1980, p. 173; Spencer and Byerlee, 1977, pp. 56, 58.] Our data would have permitted looking into this more carefully, but time and budget constraints did not. We return to this point later.

available for consumption outside the rural sector of 81 kg, shown in cell 28,10.

Reading down the columns shows how a given total is disposed of--to whom the product goes. Reading across the rows shows what each activity or account acquires (net) from a given total. Thus, from the total output of 207 kg per capita, rice production acquires 37 kg of rice for use as seed,[1] the producing households obtain 88 kg for consumption, and 81 kg are available for sale outside the rural sector. The total consumption of rice by rural households (row 19) consists of 66 kg grown by the household that consumes it and 22 kg purchased from the market.

As we saw from Table 1, the principal food items produced in Sierra Leone, measured in kilograms per capita, are rice (207 kilograms per capita), fish (76 kilograms),[2] vegetables (33 kilograms) and cassava root (22 kilograms). In Table 4 vegetables are included in the "all other" category. (cell 9,37 or 37,9). The principal component of the "all other" category is palm kernel, of which 313 kilograms are produced per capita. Palm kernel is not used to a significant extent as a food in Sierra Leone, but we include it among the production activities because it is a joint product in the production of palm oil. Palm kernel can also be produced from the dried nuts without producing palm oil.

Most of the food produced by the rural sector is consumed by the household that produces it. Consumption from own production[3] is recorded in Table 4

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

[2]The fish output estimates are for rural households only. The output of large-scale commercial fishing enterprises presumably was not captured in our data.

[3]With the exception of rice, the quantities recorded here as consumed from home production include also quantities used for seed within the household. No data on seed use were available except for rice.

in rows 19-27 of columns 1-9. The quantities provided to the market by the rural sector, generally small by comparison, are given in rows 10-18 of the same columns.[1] Only for rice, fish and "all other" do the markets receive large quantities in relation to the quantities consumed within the producing households. Furthermore, the entry for "all other" is large primarily because it includes palm kernel. Even after eliminating this, however, the market receives 31 kilograms per capita of the "all other" group, somewhat more than is retained by households for their own consumption. The largest component of this 31 kilograms consist of vegetables. (Cf. Table 1.)

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

Subtracting the quantities obtained from the market by rural households from the quantities provided by them leaves the quantities available for sale outside the rural sector (lines 28-36 of columns 10-18). Aside from palm kernel (included in "all other"), only modest amounts per capita are available for consumption outside the rural sector, with the exception of rice and fish. The net marketable surplus of 81 kilograms of rice per capita is

[1]Unless the quantities are relatively large it is unlikely that they differ significantly from zero, once one takes account of sampling error.

equivalent to approximately 126,000 metric tons for that three-quarters of the rural population contained in the seven ecological zones covered by these figures. Ten and one-half kilograms of fish per capita are equivalent to some 16,000 metric tons of fish, while 2.2 kg of groundnuts per capita are equivalent to some 34,000 metric tons of grounnuts. Many of these per capita figures for the net marketed surplus are small and, being calculated as residuals, cannot be regarded as particularly accurate.[1] Negative figures for the net marketable surplus may be regarded as errors, reductions in inventories, the result of gifts or loans, or consumption of commodities produced outside the rural sector. In the case of palm oil (cell 32,14) we know that an appreciable amount of palm oil is produced by the marketing board or others from oil palm fruit produced on plantations, which were not represented in our sample. We know also that perhaps as much as seven percent of the alcoholic beverages consumed by the sample households consisted of beer and distilled beverages, presumably produced outside the rural sector [Smith et al., 1980, pp. 29-30]. The negative entry for cassava root (cell 31,13) may be in error; the data concerning the production and consumption of fresh cassava root were very poor. Quantity measurements for fresh cassava root are notoriously difficult.

The bottom block in Table 4 presents per capita daily calorie flows, from home production and from the market, for the rural population of the seven zones. They may be compared with Table 3, which gives the breakdown between home and market sources by regions, but not for the two regions taken together.

We turn now to a five-food FAM (Table 5).

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

TABLE 5

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

Disposals			Acquisitions	Production Accounts (Activities)						Appropriation Accounts					
										Market					
				Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Total calories	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Total calories
				1	2	3	4	5	C_h	6	7	8	9	10	C_m
Production Accounts (Activities)			Rice 1	37.5											
			Root crops and other cereals 2												
			Oils and fats 3												
			Fish and animal products 4												
			Miscellaneous foods 5												
Appropriation Accounts	Market		Rice 6	103.2											
			Root crops and other cereals 7		6.1										
			Oils and fats 8			316.7									
			Fish and animal products 9				65.4								
			Miscellaneous foods 10					34.6							
	Consumption Activities	Rural Households	Rice 11	66.2						21.9					
			Root crops and other cereals 12		31.2						9.6				
			Oils and fats 13			10.0						7.3			
			Fish and animal products 14				11.1						57.6		
			Miscellaneous foods 15					35.6						12.8	
		All Other	Rice 16							81.3					
			Root crops and other cereals 17								-3.5				
			Oils and fats 18									309.4			
			Fish and animal products 19										7.8		
			Miscellaneous foods 20											21.8	
Total			21	206.9	37.3	326.7	76.5	70.2		103.2	6.1	316.7	65.4	34.6	
Calorie Accounts	Rural Households		Rice C1	660.4						217.9					
			Root crops and other cereals C2		173.3						40.8				
			Oils and fats C3			240.6						167.3			
			Fish and animal products C4				21.4						273.7		
			Miscellaneous foods C5					170.1						45.5	
			Total C6						1265.8						745.2

[a]Not including the Northern Plateau.

TABLE 5 -- Continued

Disposals			Acquisitions	Appropriation Accounts										Total
				Consumption Activities										
				Rural Households					All Other					
				Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	
				11	12	13	14	15	16	17	18	19	20	21
Production Accounts (Activities)			Rice 1	88.1					81.3					206.9
			Root crops and other cereals 2		40.8					-3.5				37.3
			Oils and fats 3			17.3					309.4			326.7
			Fish and animal products 4				68.7					7.8		76.5
			Miscellaneous foods 5					48.4					21.8	70.2
Appropriation Accounts	Market		Rice 6											103.2
			Root crops and other cereals 7											6.1
			Oils and fats 8											316.7
			Fish and animal products 9											65.4
			Miscellaneous foods 10											34.6
	Consumption Activities	Rural Households	Rice 11											88.1
			Root crops and other cereals 12											40.8
			Oils and fats 13											17.3
			Fish and animal products 14											68.7
			Miscellaneous foods 15											48.4
		All Other	Rice 16											81.3
			Root crops and other cereals 17											-3.5
			Oils and fats 18											309.4
			Fish and animal products 19											7.8
			Miscellaneous foods 20											21.8
Total			21	88.1	40.8	17.3	68.7	48.4	81.3	-3.5	309.4	7.8	21.8	
Calorie Accounts	Rural Households		Rice C1											878.3
			Root crops and other cereals C2											214.1
			Oils and fats C3											407.9
			Fish and animal products C4											295.1
			Miscellaneous foods C5											215.6
			Total C6											2011.0

The Five-Group Table

We present Table 5, which uses the five food groups of the systems model, because we wish later to look at systems estimation projections of the effects of price changes on production and consumption. There is no information here that is not in Table 4, but the information is presented in different groupings. Table 6 defines the content of each of the groups. The only commodity that can be compared directly between Tables 4 and 5 is rice. In no other case is there a simple correspondence between the group as defined in Table 5 and the individual groups in Table 4. For instance, "root crops and other cereals" in Table 5 consists of cereals other than rice and cassava (groups 2, 3 and 4 from Table 4) but also contains other root crops which in Table 4 are a part of the "all other" group. Similarly oils and fats in Table 5 consists of palm oil plus other oils and fats and palm kernels, but the two latter categories were part of the "all other" group in Table 4. Palm kernels account for 313 kg of the per capita production of oils and fats. The negative figure for the net marketable surplus of root crops and other cereals reflects the negative estimate obtained for cassava in Table 4. It is undoubtedly the result of errors in the measurement of cassava root.

Food and Calorie Flows by Region and by Expenditure Class

We also use a five-group table to study food and calorie flows by region and by expenditure class. Table 7 contains population estimates for the North (zones 1, 3 and 5 only) and the South (zones 2, 4, 6 and 8).[1]

[1] Note that the sampled area in the Eastern Province is here included with the Southern Province.

TABLE 1

COMMODITY GROUPS USED IN SYSTEMS ESTIMATION[a]

Rice	Rice
Root crops and other cereals	Cereals other than rice, cassava, yams, other root crops
Oils and fats	Palm oil, palm kernel oil, other oils & fats and (for production only) palm kernels
Fish and animal products	Fish, game, other meat, other animal products
Miscellaneous foods	Groundnuts, other legumes, vegetables, citrus fruits, bananas, plantains and avocados, other fruit, kola-nut, nonalcoholic beverages, alcoholic beverages, and (for consumption only) sugar, salt and other condiments
Nonfoods	Clothing, fuel, transport, services and ceremonies, education, tobacco, local saving, and miscellaneous
Household labor	Farm and nonfarm production and marketing activities, plus labor sold out. Excludes domestic activities such as food preparation, child care and ceremonies.

[a]For more detail see Strauss et al., 1981b, Table A.1, p. 64.

