NUTRITIONAL STATUS OF RWANDAN HOUSEHOLDS:

SURVEY EVIDENCE ON THE ROLE OF HOUSEHOLD CONSUMPTION BEHAVIOR

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The Cornell Food and Nutrition Policy Program (CFNPP) was created in 1988 within the Division of Nutritional Sciences, College of Human Ecology, Cornell University, to undertake research, training, and technical assistance in food and nutrition policy with emphasis on developing countries.

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CFNPP is funded by several donors including the Agency for International Development, the World Bank, UNICEF, the Pew Memorial Trust, the Rockefeller and Ford Foundations, The Carnegie Corporation, The Thrasher Research Fund, and individual country governments.

 ISBN 1-56401-123-2

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The manuscript was edited by Elizabeth Mercado. The text was formatted by Gaudencio Dizon. The cover was produced by Jake Smith.

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ABBREVIATIONS

FRW	Franc Rwandais (Rwandan Francs)
MINAGRI	Ministère d'Agriculture, d'Elèvage, et des Forêts (Ministry of Agriculture)
MINIPLAN	Ministère du Plan (Ministry of Planning)
MINISAPASO	Ministère de la Santé Publique et des Affaires Sociales (Ministry of Health and Social Affairs)
MUAC	Mid-upper Arm Circumference
NBCS	National Budget and Consumption Survey
ONAPO	Office National de la Population (National Population Office)

FOREWORD

CFNPP conducts research to generate information about the effect government action has on poverty, food security, and human nutrition. As part of this effort, CFNPP began collaborative work with UNICEF/Kigali in early 1989 to improve upon existing knowledge concerning the prevalence and etiology of malnutrition in Rwanda.

Rwanda is the most densely populated country in Africa. It has the world's highest fertility rate and one of the highest population growth rates. This tremendous population dynamic, coupled with limited land expansion, has propelled Rwanda to the forefront of African countries struggling with nutrition and health-related problems.

Although Rwanda's endemic poverty and food insecurity is well recognized, little attention has been given to understanding the nature of malnutrition. Instead, policymakers have relied principally on aggregate calorie production levels as the sole indicators of nutritional well-being, ignoring the implications of household-level food security, health, and fertility behavior.

CFNPP, in collaboration with UNICEF/Kigali, has worked to overcome this dearth of knowledge about the intricate relationship between individual nutrition and the household's socioeconomic, demographic, and health environment.

This working paper provides new information on the structure underlying Rwandan household decisionmaking. This information was derived from a statistical analysis of data from a national budget-consumption expenditure survey of rural and urban households. The survey was undertaken by the Ministry of Plan, Government of Rwanda, from 1982 to 1986. Using the survey data, this study focuses on the links between the household's food consumption behavior and nutritional status of preschool children.

Although limited in size, the sample data represent a first attempt at measuring the welfare of Rwandan households. The survey's evidence of high prevalences of chronic malnutrition and underweight children should signal the need for considering the nutritional impacts of all development projects and programs in Rwanda.

Finally, it is hoped that this study will provide a useful benchmark for future work in this area in Rwanda by providing empirical evidence of the underlying structure governing nutrition and food consumption behavior and by identifying the information gaps that must be filled completely and thoroughly understand the etiology of malnutrition among Rwandan children.

Financial support from UNICEF/Kigali for this study is gratefully acknowledged.

Ithaca, New York
March 1992

Per Pinstrup-Andersen
Director, CFNPP

EXECUTIVE SUMMARY

In the mid-1980s the Ministry of Plan of the Government of Rwanda undertook its first national household survey of budgetary expenditure and consumption behavior, entitled the National Budget and Consumption Survey (NBCS) for rural (1982-1983) and urban (1984-1986) areas.

This paper examines the nutritional status of preschool children from the NBCS survey, with an emphasis on the role of household consumption behavior. In addition, household income, demographic characteristics, and subsistence orientation are examined for their influence on household food consumption behavior.

The prevalences of chronic malnutrition and underweight children are extremely high in Rwanda, relative to other African countries, and reflect the widespread poverty of the rural and urban populations.

Nearly 53 percent of rural children younger than six in Rwanda were found to be chronically malnourished, while 5 percent were acutely malnourished, and nearly 30 percent were underweight. These figures are slightly higher than levels of urban malnutrition: 38 percent of urban children younger than five years of age were stunted, over 6 percent were wasted, and 22 percent were underweight.

Several important age-related nutritional implications can be drawn from the results. First, the initial 6 months of a child's life represent a period of significantly higher nutritional status as compared with the following 6-to-24 month period for both the rural and urban samples. Second, also during the initial 6 months rural children exhibit higher levels of malnutrition than do their urban counterparts (perhaps a result of greater maternal nutritional stress during pregnancy in rural areas). Third, as expected, the data indicate a pattern of increased nutritional vulnerability during the 6-to-24 month "weaning" period for both rural and urban children. Fourth, high infant and child mortality rates in rural areas decimate the ranks of malnourished children and give the false appearance of limited "recovery" from the high levels of malnutrition associated with the 6-to-24 month period. The first and third points make a strong case for mothers to maintain current breast-feeding practices through the child's first 6 months of infancy, and hint at the nutritional vulnerability associated with child weaning behavior in Rwanda. The second and fourth points are related to the household's access to adequate health infrastructure and reflect, in part, the greater access that urban dwellers have to health infrastructure.

Regression results reveal that household food acquisition behavior is an important determinant of child nutritional status. A clear pattern emerges:

household calorie availability per day per adult equivalent is more important than food expenditures per adult equivalent, which in turn is a stronger determinant of child nutritional status than is household permanent income.

Although specific information is lacking, this study hints at the importance of health infrastructure and sanitary environment. Total expenditures, food expenditure, and calorie availability all appear to have a greater impact in an urban setting than in a rural setting. This could be the result of improved access to health infrastructure in urban areas, which would complement nutrient intake. Similarly, lack of access to health infrastructure in rural areas may be constraining the household's response to perceived morbidity. Present results could be greatly strengthened with the addition of household-level data on the sanitary environment and individual-level data on morbidity.

Household size has a negative influence on both current (or near term) child nutritional status, as well as on household food consumption behavior. Household food expenditure per adult equivalent, calorie acquisition per adult equivalent, and food budget share in both rural and urban areas all decline (and the level of prices paid per calorie in rural areas rises) with increases in the household's size.

In rural households, the value of consumption from home production as a percentage of total expenditures (i.e., the household's subsistence orientation) is associated with greater food expenditures per adult equivalent, calorie acquisition per adult equivalent, and food budget shares, and with lower levels of prices paid per calorie acquired.

Food expenditure and calorie acquisition elasticities with respect to income are significantly higher in rural areas than in urban areas, reflecting in part greater overall poverty of rural households and the greater availability of consumer goods in urban areas.

As expected, increases in income are associated with declines in the food budget share. However, this effect is greater in urban areas where wider income dispersion and lower levels of home production prevail. Similarly, rises in income are associated with increases in the price paid per calorie consumed, with practically no difference in the rate of change emerging between the rural and urban samples.

In summary, the positive effects of household income and calorie acquisition on child nutritional status are apparent from this study; however, the role of health infrastructure merits further research. The analytical results suggest that the impact of agricultural policies and programs may be greater in the presence of complementary health infrastructure. In addition, family planning activities to reduce household size could benefit both household food consumption behavior (directly) and child nutritional status (both directly via lower child intrahousehold orderings and indirectly via improved household food consumption behavior).

1. INTRODUCTION

BACKGROUND

Rwanda, a small, landlocked nation situated in the central Africa highlands, has been experiencing rapid population expansion since the mid-1970s.[1] Already the most densely populated country in Africa, Rwanda's estimated population growth rate of 3.5 to 3.8 percent (Office National de la Population [ONAPO] 1985) is beginning to surpass its ability to produce food for itself. This fragile state exacerbates the impact of peripheral problems, such as soil erosion and rapid urbanization.

However, very little hard information exists about the nutritional impact of the rapid population growth and the ensuing degradation in the agricultural environment and national food security situation. In 1976 Meheus et al. (1977) undertook the first national nutrition survey. They found that 33 percent of Rwandan children younger than five years of age were stunted, another 39 percent were underweight, and 6 percent were wasted.[2] These malnutrition prevalences are sufficiently high to cause alarm among government policymakers. Unfortunately, Meheus et al. did not collect socioeconomic data, thus preventing the study of any potential causal relationships.

Since the mid-1980s Rwanda has been in the midst of an economic downturn that began with the fall of coffee prices in 1987, which further aggravated an already precarious nutritional situation.[3]

In the summer months of 1989 famine conditions developed in several parts of Rwanda and required the mobilization of food aid from the international donor

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1 Rwanda's population grew from 4,831,527 in 1978 to an estimated 7,800,000 by January 1992. In January 1983 (the approximate survey period), the population was estimated at 5,670,000 (ONAPO 1985).

2 Stunting is height-for-age below 90 percent of the reference median; underweight is weight-for-age below 80 percent of the reference median; and wasting is weight-for-height below 80 percent of the reference median. Refer to Table 3 for comparisons with other African survey data.

3 Rwanda depends heavily on coffee both as an earner of foreign exchange and to generate government revenues. Coffee traditionally represents 70 to 80 percent of Rwanda's total export value.

community (Desmoulins 1990).[4] This difficult situation only worsened with the outbreak of open warfare with Uganda along the northeastern frontier. In October 1990 an armed force of former Rwandan refugees mounted an invasion into Rwandan territory from southern Uganda. Although fighting has essentially ended, the main trade route from Kigali to Mombassa via Kampala remains closed.[5]

These two events have heightened the awareness of Rwanda's food insecurity and have painfully sensitized policymakers to the importance of an improved understanding of the nature of malnutrition in Rwanda. Because fiscal resources from the Government of Rwanda and the international donor community are diminishing, timely information about the distribution and causes of malnutrition in Rwanda is increasingly important in order to initiate new intervention activities and fine tune ongoing development projects in the areas of food and nutrition.

In November 1982 the Ministry of Plan of the Government of Rwanda began its first national household survey of budgetary expenditure and consumption behavior. Entitled the National Budget and Consumption Survey (NBCS),[6] the survey was conducted in two distinct phases: the rural survey undertaken between November 1982 and December 1983; and the urban survey conducted between October 1984 and January 1986.

Both survey phases, rural and urban, involved collecting data during at least four survey rounds over a year.[7] The surveys produced a wealth of household information covering a multitude of subjects that ranged from detailed inventories of asset ownership and work activities to observed food consumption during household meals. In addition, a single round of anthropometric measurements was taken during both survey phases. This combination of household-level socioeconomic and nutritional status variables represents a unique opportunity to evaluate both the extent and determinants of malnutrition in Rwanda.

The NBCS data were used in this paper to increase current understanding of rural and urban malnutrition in Rwanda and to provide a reference base for future nutritional work in Rwanda.

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4 The famine represented the accumulation of several factors (weather, pests, disease), but essentially it represented the manifestation of population pressure forcing greater agricultural activity on very fragile land of only marginal productive value in the southeastern highlands of Rwanda.

5 The date of the initial writing of this paper was December 1991.

6 Enquête Nationale sur le Budget et la Consommation.

7 The urban survey included an initial fifth survey round during which information concerning the household composition and structure was collected.

This paper summarizes the analytical findings of the anthropometric data available from the NBCS survey. Nutritional status indicators are used to evaluate the nutritional reality as it existed in Rwanda at the time of the survey data collection, as well as to attempt to trace out and quantify the key relationships between malnutrition and its causal factors, particularly as they relate to household food consumption behavior.

Moving beyond the nutritional status indicators, household consumption behavior is examined by studying the impact of household income, demographic characteristics, and subsistence orientation on four measures of household food consumption behavior: food expenditures per adult equivalent, calorie acquisition per adult equivalent, prices paid per 1,000 calories, and the food value share of household total expenditures.

SAMPLE SPECIFICS

Although the initial sample design covered some 1,170 rural households, the elimination of periphery cluster households with insufficient data on budget expenditures and food consumption behavior reduced the eventual rural sample size to a core of 264 households. Similarly, the urban sample included a total of 297 households with detailed budget expenditure and food consumption behavior information.

