

The Analysis of Food Poverty: An Illustration from Kenya

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The study describes a methodology which is used to estimate the magnitude and regional distribution of food poverty among Kenyan smallholders. One-fourth of all smallholder-households were estimated to have a food intake below the recommended daily allowance. Notable differences were found in the provincial incidence of food poverty. Despite these interprovince differences, considerable variation in food consumption levels appeared within regions. Some possible causal factors underlying the prevailing pattern of food poverty are brought out.

INTRODUCTION

The specific aim of this paper is to assess the regional and socio-economic pattern of food poverty among smallholders in Kenya.¹ The extent to which basic food consumption requirements are satisfied is considered a key dimension of the standard of living.

Data for the study came from the first Kenya Integrated Rural Survey (IRS-1), carried out by the Central Bureau of Statistics in 1974-75 and published in 1977.² The survey was based on a stratified sample of 12 households in each of 139 sub-locations, covering 1668 smallholder households in all.³ Since the total number of small holders in Kenya was estimated to be 10.34 million in 1974 compared to a

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¹This paper draws on a broader study of living standards among small-holder farmers in Kenya by Eric Crawford and Erik Thorbecke [3], undertaken as a contribution to the 1979-83 Kenya Development Plan. This paper extends the analysis contained in the referred document.

²See [6], hereafter referred to as CBS (1977).

³The sub-location is the smallest administrative unit in Kenya. Provinces are divided successively into Districts, Divisions, Locations and Sublocations.

total population of about 13 million, the survey covered approximately 80 percent of the total population. Figure 1 shows the location of the survey area. Urban areas and areas characterized by large-scale farms or pastoral livestock herding, were not sampled, nor were households without access to land.⁴ The sample size for IRS-1 is considered adequate for generalizations at the level of the province or agro-ecological zone, but not at the district level. The results of IRS-1 are presented in terms of six provinces and fifteen agro-ecological zones.

Organizationally, the paper begins by discussing the rationale and significance of the approach used. Issues and methods of defining and measuring food poverty are then treated, followed by a description and analysis of the level and geographical distribution of food poverty. Conclusions and implications for further research close the paper.

Significance of Approach

Food consumption is a crucial aspect of welfare. It indicates the availability of foodstuffs to the household, and thus represents an important determinant of nutritional status. Conceptually, the value of food consumption (including expenditures on food purchases as well as the imputed value of own-produced commodities consumed) can be mapped into a set of food commodities with their associated nutrient characteristics. While this provides some evidence of nutritional intake at the household level, the link between household food consumption and the nutritional status of individual household members is, of course, influenced by factors such as disease, intra-household food distribution arrangements, and so on.

Food consumption is of added significance because of its close relationship to total household consumption.⁵ As an indicator of welfare, total consumption was preferred to income in the study reported here for two main reasons. Firstly, households tend to maintain a fairly stable living standard, which is considered a function of permanent or long-run income. As a measure of the concept of permanent income, current consumption has advantages over current income, which may include sizable transitory fluctuations around the normal level. Secondly, the IRS-1 income data show a significant group of households receiving negative incomes despite average or above-average asset and expenditure levels.⁶

⁴Coverage was considerably extended in the second survey (IRS-2) carried out in 1975-76. Unpublished data from IRS-2 made possible a preliminary assessment of the number of landless households by Province, as reported in [3].

⁵Total consumption is defined as food consumption plus the actual or imputed value of clothing, appliances, home furnishings, fuel, taxes, and other miscellaneous items. Food consumption is defined as the actual value of expenditures on food purchases plus the imputed value of own-produced items consumed. Local market prices were used in IRS-1 to value the consumption of own-produced items.

⁶This is partly a result of large negative changes in livestock valuation over the survey period, and perhaps also a result of over-reporting of expenses by households who wished to disguise their ability to repay outstanding loans.