FOOD FLOWS BY REGION, 1974/75 - FIVE FOOD GROUPS[a]
(annual kilograms per capita; daily calories per capita)

Disposals \ Acquisitions			Production Accounts (Activities)										Appropriation Accounts										Totals	
			North (Zones 1, 3 & 5)					South (Zones 2, 4, 6 & 8)					Market: North (Zones 1, 3 & 5)					Market: South (Zones 2, 4, 6 & 8)					By Region	Both Regions
			Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Appropriation Accounts: Market	North	Rice	1	143.4																			143.4	
		Root crops and other cereals	2		4.4																		4.4	
		Oils and fats	3			108.8																	108.8	
		Fish and animal products	4				163.6																163.6	
		Miscellaneous foods	5					72.6															72.6	
	South	Rice	6						138.8														138.8	140.7
		Root crops and other cereals	7							7.3													7.3	6.1
		Oils and fats	8								451.0												451.0	316.7
		Fish and animal products	9									2.1											2.1	65.4
		Miscellaneous foods	10									10.0											10.0	34.6
Appropriation Accounts: Consumption Activities: Rural Households	North	Rice	11	63.0									30.2										93.2	
		Root crops and other cereals	12		12.9									8.8									21.7	
		Oils and fats	13			1.3									5.2								6.5	
		Fish and animal products	14				12.3									78.3							90.6	
		Miscellaneous foods	15					41.6									13.7						55.3	
	South	Rice	16						68.3									16.4					84.7	88.1
		Root crops and other cereals	17							43.0									10.2				53.2	40.8
		Oils and fats	18								15.6									8.7			24.3	17.3
		Fish and animal products	19									10.3									44.3		54.6	68.7
		Miscellaneous foods	20									31.7										12.2	43.9	48.4
Appropriation Accounts: Consumption Activities: All Other	North	Rice	21										113.2										113.2	
		Root crops and other cereals	22											-4.4									-4.4	
		Oils and fats	23												103.6								103.6	
		Fish and animal products	24													85.3							85.3	
		Miscellaneous foods	25														58.9						58.9	
	South	Rice	26															122.4					122.4	118.8
		Root crops and other cereals	27																-2.9				-2.9	-3.5
		Oils and fats	28																	442.3			442.3	309.4
		Fish and animal products	29																		-42.2		-42.2	7.8
		Miscellaneous foods	30																			-2.2	-2.2	21.8
Totals		By regions	31	206.4	17.3	110.1	175.9	114.2	207.1	50.3	466.6	12.4	41.7	143.4	4.4	108.8	163.6	72.6	138.8	7.3	451.0	2.1	10.0		
		Both regions	32						206.9	37.3	326.7	76.5	70.2						140.7	6.1	316.7	65.4	34.6		
Calorie Accounts: Rural Households	North	Rice	C1	628.5										301.2									929.7	
		Root crops and other cereals	C2		120.2										38.1								158.3	
		Oils and fats	C3			31.6										124.4							156.0	
		Fish and animal products	C4				27.2										349.2						376.4	
		Miscellaneous foods	C5					177.4									77.2						254.6	
		Total	CTN					984.9									890.1						1875.0	
	South	Rice	C6						680.9									164.1					845.0	878.3
		Root crops and other cereals	C7							207.5									42.6				250.1	214.1
		Oils and fats	C8								375.5									195.0			570.5	407.9
		Fish and animal products	C9									17.6									225.1		242.7	295.1
		Miscellaneous foods	C10									165.3										25.3	190.6	215.6
		Total	CTS									1446.8										652.1	2098.9	2011.0

[a]Not including the Northern Plateau. The regional population figures (in thousands) are: North, 606.7; South, 939.9.

It is not a complete FAM, but contains all the essential information. To save space we have omitted the production rows and all appropriation account columns other than the market accounts. The quantity of rice seed used, formerly recorded in the production rows, is added to the quantity sent to market. Doing this increases the amount recorded as available for "all other" households, but gives an accurate measure of the rice available for consumption by rural households, which is our main concern.

In addition to the regional detail, Table 7 includes totals for the seven zones together. Except for the entry for rice sent to market and the marketable surplus of rice, these figures are identical with the totals in Table 5. The per capita figures for the seven zones are population-weighted averages of the two regional per capita figures.

The seven-zone averages conceal marked regional differences. The North eats a little more rice than the South, but takes about twice as much from the market. The South is a much heavier consumer of "root crops and other cereals" (notably cassava) and of oils and fats from home production; it takes only about two-thirds as much fish and animal products from the market. In total consumption the South takes less of fish and animal products, rice and miscellaneous foods, and more of oils and fats and root crops and other cereals.

The South obtains 69 percent of its calories from home production, but the North only 53 percent (of a somewhat smaller total). The South produces far more oils and fats per capita than the North and much less of fish and animal products and of miscellaneous foods.

On a per capita basis the North and South contribute about equally to the marketed surplus of rice; the South is the major provider of oils and fats to the remainder of the country and a net importer from the North of fish and animal products.

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

Disposals \ Acquisitions		Production Accounts (Activities)														
		Expenditure Class[b]														
		Low - Under 350 Leones					Medium - 350 but Under 750 Leones					High - 750 Leones and Over				
		Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Appropriation Accounts – Market – Expenditure Class – Low	Rice 1	158.8														
	Root crops and other cereals 2		2.2													
	Oils and fats 3			21.0												
	Fish and animal products 4				0.2											
	Miscellaneous foods 5					1.6										
Market – Expenditure Class – Medium	Rice 6						172.4									
	Root crops and other cereals 7							10.4								
	Oils and fats 8								195.3							
	Fish and animal products 9									7.5						
	Miscellaneous foods 10										13.2					
Market – Expenditure Class – High	Rice 11											97.3				
	Root crops and other cereals 12												5.4			
	Oils and fats 13													668.6		
	Fish and animal products 14														170.9	
	Miscellaneous foods 15															80.7
Consumption Activities – Rural Households – Expenditure Class – Low	Rice 16	32.8														
	Root crops and other cereals 17		19.6													
	Oils and fats 18			5.2												
	Fish and animal products 19				2.6											
	Miscellaneous foods 20					15.7										
Rural Households – Expenditure Class – Medium	Rice 21						81.7									
	Root crops and other cereals 22							37.3								
	Oils and fats 23								7.1							
	Fish and animal products 24									9.5						
	Miscellaneous foods 25										45.4					
Rural Households – Expenditure Class – High	Rice 26											79.8				
	Root crops and other cereals 27												35.4			
	Oils and fats 28													16.5		
	Fish and animal products 29														19.5	
	Miscellaneous foods 30															43.2
All Other Consumption Activities – Expenditure Class – Low	Rice 31															
	Root crops and other cereals 32															
	Oils and fats 33															
	Fish and animal products 34															
	Miscellaneous foods 35															
All Other – Expenditure Class – Medium	Rice 36															
	Root crops and other cereals 37															
	Oils and fats 38															
	Fish and animal products 39															
	Miscellaneous foods 40															
All Other – Expenditure Class – High	Rice 41															
	Root crops and other cereals 42															
	Oils and fats 43															
	Fish and animal products 44															
	Miscellaneous foods 45															
	Total 46	191.6	21.8	26.2	2.8	17.3	254.1	47.7	202.4	17.0	58.6	177.1	40.8	685.1	190.4	123.9

TABLE 8 -- Continued

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

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

Table 8 contains similar figures for households classified into three expenditure groups: (a) under 350 Leones, (b) above 350 but less than 750 Leones, and (c) 750 Leones and over. Similar tables could be developed for nine food classes, or 23, or even more, but budget restrictions forced us to limit the analysis to the five food groups. The per capita calorie entries will be given in Table 9. In Table 8 the per capita figures for the entire rural population of the seven zones are not simple population-weighted averages of the per capita figures for the three expenditure classes in that population. The proportion in which the zones are represented in a given expenditure class differ from their proportions in the population as a whole and in each other. For the rural population of the seven zones as a whole we estimate the 1974-75 figures by expenditure class to

Expenditure Class	Rural Population
Low	467,600
Medium	636,400
High	442,600
Total, Seven Zones	1,546,600

The seven zone averages conceal great variations among expenditure classes.[1] Households in the low expenditure group consume less than half as much rice from their own production as do households in the two higher groups; they buy from the market about as much as do middle-expenditure households; high-expenditure households buy much more--nearly half as much as they produce themselves. Low expenditure households consume less than half as much rice per capita, in total, as households in the middle expenditure bracket. This raises a question about the generally accepted proposition that most rice purchased from the market is financed by money lenders. (Cf. Snodgrass

Of course we must remember that the averages by expenditure class are less reliable than those for all classes together.

et al., 1980, p. 173.) The high expenditure households may finance their purchases with their large sales to the market of nonfood crops and of oils and fats, fish and animal products, and miscellaneous foods--vegetables, for instance (rows 11-15). On a per capita basis they sell less rice to the market than either of the other expenditure groups.

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

Per capita consumption from home production does not differ greatly between the two top expenditure classes, although the highest group consumes more oils and fats (sometimes referred to hereafter as oil or oils) and fish and animal products (sometimes hereafter called fish). The lowest expenditure class (L) consumes much less from its own production, although its consumption of oil is not far behind that of the middle expenditure class (M).