Anthropometric measurements were recorded for all children present in these "core" sample households at the time of the survey. This study restricts itself to preschool children aged 0 to 74 months in the rural areas and 0 to 60 months in the urban areas to obtain equal samples of 276 children from both rural and urban samples. The rural sample children came from 184 (or 70.0 percent) of the 264 sample households, whereas 159 (or 53.5 percent) of the urban households total of 297 had children under the age of 60 months. The much higher propensity for rural households to have infants is primarily the result of migratory patterns: young single males make their way to Rwanda's urban areas in pursuit of employment (Schnepf 1990a). Thus, urban household composition contains a much higher proportion of unmarried adults, although it is noteworthy that overall mean household size appears to be much higher in urban settings.

It is important to note that the two samples do not correspond to the same periods of time. The anthropometric data for the rural areas were collected during the fourth round of rural data collection (August to November 1983), while the anthropometric data for the urban areas were collected during the first urban survey round (October 1984 to January 1985).

ANTHROPOMETRIC INDICATORS

Since it not possible to measure an individual's nutritional status per se, certain physical measurements are used to create indices that serve as "indicators" of nutritional well-being. With respect to the NBCS survey data, the height, weight, and mid-upper arm circumference (MUAC) measurements were recorded for qualifying sample children.

Malnutrition can exist in several forms. Chronic malnutrition is manifested in the form of "stunting" (measured by height-for-age), and is indicative of long-term, habitual calorie inadequacy and exposure to infectious diseases.[8] Acute malnutrition or "wasting" (measured by weight-for-height or arm circumference) represents near term nutritional problems resulting from either recent bouts of illness or lack of sufficient calories. Underweight status (measured by weight-for-age) represents a combination of chronic and acute malnutrition and as such is generally a more difficult indicator to interpret.

This study limits itself to nutritional status indicators created from the height and weight measures. Results for the MUAC data are reported in Schnepf (forthcoming).

The difficulty in identifying the exact nature of malnutrition is further complicated by interpretational changes associated with the age of the child (Zerfas 1986). The child's weight at birth and its nutritional status during the first month of life directly reflect the mother's health and nutrition during pregnancy. The child's nutritional status during the first year represents a combination of fetal, natal, and postnatal influences (e.g., birthweight, breast-feeding behavior, and introduction of supplementary foods). Finally, child nutritional status during the first to fifth years reflects the interaction of food intake, disease, infections, internal parasites, and the socioeconomic environment.

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[8] Martorell (1991) provided evidence from Guatemala that stunting in adolescents does not necessarily indicate chronic malnutrition. Instead, stunting does indicate nutritional inadequacies of significant magnitude and duration that occurred some time during the child's first three years of life and from which growth recovery is unattainable.

2. THE PREVALENCE AND DISTRIBUTION OF MALNUTRITION

GENERAL RESULTS

During the fourth round of the rural survey (August to November 1983), 53 percent of Rwandan children younger than 6 years of age were found to be chronically malnourished, 5 percent were acutely malnourished, and 30 percent were underweight. These figures (Table 1) compare with slightly lower levels of urban malnutrition recorded during the first round of the urban survey (October 1984 to January 1986). Almost 38 percent of urban children younger than 5 years were stunted, over 6 percent were wasted, and 22 percent were underweight.

The mean and standard deviations of the Z-score distributions reflect these same patterns of high levels of chronic malnutrition and underweight, alongside low levels of acute malnutrition.

Seckler (1980), Srinivasan (1981), and Edmundson and Sukhatme (1990) have suggested that moderate stunting indicates the body's defense mechanism against low or insufficient levels of calorie absorption relative to physical needs. The body seeks an optimum size with respect to its environment. By limiting stature, the body is reducing its potential for overall physical growth, and subsequently the body's potential caloric needs levels.[9]

This theory is borne out by Figures 1 and 2, which show that the overall distributions of height-for-age Z-scores for both the rural and urban areas are shifted to the left of the weight-for-age Z-score distributions, thus resulting in nearly normal weight-for-height Z-score distributions.

However, such growth patterns do not constitute "acceptable" nutritional growth. Such severe apparent limits on growth need to be addressed. Furthermore, the intellectual loss resulting from this hypothetical "adaptive" process may be substantial (Selowsky and Taylor 1973; Selowsky 1981).

INTERNATIONAL COMPARISONS OF NUTRITIONAL STATUS

The levels of malnutrition found in Rwanda are compared with results from similar surveys in African countries in Table 2. The prevalences of chronic malnutrition and underweight in children are extremely high in Rwanda relative

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[9] This concept has been called the "Homeostatic Theory of Growth" (Seckler 1980).

Table 1 — Rwanda: Overall Malnutrition Levels from the Anthropometric Data Based on Z-Scores

	Percent Malnourished		Z-Score	
	< -2	< -3	Mean	Standard Deviation
Chronic malnutrition				
Rural	52.8	25.8	-1.87	(1.84)
Urban	37.5	15.6	-1.52	(1.62)
Acute malnutrition				
Rural	5.4	2.1	-0.19	(1.41)
Urban	6.3	1.1	0.06	(1.54)
Underweight				
Rural	29.8	9.5	-1.33	(1.28)
Urban	21.9	5.4	-0.92	(1.51)

Source: Calculated from NBCS data.

Notes: Rural (August-November 1983): N = 276 children aged 0 to 74 months; urban (October 1984-January 1985): N = 276 children aged 0 to 60 months.

Figure 1 — Rwanda: Distribution of Rural Z-Scores by Nutritional Status Indicator

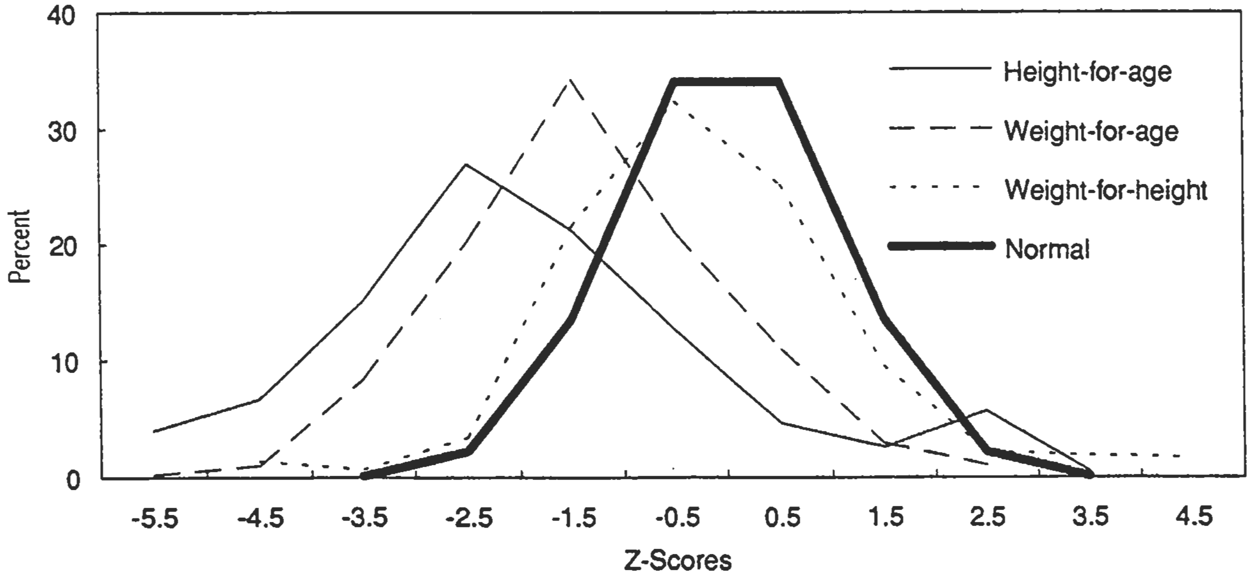

Figure 2 — Rwanda: Distribution of Urban Z-Scores by Nutritional Status Indicator

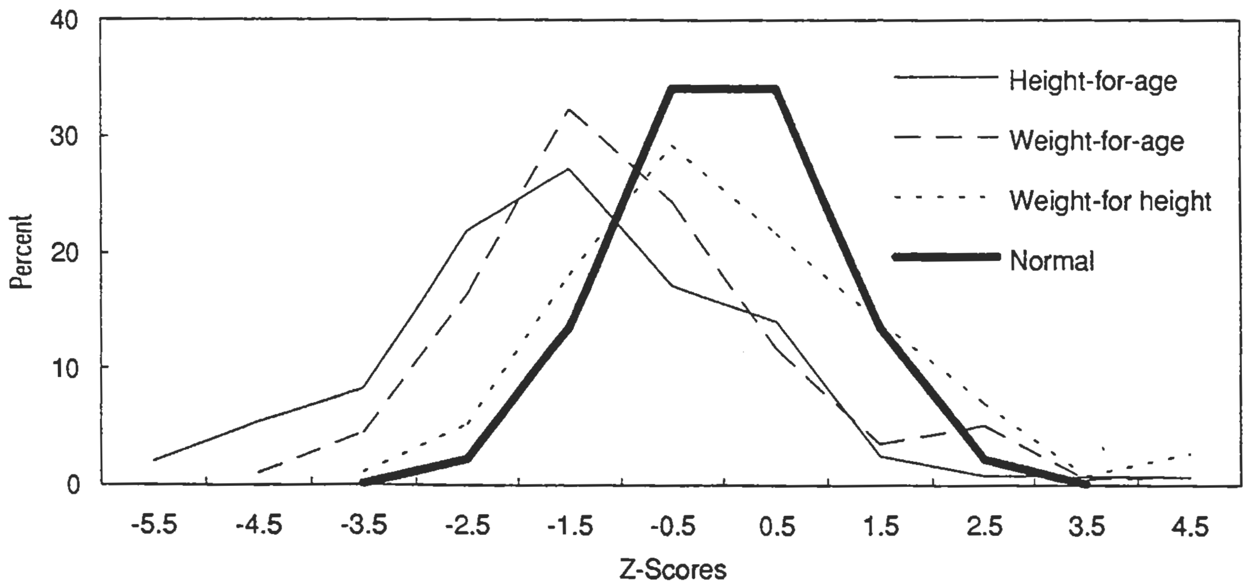

Table 2 — Z-Score Indicators for Preschool Children from Selected African Countries (Percentage Below -2)

	Chronic Undernutrition		Acute Undernutrition		Underweight	
Country (Year)	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**
Rwanda (1983/84)[a]	52.8	37.5	5.4	6.3	29.8	21.9
Burundi (1987)[b]	48.8	27.1	5.6	6.5	38.9	20.2
Egypt (1988)[a]	35.1	25.5	0.9	1.3	17.0	8.9
Ghana (1987-88)[a]	36.1	24.7	8.0	6.6	31.4	22.8
Ivory Coast (1986)[a]	36.1	24.8	8.0	6.6	13.7	10.3
Madagascar (1983-84)[c]	37.7	28.8	12.9	10.5	36.9	28.4
Malawi (1980-81)[f]	56.4[g]	—	2.2[g]	—	22.2[h]	—
Mali (1987)[b]	26.7	19.7	11.1	10.7	33.8	25.7
Morocco (1987)[d]	29.8	17.2	4.7	1.9	19.7	8.0
Niger (1985)[a]	39.5	22.0	24.2	14.9	52.0	27.4
Senegal (1986)[e]	25.5	17.7	7.2	4.5	25.2	15.2
Togo (1988)[d]	33.0	21.3	5.9	3.7	27.8	15.9
Tunisia (1988)[b]	24.6	11.8	2.7	3.4	14.0	6.7
Uganda (1988-89)[a]	25.6	46.3	1.0	2.0	12.8	24.3

Source: Carlson and Wardlaw (1990).

[a] Children aged 0-60 months.
[b] Children aged 3-36 months.
[c] Children aged 0-24 months.
[d] Children aged 0-36 months.
[e] Children aged 6-36 months.
[f] Source: National Statistical Office (1984).
[g] Average for pre and postharvest percentages for rural areas.
[h] Source: Center for Social Research (n.d.).

to other African countries, whereas the level of acute malnutrition falls into the midrange.

The reader should note that the ages of the sample children vary across samples, thus complicating the comparison. As discussed in the next section, children in the 6-to-24-month age range (weaning period) are more nutritionally vulnerable than children in either the preceding or subsequent age periods. Thus, samples with children from only this vulnerable age range tend to overstate the level of malnutrition in the overall population of children under five. Table 3 presents similar results based on the percentage of median nutritional status indicator.[10]

COMPARISON OF NUTRITIONAL STATUS, BY AGE AND SEX

Previous survey data from Rwanda and from other African countries have suggested that nutritional vulnerability changes with age, principally as a result of weaning behavior and exposure to infectious diseases.[11] The potential for age-related nutritional problems is examined in a bivariate framework in Table 4 and Figures 3 and 4. Table 4 has three important age-related nutritional implications.