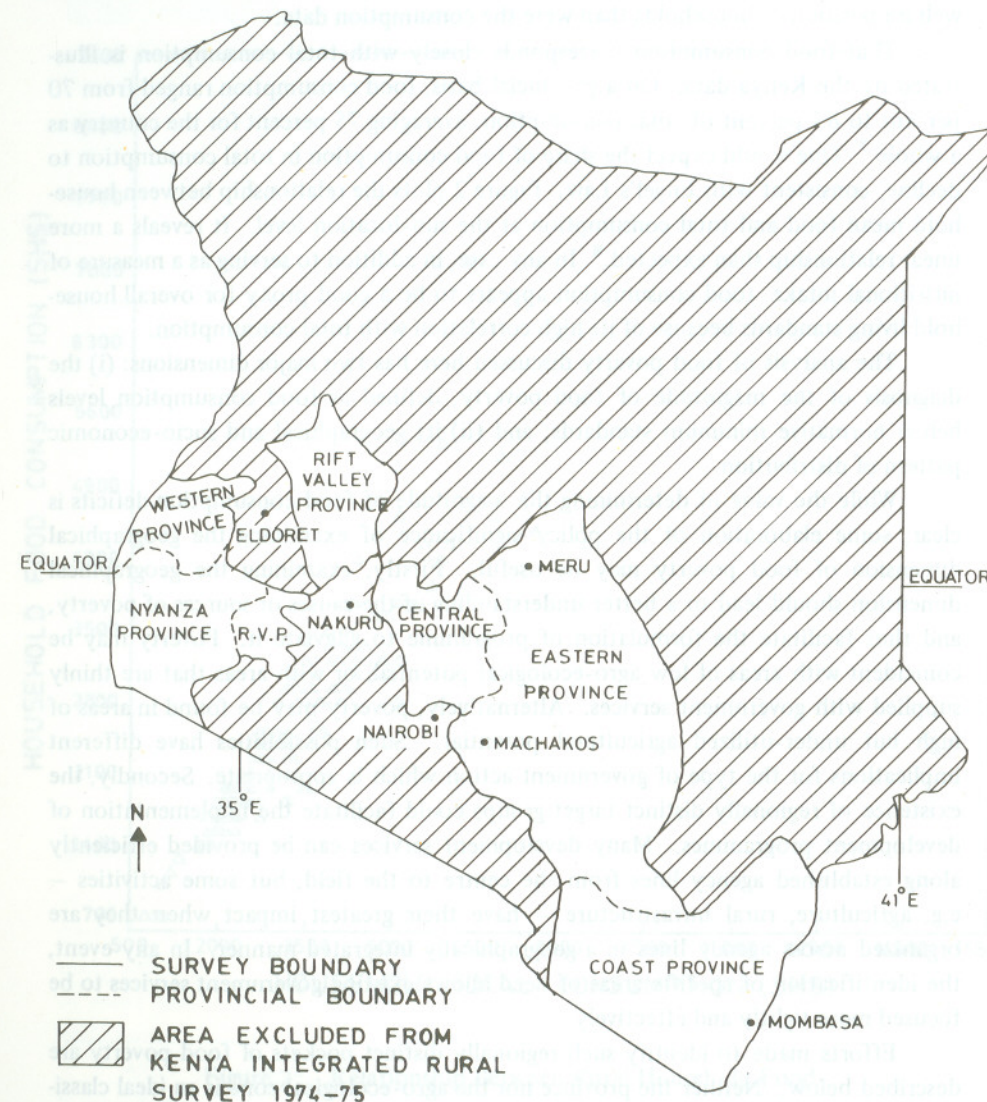


Figure 1: Map of Kenya: Survey Area and Provincial Boundaries

Consequently the IRS-1 income data were regarded as less representative of the true welfare position of households than were the consumption data.

That food consumption corresponds closely with total consumption is illustrated by the Kenya data. On a provincial basis, food consumption ranged from 70 percent to 83 percent of total consumption, averaging 75 percent for the country as a whole.⁷ One would expect the share of food consumption in total consumption to decline, consistent with Engel's Law. Figure 2 plots the relationship between household mean food and total consumption at the sub-location level. It reveals a more linear relationship than expected.⁸ In any case, in addition to serving as a measure of nutritional intake, food consumption appears to be a good proxy for overall household living standards because of its high correlation with total consumption.

The analysis of food poverty discussed here has two major dimensions: (i) the diagnosis of the magnitude of food poverty, defined as food consumption levels below normative minimum standards; and (ii) its geographical and socio-economic pattern of distribution.

While the value of determining the magnitude of food consumption deficits is clear, some elaboration of the policy significance of examining the geographical dimension of food poverty may be useful. Firstly, examining the geographical dimension should lead to a better understanding of the causes or sources of poverty, and thus facilitate the formulation of programme to alleviate it. Poverty may be coincident with areas of low agro-ecological potential, or with areas that are thinly supplied with government services. Alternatively, poverty may be found in areas of high but under-utilized agricultural potential. Such possibilities have different implications for the type of government action which is appropriate. Secondly, the existence of regionally distinct target groups could facilitate the implementation of development programmes. Many development services can be provided efficiently along established agency lines from the centre to the field, but some activities — e.g. agriculture, rural infrastructure — have their greatest impact when they are organized across agency lines in a geographically integrated manner. In any event, the identification of specific areas of need allows existing government services to be focused more tightly and effectively.

Efforts made to identify such regionally distinct pockets of food poverty are described below. Neither the province nor the agro-ecological zone is an ideal classification scheme. Neither is homogeneous internally with respect to general living

⁷ Among low-income families, the ratio of food to total consumption is even higher. For families receiving 0-3000 shillings annual income, the figure was 78 percent [6, p. 59]. At the time of the survey, one U.S. dollar was approximately equal to 8 Kenya shillings (shs.).

⁸ The coefficient of determination (R^2) between mean household food consumption and total consumption at the sublocation level is .89. The corresponding R^2 expressed in terms of adult equivalents is .88. The share of food consumption to total consumption per adult is negatively correlated with total consumption, but the correlation coefficient is low ($R = .403$). It is probable that the relatively narrow range of sublocation mean consumption levels accounts for this last result.

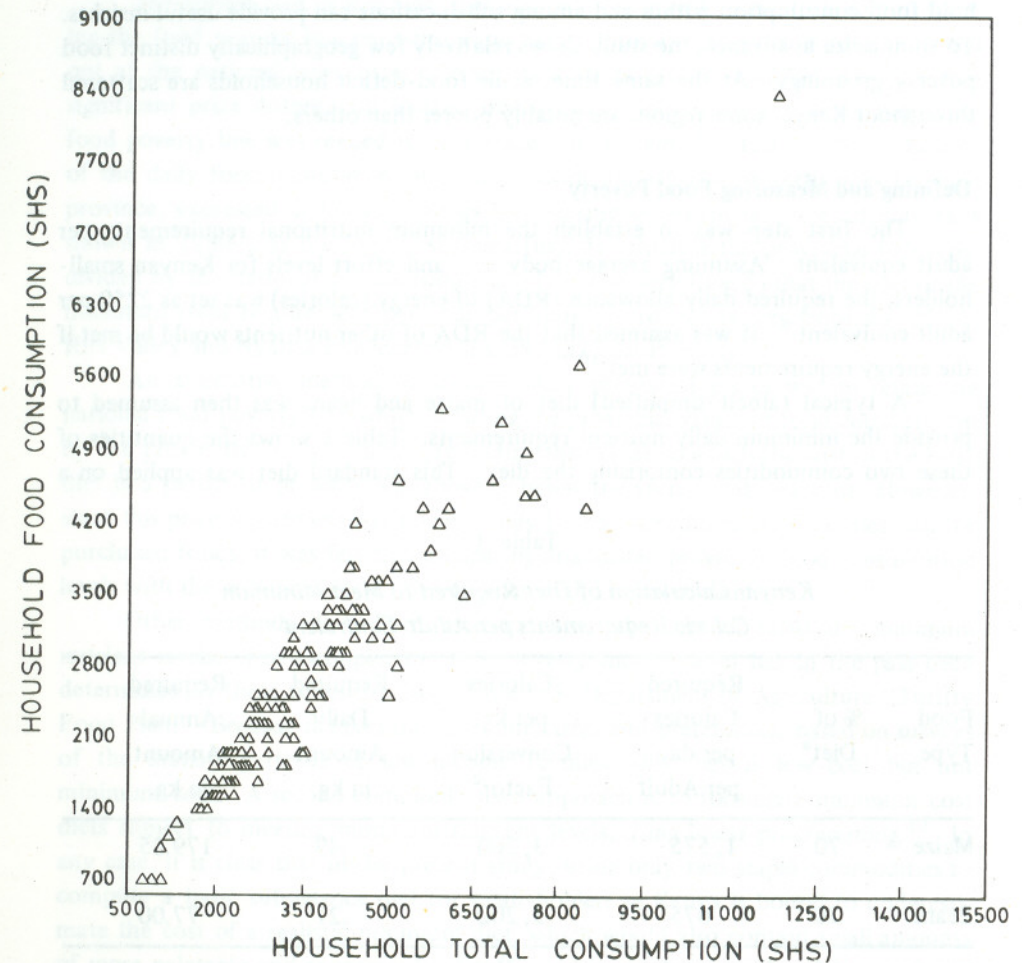


Figure 2: Relationship Between Rural Household Food Consumption and Total Consumption by Sublocation
Kenya Integrated Rural Survey, 1974-75

standards; each displays considerable diversity of economic activity. In contrast, the sub-location appears to be a sufficiently small unit so that a comparison of household food consumption within and among sub-locations can provide useful insights. To summarize in advance, the study shows relatively few geographically distinct food poverty groupings. At the same time, while food-deficit households are scattered throughout Kenya, some regions are notably poorer than others.