In general, the L households produce much less per capita than the others, but their rice production per capita exceeds that of the H group. The L households sell four times as much in the oil groups as they retain for their own consumption, but palm kernel probably accounts for most of this. Rice is the principal food sold by L households; they market nearly five times the quantity they retain for their own consumption. The highest expenditure households (H) market only a little more rice than they retain, but 40 times as much in the oils and fats group (which includes palm kernel),

nine times as much fish and nearly twice as much in the miscellaneous category (vegetables, legumes, fruit, etc.). In general, the wealthiest households are large sellers of oil, fish and vegetables; perhaps the least well off do not have these opportunities. However that may be, the least well off are large sellers of rice, marketing almost exactly as much per capita as the M households after accounting for seed usage[1] and nearly twice as much as the H group. Of course both groups of households also buy some from the market. After providing for that the L and M households are the principal sources of the marketable surplus of rice on a per capita basis (112 and 116 kg, respectively, after allowing for seed use); the H households market only 26 kg per capita. Taking account of the population in each expenditure class, the L households produce a marketable surplus of some 50,000 metric tons, and the M households another 70,000. The high expenditure households provide only about 10,000 metric tons (but they produce large marketable surpluses of other products).

Households outside the H group are net purchasers (from H) of fish and miscellaneous foods (vegetables, etc.). M households contribute appreciably to the marketed surplus of oil products, but the H group is by far the major source of surpluses of oils, fish and miscellaneous foods.

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

Unfortunately, the less dependent a household is on rice production, the better is its income. Spencer, Byerless and Franzel [1979, p. 43] found that net margins to household labor and management from rice production were

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

generally low in 1974-75 (except for subsidized mechanical cultivation), in comparison with other rural activities.

However, 1974-75 was not an entirely normal year for rice production. The rains came late and lasted less long than usual. While this apparently had little effect on swamp rice yields it did reduce yields from upland rice. Those yields may also have been reduced by acreage increases that occurred in response to a doubling of the government's producer price for rice. The larger acreages were associated with less weeding and poorer cultural practices in general. All in all, upland rice yields were about 60 percent of those reported in earlier surveys. [Spencer and Byerlee, 1977, p. 54.] Of course lower yields do not necessarily mean lower outputs of upland rice.

Snodgrass et al. [1980, pp. 155-6] estimating costs and returns for 1980, found again that except for subsidized mechanical cultivation most modes of rice production yielded negative financial returns to the farmer. All forms of rice production were socially unprofitable in comparison with the price of imported rice.

It is clear from these data that the high expenditure households in 1974/75 were large producers of palm products, fish and miscellaneous foods, but <u>not</u> of rice, although they consumed more rice than the others.[1]

This again casts doubt on the often-stated opinion that farmers give first priority to producing rice for their families even though other activities may be more rewarding. But perhaps many of them do--and perhaps that is why their incomes are so low. Or perhaps they emphasize rice production because the highly productive alternatives are not open to them for one reason or another. This is a matter that deserves careful investigation. Overall agricultural productivity in Sierra Leone could rise markedly if indeed it were possible for the low income households to reach the productivity levels of those in the top group.

Total consumption among the L households is low in every category; they consume less than half as much rice per person as the M households. Interestingly enough, M households consume more fish and miscellaneous foods than H households.

Naturally L households consume the fewest calories per person per day--1156, compared with 1627 for M households and 3473 for the H group (Table 9).[1] In one respect these per capita figures somewhat understate the nutritional problem facing L households. On the average only 25 percent their members are under ten years old, while in the two other expen classes about one third are in that age category [Strauss et al., p. 33].

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

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

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

TABLE 9

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

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

[a]Not including the Northern Plateau.

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

The Five-Group Table in Weighted Kilograms

The quantity measures used so far in this report have been in natural kilograms: the total consumption of root crops and other cereals (hereafter often referred to as roots) was simply the sum of the quantities consumed of cassava, sorghum, and so forth. A kilogram of cassava and a kilogram of sorghum were regarded as equivalent for this purpose. But in the regression analysis quantities consumed, produced and marketed were measured in weighted kilograms. For a single commodity, when home-produced quantities and those obtained from the market were added they were treated as different commodities possessing different economic characteristics and combined as the sum of the expenditures on the two divided by their average price. The same procedure was used in calculating quantities for groups of foods. [Smith et al., 1981, pp. 10-11.] Thus the quantity of root crops and other cereals consumed is calculated by adding expenditures on cassava and other roots to expenditures on cereals other than rice and dividing the total by an average of the prices. The average prices used in these calculations were value-weighted averages for each region [Smith et al., 1981, pp. 10-11, 18-19; Strauss et al., 1981b, pp. 10-11]. The quantity resulting from this operation is the quantity, in weighted kilograms, of a new composite commodity. We regard it as selling at a single price.

The procedure is well suited to the purposes of regression analysis, but creates problems in interpretation, particularly when a low-priced food like cassava root is combined with a much higher-priced food like sorghum. It is as though the new commodity consists of a smaller physical quantity of cassava (now valued at the average price) and a larger physical quantity of sorghum (also valued at the average price).

Our intent is to use the systems regressions to predict the results of government policies that affect relative prices, but those predictions are predictions for the composite commodities defined by each of the food groups. They are expressed in weighted kilograms. To allow the reader to make the transition from quantities expressed in natural kilograms to quantities expressed in weighted kilograms, which have no simple intuitive meaning, we present Table 10. It contains the same information as did Table 5, but expressed this time in weighted kilograms.

We may use the two right-hand columns on the second page of Table 10 to compare the two quantity measures that correspond to exactly the same set of physical facts. Let us look first at the total quantities consumed by rural households. For rice and for oil the differences are negligible. Rice, of course, is our most homogeneous category, while the oils and fats group consists almost entirely of palm oil.

Where the food groups are less homogeneous the weighting has much more effect. In root crops and other cereals, the cassava component is large in kilograms, but usually priced from .02 to .07 Leones per kilograms, while other cereals, constituting a relatively small part of the total in natural kilograms, may be priced from five to twenty times as high. The effect of the weighting is to reduce drastically the kilogram equivalent of the cassava and to raise somewhat the kilogram equivalent of "other cereals." The net result is that a total consumption of 10.7 (cell 12, 11) is the weighted kilogram equivalent of 40.8 kg in this food group.

For the fish and miscellaneous groups also the weighted quantity is much less than the quantity in natural kilograms. In the case of fish another complication exists. The "natural" weights were obtained by first converting dried fish to their fresh fish equivalent. The quantities on which the weighted kilogram figure is based were either fresh or dried, as

TABLE 10

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

Disposals			Acquisitions	Production Accounts (Activities)						Appropriation Accounts: Market						Totals	
				Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Total calories	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Total calories	Weighted kilograms	Natural kilograms
				1	2	3	4	5	C_h	6	7	8	9	10	C_m	11	12
Production Accounts (Activities)			Rice 1	37.5												206.9	206.9
			Root crops and other cereals 2													39.3	37.3
			Oils and fats 3													39.6	326.7
			Fish and animal products 4													53.5	76.5
			Miscellaneous foods 5													44.6	70.2
Appropriation Accounts	Market		Rice 6	107.9												107.9	103.2
			Root crops and other cereals 7		32.2											32.2	6.1
			Oils and fats 8			30.6										30.6	316.7
			Fish and animal products 9				46.6									46.6	65.4
			Miscellaneous foods 10					35.0								35.0	34.6
	Consumption Activities	Rural Households	Rice 11	61.5						25.4						86.9	88.1
			Root crops and other cereals 12		7.1						3.6					10.7	40.8
			Oils and fats 13			9.0						6.6				15.6	17.3
			Fish and animal products 14				6.9						21.6			28.5	63.7
			Miscellaneous foods 15					9.6						5.8		15.4	48.4
		All Other	Rice 16							82.5						82.5	81.3
			Root crops and other cereals 17								28.6					28.6	-3.5
			Oils and fats 18									24.0				24.0	309.4
			Fish and animal products 19										25.0			25.0	7.8
			Miscellaneous foods 20											29.2		29.2	21.8
Total			21	206.9	39.3	39.6	53.5	44.6		107.9	32.2	30.6	46.6	35.0			
Calorie Accounts	Rural Households		Rice C1	630.7						260.5						891.2	878.3
			Root crops and other cereals C2		146.0						74.0					220.0	214.1
			Oils and fats C3			225.5						165.3				390.8	407.9
			Fish and animal products C4				60.4						189.2			249.6	295.1
			Miscellaneous foods C5					116.5						70.4		186.9	215.6
			Total C6						1 179.1						759.4	1938.5	2011.0

[a]Not including the Northern Plateau.

the case might be. The difference in their prices in itself provided a kind of conversion between the fresh and dried forms.

Of course this reduction in the weighted kilogram figure need not affect the home and market components of total consumption equally. The proportions of the various constituents of any food group in the part consumed from home production will differ from those in the part obtained from the market. In the case of fish, for instance, almost no dried fish is consumed from home production while very little fresh fish comes from the market.

In calculating the weighted equivalent of consumption from home production, the value of that consumption (at farm gate prices) is divided by the average price calculated from the total consumption data. The same price divisor is used to calculate the weighted kilogram equivalent of consumption from market sources, but that consumption is valued at market prices, normally higher than farm prices. The result is an underestimate of home consumption and an overestimate of consumption from the market. This is awkward, but it does give a table that is easy for the reader to use. Total per capita consumption is the sum of home and market consumption, which it would not have been had different price divisions been used for each component.