First, as expected, the data indicate a pattern of heightened nutritional vulnerability during the 6-to-24-month period for both rural and urban children as the percentage of children falling below a Z-score of -2 increases for all three nutritional status indicators. This period corresponds with a child's weaning period when the introduction of supplementary foods, often of low nutritional value (e.g., cassava and sweet potatoes) and often prepared in unsanitary conditions, combine with the increasing mobility of the child to greatly increase the infant's exposure to his surrounding environment.[12]

Second, rural children have much higher levels of malnutrition during the initial 0-to-6-month period than do their urban counterparts. This suggests nutritional shortcomings, whether inadequate diet or health problems, during the mother's pregnancy.

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10 See Alderman (1990) or Martorell (1982) for a discussion of the potential differences across nutritional status methodologies (Z-score vs. percentage of median).

11 See Meheus et al. (1977), Ministry of Health and Social Affairs (MINISAPASO) (1987), and Schnepf (forthcoming a and b) for examples of declining weight-for-age during weaning.

12 This same pattern is supported by arm circumference data (indicative of wasting) from the NBCS survey reported in Schnepf (forthcoming).

Table 3 — Percentage of Median Indicators for Preschool Children in Selected African Countries

	Chronic Undernutrition[a]		Acute Undernutrition[b]		Underweight[c]	
Country (Year)	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**
Rwanda (1983/84)	37.7	24.1	3.0	3.9	33.4	26.6
(1976)	33.0	—	6.0	—	39.0	—
Cameroon (1977)	22.4	15.7	1.1	0.7	23.0	12.1
Ghana (1988)	34.8	22.0	8.6	6.1	22.9	14.3[d]
(1988)	22.8	12.3	5.8	3.5	34.8	23.5
Ivory Coast (1985)	18.4	11.3	6.5	5.0	—	—
(1986)	19.4	11.2	6.8	8.4	—	—
Egypt (1978)	23.8	12.7	0.7	0.4	9.9	5.2[d]
Kenya (1977)	28.7	12.7	0.7	0.4	9.9	5.2
Liberia (1976)	20.2	13.8	1.6	1.7	25.5	20.5
Sierra Leone (1977)	26.6	13.8	3.2	2.4	32.4	21.3[d]
Togo (1977)	20.5	11.4	2.3	0.8	16.5	8.9[d]

Sources: Alderman (1990) for all countries except Rwanda; Meheus et al. (1977) for Rwanda (1976); Rwanda (1983/84) are calculated from NBCS data.

[a] Children below 90 percent of reference height/age.
[b] Children below 80 percent of reference weight/height.
[c] Children below 80 percent of reference weight/age, except where noted.
[d] Children below 75 percent of reference weight/age.

Table 4 — Rwanda: Prevalence of Malnutrition for Rural and Urban Samples, by Age and Sex

	Rural				Urban			
	Percent	Height-for-Age	Weight-for-Age	Weight-for-Height	Percent	Height-for-Age	Weight-for-Age	Weight-for-Height
Age (months)								
0 - 5.9	7.5	39.7	10.0	2.7	13.0	10.8	1.9	1.9
6 - 11.9	6.3	60.1	52.0	20.7	11.4	31.7	21.1	0.0
12 - 23.9	16.2	72.4	32.9	10.2	20.3	54.7	22.5	12.8
24 - 35.9	15.0	62.4	45.3	1.1	21.4	27.1	28.8	1.7
36 - 47.9	14.7	44.2	33.2	5.8	11.2	45.2	25.8	9.7
48 - 59.9	21.1	54.3	20.7	3.5	22.7	41.3	22.2	6.3
60 - 74.0	19.1	36.4	23.0	2.6	—	—	—	—
Total	**100.0**	**52.8**	**29.8**	**5.4**	**100.0**	**37.5**	**21.9**	**6.3**
Sex								
Masculine	58.6	48.0	23.5	3.4	51.5	33.5	22.4	10.2
Feminine	41.4	59.6	38.8	8.2	48.2	41.7	21.4	2.2
Total	**100.0**	**52.8**	**29.8**	**5.4**	**100.0**	**37.5**	**21.9**	**6.3**

Source: MINIPLAN (n.d.).

Notes: Rural sample: N = 276 children between 0 and 74 months of age; urban sample: N = 276 children between 0 and 60 months of age. Percentage below a Z-score of -2.

Figure 3 — Rwanda: Rural Malnutrition by Age Group

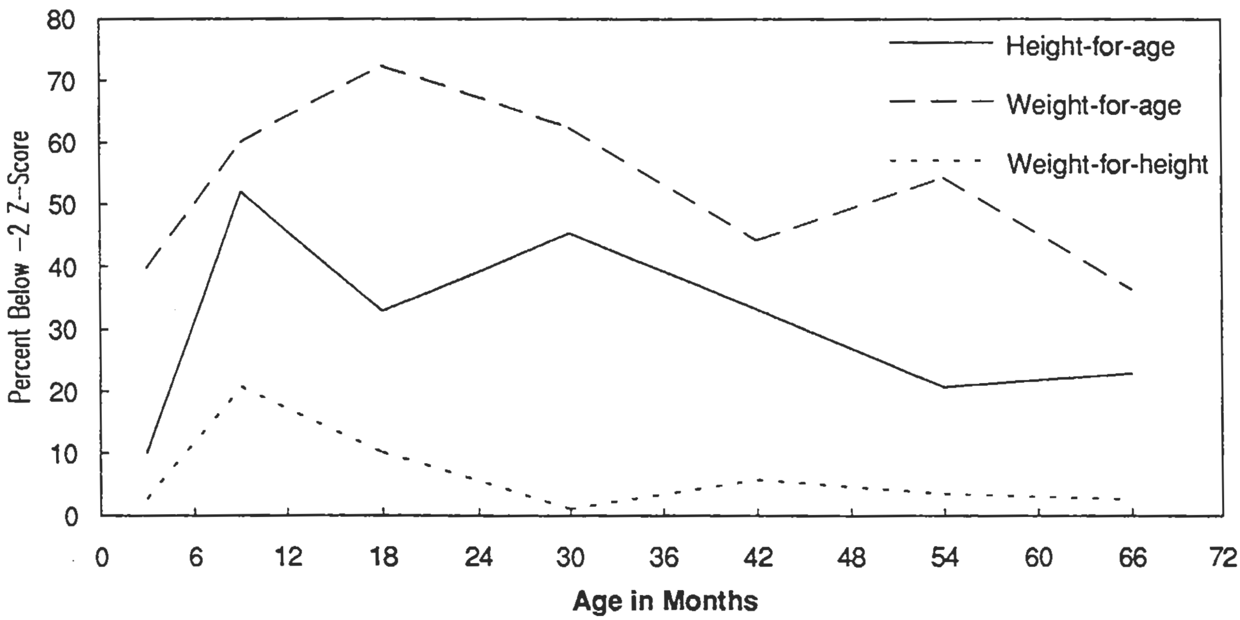
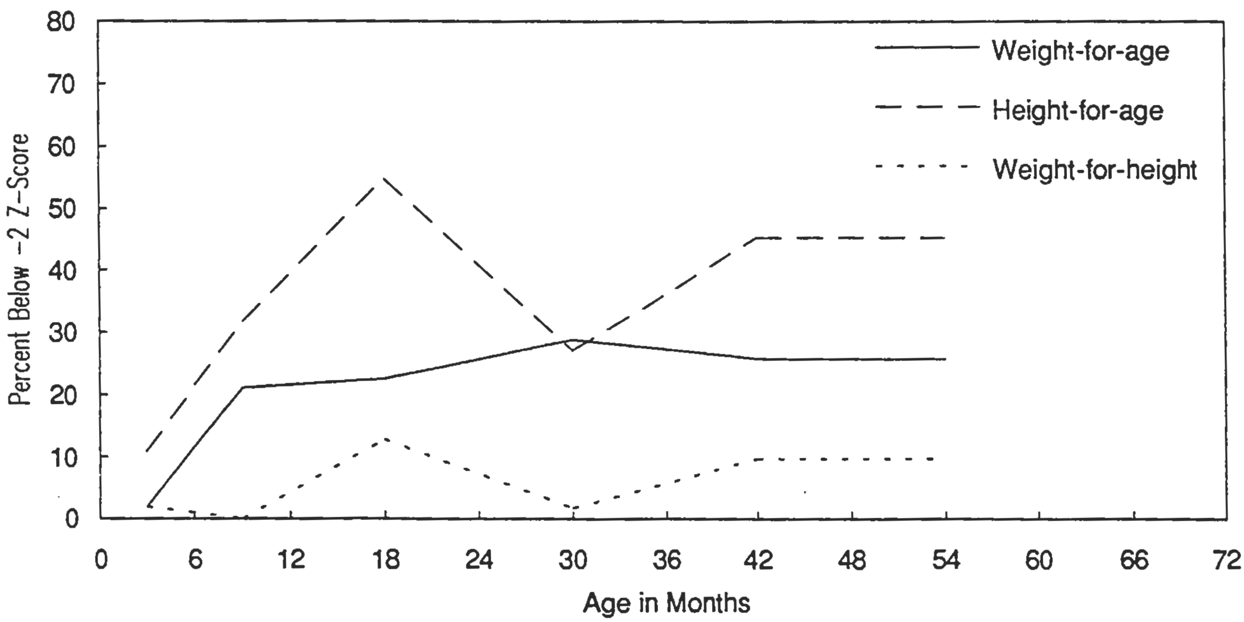


Figure 4 — Rwanda: Urban Malnutrition by Age Group



Third, rural children appear to recover somewhat from the high levels of malnutrition associated with the 6-to-24-month period, whereas urban children tend to maintain fairly high levels of malnutrition.

The second and third points are related to the household's access to adequate health infrastructure and reflect, in part, the greater access available to urban dwellers. Elevated infant and child mortality rates (127 per 1,000 for the first 12 months, and 214 per 1,000 for the first five years) [ONAPO 1983] prevail in rural Rwanda. Although corresponding mortality rates in urban areas are not known, one can hypothesize that improved urban access to medical facilities reduces the number of deaths from easily treatable infectious diseases. However, urban children do not improve their overall nutritional status as the health infrastructure is essentially curative rather than preventive, particularly with respect to nutritional rehabilitation activities for moderately malnourished children. On the other hand, the rural ranks of the severe and moderately malnourished are decimated by mortality, thus giving the statistical appearance of improving levels of nutritional status.

Table 4 shows differences in malnutrition rates by sex. The bivariate framework suggests that female children have higher levels of malnutrition for all three nutritional status indicators from the rural sample. They have higher levels of chronic malnutrition only in the urban sample. Male urban children have higher levels of acute malnutrition (10.2 percent) than their urban female counterparts (2.2 percent). However, the bivariate results of Table 4 are not supported by the multivariate analysis presented in Section 3, where no differences between nutritional status for the sexes are found.

COMPARISON OF NUTRITIONAL STATUS, BY SEX ACROSS AGES

Tables 5 and 6 examine in greater detail differences by sex across age groups.[13] In both tables females in all age groups show higher levels of chronic malnutrition; however, their pattern of vulnerability is very different from that of males. The male children in both rural and urban areas appear to become gradually more malnourished until their second year, when chronic malnutrition levels reach a peak (75.6 percent and 54.2 percent, respectively, for rural and urban boys). Significant retrenchment occurs after the second year. Urban female children displayed a similar pattern; however, rural girls demonstrated a tendency for chronic malnutrition to begin at dramatically high levels during the first six months (72.4 percent), then taper downward thereafter.

With respect to acute malnutrition rates, rural children of both sexes attained peak levels during the 6-to-12-month period (21.9 percent and 19.9

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[13] Tables 5 and 6 are included for descriptive purposes. They reveal general patterns rather than absolute levels. Their interpretation should be made with the understanding that small sample sizes within cells may exaggerate or understate the absolute level of malnutrition across specific age and sex groups.