Defining and Measuring Food Poverty

The first step was to establish the minimum nutritional requirements per adult equivalent. Assuming average body size and effort levels for Kenyan small-holders, the required daily allowance (RDA) of energy (calories) was set as 2250 per adult equivalent.⁹ It was assumed that the RDA of other nutrients would be met if the energy requirements were met.¹⁰

A typical (albeit simplified) diet of maize and beans was then assumed to provide the minimum daily nutrient requirements. Table 1 shows the quantities of these two commodities comprising the diet. This standard diet was applied on a

Table 1

Kenya: Calculation of Diet Required to Meet Minimum Caloric Requirements per Adult-Equivalent

Food Type	% of Diet ^a	Required Calories per day per Adult	Calories per kg. Conversion Factor ^c	Required Daily Amount in kg.	Required Annual Amount in kg.
Maize	70	1,575	3,200	.49	179.65
Beans	30	675	3,200	.21	77.00
Total	100	2,250 ^b			

^aBy assumption.

^bCaloric requirements based on Anzagi and Bernard [2]. See text.

^cCaloric conversion based on Anzagi and Bernard [2].

⁹Calorie requirements were based on [2].

¹⁰P. V. Sukhatme [8] has argued quite convincingly that the RDA of calories – as calculated, for instance, by FAO – tends to over-estimate nutritional requirements by ignoring intra-individual and inter-individual differences. These differences are likely to be quite significant even in a relatively homogeneous population. Sukhatme [8] suggests that a more reasonable level for minimal nutritional requirements might be 10% to 15% below the average RDA's. The level which we have selected translates from 2250 calories at the consumption level to about 2000 calories in terms of actual nutritional intake. This last figure is certainly somewhat below the RDA for Kenyan small-holders at the actual food intake level.

national basis. Regional dietary differences are evident in Kenya, but due to data limitations they could not be incorporated.

The annual cost of this basic diet was then calculated, as the final step in deriving the food poverty line per adult equivalent. Initially, this calculation was carried out at the national level, using average national prices. It then became clear that significant price differentials existed among provinces and sub-locations; hence the food poverty line was revised to take these into account.¹¹ Table 2 shows the cost of the daily food requirement and the resulting annual food poverty lines for each province, expressed in Kenya shillings. A measure of provincial price differences is shown in Table 2 as the food cost index (line 4), which is the provincial food cost divided by the national average food cost. It can be seen (line 5) that the cost of the minimum food requirement per year per adult equivalent ranges from shs. 256 in Rift Valley and Nyanza Provinces to shs. 391 in Coast Province.¹²

An alternative method of incorporating provincial prices was to retain the national food poverty line while deflating the provincial values of food consumption by the provincial food cost index, reflecting the degree to which the cost of the basic diet in a particular province was above or below the average national cost. However, since this price adjustment was possible only for own-produced commodities, not for purchased foods, it was felt that comparing unadjusted provincial food consumption levels with the provincial food poverty lines would be more valid.

Other methods have been used to derive the cost of satisfying minimum nutrient levels. For example, the U.S. poverty income level has in the past been determined as three times the cost of the U.S. Department of Agriculture "Thrifty Food Plan." Because it takes into account tastes and preferences, based on surveys of the dietary patterns of low-income families, this diet is low-cost but not minimum-cost. A second commonly used approach is to formulate minimum-cost diets subject to meeting minimum nutrient levels, using linear programming.¹³ In any case, it is clear that in the present study, using only two staple commodities to compute a basic subsistence diet for small-holders in Kenya is bound to underestimate the cost of a realistic minimum diet, which would also contain small amounts of more palatable and expensive foodstuffs, such as meat, vegetables, dairy products, and sugar.

After determining the minimum annual food requirement per adult equivalent, it was then necessary to establish the number of adult equivalents per household in the sample, in order to calculate household food consumption per adult equivalent for comparison with the adult equivalent food poverty standard. Using information

¹¹As noted previously, only local market prices for commonly-produced agricultural goods were collected in IRS-1. There was no information on the prices of purchased items.

¹²Note that this is a food poverty line for rural areas; because of higher prices, the minimum food requirement would cost one and one-half times as much in urban areas, if computed on the same basis.

¹³For example, see a recent study for Sao Paulo [1].

on the age structure of each household and a set of normative adult equivalent weights for each age category, the number of adult equivalents was calculated.¹⁴ Using the same weights and the average age structure per household for

Table 2

Kenya: Calculation of Rural Food Poverty Line per Adult Equivalent and per Household, by Province

	Central	Coast	Eastern	Nyanza	Rift	Western	National Average
1. Maize Price per kg (shs.)	0.85	.91	.78	.77	.74	.85	.80
2. Bean Price per kg (shs.)	2.59	2.94	2.19	1.56	1.62	1.99	2.21
3. Daily Cost of Basic Diet (shs.) ^a	.96	1.07	.84	.70	.70	.84	.85
4. Food Cost Index ^b	1.13	1.26	.99	.82	.82	.99	1.0
5. Yearly Cost of Basic Diet per Adult Equiv. (shs.)	350.4	390.6	306.6	255.5	255.5	306.6	310.3
6. Number of Adult Equivs.	4.94	5.89	4.84	4.95	5.35	5.42	5.06
7. Yearly Food Cost per Household (Food Poverty Line) (shs.)	1731	2301	1484	1265	1367	1662	1570

Source: Raw data file for IRS-1. Also, CBS (1977).

^aCost of maize and beans supplying 2250 cal. per day.