The weighted kilograms for quantities produced are obtained by dividing the total farm gate value of the output by the average farm gate price. The figure for the quantity sold on the market is the difference between this total production figure and the figure for consumption from home production. This process gives a lower kilogram figure for consumption than would have been obtained if the farm gate price had been the divisor. Consequently the amount going to market (and also the marketed surplus) are inflated. The effect is very large in the case of a strongly nonhomogenous group like roots and other cereals. The estimate of the quantity consumed from home production is drastically reduced when it is calculated by dividing the

value of consumption by the average price for total consumption. The result is a greatly expanded figure for quantity marketed and a sizable positive marketed surplus in weighted kilograms.[1] In natural kilograms the marketed surplus was negative--probably not significantly different from zero. In this case the marketed surplus figure in weighted kilograms should be regarded as uniformative. For fish, too, the marketed surplus estimate changes greatly when measured in weighted kilograms. Again we suggest that the weighted kilogram figure be given little credence. The intuitive meaning one is tempted to give this construct is likely to be misleading.[2]

The great difference between the two marketed surplus figures for oils is not so troublesome. Here it stems from an enormous difference between the oils and fats production figure in weighted and in natural kilograms. This is caused by the palm kernel component, 313 kg per capita in natural kilograms. Palm kernel prices per kilogram tend to be about 1/3 to 1/4 of the prices of palm oil. In the weighted kilogram figure the palm kernel component has been reduced to 20.5 kg and the component for palm oil plus the other constituents of the group has risen from 14 kg (Table 1) to 19.1 kg. Note that the correspondence is excellent between the weighted and natural figures for the consumption of palm oil by rural households.

[1]The production figure was little affected by the change in units. Perhaps the consumption figure was affected so much because the consumption prices in certain zones were much higher than the production prices. This could be because in some zones "other cereals" consumption in actual kilograms is more than twice that of cassava, while in others three times as much cassava as "other cereals" is consumed. [Smith et al., 1979, p. 55.]

[2]Not that the weighted kilos are wrong (unless unduly affected by an erroneous price figure), but they are difficult to interpret whenever the commodity group is heterogenous. In those cases, of course, the results would have been difficult to interpret in any event, for we wouldn't have known exactly which commodities were involved when changes occurred. Fortunately, the problems of interpretation are least for the food groups that most interest us: rice and palm oil.

At the bottom of Table 10 (as in Table 5), there is a tabulation of the daily calories available per capita from each food group. The calorie figures are calculated from the weighted kilogram data, using conversion factors specific to these quantity measures. A glance at Table 10 will show that despite the complexity of the quantity measures used, they yield extremely satisfactory estimates of caloric availability--which was, after all, one of their main purposes.

In the earlier tables the estimates of daily calories available from each food group were made by converting actual kilograms consumed per capita into calories available, food by individual food, and summing across foods to obtain a figure for calories available per capita from that group. These per capita calorie figures were calculated at the zonal level and then combined into population projections in the same way as were the estimates of output or consumption per capita. This was done from the observed values for each household, for total consumption and for consumption from home production. Calories from the market were obtained as the difference between the two population estimates.

In Table 10, and in all following tables, the calorie figures are obtained by using the following conversion factors [Strauss et al., 1981b, p. 71]:

Food Group	Calories per Weighted Kilogram
Rice	3,743.3
Root crops and other cereals	7,505.6
Oils and fats	9,143.6
Fish and animal products	3.196.4
Miscellaneous foods	4,430.7

These are mean values for the sample, obtained by calculating the caloric content of the actual quantities consumed (available for consumption), food

by food, after allowing for the inedible portion. The calorie totals for each food group were then divided by the mean quantities consumed, in weighted kilograms. Thus these conversion rates take into account the actual composition of each group, expressed in weighted kilograms as they were defined for measuring total consumption.

The use of weighted kilograms has little effect on the size of the conversion factor for rice or for oils, but the conversion for roots and "other cereals" seems surprising until we remember that in weighted kilograms the consumption quantity is only about one-fourth of its level in natural kilograms. The high conversion factor allows for this, yielding an estimate of calories available almost identical with that for consumption in natural kilograms (cells C2, 11 and C2, 12). The conversion factor for fish, being the same for both home and market sources, overestimates the proportion of calories from home production (largely fresh fish). The fish conversion factor may also be somewhat too high in general because the dried fish conversion we used in calculating our ratio probably was intended for fish dried more thoroughly than those in Sierra Leone.

One other point: these conversion factors are based upon observed data for the sample households as a whole. They are not estimates for the population. From the results in Table 10 it appears unlikely that the more complicated procedure involved in making true population estimates would have altered the results greatly.

Simbase

Lastly, we present the essential information in the food accounting matrix as it would appear if based upon predictions from the systems estimation model. These are in weighted kilograms per capita. The production rows have been deleted, rice used for seed being included with rice sent to

market (and thus with the marketed surplus). Net wages paid in kind are also included with the marketed surplus. (See Table 11.)

These values are not predictions for a single average household, one which may not even exist in fact, but an average of predictions for 138 actual households. The per capita figures given here were obtained in exactly the same way as the per capita figures in Table 10, except that those figures were based on observed values, not predicted values. The Simbase figures are given here in order that they may be compared with the weighted kilogram form of the population estimates made from the observed values. This will also serve as a basis for evaluating the reliability of the simulation predictions.

The variables predicted for each food group were household production and consumption (total consumption). The model did not identify consumption from home production as a separate variable. The division of total consumption between home and market sources in Table 11 simply preserves proportions observed among the actual values, shown in Table 10. The amount marketed by rural households (rows 1-5) is a residual obtained by subtracting predicted consumption from home production from the total production predictions. The marketed surplus is another residual, defined as predicted production minus predicted total consumption.

These averages for the rural population of the seven zones are based on individual predictions for each of the 138 households in the sample, so comparable values for any subset of households can be readily obtained. Hence predicted food flows can be calculated by expenditure class or region if one wishes. Budgetary constraints prevented us from extending the analysis to this extent.

As we know, the systems estimation results for the consumption side of the model were much better than those for the production side. That is

TABLE 11

SIMBASE - PREDICTED FOOD AND CALORIE FLOWS, WEIGHTED KILOGRAMS, 1974/75
(weighted kilograms per capita per year; daily calories per capita)

Disposals				Acquisitions	Production Accounts (Activities)								Appropriation Accounts: Market								Totals	
					Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Nonfoods	Labor	Total calories	Rice	Root crops and other cereals	Oils and fats	Fish and animal products	Miscellaneous foods	Nonfoods	Labor	Total calories	Simbase	Table 10
					1	2	3	4	5	6	7	C_h	8	9	10	11	12	13	14	C_m	15	16
Appropriation Accounts	Market		Rice	1	163.4[a]																163.4	
			Root crops and other cereals	2		228.5[a]															228.5	
			Oils and fats	3			42.4[a]														42.4	
			Fish and animal products	4				133.1[a]													133.1	
			Miscellaneous foods	5					62.8[a]												62.8	
			Nonfoods	6						7.0[b]											7.0[b]	
			Labor	7							101.3[c]										101.3[c]	
	Consumption Activities	Rural Households	Rice	8	49.3[a]								20.4[a]								69.7	86.9
			Root crops and other cereals	9		12.3[a]								6.2[a]							18.5	10.7
			Oils and fats	10			9.4[a]								7.0[a]						16.4	15.6
			Fish and animal products	11				6.6[a]								20.8[a]					27.4	28.5
			Miscellaneous foods	12					8.7[a]								5.4[a]				14.1	15.4
			Nonfoods	13						0.0[b]								51.5[b]			51.5	--
			Labor	14							585.8[d]								0.0[c]		585.8	--
		All Other	Rice	15									143.0								143.0	82.5
			Root crops and other cereals	16										222.3							222.3	28.6
			Oils and fats	17											35.4						35.4	24.0
			Fish and animal products	18												112.3					112.3	25.0
			Miscellaneous foods	19													57.4				57.4	29.2
			Nonfoods	20														-44.5			-44.5	--
			Labor	21															101.3		101.3	--
Totals			Simbase	22	212.7	240.8	51.8	139.7	71.5	7.0	687.1		163.4	228.5	42.4	133.1	62.8	7.0[b]	101.3			
			Table 10	23	206.9	39.3	39.6	53.5	44.6	--	--		107.9	32.2	30.6	46.6	35.0	--	--			
Calorie Accounts	Rural Households		Rice	C1	505.6								209.2								714.8	691.2
			Root crops and other cereals	C2		252.9								127.5							380.4	220.0
			Oils and fats	C3			235.5								175.4						410.9	390.8
			Fish and animal products	C4				57.8								182.2					240.0	249.6
			Miscellaneous foods	C5					105.6								65.6				171.2	186.9
			Nonfoods	C6																		
			Labor	C7																		
			Total	C8								1157.4								759.9	1917.3	1936.5

[a]Estimates based on percentage of consumption that came from home production as derived in Table 10.

[b]Maximum value: assumes nothing consumed from home production.

[c]Net, after allowing for sales to other rural households. Households may be either net buyers or sellers of labor; the individual household is likely to both buy and sell labor, as from day to day during the harvest season.

[d]Total labor used in "productive activities," not just what is used by the household that supplies it.

evident here, the total consumption predictions (rows 8-12) according very well with the actual values expressed in weighted kilos. We would not expect them to agree exactly, if only because these are population estimates; a deviation between the predicted and observed value for a given household has a quite different effect if it is in a zone with a large population rather than in one with a small population. The only bad estimate is for root crops and other cereals, but that group has such disparate elements as to render predictions about the behavior of the group of little use in any case.

The production estimate is excellent for rice, the most important single commodity, and quite good for fats and oils, the second most important calorie source. The fish group is a disappointment, but given the fact that the size of the model forced us to assume a common joint production function for all outputs, we can hardly be surprised. Moreover, we know that the ten households in zone 1, large producers of fish and vegetables, are quite different from the remainder of the sample in their production behavior. With only ten households in the group we cannot expect great success in dealing with them, even though the model did identify them as a group and the EA 13 dummy variable was used in making the predictions.