Table 5 — Rwanda: Rural Distribution of Nutritional Indicator Z-Scores, by Age and Sex

	Age Group (In Months)				
	0.0-5.9	**6.0-11.9**	**12.0-23.9**	**24.0-60.0**	**All**
			Males		
Height-for-age					
<-2	25.6	46.0	75.6	44.7	48.0
-2 <-1	38.2	43.0	17.9	23.0	24.4
-1 < 0	15.3	0.0	6.5	15.6	13.5
0 < 1	8.4	0.0	0.0	6.9	5.7
1 < 2	0.0	0.0	0.0	3.2	2.3
2 <=	12.5	11.0	0.0	6.6	6.2
Weight-for-height					
<-2	3.8	21.9	8.1	1.2	3.4
-2 <-1	17.0	0.0	17.9	28.6	24.6
-1 < 0	9.2	27.9	19.0	35.2	30.0
0 < 1	31.4	28.1	19.8	29.5	28.1
1 < 2	3.5	22.1	25.2	5.0	8.8
2 <=	35.1	0.0	10.0	0.5	5.1
Sample size	**15**	**7**	**26**	**115**	**162**
			Females		
Height-for-age					
<-2	72.4	69.5	68.0	55.2	59.6
-2 <-1	5.4	5.5	21.0	18.0	16.6
-1 < 0	22.1	6.5	11.0	11.2	11.4
0 < 1	0.0	3.1	0.0	4.4	3.3
1 < 2	0.0	0.0	0.0	4.5	3.1
2 <=	0.0	15.4	0.0	6.6	6.0
Weight-for-height					
<-2	0.0	19.9	13.0	6.2	8.2
-2 <-1	0.0	0.0	9.9	22.9	17.4
-1 < 0	0.0	26.0	23.7	42.9	35.8
0 < 1	22.1	25.9	28.5	18.8	21.2
1 < 2	49.8	0.0	16.8	7.3	10.5
2 <=	28.1	28.2	8.1	2.0	6.8
Sample size	**6**	**11**	**19**	**79**	**114**

Source: MINIPLAN (n.d.).

Notes: Percentage of cell population in each category. Some percentages may not add to exactly 100 due to rounding. N = 276 children between 0 and 74 months of age: 114 females and 162 males. Small sample size, particularly for the three youngest age groups, may result in inaccurate estimates of the prevalence of malnutrition within individual categories.

Table 6 — Rwanda: Urban Distribution of Nutritional Indicator Z-Scores, by Age and Sex

	Age Group (In Months)				
	0.0-5.9	**6.0-11.9**	**12.0-23.9**	**24.0-60.0**	**All**
			Males		
Height-for-age					
<-2	0.0	26.1	54.2	33.4	33.5
-2 <-1	6.5	13.7	11.8	36.2	25.7
-1 < 0	6.4	36.9	26.3	18.6	20.9
0 < 1	75.1	23.3	2.4	9.5	16.3
1 < 2	8.3	0.0	0.0	1.7	1.8
2 <=	3.7	0.0	5.2	0.6	1.8
Weight-for-height					
<-2	3.6	0.0	18.2	10.4	10.2
-2 <-1	4.5	0.0	10.9	18.0	13.2
-1 < 0	14.3	18.6	35.3	34.1	30.7
0 < 1	6.0	20.9	2.3	27.4	19.3
1 < 2	49.0	14.6	10.1	9.4	14.2
2 <=	22.6	45.9	23.3	0.6	12.4
Sample size	**15**	**15**	**30**	**82**	**142**
			Females		
Height-for-age					
<-2	23.3	35.0	55.3	42.4	41.7
-2 <-1	34.3	34.8	26.4	26.7	28.9
-1 < 0	6.9	9.6	12.9	16.1	13.3
0 < 1	18.7	17.6	0.0	13.0	11.8
1 < 2	11.5	0.0	5.4	1.9	3.2
2 <=	5.2	3.1	0.0	0.0	1.1
Weight-for-height					
<-2	0.0	0.0	6.8	1.5	2.2
-2 <-1	19.9	13.8	8.3	33.4	23.5
-1 < 0	0.0	38.2	15.4	33.8	27.8
0 < 1	19.2	25.4	25.0	24.3	24.2
1 < 2	6.5	15.8	39.0	5.2	14.0
2 <=	54.5	6.8	5.5	1.8	8.5
Sample size	**13**	**25**	**26**	**70**	**134**

Source: MINIPLAN (n.d.).

Notes: Percentage of cell population in each category. Some percentages may not add to exactly 100 due to rounding. N = 276 children between 0 and 60 months of age: 134 females and 142 males. Small sample size, particularly for the three youngest age groups, may result in inaccurate estimates of the prevalence of malnutrition within individual categories.

percent, respectively, for boys and girls); whereas urban children peaked during the 12-to-24-month period (18.2 percent and 6.8 percent, respectively). This result suggests that some factor or factors are delaying the onset of acute malnutrition in urban areas, although acute malnutrition levels do eventually (six to nine months later) reach the same levels as in rural areas.

COMPARISON OF NUTRITIONAL STATUS, BY LOCATION

Finally, malnutrition rates and calorie availability levels are compared across the five principal rural agroclimatic zones of Rwanda (Figure 5) in Table 7. Although the percentage of households failing to meet 100 percent and 80 percent of the suggested standard of 2,100 calories per day per adult equivalent (Ministry of Agriculture [MINAGRI] 1988) shows a positive correlation with its corresponding regional mean calorie levels, it does not correlate well with child malnutrition rates. The northwest, north central, and east are regions of high calorie production and availability relative to the southwest and south central zones; yet these same three regions all have high prevalences of stunting combined with relatively higher levels of wasting and underweight in children than do the principal food deficit zones. This suggests that factors other than regional calorie availability are important determinants of child nutritional status in rural areas. Further support for this hypothesis is borne out by the comparison of lower calorie availability alongside lower malnutrition prevalence for urban relative to rural areas.

A potential hypothesis explaining this phenomenon is the nutritional significance of infectious diseases, morbidity, and the related access to health infrastructure for household behavioral responses to perceived health needs.

Malnutrition is a problem that happens to individuals. To correctly understand its causality, research must focus on the household level and not on regional aggregates. In pursuit of this goal, the next section describes a household-level study of preschool child malnutrition.

Figure 5 — Agroclimatic Zones of Rwanda

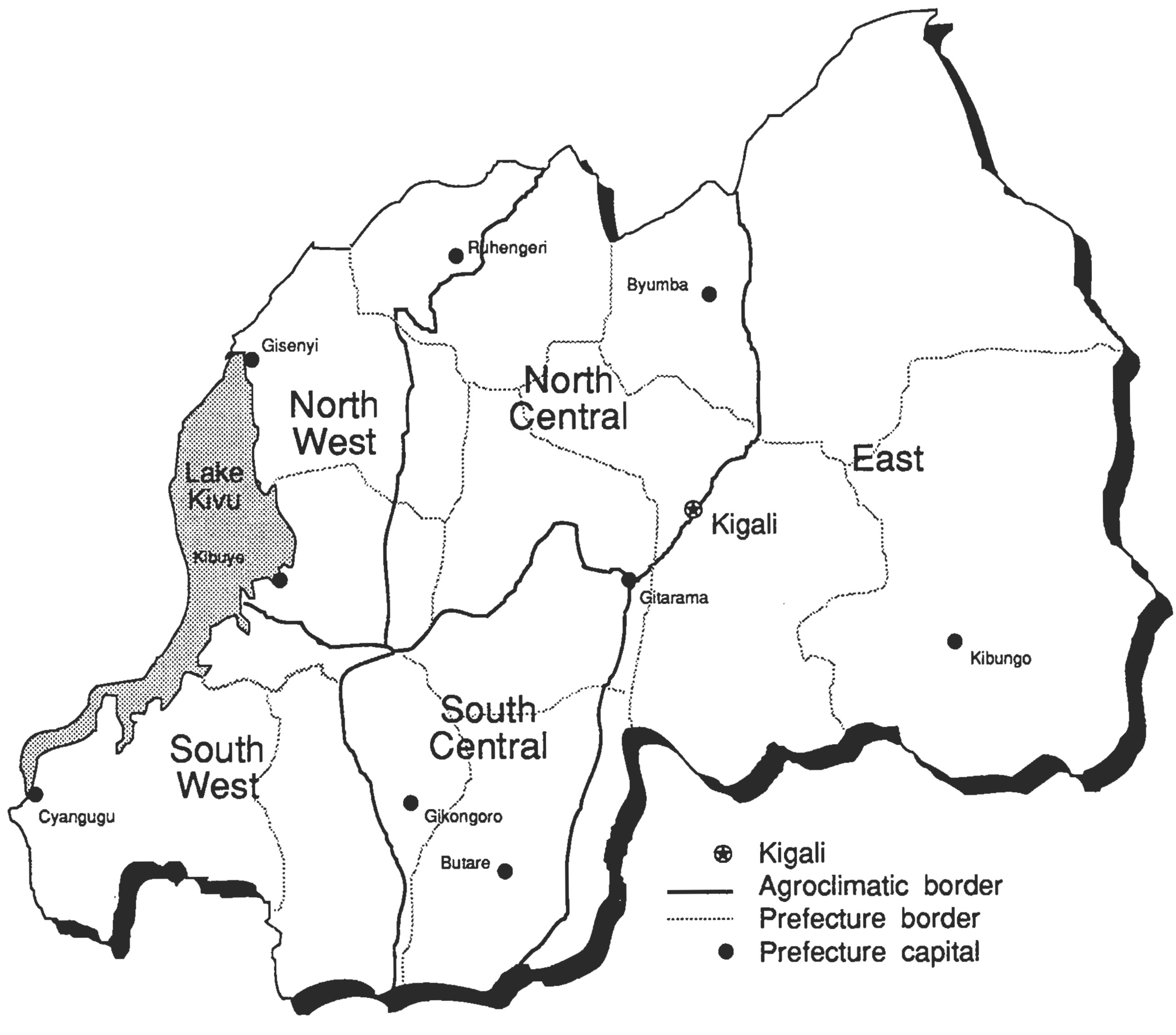

Table 7 — Rwanda: Percentage of Rural Households Below Specified Levels of Calorie Availability per Adult Equivalent per Day, Compared with Child Malnutrition Levels

		% HHs < % RDA				Child Malnutrition[c]		
Agroclimatic Zone	Sample Size	< 100%	< 80%	Calorie/ Day/AQ	Sample Size	Height-for-Age	Weight-for-Age	Weight-for-Height
Northwest	39	33	15	2,642	39	72	37	6
Southwest	42	52	31	2,169	42	38	24	0
North Central	60	36	14	2,552	63	63	33	9
South Central	57	54	26	2,122	62	52	32	4
East	66	27	8	2,701	69	42	25	7
Rural[a]	264	40	18	2,449	276	53	30	5
Urban[b]	297	71	44	2,040	276	38	22	6

Source: MINIPLAN (n.d.).

[a] Number of households = 264; number of children = 276.
[b] Number of households = 297; number of children = 276.
[c] Percentage of observations falling below a Z-score of -2.

Note: Based on 2,100 calories/day/adult equivalent = 100 percent.

3. DETERMINANTS OF CHILD NUTRITIONAL STATUS

INTRODUCTION

In an agriculturally oriented country like Rwanda, the concept of food security is often confused with nutritional status. Since this section focuses on nutritional status, it is useful to distinguish clearly between the two.

Household food security is concerned with the regularity of household calorie availability, whether derived from the household's own production or from household purchasing power. Household nutritional status, on the other hand, refers to the nutritional status of its individual members, which in turn results from a combination of nutrient intake, physical output, and disease. Nutritional status of preschool children is used as a proxy for the family's nutritional well-being. This convention is adopted for two reasons. First, preschool children, along with pregnant or lactating women, show nutritional stress earlier than other household members (Martorell 1982). Second, international reference standards exist for evaluating the nutritional status of preschool children, thus permitting comparisons over time and across countries.

To the extent that nutrient intake is a function of household food expenditure and calorie acquisition behavior, the nutritional status of a household member is directly affected by the level of household food security. But a complete study of household nutritional status is much broader and must necessarily consider calorie and nutrient composition, intrahousehold food distribution, physical and mental growth, individual activity levels, sanitary environment, frequency and severity of disease, infections, parasitic infestations, household fertility and birth spacing behavior, household feeding and childcare habits, and the condition of women in general, but more particularly with pregnant and lactating women. All of these factors influence the household's ability to respond to the nutritional needs of its members. Furthermore, each of the different factors may experience seasonal variations in their degree of influence.