^bProvincial cost of diet divided by national average cost.

¹⁴The weights were: 0.24 for persons under age 5; 0.65 for ages 5–14; 1.0 for ages 15–54; and 0.65 for persons over 54. No distinction was drawn between males and females.

the six provinces, the cost per household of the minimum diet (which is identical in physical terms) ranged from shs. 1265 in Nyanza Province to shs. 2301 in Coast Province. (See lines 6 and 7 in Table 2.) To illustrate the interaction between differential prices and household composition, in Coast Province the household food cost is high not only because prices are relatively high, but also because family size in adult equivalents is also high. In Rift Valley, on the other hand, family size is high but prices are comparatively low.

DISTRIBUTION OF FOOD POVERTY

Table 3 presents the information needed to compare actual food consumption per adult equivalent with the food poverty line, on a provincial basis. A number of interesting observations can be drawn from Table 3: (i) there are significant inter-province differences in actual average food consumption (line 1), and in the share of consumption of own-produced rather than purchased foods (lines 1a and 1b); (ii) the distribution of food consumption per household is positively skewed, as can be inferred from the noticeably lower values for the median as compared to the mean (lines 1 and 2); (iii) the percentage of households in each province falling below the food poverty line ranges from 18 percent in Central Province to 48 percent in Coast Province (line 8), averaging 25 percent for the country as a whole.¹⁵ and (iv) the absolute number of food-deficient households is substantial, about 376,000 households with the bulk of these contained in Western and Nyanza Provinces.¹⁶

The dangers of ignoring differential prices and household sizes can be inferred from Table 4, which contrasts three food poverty measures: (i) the province-specific food poverty line per adult equivalent, which corrects for both household size and regional prices; (ii) the national average food poverty line per adult equivalent, which corrects for household size but not for price differences; and (iii) the national average food poverty line per household, which corrects for neither price nor household size. Except for Western and, possibly, Eastern Provinces, the percentage of households below the food poverty line varies considerably depending on the definition. In Coast Province, for example, when its relatively high provincial prices are ignored (line 4.b) its percentage of the poor falls from 48 percent to 35 percent. When the age breakdown of the household is likewise ignored (line 4.c) the percent age of the poor falls further to 33 percent, which is nearly one-third below the correct figure of 48 percent. Thus for Coast Province, leaving these factors out of the calculation greatly underestimates the true extent of food poverty. Precisely the opposite is true of Nyanza and Rift Valley Provinces, where the percentage of the poor falls substantially when the simple poverty line is replaced by one incorporating

¹⁵This compares to a national average of 30 percent households falling below the poverty line for total household consumption.

¹⁶The exact number of persons per food-deficit household was not computed. However if one assumes that the size of poor households is the same as the average size for the corresponding province, then 402 thousand households represents 2.67 million individuals.

Table 3

Kenya: Average Food Consumption of Smallholders per Adult and per Household Compared to Food Poverty Line, by Province

	Central	Coast	Eastern	Nyanza	Rift	Western	National Average or Total
1. Ave. Household Food Cons. (shs.)	3118	2613	3068	2039	2564	2108	2594
a. Own Produce	1530	670	1667	1047	1686	896	1297
b. Purchased Food	1558	1943	1401	992	878	1212	1297
2. Median Household Food Cons. (shs.)	2164	1742	2300	1683	2158	1775	1766
3. Household Food Poverty Line (shs.)	1731	2301	1484	1265	1367	1662	1570
4. Ave. Household Total Cons. (shs.)	4473	3139	4020	2546	3426	2808	3450
5. Median Household Total Cons. (shs.)	3676	2394	3441	2050	2563	2130	2709
6. Share of Food in Total Consumption line 1 ÷ line 4)	.70	.83	.76	.80	.75	.75	.75
7. Food Poverty Line ^a per Adult Equiv. (shs.)	350	391	307	256	256	307	—

Continued —

Table 3 — Continued

8. Percent Households in Province below Food Poverty Line	18.3	48.2	20.0	22.1	19.1	42.6	25.3
9. Number of Households below Food Poverty Line (thousands)	60.5	33.6	70.6	85.3	17.1	108.6	375.7 ^b
10. Total Number of Households (thousands)	329.5	69.9	353.2	386.4	89.8	254.6	1483.4

^a Figures have been rounded.

^b The sum of the provincial totals.

price and family composition. For Kenya as a whole, the corrected figure shows that 25 percent of all households are consuming less than adequate nutrient levels, while the unadjusted poverty measure shows 32 percent of households to be food deficient. Thus, the unadjusted measure overestimates the extent of food poverty by seven percentage points, or over one-fourth of the correct figure.

Having considered the distribution of food poverty with respect to provincial poverty lines, the next objective of the analysis was to determine the pattern of regional variation in food poverty. Table 4 has already shown that some provinces, e.g. Coast and Western, have substantially greater proportions of their populations with insufficient levels of food consumption, while other provinces, e.g. Central and Rift Valley, are characterized by well-below-average proportions of households experiencing food deficits.

It does not follow that food consumption levels are therefore uniform within provinces. When analysis of variance is conducted using the province as the factor of classification, only 4 percent of the variation in food consumption per household is explained by the provincial grouping. Replacing the province with the agro-ecological zone or the district¹⁷ improves the percentage of variation explained to 9 percent, but this is still quite low. In other words, the bulk of variability remains within the units of these three regional groupings.

An effort was therefore made to devise an alternative set of regional groups within which the levels of food consumption would be more uniform than was the case for the province or agro-ecological zone. Graphical plotting and the more complex statistical technique of cluster analysis were the methods used to search for more distinct groups. Each of the 139 sub-locations in the sample was coded in terms of latitude and longitude coordinates, and mean household food consumption broken down into classes, resulting in the graphical plot shown in Figure 3.¹⁸ In

¹⁷The IRS-1 distinguishes 15 agro-ecological zones. Kenya is subdivided into 42 districts.

¹⁸A statistical point is in order here. In computing mean levels of food consumption at the province or sublocation level, two weights come into play: (1) the household weight, which is the reciprocal of the household's probability of selection in the survey [6:9]; and (2) a weight which is the product of the household weight and the number of adult equivalents in the household. This second weight was required to ensure the validity of means calculated by the BREAK-DOWN procedure of the SPSS (Statistical Package for the Social Sciences) package used in the analysis. The formula for weighted mean household food consumption is:

$$\bar{X} = \frac{\sum X_i W_i}{\sum W_i}$$

where X_i is food consumption for household i ;

W_i is the household weight for household i ;

For weighted mean household food consumption per adult equivalent, the formula is:

$$\bar{X} = \frac{\sum X_i W_i A_i}{\sum W_i A_i}$$

where A_i is the number of adult equivalents for household i .