One purpose of this study was to determine the nutritional consequences (in particular, with respect to calories) of changes affecting food consumption. Converting the quantity estimates in Table 11 to their calorie equivalents gives us just what we need. The results appear in rows C1-C5 of Table 11. The systems predictions are excellent in this respect, both for total caloric availability per capita and for calories from the several food sources, except for root crops and other cereals. That estimate is quite high, but is offset by a moderately low estimate for calories from rice.

Table 11 contains two categories not present in previous tables: non-food commodities and labor. The systems estimation predicts production of

7 kg of nonfood products per capita (all of which we record as going to the market) and total rural consumption of 51.5 kg per capita. The rural sector draws 44.5 kg per capita of nonfood commodities from the outside (all other households).

The rural sector uses 586 man-hours[1] per capita in its "productive" activities (row 14, column 15). Rural households provide 687 man-hours per capita for such uses, of which 101 are sold to other sectors.

This simulation prediction of a marketable surplus of 101 man-hours per capita (17 percent of total labor use) from the rural population of the seven zones is in marked contrast with the mean values observed in the sample. In the sample the average household in the sample used 160 more man-hours (per household) during 1974/75 than it provided [Strauss et al., 1981b, p. 15]. It obtained those hours, no doubt, from rural households outside the sample. This was no "excess demand" for agricultural labor; every hour of labor supplied or demanded in the sample was labor actually used by someone.

Furthermore, these 160 hours constituted only 3.3 percent of the total "productive" labor used by the household, so the figure must be well within the range of sampling error. From the sample itself we cannot assume that the population figure for labor marketed differs from zero.[2]

The simulation prediction is much larger and opposite in sign.[3] Of course the simulation result is a mean based upon 138 individual predictions.

[1] In male equivalents.

[2] We did not, however, calculate sampling errors for the marketed surplus of labor.

[3] 101 hours per capita X an average household size of 6.7 [Strauss et al., 1981a, p. 33] = 677 man-hours per year per household.

(A closer analog to the sample mean would have been obtained by predicting a single value for a household characterized by the mean values of the sample variables.) As the simulation estimate is a population prediction its value and sign will depend heavily upon the predicted values for households in heavily populated zones. Evidently in those zones households tended on balance to sell labor to households outside the sample. Although the FAM table identifies the excess as marketable outside the agricultural sector, in fact, if the estimate is correct, it must have been purchased almost wholly by other rural households.

In the chapter that follows the Simbase estimates in Table 11 will constitute a benchmark with which we shall compare the production and consumption patterns that can be expected in response to changes in relative price patterns.

CHAPTER III

SIMULATIONS

The effects of policies on events that alter relative prices can be predicted from the systems estimation results [Strauss et al., 1981b] in either of two ways. One method uses elasticities of output, consumption and marketed surplus [ibid., Tables V.1, VI.4 and VI.6]. However, these elasticities are precise only for infinitesimal changes in the independent variables, and have been calculated only for four hypothetical households, one "average" household in each expenditure group and one for the sample as a whole.

The other method solves the systems regression equations for each of the 138 households in the sample, using whatever new set of independent variables is of interest. It takes account of the fact that households have different elasticities of response and that elasticities vary from one point to another over the range of variation of any independent variable. The average of the several effects on individual households need not equal the effect on a single "average" household; the effect of a ten percent change in price is not simply ten times the effect of a one percent change. The system of equations is nonlinear; the response to a given percentage increase in prices depends upon the level of wages; and so forth.

This chapter presents simulations of the levels of production, consumption and marketed surpluses that would occur in response to specified price changes. We assume that 1974/75 behavioral responses are stable, as they are likely to be. The baseline pattern is the one predicted by the systems regressions using 1974/75 prices (Table 12).[1] To save space we present the essential information in compact style rather than in the FAM form. The distinction made in the FAM tables between consumption by rural households

[1]The information, though not the form, is identical with that in Table 11.

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TABLE 12

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

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

[a]Not including the Northern Plateau.

[b]In "productive" activities.

from home production and from the market is no longer possible, for the systems model does not distinguish the two. We must expect that division to change with any marked change in production or consumption patterns. The price changes to be examined are in relation to this 1974/75 pattern of prices. Price changes caused by inflation are not a problem; both demand and production systems are homogenous of zero degree. It would have been preferable, of course, to use 1980/81 prices to establish a baseline, but except for the 1974/75 survey there seem to be no useful data on rural prices. We present here the best estimates available of the consequences to be expected from current price changes.

The simulations assume that households will make the same adjustments to price changes over time as they have made to price differences existing in space. Clearly this will not always be the case. Adjustments over space are affected by geographical differences; not all households have the same opportunities. Given the multicollinearity that existed within the data, the price variation may have picked up some of the influence of spatial variation. Nonetheless, given the absence of comprehensive time series data the cross-section data provided useful estimates of responses through time, though not necessarily of short-run responses.

Although these predictions describe outcomes to be expected for the whole rural population of the seven zones, they are still partial equilibrium results. They tell us what the responses to any new price pattern will be, but do not tell us whether the specified price pattern could exist: whether indeed it could be an equilibrium price pattern. The simulations done here predict responses to market prices, but not the effects of those responses upon market prices.

What happens to marketed surplus gives us clues as to the effects of the responses on market prices. The marketed surpluses predicted in Simbase

presumably represent equilibrium situations. When these surpluses were available to other sectors market prices were the prices observed in 1974/75. A ten percent increase in a given price could still be an equilibrium price only if the resultant change in marketed surplus is exactly offset by a shift in the demand from other sectors that offsets the change in quantity supplied even in the face of the higher price to the urban sector. To say much more about the general equilibrium problem requires knowledge of the demand functions for the urban population. These we do not have.

The Policy Questions

Rice, the major food in Sierra Leone, poses major policy questions, but many other aspects of agricultural policy affect food crop production in a country where such a large proportion of the food consumed is produced by the households that consume it. Policy with respect to the production of export crops (particularly cocoa, coffee and palm products) affects food production because production for food and for export are substitutes on the production side. However, palm oil is a by-product of the production of palm kernel, a principal export crop either as kernel or as kernel oil [Snodgress et al., 1980, p. 131]. Policies with respect to fisheries development, cassava and the establishment of Integrated Agricultural Development Projects [Snodgrass, et al., 1980, p. vi] affect food production more directly.

In 1981 informants in Sierra Leone expressed concern about the high prices of rice, palm oil and agricultural labor. Of course, in the absence of accurate information about prices in rural areas it is impossible to know whether significant changes in relative prices have been occurring or whether these concerns were simply normal reactions to price change in an inflationary situation.

In this chapter we provide information relevant to decisions concerning some of these problems. We examine the effects of changes in the relative prices of rice, palm products and fish on per capita production and consumption and the marketed surplus of these crops. We also examine the consequences of a rise in agricultural wage rates, of simultaneous movements in the prices of rice and of agricultural labor, and of migration occurring simultaneously with increases in the prices of labor and of rice.

The government of Sierra Leone is greatly concerned about increasing domestic rice production, seeking to reduce dependence upon rice imports, with its consequent drain upon foreign exchange. Imports of rice in 1980 were estimated at 55,000 tons (ten percent of total production). In 1979 they had amounted to 120,000 tons, far above earlier figures. Imports "to supplement domestic production and control prices" have come to provide nearly 50 percent of marketed rice [Snodgrass et al., 1980, p. 100].

Since 1979 the Sierra Leone Produce Marketing Board has been responsible for rice policy and price stabilization. It has tried to administer producer and retail prices, along with imports, in such a way as to provide reserves adequate for domestic demand. The Marketing Board sets marketing margins and official producer prices and buys from producers through licensed buying agents [Snodgrass et al., 1980. p. 44]. According to informants in Sierra Leone, rice is cheaper in the cities than in rural areas. It is said that most people prefer the domestic rice, but buy imported rice when the other is not available.

In 1980 the government's guaranteed farm gate price for rice was Le 7.50 per bushel of paddy rice, equivalent to Le 277.50 per ton. Imported rice was much cheaper, Le 374 per ton, equivalent to Le 218 per ton for paddy at the farm [Snodgrass et al., 1980, pp. 154-5.] Most rice sold by farmers is sold in villages to small traders or to employees of grain wholesalers. A

large fraction of this is sold to traders who have previously made loans to the farmer, thus insuring that the crop be sold to themselves [Snodgrass et al., 1980, pp. 97-8]. For these and other reasons government price policy is not effective in assuring that farmers actually receive the official producer price. There are important regional as well as seasonal variations in the prices actually received by farmers. See Table 13. Snodgrass suggests that increasing the government producer price and assuring that producers receive it is of major importance if farmers are to be induced to provide larger volumes of rice to the market [Snodgrass et al., 1980, p. vii].

TABLE 13

ACTUAL PRODUCER PRICES FOR RICE BY ECOLOGICAL ZONE, 1974/75
(Leones per kilogram)

Ecological Zone	Price	Ecological Zone	Price
Scarcies	.194	Southern Coast	.244
Northern Plains	.266	Riverain Grasslands	.128
Bolilands	.182	Moa Basin	.287
Northern Plateau	.209	Southern Plains	.221

The Predictions

Table 11 above gave the predictions of the systems estimation model for total production and consumption in the form of a truncated FAM for rural Sierra Leone. In addition to this base run, six other runs were made. Each run represents an economic event known to be of importance or concern in Sierra Leone. In this section the results of the six runs will be presented and discussed. Then will follow a comparison of these results with the results predicted by means of the elasticities presented in Strauss et al., 1981b.