Given the multiplicity of factors influencing an individual's nutritional status and the potential for complexity of interactions, it is useful to develop a framework for understanding and analyzing the factors that may affect nutritional status at the household level.

HOUSEHOLD MODEL OF UNDERLYING NUTRITIONAL STRUCTURE

A graphic model (Figure 6) identifies the many potential factors and interactions at the household level that produce the nutritional status outcomes of individual family members. Figure 6 shows the allocation of the household's limited pool of physical and human resources to various income- and nonincome-generating activities. The different levels of activities produce goods and revenue, as well as domestic, nonmarket products: meals; childcare, including breast-feeding; gathering of fuel and water; and hygienic activities such as house cleaning, laundry, and bathing).[14]

The household decisionmaking process allocates pecuniary and food resources between the household's food and nonfood budgets. Intrahousehold resource control affects both the size of each budget and the composition of subsequent expenditures. These two budgets combined with the available person-hours of time represent the limiting factors to the household's efforts at satisfying its perceived nutritional and health needs.

Food acquisition behavior, along with the mother's time allocated to breast-feeding and introducing supplementary foods, as well as preparing meals, feeding, storing food, and collecting water and fuel, directly affects an individual's food intake. On the other hand, investments of time and money in water quality, and excrement and solid waste disposal, as well as kitchen, bathing, and laundry facilities, determine the quality of the household's sanitary environment. The household's sanitary environment represents the medium through which the level of household exposure to disease vectors is controlled. Thus, it has a strong relationship with household morbidity and mortality, otherwise called the "health outcome" for the household's members.

An individual's health outcome directly affects his or her nutritional status. Illness often reduces an individual's appetite and, along with infections and internal parasites, may impair the body's ability to absorb nutrients from ingested foods. Diarrhea can also produce dehydration. Severe illness may even result in death in malnourished children.

Finally, given the context of constrained household money, food, and time resources, the household members' nutritional status and health status outcomes coexist as end results of the household decisionmaking process. An individual's health and nutritional outcomes are determined simultaneously. Shortcomings in one may produce or reinforce shortcomings in the other. A malnourished child has a higher risk of illness than a well-nourished child. Similarly, a sick child has a higher likelihood of poor nutrient absorption and subsequent poor nutritional status than a healthy child.

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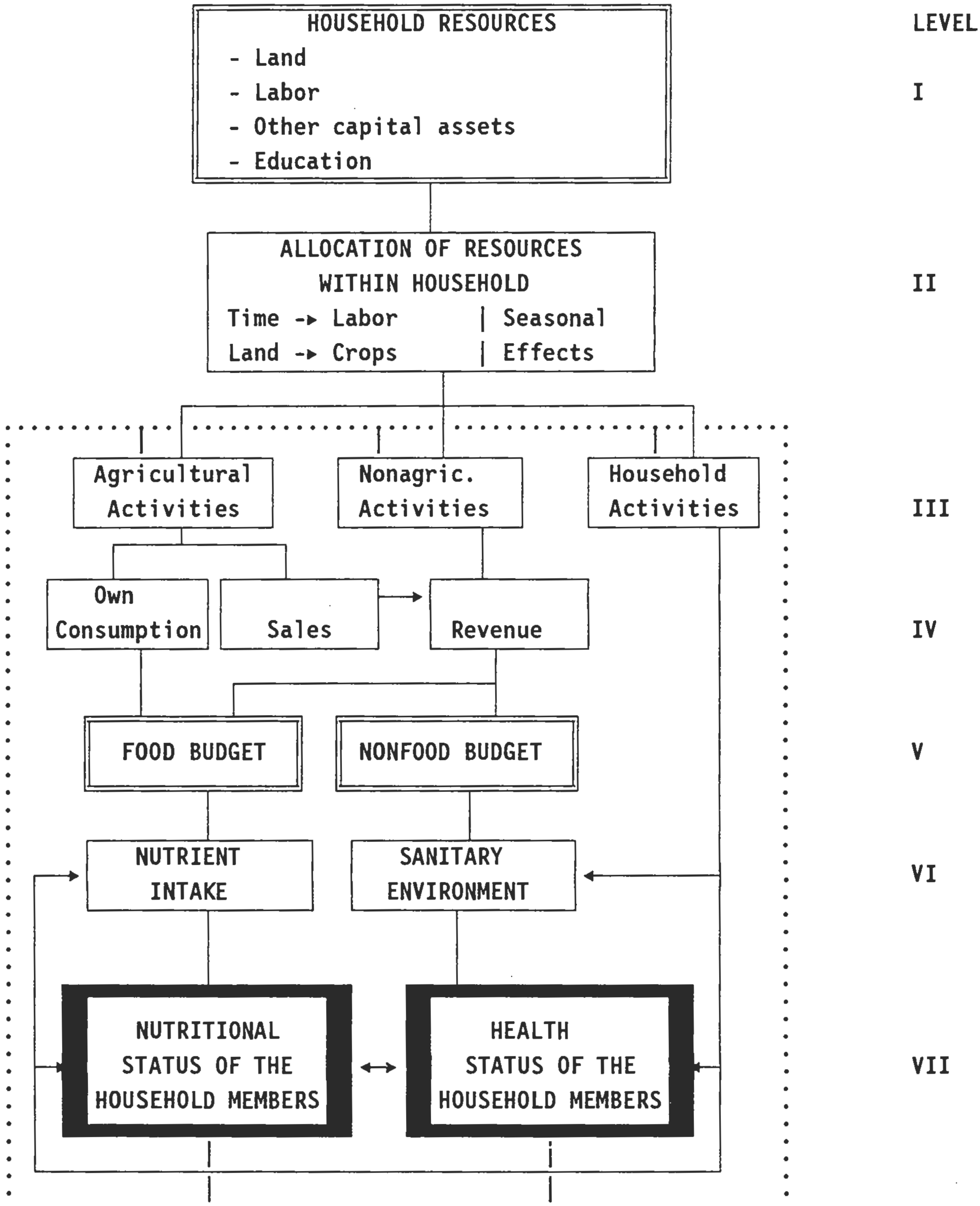
[14] These domestic, nonmarket products are the result of the "Household Activities" box at level III (Figure 6).

Figure 6 — Rwanda: Household Nutrition Model



Note: All relations marked by a continuous line run downward unless marked differently with an arrow. The dotted lines are feedback loops.

An additional feedback mechanism exists whereby the household's health and nutritional outcomes influence its ability to undertake and perform the revenue-generating activities of level III.

Strauss (1986) and Deolalikar (1988) have found a positive relationship between nutrient intake and the level of productivity generated by the household. Shortfalls in nutrient adequacy may contribute to poor nutrition and health outcomes, which subsequently reduce labor productivity and household revenue. The process may eventually become self-reinforcing via the feedback mechanism.

The model serves as a guide in tracing the causal relationship between different socioeconomic variables and the household members' nutritional status. It will be referenced throughout this report. However, due to the survey's orientation toward budget expenditure and food consumption, specific information concerning the household's sanitary environment and health outcome, and the nutritional feedback mechanism, is lacking. Thus, the actual model used in this study will incorporate only a unidirectional flow running from health status to nutritional status, while ignoring the feedback of nutritional status into labor productivity. Also, the link between the household food budget and individual food intake is not fully explored since information is lacking on intrahousehold food distribution and child feeding practices (particularly with respect to meal frequency and the calorie density of foods consumed).

TOTAL EXPENDITURES, FOOD EXPENDITURE, AND CALORIE ACQUISITION

The levels of child malnutrition are examined across quartiles of total household expenditures, food expenditure, and calorie acquisition in Tables 8 (rural) and 9 (urban).[15]

The rural data from Table 8 reveal no significant association between any of the nutritional status indicators across expenditure and calorie acquisition quartiles. This is partially the result of little variation across rural households. The coefficients of variation were 0.35, 0.40, and 0.48, respectively, for calories per day per adult equivalent, food expenditure per adult equivalent, and total expenditures per adult equivalent.

Greater variation in expenditure and calorie acquisition levels exists across quartiles for the urban sample (Table 9). The coefficients of variation were 0.59, 0.72, and 0.90, respectively, for calories per day per adult equivalent, food expenditure per adult equivalent, and total expenditures per adult equivalent.

This variation between expenditure and calorie acquisition levels produced trends of declining malnutrition levels (as measured by the percentage of

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[15] Separate tables are presented since the prices used to value household expenditures for the two samples are not deflated for either spatial or temporal differences; consequently, direct comparisons cannot be made.

Table 8 — Rwanda: Rural Child Malnutrition Using Z-Scores per Adult Equivalent — Total Expenditures, Food Expenditure, and Calories

Variable Quartile	Average	Height-for-Age % < -2	Height-for-Age Average	Weight-for-Age % < -2	Weight-for-Age Average	Weight-for-Height % < -2	Weight-for-Height Average
Total expenditures per adult equivalent (FRW)							
Q1	7,254.0	56.8	-2.4	37.2	-1.6	4.9	-0.2
Q2	9,743.2	58.2	-1.9	38.2	-1.6	8.8	-0.6
Q3	12,457.0	33.3	-1.2	18.5	-0.9	3.5	-0.0
Q4	20,077.6	63.3	-2.0	25.2	-1.2	4.6	0.1
Food expenditure per adult equivalent (FRW)							
Q1	6,180.2	51.1	-2.1	25.3	-1.5	5.0	-0.2
Q2	8,178.1	42.1	-1.1	25.9	-1.1	4.2	-0.5
Q3	10,402.7	64.9	-2.4	52.9	-1.2	7.3	-0.5
Q4	15,477.7	54.7	-1.9	17.1	-0.9	5.4	0.4
Calorie per day per adult equivalent							
Q1	1,558.1	61.9	-2.4	36.5	-0.1	4.6	-0.1
Q2	1,978.8	57.1	-2.1	40.9	-0.5	4.8	-0.5
Q3	2,430.7	43.6	-1.3	20.1	-0.2	4.9	-0.2
Q4	3,236.2	48.4	-1.8	21.6	0.1	7.3	0.1

Source: MINIPLAN (n.d.).

Note: N = 276 children between 0 and 74 months of age.

Table 9 — Rwanda: Urban Child Malnutrition Using Z-Scores per Adult Equivalent — Total Expenditures, Food Expenditure, and Calories

		Height-for-Age		Weight-for-Age		Weight-for-Height	
Variable Quartile	**Average**	**% < -2**	**Average**	**% < -2**	**Average**	**% < -2**	**Average**
Total expenditures per adult equivalent (FRW)							
Q1	14,734.0	42.2	-1.72	28.0	-1.24	15.1	-0.15
Q2	26,079.6	42.4	-1.62	31.0	-1.38	1.7	-0.44
Q3	40,653.7	36.5	-1.45	17.3	-0.98	6.3	-0.13
Q4	101,733.9	28.6	-1.27	11.1	-0.08	2.1	0.97
Food expenditure per adult equivalent (FRW)							
Q1	11,235.4	45.0	-1.83	29.6	-1.35	13.8	-0.21
Q2	17,916.4	42.1	-1.35	25.6	-1.01	3.9	-0.18
Q3	23,678.4	36.6	-1.63	18.3	-1.25	5.7	-0.27
Q4	47,783.6	26.1	-0.25	14.2	-0.08	1.8	0.89
Calorie per day per adult equivalent							
Q1	1,224.4	55.6	-1.99	26.4	-1.20	9.4	0.11
Q2	1,568.8	34.5	-1.35	23.1	-1.20	4.4	-0.40
Q3	1,909.8	29.1	-1.45	25.1	-1.01	3.5	-0.17
Q4	3,266.1	30.9	-1.28	13.1	-0.22	8.0	0.68

Source: MINIPLAN (n.d.).

Note: N = 276 children between 0 and 74 months of age.

observations falling below a Z-score of -2 of height-for-age and weight-for-age when reading from the lowest quartile (Q1) to the highest (Q4) for both total and food expenditure variables. No trend emerged for acute malnutrition across the three variables, nor for any of the three nutritional status indicators with respect to calories per day per adult equivalent.

On the other hand, the "within quartile" mean Z-score levels of height-for-age and weight-for-age (representing centrality of the entire distribution) trended upward with increases in total expenditure per adult equivalent. Likewise, mean weight-for-age Z-scores trended higher with increases in calories per day per adult equivalent.

In summary, simple cross tabulations of malnutrition levels across quartiles of total household expenditures, food expenditure, and calorie acquisition (all in per adult equivalent terms) suggest the potential for positive associations between child nutritional status and increases in household income and food for urban areas. Similar associations are less clear for rural areas.