Table 4
Kenya: Percent and Number of Smaller Household Below the Food Poverty Line,
by Province: Three Alternative Measures

	Central	Coast	Eastern	Nyanza	Rift	Western	National Average or Total
1. Provincial Food Poverty Line per Adult	350	390	310	255	255	310	-
2. National Food Poverty Line per Adult	310	310	310	310	310	310	310
3. National Food Poverty Line per Household	1570	1570	1570	1570	1570	1570	1570
4. Percent of Households below:							
a. Poverty line 1 ^a	18	48	20	22	19	43	25
b. Poverty line 2 ^b	13	35	20	33	33	43	27
c. Poverty line 3 ^c	16	33	24	45	32	42	32
5. Number of Households below: ^d							
a. Poverty line 1	61	34	71	85	17	109	376
b. Poverty line 2	41	24	71	127	29	109	402
c. Poverty line 3	52	23	86	175	29	108	473

Continued -

Table 4 - Continued

	Central	Coast	Eastern	Nyanza	Rift	Western	National Average or Total
6. Poverty Rank (1 = least poor)							
a. Percent Households (Line 4a)	1	6	3	4	2	5	
b. Number of House- holds (Line 5a)	3	2	4	5	1	6	

^aFood consumption per adult compared to the provincial poverty line per adult.

^bFood consumption per adult compared to the national poverty line per adult.

^cFood consumption per household compared to the national poverty line per household.

^dIn thousands. Figures have been rounded.

Figure 3, sub-locations whose levels of food consumption per adult equivalent are below the normative minimum (i.e. 310 shs. per adult) are indicated by the squared and circled A symbols, respectively. In turn, sub-locations displaying higher mean consumption levels are denoted by symbols B (shs. 311 to 513), C (shs. 514 to 750) and D (over shs. 750).

Twenty-three of the 139 sub-locations, or 17 percent, exhibit poverty levels of food consumption. Of these 23, there are 11 whose averages are significantly lower than the food poverty line at the 95 percent confidence level, denoted by the shaded circled A symbols in Figure 3. That is, when a 95 percent confidence interval is constructed around the means of all 23 food deficit sub-locations, there are 11 for which the entire interval lies below the poverty line.¹⁹ By the same token, there are 39 sub-locations whose mean levels of food consumption lie above the poverty line, but are close enough so that the lower end of their 95 percent confidence interval falls below the poverty line. Given the margin of error in the data which this suggests, it is difficult to justify a rigid cut-off point. This should therefore be borne in mind when studying Figure 3, which is intended to give only a rough visual indication of the pattern of food poverty.

In order to express the sub-location food consumption values in terms of national prices, each sub-location mean was deflated by the food-cost index of the province in which it was located.²⁰ When sub-location mean food consumption (price-adjusted) per adult equivalent is plotted in Figure 3, the resulting array of points shows several fairly homogeneous regions. By referring to the map of Kenya in Figure 1, it can be seen that clusters of food poverty are located in Coast and Eastern Provinces. A number of poor sub-locations can also be seen in the western part of Kenya (Nyanza, Western, and Rift Valley Provinces), but the clustering is weak; poor sub-locations appear side by side with well-off sub-locations. At the other end of the scale, Central Province is revealed clearly as a moderately homogeneous region of adequate food consumption, with most sub-locations exceeding the national average.

It is interesting to compare the magnitude and geographical distribution of inadequate food consumption with some direct (although limited) evidence of nutritional status. As part of the IRS-2 survey, a study was carried out to determine the

¹⁹In preparing confidence intervals, one would normally work with the (unweighted) sample means and standard deviations. However, since the IRS-1 survey employed a stratified sample, it was necessary to weight the sample observations before undertaking any tabulation or analysis. The approach adopted here was to combine the weighted means and the sample standard deviations. It was felt that the sample standard deviations would provide a better indication of the variability of the population than would the weighted standard deviations.

²⁰The deflated value of food consumption was computed for each household by dividing consumption of own produce by the cost index, and adding the value of purchased foods. Deflated food consumption was then divided by the number of adult equivalents in the household. Since the cost index reflects only the prices of locally grown crops, it was not used to deflate the value of purchased foods.