The six simulations presented show the effects of a 10 percent rise in the producer price of rice (all other things remaining unchanged), and of three other isolated changes in prices: a 5 percent rise in the price of oils and fats (essentially palm products), a 10 percent rise in the price

of fish and a 10 percent rise in the wage rate for agricultural labor. Another run estimates the consequences of a 5 percent rise in the price of rice and a simultaneous 10 percent rise in labor rates. Lastly we simulate the combined effects of the same changes in rice and labor prices and a 3 percent reduction in the number of adult males in the household.

All the results are expressed in per capita terms. The aggregate amounts can therefore be estimated for population levels more recent than those of 1974/75, if one is willing to assume that the per capita values are still representative. Population growth will not alter these figures appreciably for some time if we assume that household capital grows in proportion to population, for in the aggregate land scarcity is not yet an important limiting factor in Sierra Leone. Of course such improvements in methods and varieties as have occurred since 1974/75 will raise per capita output levels.

Table 14 contains the predictions when rice prices are increased by ten percent, with no change in other prices. Rice is the most important staple in Sierra Leone. In terms of production, the greatest impact is, as one might expect, on rice production. Recall that predicted rice production in the base run was 212.7 kg per capita (Table 12). It is now seven kg greater (a rise of 3.3 percent). This seven kg per capita difference translates into an increase in production of 10.8 thousand metric tons for the 1,546,600 people included in our estimate.[1]

Labor used in production rises by 30 hours per capita (five percent). The effect of this is small increases in the output of all other goods as well as of rice. Being better off, the household supplies 20 man-hours less labor per capita, so it must increase labor hired by 50 man-hours, reducing the marketable surplus of labor to 51 hours.

[1] 14,000 tons if we choose to apply it to the whole population.

TABLE 14

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

Item	Row	Production Activities	Consumption Activities	Marketed Surplus
Rice	1	219.7	66.0	153.7
Root crops and other cereals	2	241.4	19.1	222.3
Oils and fats	3	51.9	17.1	34.8
Fish and animal products	4	139.9	28.4	111.5
Miscellaneous foods	5	71.7	14.5	57.2
Nonfood	6	7.1	53.8	-46.7
Labor used[b]	7.1	616.0	--	--
Labor supplied	7.2	--	666.8	50.8
Calories	8	--	1922.7	--

[a]Not including the Northern Plateau.

[b]In "productive" activities.

The net effect of higher income and a higher opportunity cost for rice is to reduce per capita rice consumption by 3.7 kg (five percent), yielding a gain of 10.7 kg in the marketable surplus of rice (7.5 percent, or 16.5 thousand metric tons for the 1,546,600 people in the rural population, excluding zone 7). Most other marketable surpluses decline slightly, but the consumption of non-food items from other sectors rises by 2.2 kg (five percent) and the marketable surplus of labor is halved. These changes in marketable surplus would exert downward pressure on urban rice prices (unless offset by reduced rice imports), and upward pressure on the prices of nonfood items and of labor, as well as of most food items other than rice.

Consumption of foods other than rice rises, most notably for fish et al., where the gain is one kg (3.6 percent). This should improve the quality of the diet. Total daily calories per capita rise slightly (0.3 percent).

In short, a ten percent increase in the price the farmer receives for rice increases the marketable surplus of rice by some 16 thousand metric tons and improves his well-being in terms of leisure, the consumption of nonfood goods, and a more varied diet containing a higher proportion of animal protein.

A five percent increase in the prices of all oils and fats (including palm kernel) has much less important effects on production, even after allowing for the fact that the price change is only half of that assumed for rice.[1] This increase in oil product prices increases total albor use by only 0.7 percent (Table 15) and the output of oils and fats by only 0.6 percent. Effects on other outputs are negligible. Household labor supply declines slightly and the marketed surplus of labor falls by nine percent.

Effects on consumption are as one might expect, a reduction in oils and fats of 3.7 percent and small increases in other foods. The net effect on

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[1]Considering a five percent change in this case will allow us later to look at the relationship between elasticity measures and estimates of the effects of large changes in the variables in terms of two different definitions of "large."

TABLE 15

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

Items	Row	Production Activities	Consumption Activities	Marketed Surplus
Rice	1	213.0	70.2	142.8
Root crops and other cereals	2	240.9	18.9	222.0
Oils and fats	3	52.1	15.8	36.3
Fish and animal products	4	139.7	27.6	112.1
Miscellaneous foods	5	71.5	14.1	57.4
Nonfood	6	7.0	52.1	-45.1
Labor used[b]	7.1	590.0	--	--
Labor supplied	7.2	--	682.5	92.5
Calories	8	--	1917.3	--

[a]Not including the Northern Plateau.

[b]In "productive" activities.

TABLE 16

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

Items	Row	Production Activities	Consumption Activities	Marketed Surplus
Rice	1	212.1	67.3	144.8
Root crops and other cereals	2	240.5	17.4	223.1
Oils and fats	3	51.7	15.5	36.2
Fish and animal products	4	136.7	29.1	107.6
Miscellaneous foods	5	71.1	13.6	57.5
Nonfood	6	7.0	49.3	-42.3
Labor used[b]	7.1	573.2	--	--
Labor supplied	7.2	--	706.0	132.8
Calories	8	--	1856.2	--

[a]Not including the Northern Plateau.

[b]In "productive" activities.

caloric availability is negligible; what is lost in oils and fats consumption is made up in the consumption of other foods. We must remember, however, that this is an average result. Households that produce no oils and fats will gain no income benefit from the price rise. Their caloric intake will fall. On the other hand, households that produce large quantities of oils and fats will increase their caloric consumption.

The marketed surplus of fats and oils rises by 2.5 percent, but this is difficult to interpret because kilograms consumed consist almost entirely of palm oil, while kilograms produced and the marketed surplus have large palm kernel components. Except for labor, the effects on other marketed surpluses are small.

In March, 1981, there was considerable conern about the rising prices of palm oil. These results suggest that even if the relative price of palm products is rising appreciably this is unlikely to have major effects on diets or production. In terms of effect on rice consumption it takes a five percent rise in the relative price of oils and fats to offset a rise of approximately 1.35 percent in the relative price of rice. However, if the price of palm oil rises while the price of palm kernel does not, this is a very different matter--one which deserves investigation.

Fish constitute the principal source of a complete animal protein in Sierra Leone. For some years the government of Sierra Leone has been encouraging fisheries development as a means of lowering the price of fish and increasing the availability of animal protein. Table 16 shows production and consumption responses to a 10 percent fall in fish prices in the absence of any improvements in productivity. In this case fish production and household labor use drop by two percent, with small declines in other outputs. Fish consumption would rise by six percent among rural households, while the consumption of other foods would fall (roots and oils by five or six percent and

rice and miscellaneous by about 3.5 percent). Nonfood consumption would also fall, by four percent. Total caloric intake would fall by 3 percent as the change in relative prices induced people to consume more fish at the expense of rice, oils and root crops, etc. The protein content of the diet would rise, but at the expense of energy. Households would expand their labor supply by three percent.

The lower price of fish would reduce the marketed surplus of fish by four percent and purchases of nonfood items from outside the rural sector by five percent. The net surplus of labor available from the rural sector would rise 30 percent.

These results are for the rural population as a whole. Households that specialize in fish production would bear almost the entire brunt of lower fish prices and would be severely affected in terms of both income and diet. The detailed predictions for such households are in our files, but are not reported here because of budgetary limitations.

Sierra Leone has a legal minimum wage in agriculture as well as in various industrial sectors. In March 1981, the rate for agriculture was Le 1.92 per day. This was less than the free market rate; according to local informants farmers were paying 25-30 percent more than the official figure.

Production and consumption patterns associated with an autonomous ten percent rise in the market rate for agricultural labor, all other things remaining unchanged, are shown in Table 17. Such an increase would increase total caloric intake among rural households by five percent, increasing consumption of the various foods some four to six percent. Labor supplied rises three percent while labor used by the household falls about ten percent. All output groups decline, the greatest fall (four percent) being in rice. Except for labor, marketed surpluses fall, with rice falling eight percent. These changes mean upward pressures on commodity prices. The marketed surplus

TABLE 17

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

Items	Row	Production Activities	Consumption Activities	Marketed Surplus
Rice	1	204.1	72.9	131.2
Root crops and other cereals	2	237.8	19.5	218.3
Oils and fats	3	51.0	17.4	33.6
Fish and animal products	4	136.2	28.6	107.6
Miscellaneous foods	5	69.4	14.6	54.8
Nonfood	6	7.0	54.0	-47.0
Labor used[b]	7.1	524.2	--	--
Labor supplied	7.2	--	709.0	184.8
Calories	8	--	2012.2	--

[a]Not including the Northern Plateau.

[b]In "productive" activities.

for labor rises 82 percent. If the new wage is to be consistent with equilibrium there must be a comparable rightward shift in the demand for labor (or a leftward shift in the household supply curve for of labor--a possibility which we shall look at shortly).

Should an autonomous five percent increase in the price of rice occur simultaneously with a ten percent increase in wage rates, the results would be as in Table 18.[1] The effects can be approximated by adding half the changes caused by a ten percent increase in the price of rice to the changes caused by the ten percent wage increase, but this procedure will not give an exact result, for (1) the responses are nonlinear and (2) there is an interaction between the effects of a change in price and the level of wages, and vice versa.

As agricultural wages and the price of rice tend to move in the same direction, looking at their joint effects is more useful than looking at the effects of either one separately. The joint effects on production are very much like the effects of the wage increase alone, except that rice output and labor use decline less--as one would expect. On the consumption side, except for rice, food consumption rises from 20 to 40 percent more than when the price of rice does not change. The net effect on caloric intake hardly differs between the two cases. Although both higher rice prices and a higher wage rate increase caloric availability when operating singly, the two together increase calories slightly <u>less</u> than an increase in wage rates that occurs alone. The consumption of nonfood items rises 40 percent more when the price of rice rises along with the price of labor; the supply of labor (naturally) does not rise as much.