MULTIVARIATE ANALYSIS OF NUTRITIONAL STATUS DETERMINANTS

This section presents the specification and statistical estimation of the household model presented in Figure 6. The focus of this estimation procedure is to obtain approximations of the influence and degree of importance that household consumption behavior has in determining the household's nutritional outcome. The Z-scores for the three nutritional status indicators (height-for-age, weight-for-age, and weight-for-height) from the sample children are used to represent the household's nutritional outcome.

The household nutritional model shows that two main inputs produce the nutritional outcome of preschool children. These are nutrient intake and health status. Although food expenditures and calories acquired are available at the household level, individual intakes were not observed. This creates certain difficulties in using household calorie availability since adult foods (e.g., alcoholic beverages) are not always easily distinguishable from those foods potentially consumed by children.

Furthermore, the survey did not include actual measures of health status, e.g., observed disease incidence or morbidity; nor were specific measures recorded for either the status of or investments in the household's sanitary environment. However, household expenditures were recorded for medical as well as hygienic inputs; these expenditures are differentiated as curative and preventive, respectively. In light of these data omissions a simplified estimating procedure under three separate specifications of household consumption behavior is examined for nutritional outcome.

First, the natural logarithm of household permanent income is used to represent both food inputs and household investments in its sanitary environment. Household total expenditure per adult equivalent (*TX/AQ*) is used as a proxy for household permanent income.

Second, the natural logarithm of predicted household total food expenditures per adult equivalent (*FDX/AQ*) is used as a proxy for nutrient intake.

Third, the natural logarithm of predicted household daily calorie availability per day per adult equivalent (*CAL/AQ*) is also used to represent nutrient intake.

The three specifications of household consumption behavior produce three distinct nutritional status estimating equations (NS_i) represented by equation (1) for rural areas and equation (2) for urban areas. The final variable in each equation is subject to change across estimations for each of the three variable specifications described above.

Rural Estimating Equation

$$NS_i = b_0 + b_1(SEX) + b_2(AGE) + b_3(AGE)^2 + b_4(ORD) + b_5(NURSING) + b_6(SEXHD) + b_7(AGEHD) + b_8(EDM1) + b_9(EDM2) + b_{10}(EDF1) + b_{11}(EDF2) + b_{12}(NADEQ) + b_{13}(HLTH\_CUR) + b_{14}(HLTH\_PRV) + b_{15}(CAL/AQ \text{ or } FDX/AQ \text{ or } TX/AQ) \quad (1)$$

Urban Estimating Equation

$$NS_i = b_0 + b_1(SEX) + b_2(AGE) + b_3(AGESQ) + b_4(ORD) + b_5(NURSING) + b_6(SEXHD) + b_7(AGEHD) + b_8(EDM1) + b_9(EDM2) + b_{10}(EDF1) + b_{11}(EDF2) + b_{12}(NADEQ) + B_{13}(RUH\_GSY) + b_{14}(HLTH\_CUR) + b_{15}(HLTH\_PRV) + b_{16}(CAL/AQ \text{ or } FDX/AQ \text{ or } TX/AQ) \quad (2)$$

The variable definitions and descriptive statistics for all of the nutritional status indicators and household socioeconomic variables are presented in Tables 10 and 11.

Equations 1 and 2 under the first two specifications are essentially reduced-form estimating equations derivable from some underlying utility maximizing framework (Strauss 1988); whereas, the estimating equations, 1 and 2, closely represent nutrition production functions under the third specification.

Predicted food expenditure and calorie availability are used to avoid simultaneity bias (Tables 12 and 13). The inclusion of household calorie

Table 10 —Rwanda: Urban and Rural Variable Definitions

Name	Definition
SEX	Child sex: male = 1; female = 0
AGE	Child age in months
AGESQ	Child age squared
ORD	Child hierarchical order in household
NURSING	Child age 0 to 6 months = 1; otherwise 0
SEXHD	Head of household sex: 1=male; 0=female
AGEHD	Head of household age in years
AGEHDSQ	Head of household age in years squared
EDM1	Maternal education: 1=1-4 years of primary education; 0 otherwise
EDM2	Maternal education: 1=completed 5 years of primary or more; 0 otherwise
EDP1	Paternal education: 1=1-4 years of primary education; 0 otherwise
EDP2	Paternal education: 1=completed 5 years of primary or more; 0 otherwise
NADEQ	Number of household adult equivalents
HHSIZE	Number of household members
DEP_RAT	(Number of children < 14 years) / (Number of adults ≥ 14 years)
CH_0_6	Number of children aged 0 to 6 years
CH_7_13	Number of children aged 7 to 13 years
M_14_19	Number of adult males aged 14 to 19 years
M_20_59	Number of adult males aged 20 to 59 years
M_60	Number of adult males aged 60 years or older
F_14_19	Number of adult females aged 14 to 19 years
F_20_59	Number of adult females aged 20 to 59 years
F_60	Number of adult females aged 60 years or older
HLTH_CUR	Total curative health expenditure in FRW
HLTH_PRV	Total preventive health expenditures in FRW
LN(TX/AQ)	Natural log of total expenditures (FRW) per adult equivalent
LN(FDX/AQ)	Predicted natural log of food expenditures (FRW) per adult equivalent
LN(CAL/AQ)	Predicted natural log of household calorie acquisition per adult equivalent per day
FD_SHARE	Food expenditures as a percentage of total expenditures
PRICE_CAL	Price (FRW) per 1000 calories
SUBSIST	Value of consumption from own production as a percentage of total expenditures
RURAL	
OCC_AGR	Principal occupation: Agriculture = 1; otherwise 0
OCC_ART	Principal occupation: Artisan = 1; otherwise 0
OCC_OTH	Principal occupation: Other = 1; otherwise 0
ZET	Agroclimatic zone: East = 1; otherwise 0
ZNW	Agroclimatic zone: Northwest = 1; otherwise 0
ZSW	Agroclimatic zone: Southwest = 1; otherwise 0
ZNC	Agroclimatic zone: North Central = 1; otherwise 0
ZSC	Agroclimatic zone: South Central = 1; otherwise 0
URBAN	
OCC_AGR	Principal occupation: Agriculture = 1; otherwise 0
OCC_ART	Principal occupation: Artisan = 1; otherwise 0
OCC_OTH	Principal occupation: Other = 1; otherwise 0
OCC_COM	Principal occupation: Commerce = 1; otherwise 0
OCC_PBSL	Principal occupation: Public sector = 1; otherwise 0
OCC_PVSL	Principal occupation: Private sector = 1; otherwise 0
RUH_GSY	Ruhengeri/Gisenyi=1; otherwise 0

Table 11 — Rwanda: Nutrition Status Equations for Rural and Urban Variable Descriptive Statistics

	Rural		Urban	
Variable Names	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
SEX	0.57	0.50	0.52	0.50
AGE	35.76	20.76	29.54	17.95
AGESQ	1,708.63	1,540.87	1,193.57	1,119.43
ORD	5.46	1.98	6.20	4.74
NURSING	0.08	0.28	0.11	0.31
SEXHD	0.90	0.30	0.88	0.32
AGEHD	41.84	13.68	38.96	12.45
EDM1	0.21	0.41	0.38	0.49
EDM2	0.12	0.33	0.22	0.42
EDP1	0.31	0.46	0.48	0.50
EDP2	0.25	0.44	0.20	0.40
NADEQ	5.08	1.76	6.27	2.88
RUH_GSY	—	—	0.28	0.45
HLTH_CUR	267.29	436.32	3,504.75	6,310.85
HLTH_PRV	366.17	340.33	4,851.36	5,300.25
LN(TX/AQ)	9.33	0.42	10.32	0.65
LN(FDX/AQ)	9.15	0.37	9.83	0.38
LN(CAL/AQ)	7.70	0.26	7.45	0.29

Source: MINIPLAN (n.d.).

Table 12 — Rwanda: Rural Food Expenditure and Calorie Acquisition Instrument Equations

	Food[a]		Calorie[a] Acquisition	
Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
CONSTANT	1.4760***	(0.2450)	3.3040***	(0.4650)
SEXHD	0.0550*	(0.0320)	0.0230	(0.0620)
AGEHD	-0.0047	(0.0038)	-0.0100	(0.0070)
AGEHDSQ	0.5510[b]	(0.3770)[b]	1.0960[b]	(0.7150)[b]
EDM1	0.0180	(0.0260)	-0.0090	(0.0500)
EDM2	-0.0590*	(0.0330)	-0.0420	(0.0630)
EDP1	0.0070	(0.0240)	0.0610	(0.0450)
EDP2	-0.0310	(0.0280)	0.0080	(0.0540)
ZNW	-0.0280	(0.0290)	0.0400	(0.0550)
ZSW	-0.0560*	(0.0290)	-0.0750	(0.0550)
ZNC	-0.0140	(0.0270)	0.0580	(0.0520)
ZSC	-0.0430	(0.0260)	-0.0680	(0.0500)
OCC_ART	-0.0300	(0.0200)	-0.0770**	(0.0380)
OCC_OTH	-0.0270	(0.0260)	-0.1280***	(0.0480)
CH_0_6	0.0100	(0.0090)	-0.0040	(0.0160)
CH_7_13	-0.0280***	(0.0090)	-0.0490***	(0.0180)
M_14_19	-0.0320**	(0.0140)	-0.0320	(0.0270)
M_20_59	-0.0050	(0.0170)	-0.0250	(0.0320)
M_60	-0.0390	(0.0380)	-0.0750	(0.0710)
F_14_19	-0.0230	(0.0150)	-0.0310	(0.0280)
F_20_59	-0.0004	(0.0180)	0.0330	(0.0340)
F_60	0.0150	(0.0400)	0.0170	(0.0760)
SUBSIST	0.0016***	(0.0005)	0.0023**	(0.0010)
LN(TX/AQ)	0.8260***	(0.0230)	0.4900***	(0.0430)
Adjusted R^2	0.8870		0.5050	

Source: MINIPLAN (n.d.).

[a] Natural logarithm.
[b] x 10^{-4}.

Note: Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***.

Table 13 — Rwanda: Urban Food Expenditure and Calorie Acquisition Instrument Equations

	Food[a]		Calorie[a] Acquisition	
Variable	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
CONSTANT	3.8540***	(0.3770)	3.6790***	(0.4680)
SEXHD	-0.0340	(0.0600)	0.0020	(0.0740)
AGEHD	-0.0070	(0.0074)	0.0029	(0.0092)
AGEHDSQ	0.6690[b]	(0.8180)[b]	-0.3980[b]	(1.0160)[b]
EDM1	-0.0330	(0.0370)	0.4100	(0.0460)
EDM2	-0.1210**	(0.0520)	-0.1340**	(0.0950)
EDP1	0.1010**	(0.0480)	0.0920	(0.0590)
EDP2	0.0840	(0.0610)	0.0450	(0.0760)
RUH_GSY	-0.0430	(0.0380)	-0.0020	(0.0470)
OCC_AGR	0.1290*	(0.0720)	0.2860***	(0.0900)
OCC_ART	0.0550	(0.0570)	0.1090	(0.0710)
OCC_OTH	0.0020	(0.0560)	-0.0220	(0.0960)
OCC_COM	0.0140	(0.0680)	-0.0470	(0.0840)
OCC_PBSL	0.0800	(0.0660)	0.1360*	(0.0820)
CH_0_6	0.0020	(0.0140)	0.0010	(0.0180)
CH_7_13	-0.0080	(0.0160)	-0.0150	(0.0200)
M_14_19	-0.0240	(0.0240)	-0.0260	(0.0300)
M_20_59	-0.0640***	(0.0200)	-0.0490**	(0.0240)
M_60	0.0270	(0.0800)	0.0470	(0.0990)
F_14_19	-0.0220	(0.0230)	-0.0620**	(0.0280)
F_20_59	-0.0300	(0.0250)	-0.0100	(0.0310)
F_60	0.0070	(0.0770)	0.0910	(0.0960)
LN(TX/AQ)	0.6050***	(0.0290)	0.3640***	(0.0360)
Adjusted R^2	0.7400		0.3910	

Source: MINIPLAN (n.d.).

[a] Natural logarithm.
[b] x 10^{-4}.

Note: Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***.

availability or food expenditure in any nutritional status production function or reduced form estimating equation could violate the required independence between the regressors and the error term. Household calorie availability is a choice variable for the household and would, therefore, be correlated with the error term. Both food expenditure and calorie availability are instrumented using household composition and per adult equivalent total expenditures.