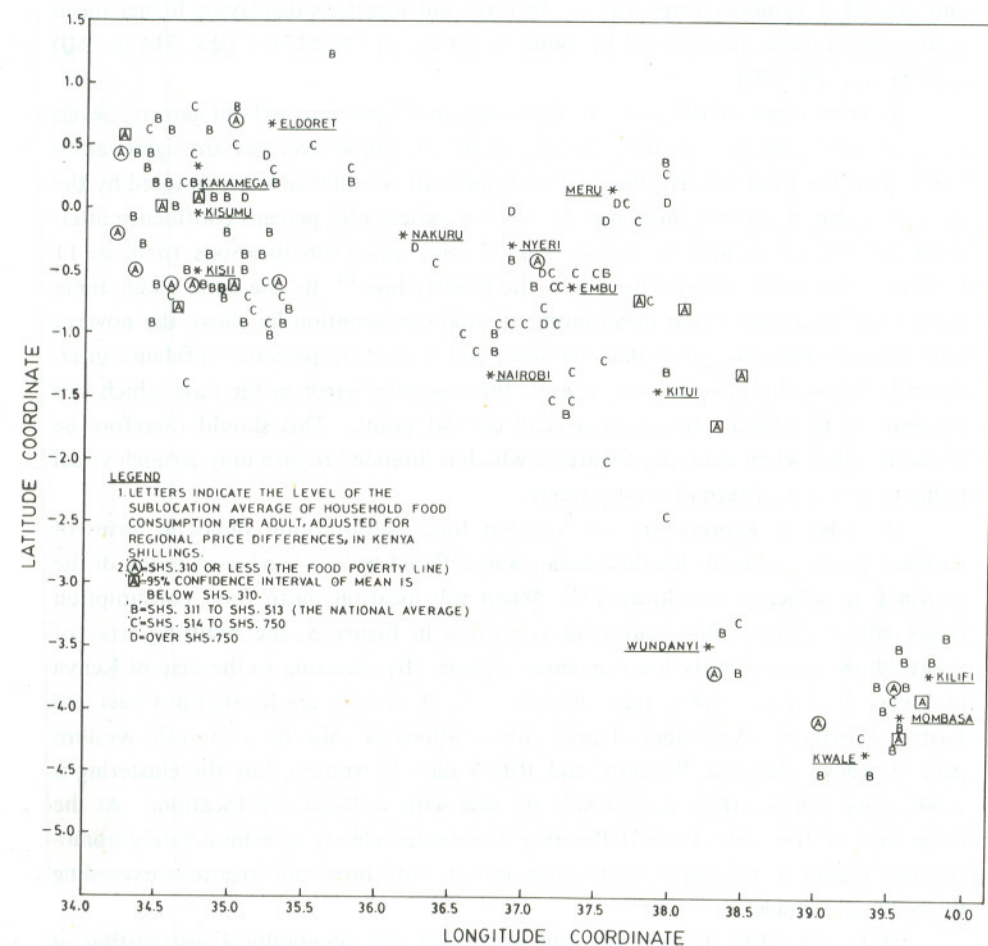


Figure 3: Geographical Pattern of Household Food Consumption per Adult
Kenya Integrated Rural Survey, 1974-75

nutritional status of children aged one to four years. Data were collected on physical development and compared with the Harvard norms for each age group to determine the extent of malnutrition. Results show that infant malnutrition does not appear to be as serious in the Nyanza and Western Provinces as in the others, since 59 percent and 60 percent, respectively, of the children in the age group 1-4 in these provinces were found to have a height-age and weight-height ratio above 90 percent of the Harvard norm. In contrast, the Eastern and Central Provinces display respectively the highest incidence of malnutrition with only 40 percent and 44 percent, respectively, of the children in the above category. What is somewhat surprising is that these first two provinces above show up rather badly with respect to the proportion of households below the poverty line in Table 3 (line 8) and vice versa for Central Province. The share of food deficit households is 43 percent for Western Province, exceeded only by Coast Province with 48 percent. Nyanza Province ranks third with 22 percent.²¹ There is some correspondence between this picture and the one based on food consumption levels, if it is recalled that a pocket of food poverty exists in Eastern Province, located in a semi-arid area of marginal agricultural potential. However, it is surprising that Central Province should have a high incidence of moderate protein-energy malnutrition among infants since it has the lowest share of food-deficit households. Other determinants of nutritional status may have intervened. As is well known, the link between household food intake and the nutritional status of individual household members is a complex one influenced by such factors as health (disease can reduce absorption of nutrients ingested) and the allocation of food supplies among family members.

In addition to the graphical analysis described above, a more formal attempt was made to identify regional poverty groups, using the technique of cluster analysis. As reported in Crawford and Thorbecke [3], the focus was on a broader concept of standard of living, not just on food consumption levels. The two variables of interest were total household consumption and geographical location, but the intention was to eventually include other corollary indicators of welfare, such as household amenities and access to government services, for which data were provided by the IRS-1 survey. For two reasons, a brief summary of the approach and results of this earlier study are worth mentioning here. Firstly, the technique of cluster analysis is directly applicable to the study of food poverty patterns. Secondly, the regional groups obtained from the clustering exercise would have been essentially identical had food consumption been used rather than total consumption, given the very close relationship between the two.

Statistically, the problem was to identify the grouping scheme that minimizes the variance within the group by comparison to the variance between groups, given

²¹In this respect it might be noted that the Nyanza and Western Provinces have the highest proportion of meat and fish in their diets. Whether this fact has any bearing on reduced infant malnutrition can only be speculated upon at this time.

the variables of interest. Cluster analysis serves this purpose well.²² Minimum variance groupings were calculated for a fixed number of clusters ranging from five to twelve. A scaling factor of 1:50:50 was applied to consumption, latitude, and longitude, respectively, i.e. total household consumption (varying from shs. 900 to shs. 11,000) received 1/50th the weight of latitude and longitude, which varied from one degree north to four degrees south and 34 to 39 degrees east, respectively.²³ In spite of the heavy weight given to the geographical variables, the programme generated a set of clusters that were relatively homogeneous in terms of consumption level, but not in terms of geographical location.

Although quite tentative, the results underline the diversity of rural Kenya, with rich and poor found in the same region. A similar conclusion was drawn from the graphical analysis of food consumption patterns. However, although the statistically-determined regional groups greatly improved on the province and the agro-ecological zone in terms of within-group homogeneity, they were not useful in other respects.²⁴ The clusters reflected narrow ranges of consumption, but were usually composed of sub-locations representing all six provinces. Such clusters are inconveniently shaped from the standpoint of targeting programmes to meet the needs of their inhabitants; moreover, they do not suggest any causal mechanism underlying the pattern of welfare levels. As a result, although the method of cluster analysis is promising in general, the use of graphical plotting proved to be quicker to implement and easier to interpret when applied to the Kenya data.

Possible Factors Affecting Food Poverty

It is interesting to speculate on possible explanations for the pattern of food poverty described above.²⁵ Given the information available from IRS-1, several factors were considered: (i) agro-ecological potential; (ii) size and distribution of land holdings; (iii) level of household amenities; and (iv) access to government services.²⁶

²²A hierarchical clustering algorithm designed by Howard and Harris and described in P.E. Green and V. R. Rao [4] was used. This algorithm first divides the data randomly into a number of clusters (from two to fifteen, as specified by the user). A local optimization is then carried out by comparing the distance from each observation to the centroid of the group in which it is located. Points are shifted and centroids recomputed until the configuration of groups is characterized by minimum squared distance to the centroid of each cluster. According to P.E. Green and V.R. Rao [4, p. 209], "The property of the locally optimal solution is: should any single point be moved from its assigned group to any other group, total within-group variance would be increased."

²³This was partly to correct for differences in magnitudes, and partly to emphasize the locational variables. The correct scaling for dissimilar variables such as the ones used here is difficult to determine *a priori*; the intention was to experiment with a range of scaling factors and to evaluate which scaling gave the most useful results.

²⁴When seven clusters are generated, over 90 percent of the total variation in consumption is accounted for by differences between clusters.

²⁵For a more extensive discussion, see [3].

²⁶Other factors of a political, ethnic, and historical nature clearly have exerted a strong effect on the current pattern of income and living standards in Kenya. Other studies treat these factors more effectively than could be done here. See, for example Colin Leys [7].