[1]This combination is purely illustrative. The solutions can be obtained for any combination whatever.

TABLE 18

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

Items	Row	Production Activities	Consumption Activities	Marketed Surplus
Rice	1	207.4	70.8	136.6
Root crops and other cereals	2	238.1	19.7	218.4
Oils and fats	3	51.0	17.7	33.3
Fish and animal products	4	136.3	29.1	107.2
Miscellaneous foods	5	69.5	14.8	54.7
Nonfood	6	7.0	55.0	-48.0
Labor used[b]	7.1	536.1	--	--
Labor supplied	7.2	--	700.1	164.0
Calories	8	--	2009.1	--

[a]Not including the Northern Plateau.

[b]In "productive" activities.

Except for rice and labor the positive marketed surpluses differ little from the case in which the wage rate is the only price to change. The adverse effect of the wage change on the marketed surplus of rice is reduced nearly half by the increase in the price of rice; the gain in labor supplied is only three-fourths what it was when only the wage rate changed. The increase in rural households' purchases of nonfood goods from other sectors is 40 percent greater when the price of rice rises five percent than when it does not. In the case of the joint price change the new wage rate requires a smaller rightward movement of the demand curve for labor to sustain it, and a smaller leftward movement of the urban demand curve for domestic rice to offset the effect of the fall in marketable surplus.

Given the inflationary situation in Sierra Leone it is possible that the changes occurring in prices and wages are only changes in nominal prices that do not actually alter price relationships. If so, they have relatively little effect upon production and consumption decisions. The predictions we make here concern the results of changes in relative prices--all prices are assumed constant except those we specify as varying.

We have reason to believe, however, that at least part of the changes occurring in agricultural wage rates represents genuine changes in relative prices, for informants assert that migration from rural to urban areas is reducing the quantity of agricultural labor (at least of male agricultural labor) available to the rural household. There is much concern about the effects of such migration. If it is reducing the supply of agricultural labor, part of the observed wage increase evidently represents a rise in the relative price of labor. The systems model used here was not designed to study the effects of migration on wage rates, but we can illustrate the consequences of joint change in the wage rate and the number of adult males in the household. Table 19 shows predicted consumption and production patterns if there

TABLE 19

THE NUMBER OF ADULT MALES FALLS BY THREE PERCENT WHILE RICE PRICES RISE BY FIVE PERCENT AND THE WAGE RATE BY TEN PERCENT: PER CAPITA ESTIMATES OF PRODUCTION, CONSUMPTION AND THE QUANTITIES AVAILABLE FOR OTHER SECTORS, RURAL SIERRA LEONE (7 ZONES[a]), 1974/75 PRICES (Commodities in weighted kilograms per year, labor in male-equivalent man-hours per year, and calories in calories per day)

Items	Row	Production Activities	Consumption Activities	Marketed Surplus
Rice	1	209.4	70.9	138.5
Root crops and other cereals	2	240.4	19.5	220.9
Oils and fats	3	51.5	17.4	34.1
Fish and animal products	4	137.6	29.1	108.5
Miscellaneous foods	5	70.2	14.9	55.2
Nonfood	6	7.1	54.9	-47.9
Labor used[b]	7.1	541.2	--	--
Labor supplied	7.2	--	694.9	153.7
Calories	8	--	1998.2	--

[a]Not including the Northern Plateau.

[b]In "productive" activities.

is a decrease of three percent in the number of adult males in the household coupled with a ten percent increase in wage rates and a five percent increase in the price of rice. If the joint effect of the decrease in adult males and the rise in wages leaves the labor available for other sectors unchanged from what it would have been had only the price of rice risen by five percent we may regard the rise in wages as the equilibrium adjustment to the leftward shift of the labor supply curve. From Table 14 we estimate that a five percent increase in the relative price of rice would be consistent with an excess supply (marketable surplus) of agricultural labor of about 25 hours per capita. The combined effect of the changes in rice price, wages and the number of adult males (Table 19) creates an excess supply of about 150 hours. Clearly the ten percent wage rise we have chosen as an illustration is far more than would be required simply to offset the effects of the decrease in manpower available in the household.

But let us look at other results from this simulation. The per capita production figures have risen one percent from their levels in Table 18. This represents no change at all in total production, which is what the model must predict, for labor available at home places no restriction on output. The model assumes that any quantity of labor can be obtained from the market at the specified wage rate. The level of prices and the wage rate (unchanged from Table 18) affect output, not the quantity of labor available at home. Per capita outputs rise because a three percent reduction in the number of adult males is equivalent to a reduction of 0.94 percent in the size of the rural population.

Aggregate consumption declines slightly compared with Table 18, because the average household has less manpower and less income. With production unchanged, the aggregate marketable surpluses of commodities rise slightly. The aggregate quantity of labor supplied falls two percent when the number

of adult males declines three percent[1] and the aggregate marketable surplus of labor by seven percent.

The per capita consumption of the new smaller population (Table 19) is nearly unchanged from Table 18, up slightly for rice and miscellaneous and down slightly for most other goods. Per capita caloric availability is now 1998 per day, down half of one percent from Table 18, but as the household has fewer adult males the remaining members of the household may have a few more calories than before.

In short, given the price and wage changes specified, a three percent decline in males over 15 years of age reduces the marketable surplus of rural labor, causes modest increases in the marketable surpluses of commodities, and has negligible effects on per capita consumption and diets in rural areas. This should not be too surprising; as production and labor use are unaffected under the assumptions of this model, the principal effect of the migration is to reduce the number of rural consumers.

Simulations or Elasticities?

Economists customarily use point elasticities when dealing with policy issues, but in this case, where it was possible to use the systems model to obtain predictions for each household in the sample, we could examine the consequences of relatively large changes in the independent variables. Thus we could allow the elasticities to change over the range of the independent variable and recognize that elasticities characteristic of a more-or-less representative "mean" household will not be a characteristic of all households. Moreover the point elasticities presented in Strauss et al., 1981b, are based on average values for the sample; with the simulation results we can project the data for individual households to obtain estimates for the whole rural

[1]The remaining members of the household supply more labor than before.

TABLE 20

COMPARISON OF ARC AND POINT ELASTICITIES OF PREDICTED PRODUCTION, CONSUMPTION, AND LABOR SUPPLIED AND DEMANDED[a]

With Respect to Price of	Outputs of						Labor Demanded		Consumption of						Labor Supplied	
	Rice		Oils & Fats		Fish & Animal Products				Rice		Oils & Fats		Fish & Animal Products			
	Point	Arc	Point	Arc	Point	Arc	Point	Arc	Point	Arc	Point	Arc	Point	Arc	Point	Arc
Rice	.11	.33					.14	.52	-.66	-.53					-.09	-.30
Oils and fats			.02	.11			.02	.14			-.73	-.73			-.07	-.13
Fish and animal products					.09	.21	.23	.22					-.68	-.62	-.20	-.28
Labor							-.75	-1.05							.26	.32

[a]Point elasticities from Strauss et al., 1981b, Tables V.1 and VI.4; arc elasticities computed from simulation results in Tables 12 and 14-19 of present report.

population, with some individual households representing a larger fraction of the total population than others.

Some comparisons of the two approaches are given in Table 20. The estimates often differ greatly. Unless policy changes involve only very small changes in the independent variables arc elasticities such as those presented here are preferable. To be sure, arc elasticities can be estimated directly from the regression equation. The simulation method has still another advantage, however. A single solution of the system takes account of all the elasticities in the system, whereas working with the elasticities requires one to identify each relevant elasticity and combine the results of the several applications.

Policy Implications

Nutrition

We found in Strauss et al., 1981b, Table VI.7, that the expenditure (income) elasticity of the demand for calories was 0.86, and did not vary greatly among expenditure groups. In the simulation runs we find that the price most important to the caloric adequacy of the diet is the wage of agricultural labor. A ten percent rise in the wage rate increases caloric availability by five percent. This is consistent (but of course not identical with) the point elasticity of .41 reported in Strauss et al., 1981b, Table VI.9.

Lowered fish prices (by ten percent) reduced caloric intake by three percent[1] as people reduced their consumption of oils, roots and cereals in order to eat more fish. This result, too, is consistent with those in Strauss et al. [ibid.

[1]Or perhaps more. Our conversion factor between dried fish and calories may have been high.

Neither the price of rice nor that of oils and fats had an appreciable effect on calories consumed. At first glance this result for rice is not consistent with the point elasticity figure (-0.26) for a household at the sample mean [ibid.]. But the point elasticity for a household at the mean of the low expenditure group is +0.19, so it is natural that the population elasticity should be near zero if there are enough low expenditure households in the population--particularly when we remember that the simulation elasticity is an arc elasticity.

The most important policy questions with respect to nutrition have to do with the effect of price and wage changes on the caloric adequacy of the diets of low-income households. For this we must go to the point elasticity results, which were calculated by expenditure class. (We could have looked at those households also with the simulation results, but budget limitations prevented.) From the point elasticities we observe that a rise in the wage rate raises caloric intake even more for low-income households than for other and that rises in food prices have <u>positive</u> effects on calorie consumption for such households, even when the effects on households at higher expenditur levels are negative. Furthermore, the effects are larger in absolute terms for low income households than for others, except for rice, where the effects are negative at higher income levels [ibid.]. Higher prices for labor <u>or</u> for products improve the caloric adequacy of the diets of low-income semi-subsistence households. The positive profit effect of higher output prices generally dominates the adverse income effect from their higher opportunity cost. But in the case of rice (which accounts for the largest share of food expenditure) the adverse income effect is large enough (and the profit effect small enough) to allow the negative consumption response to a higher price to dominate in medium and high income households.