Three child specific variables — sex, age, and the child's hierarchical household ordering (*ORD*) — are included along with a zero-one variable (*NURSING*) designed to reflect the first six months of life when the infant depends principally upon maternal breast milk. The quadratic age term (*AGESQ*) is included to capture the effect of "catch-up" growth that often occurs after the child has made some physical adjustment to his or her environment. The child's hierarchical household ordering should reflect the child's relative bargaining strength for food resources within the household, a higher ordering number implying a poorer bargaining position.

The remainder of the variables are household specific. The first two of these are the age and sex of the household head. The age of the household head (*AGEHD*) generally captures "life cycle" effects (i.e., the developmental stage of the household with respect to demographic characteristics and asset structure). The sex of the household head (*SEXHD*) is designed to portray legal and societal advantages afforded males in Rwandan society.

Four discrete parental education variables (*EDM1*, *EDM2*, *EDP1*, *EDP2*) are included. *EDM1* and *EDP1* reflect one to four years of completed primary school, while *EDM2* and *EDP2* represent individuals who have completed at least five years of primary school. The education variables measure parental ability to make decisions concerning child rearing, food acquisition and preparation, and investments in the household's sanitary environment. In addition, these variables reflect the household's general attitude toward learning and information. As such it provides a rough portrayal of the intellectual environment in which the children are being raised.[16]

A zero-one urban location variable (*RUH_GSY*) is included to reflect two fairly distinct urban settings. The first of these urban settings is made up of both Kigali interior and exterior, and the city of Butare. The second urban setting comprises Ruhengeri and Gisenyi. Geographic and agricultural circumstances determine these two natural groupings.

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[16] Data on mother's height (often used to reflect genetic background) are not available. However, it is felt that this is not harmful to the estimation process since mother's height partly reflects her childhood environment (particularly during her first three years of life). If the child is being raised in the same socioeconomic environment as the sample child, the presence of the mother's height variable may diminish the importance of the included socioeconomic variables for which information is sought.

Finally, household expenditures on both curative and preventive hygienic inputs (*HLTH_CUR, HLTH_PRV*) are included. The former reflects disease incidence or morbidity, while the latter serves as a proxy for household investments in the sanitary environment.

The estimation results for rural and urban height-for-age, weight-for-age, and weight-for-height are presented in Tables 14, 15, and 16, respectively.

RESULTS OF REGRESSIONS FOR CHILD NUTRITIONAL STATUS

Household Consumption Behavior

Household food acquisition behavior appears to play a major role in determining child nutritional status. Three important results emerge from the regression equations concerning the link between household consumption behavior and child nutritional status.

First, a clear pattern emerges with actual household calorie availability per day per adult equivalent being more important than food expenditure, which in turn plays a greater role in determining child nutritional status than does household permanent income (represented by total household expenditures).

This is not surprising since leakages away from nutrient acquisition occur as the household allocates its available income, first between food and nonfood expenditures, and then among different food groups. Furthermore, increasing food expenditure, whether as a total or within specific subgroups, does not transfer directly into parallel increases in calorie availability. Numerous studies (Silberberg 1985; Behrman and Deolalikar 1987, 1989) have shown that consumers tend to choose foods with higher quality and more variety rather than increased energy content as their incomes rise. Behrman and Deolalikar (1987) go so far as to suggest that the response of energy acquisition to increases in income may be near zero in some cases.[17]

Schiff and Valdés (1990) have pointed out the importance of household income on household nutritional status via several indirect channels, including investments in health care, sanitary environment, human capital, and improved information acquisition. The low total expenditure coefficient estimates relative to food expenditure and calorie acquisition would suggest that the NBCS survey expenditure data failed to account for variations of household investments in the sanitary environment. In low-income countries such household-level investments are often in the form of increased time allocated to more efficient

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[17] However, these responses have been found to vary across income levels, with poorer households placing greater emphasis on energy acquisition. In general households look for a balance between the energy composition of their diet and other nonenergy aspects such as quality and variety. Noncalorie aspects of food purchases gain in importance with rising real incomes.

Table 14 —Rwanda: Rural and Urban Nutritional Status Estimates Based on Height-for-Age Z-Scores

	Rural			Urban		
Variable Names	(1)	(2)	(3)	(1)	(2)	(3)
CONSTANT	-10.415***	-11.845***	14.223***	-8.573***	-13.687***	-15.412***
	(2.925)	(3.336)	(4.005)	(2.276)	(3.647)	(3.476)
SEX	0.281	0.281	0.290	0.146	0.146	0.160
	(0.211)	(0.210)	(0.210)	(0.192)	(0.191)	(0.189)
AGE	-0.025	-0.024	-0.023	-0.043	-0.042	-0.042
	(0.027)	(0.027)	(0.027)	(0.031)	(0.031)	(0.031)
AGESQ	4.620[b]	4.486[b]	4.311[b]	6.460[b]	6.406[b]	6.545[b]
	(3.386)[b]	(3.386)[b]	(3.385)[b]	(4.546)[b]	(4.526)[b]	(4.488)[b]
ORD	-0.087	-0.083	-0.087	0.030	0.031	0.029
	(0.128)	(0.128)	(0.127)	(0.023)	(0.023)	(0.023)
NURSING	0.624	0.623	0.647	1.278***	1.305***	1.286***
	(0.510)	(0.509)	(0.509)	(0.466)	(0.464)	(0.460)
SEXHD	0.437	0.406	0.515	0.218	0.277	0.161
	(0.382)	(0.382)	(0.379)	(0.353)	(0.351)	(0.349)
AGEHD	0.013	0.013	0.012	0.018*	0.018*	0.015
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
EDM1	-0.102	-0.123	-0.099	0.155	0.194	0.177
	(0.288)	(0.288)	(0.287)	(0.236)	(0.232)	(0.230)
EDM2	-0.446	-0.398	-0.418	0.229	0.344	0.482
	(0.344)	(0.344)	(0.343)	(0.333)	(0.328)	(0.327)
EDP1	0.131	0.134	0.074	0.313	0.189	0.167
	(0.267)	(0.267)	(0.269)	(0.283)	(0.288)	(0.285)
EDP2	0.476	0.502	0.514	-0.220	-0.370	-0.377
	(0.337)	(0.334)	(0.333)	(0.373)	(0.383)	(0.373)
NADEQ	0.274*	0.284*	0.305**	0.071	0.097*	0.138**
	(0.146)	(0.146)	(0.147)	(0.051)	(0.053)	(0.056)
RUH_GSY	—	—	—	0.268	0.349	0.303
				(0.218)	(0.223)	(0.216)
HLTH_CUR	-0.641[b]	-0.599[b]	-0.555[b]	-0.282[b]	-0.294[b]*	-0.207[b]
	(2.446)[b]	(2.443)[b]	(2.439)[b]	(0.178)[b]	(0.177[b])	(0.171[b])
HLTH_PRV	-1.824[b]	1.644[b]	-1.253[b]	0.376[b]	0.370[b]	0.459[b]*
	(3.335[b])	(3.301)[b]	(3.254)[b]	(0.299)[b]	(0.293[b])	(0.281[b])
LN(TX/AQ)	0.698**	—	—	0.526**	—	—
	(0.292)			(0.210)		
LN(FDX/AQ)[a]	—	0.859**	—	—	1.053***	—
		(0.341)			(0.358)	
LN(CAL/AQ)[a]	—	—	1.305***	—	—	1.604***
			(0.485)			(0.445)
Adjusted R^2	0.069	0.071	0.075	0.182	0.189	0.202
N = 276						

Source: MINIPLAN (n.d.).

[a] Predicted.
[b] x 10^{-4}.
[c] Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***.

Note: Standard errors in parentheses.

Table 15 —Rwanda: Rural and Urban Nutritional Status Estimates Based on Weight-for-Age Z-Scores

	Rural			Urban		
Variable Names	(1)	(2)	(3)	(1)	(2)	(3)
CONSTANT	-5.841***	-7.450***	-10.310***	-8.993***	-12.938***	-16.284***
	(2.224)	(2.531)	(3.027)	(1.824)	(2.951)	(2.766)
SEX	0.022	0.022	0.028	-0.079	-0.071	-0.058
	(0.160)	(0.160)	(0.159)	(0.154)	(0.155)	(0.151)
AGE	-0.037*	-0.035*	-0.033	-0.057**	-0.057**	-0.057**
	(0.021)	(0.021)	(0.021)	(0.025)	(0.025)	(0.024)
AGESQ	4.651^{b*}	4.477^{b*}	4.219^{b*}	7.543^{b**}	7.606^{b**}	7.708^{b**}
	(2.574^{b})	(2.568^{b})	(2.558^{b})	(3.645^{b})	(3.661^{b})	(3.571^{b})
ORD	-0.229**	-0.224**	-0.223**	-0.009	-0.008	-0.010
	(0.097)	(0.097)	(0.096)	(0.019)	(0.019)	(0.018)
NURSING	1.180***	1.186***	1.121***	1.579***	1.600***	1.585***
	(0.388)	(0.386)	(0.384)	(0.373)	(0.375)	(0.366)
SEXHD	0.103	0.074	0.149	0.253	0.322	0.190
	(0.290)	(0.290)	(0.286)	(0.283)	(0.284)	(0.278)
AGEHD	0.006	0.006	0.006	0.019**	0.019**	0.015**
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
EDM1	0.224	0.204	0.215	0.077	0.147	0.118
	(0.219)	(0.219)	(0.217)	(0.189)	(0.188)	(0.183)
EDM2	0.298	0.330	0.318	0.211	0.368	0.529**
	(0.262)	(0.261)	(0.259)	(0.267)	(0.265)	(0.260)
EDP1	0.083	0.079	0.024	0.048	-0.062	-0.113
	(0.203)	(0.202)	(0.203)	(0.227)	(0.233)	(0.226)
EDP2	0.063	0.068	0.065	-0.303	-0.392	-0.451
	(0.256)	(0.253)	(0.251)	(0.299)	(0.310)	(0.297)
NADEQ	0.359***	0.369***	0.392***	0.070*	0.086**	0.143***
	(0.111)	(0.111)	(0.111)	(0.041)	(0.043)	(0.045)
RUH_GSY	—	—	—	0.559***	0.617***	0.585***
				(0.175)	(0.180)	(0.172)
HLTH_CUR	-2.763^{b}	-2.726^{b}	-2.676^{b}	-0.373^{b***}	-0.356^{b***}	-0.268^{b**}
	$(1.859)^{b}$	$(1.853)^{b}$	$(1.843)^{b}$	(0.143^{b})	(0.143^{b})	(0.136^{b})
HLTH_PRV	0.831^{b}	0.728^{b}	0.845^{b}	0.162^{b}	0.226^{b}	0.299^{b}
	$(2.535)^{b}$	$(2.504)^{b}$	$(2.459)^{b}$	$(0.240)^{b}$	$(0.237)^{b}$	$(0.224)^{b}$
LN(TX/AQ)	0.421*	—	—	0.700***	—	—
	(0.222)			(0.168)		
LN(FDX/AQ)[a]	—	0.596**	—	—	1.114***	—
		(0.258)			(0.289)	
LN(CAL/AQ)[a]	—	—	1.055***	—	—	1.896***
			(0.367)			(0.354)
Adjusted R^2	0.107	0.113	0.123	0.322	0.316	0.349
N = 276						

Source: MINIPLAN (n.d.).

[a] Predicted.
[b] $\times 10^{-4}$.
[c] Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***.

Note: Standard errors in parentheses.