With respect to the first factor, it was found that poverty did not occur only in areas of low agricultural potential. The three agro-ecological zones with the highest proportion of poor households were all high- or medium-potential areas. In fact, the agro-ecological zones delineated in the survey were not homogeneous with respect to crop mix or other type of economic activity, so that actual as compared to potential agricultural production is not a convenient explanatory variable either.

There is some relationship between the proportion of food-poor households and the size distribution of land holdings by province, as given by IRS-2. In particular, the percentage distribution of very small holdings, i.e. those below 1 ha., is closely related to the share of food-poor households, as Table 5 indicates.²⁷

Table 6 presents data on household amenities and access to government services, by province. Household amenities include sanitation and materials used in the construction of the house; government services include water, health, and primary and secondary schools; other indicators in Table 6 include access to market, transport, and cooperative and retail trade outlets. For every amenity indicator,

Table 5

Kenya Smallholders: Percentage Distribution of Holdings Below 1 ha. Compared to Percentage Households Below Food Poverty Line, by Province

	Central	Coast	Eastern	Nyanza	Rift Valley	Western
Percentage of Holdings below 1 ha ^a	17.2	38.8	26.9	41.9	35.1	39.2
Rank	1	4	2	6	3	5
Percentage of Households below Poverty-line ^b	18	48	20	22	19	43
Rank	1	6	3	4	2	5

^aCBS (1977, p. 44).

^bFrom Table 3, line 8.

²⁷It should be recalled that the IRS-1 survey excluded the landless.

each province was ranked according to its standing vis-a-vis the other provinces. A rank of one was given to the province with the best rating. An important result of this ranking exercise was to reveal that as a whole the amenity and service access indicators showed significant and consistent rankings among provinces.²⁸ In other words, in general, a province which ranked well with respect to one indicator tended also to rank well on the other indicators. However, an important qualification is that most amenities and services listed in Table 6 are likely to be highly related to population density. Only four indicators (listed under B in Table 6) appear to be relatively independent of population density.

From Table 7, which compares the ranking of provinces on the food poverty indicator (column 5) with the combined ranking for all amenity and service indicators (column 3), it can be seen that the densely populated provinces (Central, Nyanza and Western) appear relatively well supplied with services, while the more sparsely populated provinces (Eastern, Rift Valley, and Coast rank more poorly. Western Province therefore does not stand as badly on this aspect of welfare as it does with respect to consumption. It appears to have ample health and education facilities, and good access to roads, markets, and trading outlets. Hence, it is difficult to explain the relatively high incidence of poverty in Western Province on the basis of below - average access to government services. However, this factor may explain to a degree the low consumption levels in Coast Province.

Perhaps a better, but more limited, measure of availability of amenities is to take the set of indicators independent of population density, listed under B in Table 6. The corresponding combined ranking for this limited set is given in Table 7, column 4. It can be seen that the ranking of provinces according to these amenities is almost the same as the one obtaining for the relative incidence of food poverty (column 5).

Data Limitations and Implications for Research

Before summarizing the main findings of the study it seems desirable to indicate some of the limitations of the data used in the study, and to suggest areas for further research. First, although the IRS-1 survey covered 22 districts representing the main small farming areas of Kenya, certain groups were excluded: pastoralists, landless households, households with over 20 hectares of land (the official definition of a large farm), and small farmers located in predominantly large farm districts.²⁹ For the regions included in IRS-1, however, the survey coverage is sufficient to be fairly representative of the pattern of rural poverty.

²⁸The Friedman matched-pairs statistic was computed to be 33.9, which exceeds the critical chi square value of 16.75, significant at the .005 level. This test is described in William L. Hays [5].

²⁹These groups together probably constitute 15 to 20 percent of the total population of Kenya [3, p. v-8].

Table 6
Percentage Distribution and Ranking of Kenya Smallholders, by
Amenity and Service Indicators, and Province (1976)

Indicator	Central ¹	Coast	Eastern	Nyanza	Rift Valley	Western	National Average % (ROW)
<i>Household Amenities</i>							
A. Correlated with Population-Density							
% Piped water (wet) ²	23 (2)	35 (1)	8 (5)	13 (4)	17 (3)	1 (6)	15
% Piped water (dry)	21 (2)	42 (1)	8 (5)	13 (4)	15 (3)	2 (6)	15
% < 2 km. to water supply (dry) ³	98 (1.5)	71 (6)	80 (5)	88 (3)	87 (4)	98 (1.5)	89
% < 1 km. to water (dry)	88 (1.5)	41 (6)	65 (5)	68 (4)	77 (3)	88 (1.5)	74
B. Not Correlated with Population-Density							
% with concrete floor	12 (1)	8 (4)	11 (2)	7 (5)	10 (3)	6 (6)	9
% with pit latrine	89 (1)	23 (6)	56 (4)	72 (2)	33 (5)	66 (3)	60
% without sanitation	9 (1)	70 (6)	43 (4)	28 (2)	65 (5)	33 (3)	38
% thatched roof	32 (1)	92 (6)	63 (2)	82 (4)	76 (3)	85 (5)	69
% corrugated iron roof	57 (1)	3 (6)	35 (2)	18 (3)	18 (4)	14 (5)	27

Indicator	Central ¹	Coast	Eastern	Nyanza	Rift Valley	Western	National Average % (ROW)
Access to Services							
Primary school < 2 km.	82 (2)	51 (6)	78 (3)	76 (4)	59 (5)	83 (1)	73
govt. secondary school < 8 km	74 (1)	30 (6)	59 (2)	57 (3)	36 (5)	56 (4)	54
harambee secondary school < 8 km.	70 (2)	34 (6)	64 (4)	81 (1)	50 (5)	67 (3)	64
health centre < 2 km.	14 (4)	5 (6)	12 (5)	18 (2)	16 (3)	21 (1)	11
local market < 2 km.	32 (3)	18 (6)	29 (4)	54 (2)	24 (5)	67 (1)	39
duka (shop) < 2 km.	70 (2)	40 (6)	69 (3)	63 (4)	50 (5)	80 (1)	64
Cooperative store < 2 km.	27 (1)	11 (5)	22 (2.5)	22 (2.5)	7 (6)	14 (4)	18
bus route < 2 km.	50 (2)	31 (6)	43 (5)	45 (3.5)	45 (3.5)	52 (1)	46
Population Density							
Persons/sq. km.	127	8	12	168	12	161	

Source: Preliminary tabulations, IRS-2.