Rice

Government policies that increase the producer price of rice will expand rice production, reduce rural consumption and increase the marketable surplus. Given 1974/75 conditions a ten percent increase in the farmer's price would increase the marketable surplus produced by the rural population of Sierra Leone (excluding the Northern Plateau area) by 16,000 metric tons, a significant contribution to reducing rice imports. On the average, rural diets would contain slightly more calories and appreciably (3.6 percent) more fish--the major source of animal protein.

The average, however, conceals important differences among households. Per capita income benefits from a rise in the price of rice would be greatest for M households, who produce more rice per capita than either of the other groups (Table 8). Strauss et al., 1981b, p. 49, shows that in low expenditure households the caloric content of the diet rises by 0.19 percent when the price of rice rises one percent.[1] In middle and high income households the effect is comparable in size but opposite in sign. For high income households, for whom we estimate daily per capita caloric availability at 3470 calories (Table 9), a decline in caloric intake would be of no concern. Middle income households, with estimated mean availability of 1630 calories, on the average, would suffer from a small loss in the energy content of the diet. For the low income households, with average daily per capita availability of only 1160 calories, the small gain in caloric availability (perhaps two percent) could be very important.

If the increased producer price were brought about by improved marketing and transportation opportunities for the isolated farmer, opportunities

[1]Among L households the ratio of rice marketed to total rice consumed is nearly twice what it is for M households and four times the figure for H households. See Table 8.

that reduced the gap between the farmers' price and the price paid by the grain marketing board, the gain to the farmer would not be at the expense of the urban consumer (though traders and taxpayers might lose). But if the marketing board raises its price for domestic rice, either the urban consumer or the taxpayer would suffer (unless a government deficit were incurred that increased inflation rates to the disadvantage of consumers generally). It is possible that the damage to urban diets would more than balance the gain for the poorest of the rural households.

Of course, Snodgrass et al. [1980, pp. 155-8, 170] points out that it is socially unprofitable to substitute domestic rice for imports. Our results indicate that if lower producer prices for rice were to prevail because of increased importation of cheaper foreign rice the effects on the diets of rural households would be relatively unimportant--except for the least well off, whose diets are already energy deficient and would become more so unless the lower price of rice were offset by improvements elsewhere.

There are important unanswered questions which this research does not address. One concerns the possible adverse nutritional effects on rural diets of encouraging the production of swamp rice at the expense of upland rice. (Of course many farmers produce both.) It is true that the share of labor devoted to upland rice is positively associated with cassava root consumption [Smith et al., 1981, pp. 38-39, 65], and cassava leaves constitute an important source of protein and vitamins in the diet. For budgetary reasons we have not pursued the question beyond this point, although the effects of upland rice production on calorie consumption could be estimated from our data.

Agricultural Wages

While changes in the price of rice have relatively small effects on the energy content of the diet, a ten percent increase in agricultural wages

(if it did not lead to unemployment) would raise the energy content of the average rural diet by five percent and increase consumption of a variety of foods, including fish (important for its animal protein). Low income households would benefit more from this than those in the higher income classes. [Strauss et al., 1981b, p. 49].

While rural diets would improve, on the average, the marketed surplus of rice would fall by eight percent (slightly more than a ten percent increase in the price of rice would increase it.) Such results would occur, of course, only if the wage were a free market rate, as current rates for agricultural labor appear to be in Sierra Leone. Raising the minimum wage above the free market level would wipe out some of the benefits by reducing employment opportunities and the incomes of households unable to find as much work as they were willing to do.

Any policy that improves the productivity of agricultural labor will raise agricultural wage rates. Such policies include improving marketing or transportation facilities, promoting the adoption of improved agricultural methods or varieties (perhaps through such projects as Integrated Agricultural Development and ACRE--Adaptive Crop Research and Development),[1] reducing the amount retained by the Marketing Board from the value of export crops, and encouraging the development of rural non-farm enterprise. The last item appears to be much more important than is generally recognized.

The combined effect of increased agricultural wages and higher rice prices on the energy content of the rural diet is almost the same as (but slightly less than) that of higher wage rates alone. Of course rice output and labor use fall less than had rice prices not risen, and there is less rice and more of other foods in the consumption increases associated with

[1]But unsubsidized rice production is not promising in this respect.

the higher wages. Likewise the marketable surplus of rice is greater than when only the wage rate changes.

When we consider the effects of a modest migration along with rises in wage rates and the price of rice (see Table 19), we observe only negligible effects on the diet and its caloric content as long as the labor available to agriculture is at least equal to the quantity demanded. Higher rates of migration might have more striking effects. At some level of migration more than a ten percent wage increase would be required to bring forth enough agricultural labor to staff the production enterprises desired by rural households.

Government promotion of fisheries will have different effects if it results in (1) an expansion of large-scale fisheries or improvements in their techniques without change in the techniques used by rural households engaged in small-scale fishing or (2) technical improvements made by the smaller enterprises engaged in by the rural households in our sample. Our Table 16 presents the consequences for the rural sector of a fall in fish prices arising from the first situation: appreciably greater fish consumption by rural households, along with reduced consumption of roots, fats and oils and, to a lesser extent, rice and miscellaneous foods. On the average a ten percent decrease in fish prices would cause a three percent reduction in the caloric content of the diet. Our elasticity results by expenditure classes [Strauss et al., 1981b, p. 49] indicate that the diets of low expenditure households would fall five percent in caloric content. Of course these reductions reflect adverse effects on income in the households that produce fish.

Households that are consumers only will increase their caloric intake (by two percent in the lowest expenditure group and almost one percent in the other two groups [ibid., p. 48]). Furthermore, the protein quality of the diet will improve. The response of fish consumption to lower fish prices

is high; among low expenditure households the elasticity is -1.29 [ibid., p. 36].

We have not estimated the effects of a fall in fish prices resulting from improved methods used by rural households. In such a case the adverse income effects on rural fishing households would be small. The elasticity of demand for fish (at least in the rural sector [ibid., p. 36]) is nearly unity, so total receipts from fish sales might be nearly as great after the production expansion as before. Thus no great fall in production costs would be required to make the income effect on fishing households a favorable one. In this connection we should note that Linsenmeyer [1976, p. 160] found that small scale fishing was not only profitable, but more profitable than large-scale fishing techniques.

Changes in the prices of palm products, on the average, have negligible effects on caloric availability. They lead to lower consumption of oils and fats and greater consumption of other foods. Thus Produce Marketing Board price policies appear to have little effect on the nutritional status of rural households.

However, more research is needed on this question. There are marked differences in the importance of palm product output to various households. The diets of those who produce few palm products will be adversely affected by increases in the price of palm oil, for there is no beneficial income effect to offset the adverse price effects.[1] Furthermore, our assumption that the prices of palm oil and palm kernel change in the same proportion is too restrictive. We must know the effects of separate changes in the two prices.

[1]The own-price elasticity of demand for palm oil is -0.82 for L households, rising (in absolute terms) to -1.25 for H households [Strauss et al., 1981b, p. 36]. See also Smith et al., 1981, p. 83.

There are many significant policy issues that have not been discussed here. Strauss et al. [1981b, pp. 51-57] considers a number of them. In addition, caloric availability is only one of the nutritional questions deserving study, though it is undoubtedly the most important single question for Sierra Leone. Nutrients other than calories should also be examined--protein at least, plus iron and the B-vitamins, as well as others. With the data now available this would not be difficult. Furthermore, for calories, and perhaps for other nutrients as well, it would be useful to classify households by the ratio of nutrient availability to the estimated requirement for the household. Our per capita figures are useful, but far inferior to household-by-household comparisons of nutrient availability with recommended nutrient allowances if we wish to have a sound understanding of the number and characteristics of households at nutritional risk. Lastly, although this study has revealed a great deal of importance about low income households, the data contain much more that would be useful. We need to examine the characteristics of low income households. To understand the food choices of low income households is important; to understand why their incomes are low would be still more useful.

CHAPTER IV

CONCLUSION

It is clear from this and earlier reports from this project that households that produce large amounts of their own food respond to prices and wages in a systematic way; that these responses can be predicted; and that the nutritional consequences of government policies that affect prices and wages can be anticipated and taken into account in choosing these policies. It is clear also that the effects upon rural households are more complicated than those upon urban families. Urban households are affected only by the consumption consequences; rural households by both the production and consumption effects of any event. In addition, effects differ among commodities, among regions, among ethnic groups, among expenditure classes and between those who do and those who do not produce a given commodity.

In particular, a rise in the agricultural wage rate increases both calories and protein in the average rural diet, at the expense of the marketed surplus of rice, as long as the rate is a free market rate. Policies that improve the productivity of rural labor are clearly beneficial for rural diets.

Lower prices for fish, if they result from the competition of large scale fisheries, increase the protein content of the average rural diet, but reduce the energy content, as a result of the adverse effects on rural incomes from fishing. But fishing is at best a minor activity for most households. Among non-fishing households caloric availability rises in greater degree for low income households than for others.

Increases in the producer price of rice increase the marketable surplus of rice significantly, with little effect on the energy content of the average rural diet. Households in the lowest expenditure class, however, consume

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appreciably more calories as a result of the increased producer price.

The effects of many other policies can be anticipated by similar analysis. No longer need we feel that the nutritional consequences of government policies lie beyond our capacity to predict.

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