¹First column is percentage of households in the category; second column (in parentheses) is the rank of the Province, compared to other provinces on the same indicator. Rank of 1 = best rating.

²“Wet” means in wet season.

³km. means kilometer; “dry” means in dry season.

Table 7

Summary of Provincial Ranks on Amenity and Service Access Indicators Compared to Indicators of Food Poverty^a

Province	Rank Sum ^b	Average Rank	Overall Rank ^c	Rank on Amenities Independent of Population-Density ^d	Percent Households below food Poverty line ^e
Central	29	1.71	1	1	18 (1)
Coast	89	5.24	6	6	48 (6)
Eastern	62.5	3.68	4	2	20 (3)
Nyanza	53	3.12	3	3	22 (4)
Rift Valley	70.5	4.15	5	4	19 (2)
Western	53	3.12	2	5	43 (5)

^aBased on Table 6.

^bSum of ranks on all indicators.

^cTie between Nyanza and Western resolved by using unrounded percentages.

^dAmenities listed under set B in Table 6. Note that percentage distribution of households with pit latrine is inversely related with the proportion without sanitation. Thus only one of these indicators was used in computing the rank.

^eFrom line 8, Table 3. Rank in parentheses.

A second data limitation is that information was available only for one year, 1974-75.³⁰ As follow-up surveys are run, it is hoped that comparable information will be generated to permit a comparison of household consumption patterns at different points in time. With such information, the effects of weather on production and consumption, as well as the influence of other transitory factors such as world price movements, could be taken into account.

Thirdly, with more information available it would improve the analysis to specify normative regional diets rather than a standard maize and beans diet applied in all rural areas. Realistically, these should be typical rather than minimum-cost diets *per se*, i.e. they should reflect the actual dietary patterns of low-income households in the respective regions. The household's demand for taste as well as for nutrient content would therefore be incorporated. For the sake of consistency, it

³⁰The scope of the IRS-2 survey conducted in 1975-76 was considerably improved, but unfortunately no information was collected on income or consumption patterns.

would be important to ensure that each of these normative regional diets include the same nutritional content, at least in terms of calories, but preferably also in terms of protein and other key nutrients. Since the IRS-1 survey was designed more with production than with consumption or nutrition data in mind, it would be necessary to undertake more detailed studies of regional food consumption patterns as a prerequisite to the formulation of region-specific diets.

Notwithstanding the drawbacks of specifying a nationwide minimum diet, it should be re-emphasized that the food poverty line established in this study is a conservative one in the sense that it tends to underestimate the cost of providing a subsistence level of food intake, and hence may underestimate the extent of food poverty. The hypothesized maize and beans diet contains inexpensive staples which in reality would be supplemented by small amounts of more expensive foodstuffs.³¹ Thus, there are likely to be households who, because of taste or cultural factors, spend more than the value of the normative minimum food requirement yet do not satisfy their RDA of calories since their diet includes foodstuffs which are relatively expensive per calorie provided. Such households would not be identified in this study as suffering from inadequate food consumption levels.

SUMMARY AND CONCLUSIONS

A methodology was formulated in this study to estimate the extent and regional distribution of food poverty among Kenyan small-holders. One-fourth of all small-holder households were estimated to have a food intake below the recommended daily allowance. Notable differences were found in the provincial incidence of food poverty, with Coast and Western Provinces displaying the highest shares of households below the food poverty line (48 and 43 percent, respectively). The corresponding share in each of the other four provinces was around one-fifth. Despite these inter-province differences, considerable variation in food consumption levels was found within regions. Neither the province nor the agro-ecological zone was capable of explaining more than ten percent of the total variance in food consumption among households in the sample.

A more detailed picture of the regional pattern of food consumption was obtained by plotting the values for the 139 sub-locations sampled in IRS-1. The resulting graphical array reveals a few food poverty pockets (Primarily in Eastern and Coast Provinces), as well as a concentration of relatively high food-consumption levels in Central Province.

An important finding of the study was that the estimated number of food-deficit households is quite sensitive to regional food price differentials, and to the

³¹Even a strict minimum-cost diet would be likely to include more numerous and costly ingredients. For example, D. C. Alves, R. E. Evenson and M. R. Rosenzweig [1] computed through linear programming a minimum diet for Sao Paulo. Satisfying the RDA for all nutrients, the diet included four commodities: maize, beans, bread and sardines.

size and age structure of the household. An accurate measurement of food poverty requires the incorporation of these factors into the analysis.

The use of cluster analysis to identify distinct, homogeneous regions in terms of household consumption reinforced the conclusion that a few uniform regional pockets of poverty do exist. As the graphical analysis of food poverty showed, the tendency is for poor households to be scattered among better-off households.

The final part of this study evaluated some possible causal factors underlying the prevailing pattern of food poverty in Kenya. Of these, the extent of land holdings under one hectare in size, and the availability of certain services not related to population density, appeared to have a relationship to the extent of food poverty.

REFERENCES

1. Alves, D. C., R. E. Evenson and M. R. Rosenzweig. "Nutrition and Taste in the Sao Paulo District". New Haven, Conn. (USA): Economic Growth Center, Yale University. 1978. Mimeographed.
2. Anzagi, Simon K., and Frank E. Bernard. *Population Pressure in Kenya: A Preliminary Report*. Nairobi: Central Bureau of Statistics, Kenya. 1977.
3. Crawford, Eric, and Erik Thorbecke. "Employment, Income Distribution, Poverty Alleviation and Basic Needs in Kenya". Report of an ILO Mission to the Ministry of Finance and Planning, Kenya. 1978. Mimeographed.
4. Green, P. E., and V. R. Rao. *Applied Multi-Dimensional Scaling*. New York: Holt, Rinehart and Winston, Inc. 1972.
5. Hays, William L. *Statistics for the Social Sciences*. New York: Holt, Rinehart and Winston, Inc. 1973.
6. Kenya. Central Bureau of Statistics. *Integrated Rural Surveys, 1974-1975*. Nairobi. 1977. Hereafter referred to as CBS (1977).
7. Leys, Colin. *Underdevelopment in Kenya: The Political Economy of Neo-Colonialism, 1964-1971*. London: Heinemann. 1975.
8. Sukhatme, P. V. "Assessment of Adequacy of Diets at Different Income Levels". *Economic and Political Weekly* (Bombay). Special Number. August 1978.