Table 16 —Rwanda: Rural and Urban Nutritional Status Estimated Based on Weight-for-Height Z-Scores

	Rural			Urban		
Variable Names	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
CONSTANT	1.716 (2.540)	0.673 (2.901)	-1.451 (3.485)	-4.876** (1.967)	-6.148* (3.189)	-9.065** (3.030)
SEX	-0.242 (0.183)	-0.243 (0.183)	-0.241 (0.183)	-0.270 (0.166)	-0.258 (0.167)	-0.252 (0.165)
AGE	-0.053** (0.024)	-0.052** (0.024)	-0.050** (0.024)	-0.050* (0.027)	-0.051* (0.027)	-0.050* (0.027)
AGESQ	4.844[b]* (2.940[b])	4.710[b] (2.944[b])	4.475[b] (2.945[b])	5.619[b] (3.929[b])	5.745[b] (3.957[b])	5.780[b] (3.912[b])
ORD	-0.278** (0.111)	-0.274** (0.111)	-0.269** (0.111)	-0.040** (0.020)	-0.039** (0.020)	-0.040** (0.020)
NURSING	1.045** (0.443)	1.056** (0.443)	1.076** (0.443)	0.547 (0.402)	0.553 (0.406)	0.547 (0.401)
SEXHD	-0.241 (0.331)	-0.255 (0.332)	-0.250 (0.330)	0.184 (0.305)	0.231 (0.307)	0.146 (0.304)
AGEHD	0.002 (0.008)	0.002 (0.008)	0.002 (0.008)	0.010 (0.008)	0.010 (0.008)	0.008 (0.008)
EDM1	0.389 (0.250)	0.379 (0.251)	0.370 (0.250)	-0.013 (0.204)	0.050 (0.203)	0.026 (0.201)
EDM2	0.736** (0.299)	0.736** (0.299)	0.737** (0.299)	0.110 (0.288)	0.230 (0.286)	0.336 (0.285)
EDP1	0.020 (0.232)	0.012 (0.232)	-0.014 (0.234)	-0.252 (0.245)	-0.303 (0.252)	-0.350 (0.248)
EDP2	-0.241 (0.292)	-0.260 (0.290)	-0.279 (0.289)	-0.298 (0.323)	-0.301 (0.335)	-0.367 (0.325)
NADEQ	0.288** (0.127)	0.293** (0.127)	0.307** (0.128)	0.039 (0.044)	0.040 (0.047)	0.083* (0.049)
RUH_GSY	—	—	—	0.464** (0.189)	0.478** (0.195)	0.469** (0.188)
HLTH_CUR	-3.294[b] (2.124[b])	-3.280[b] (2.124[b])	-3.245[b] (2.122[b])	-0.219[b] (0.154[b])	-0.186[b] (0.155[b])	-0.137[b] (0.149[b])
HLTH_PRV	2.858[b] (2.896[b])	2.555[b] (2.870[b])	2.271[b] (2.831[b])	-0.124[b] (0.258[b])	-0.035[b] (0.256[b])	-0.004[b] (0.245[b])
LN(TX/AQ)	-0.064 (0.253)	—	—	0.523*** (0.181)	—	—
LN(FDX/AQ)[a]	—	0.044 (0.296)	—	—	0.666** (0.313)	—
LN(CAL/AQ)[a]	—	—	0.314 (0.422)	—	—	1.253*** (0.388)
Adjusted R^2 N = 276	0.124	0.124	0.126	0.120	0.107	0.127

Source: MINIPLAN (n.d.).

[a] Predicted.
[b] x 10^{-4}.
[c] Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***.

Note: Standard errors in parentheses.

waste removal, longer search of improved water sources, or greater care in latrine maintenance. Unavailability of information on use of household time prevented the creation of a full income variable that would incorporate the value of such household time allocations.

Similarly, the absence of a true health status or morbidity variable may result in an overestimate of the importance of calorie availability.[18]

A second important result concerning household consumption behavior and child nutritional status evident from the regressions is that total expenditures, food expenditure, and calorie availability all appear to have a greater impact in an urban setting than in a rural setting.[19] This could be the result of improved access to health infrastructure in urban areas, which would complement nutrient intake.

Present results could be greatly strengthened with the addition of household-level data on the sanitary environment and individual-level data on morbidity.

The third important result concerning household consumption behavior and child nutritional status deals with the temporal nature of the household variables and their subsequent nutritional implications.

The rural Rwanda labor market has been very thin, thus limiting off-farm employment opportunities. As a result, rural household permanent income and calorie acquisition are closely tied to household assets, particularly land, and, as such, they tend to assume a "long-term" nature. On the other hand, in urban areas, income and calories are more closely related to employment status, which may vary from month to month or even week to week. Thus, the urban income and calorie variables assume a "short-term" nature. This is borne out by the regression results, which suggest that rural household permanent income, food expenditure, and calorie availability are important determinants of child height-for-age (chronic malnutrition) and weight-for-age, but that they have little

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[18] Following Kmenta (1971), the estimated coefficient of the included calorie variable is biased by the omission of a morbidity variable if two conditions hold. First, the unestimated morbidity variable's coefficient would be significantly different from zero. Second, the correlation between the included calorie variable and the missing morbidity variable is significantly different from zero. Intuition would suggest that morbidity is negatively associated with nutritional status, and negatively correlated with calorie intake. This implies an overestimate of the included calorie coefficient. The degree of bias is an empirical issue. Previous work in Rwanda by Schnepf (forthcoming a) has shown morbidity to have a strong negative association with child nutritional status in a multivariate framework. However, it is also likely that morbidity has similar relationships with household food expenditure and income such that comparisons across these three variables may still be valid.

[19] The sole exception is total expenditures in the height-for-age regressions.

influence on child weight-for-height (acute malnutrition). Since child weight-for-age includes aspects of both height-for-age and weight-for-height, one could reason that it is the influence of income on the height-for-age component that is dominant.

This contrasts with the urban results where household permanent income, food expenditure, and calorie availability appear to be important determinants of both height-for-age and weight-for-height nutritional status, but show their greatest impact on child weight-for-age, which combines aspects of both height-for-age and weight-for-height.

Household Health Status

Data permitting, the household model adopted here would incorporate one or more variables reflecting household morbidity, the quality of the household's sanitary environment, and household investments in health care. Unfortunately, the NBCS did not include specific survey components addressing these data needs. Instead, the model includes household-level curative health expenditure and preventive health expenditure.

The household curative expenditure variable (reflecting the household's response to its perceived morbidity incidence) appears important as a determinant of child nutritional status in four of the urban equations (the second urban height-for-age equation of Table 14 and all three urban weight-for-age equations of Table 15), but in none of the rural equations (although the variable consistently maintains a negative sign throughout all of the rural estimating equations). Lack of access to health infrastructure in rural areas may constrain the household's response to perceived morbidity and, thus, prevent the household curative expenditure from playing a determining role in child nutritional status in rural areas.

The household preventive expenditures variable has a positive association with child height-for-age only in the third urban calorie equation of Table 14. As mentioned earlier, such monetary expenditures fail to include the household's investment of "time" allocated to either child health care or household hygiene.

The importance of differences in rural and urban access to health infrastructure is further borne out by the fact that the urban equations produce a slightly better fit than the rural equations.[20] Thus, urban households' greater access to health infrastructure tends to reduce the importance of unobserved morbidity since households are physically able to respond to perceived health needs. Calorie intake consequently plays a more important role in determining nutritional status.

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[20] The equations exhibit a low level of explanatory power, although this is not uncommon in reduced form nutritional status estimating equations.

Child Specific Variables

Child age shows a quadratic relationship with the near term nutritional status indicators, weight-for-age and weight-for-height, while it appears to have a neutral effect for child height-for-age. Weight-for-age Z-scores decline until the 39-to-40-month age range for rural children (37-to-38 for urban) after which some recovery is made. Weight-for-height Z-scores reach their low point much later at 55-to-56 months for rural children and 43-to-44 months for urban children. High mortality rates during the first five years in Rwanda (ONAPO 1983) may contribute to an overestimation of the true extent of recovery from acute malnutrition and underweight status as the ranks of the severely malnourished are depleted by death.

More importantly, the first six months of a child's life represent a period of significantly higher nutritional status as compared with the weaning period (6-to-24 months) for urban height-for-age, rural weight-for-height, and both rural and urban weight-for-age nutritional status indicators. This makes a strong case for maintaining current breast-feeding practices through the first six months of infancy, and hints at the nutritional vulnerability associated with child weaning behavior in Rwanda.[21]

No nutrition-related gender bias for children is observed for any of the equations, thus refuting the results from the bivariate statistics of Section 2. This result is consistent with previous African studies (Svedberg 1990), which suggest that females do not appear to be at a relative nutritional disadvantage in Africa.

The child's ordering variable shows a strong negative association with his or her near term nutritional status. Rural and urban weight-for-height and rural weight-for-age show tendencies to decline in the face of higher child orderings. In other words, the larger the number of older household members, the poorer the child's relative bargaining position with respect to the intrahousehold calorie distribution. This has obvious implications for overall household size. Lowering the number of household members by definition lowers the child ordering variable and consequently may produce a situation conducive to improved child nutritional status. Horton (1988) used actual birth order effects to show a negative relationship with child nutritional status. Her work suggested that it is the increased strain on household resources produced by increased child numbers that leads to the degradation in child nutritional status.

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[21] The general literature on breast-feeding recommends the introduction of supplementary foods between the fourth and sixth months of life. In Rwanda many households are faced with poor availability of adequate weaning foods due to a combination of limited purchasing power and market inefficiency (i.e., rural isolation and seasonal availability of sorghum for porridge, the principal weaning food). Such households should be encouraged to continue exclusive breast-feeding through the first six months rather than to introduce inadequate tuber-based supplementary meals or to begin feeding the child the family meal.

Other Household Specific Variables

The number of adult equivalents shows a positive association with child nutritional status in apparent contradiction with the child order results. However, the number of adult equivalents in a household has implications that reach far beyond family size. More labor power represents potentially greater earning power with consequent increases in household purchasing power for food acquisition, as well as more time available for use in childcare and feeding, meal preparation, hygiene activities, etc., all of which have potentially positive influences on child nutritional status.

The age of the head of urban households has a positive association with child height-for-age and weight-for-age. This may reflect life cycle effects, as well as experience. This feature appears to be particularly important in an urban setting, where the rural to urban migratory patterns of Rwanda bring younger, generally poorer households into the urban fringe (MINIPLAN n.d.).

No difference in child nutritional status related to gender of head of household emerges from the results.

Further empirical work remains to be done in examining the linkages between health infrastructure and sanitary environment, morbidity, and nutritional status on the one hand, and morbidity, calorie intake, and nutritional status on the other hand. Such analysis cannot be done with existing data sets.

4. FOOD EXPENDITURE AND CALORIE ACQUISITION BEHAVIOR

INTRODUCTION

The regressions in the previous section have shown the importance of household food consumption behavior as it relates to nutritional status. This section turns the focus away from nutritional status and examines the determinants of household food consumption behavior. Minot (Ministère du Plan [MINIPLAN] 1988a) and Ansoanuur (MINIPLAN 1990a) have used the NBCS data to produce detailed work on household budget shares, marginal propensities to consume, and elasticities of demand across budgetary expenditure categories for the rural and urban samples, respectively; while Nyibizi (MINIPLAN 1988b) has documented household calorie sources, as well as home production shares by food groups and specific commodities for rural households.

This study enhances previous work by examining household income, regional price differences, household demographic characteristics, and occupational status for their effects on three measures of household food expenditure behavior (food expenditure per adult equivalent, the share of income spent on food, and the cost per available calorie of food) and a measure of nutrient availability (calories per day per adult equivalent).

BACKGROUND

A dominant feature of rural Rwanda is the fairly even distribution of poverty across income quintiles as mean total expenditures range from a low of FRW 6,991 to a high of only FRW 23,255 per adult equivalent (Table 17). On the other hand, urban households exhibit a greater dispersion of wealth across income quintiles ranging from FRW 13,870 to FRW 120,487 per adult equivalent.[22]

This same pattern of relative rural equity coupled with greater urban income dispersion is reflected in the household food budget share means. The value share of food in the total budget for rural households remains at high levels across income quintiles, ranging from 88.2 percent in the lowest quintile and falling only to 75.4 percent for the wealthiest quintile. Meanwhile, the urban food budget share falls from a high of 80.2 percent in the poorest quintile to a low of 46.7 percent in the wealthiest quintile.

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22 In 1982 US$ 1.00 equaled FRW 92.84, while in 1983 US$ 1.00 equaled FRW 94.34. This compares with the annual average of FRW 101.26 to US$ 1.00 for 1985. However, the commodity bundles vary significantly between the rural and urban samples. Refer to MINIPLAN (1988a and 1990a) for details. The prices (and values) used in Table 17 and throughout this study represent undeflated, imputed prices.

Table 17 —Rwanda: Household Consumption Characteristics, by Quintile of Total Expenditure per Adult Equivalent

	Quintiles					
	1	2	3	4	5	Average
Total expenditures per adult equivalent (FRW)						
Rural	6,991	9,421	11,488	14,708	23,255	13,173
Urban	13,870	24,549	36,563	53,639	120,487	49,287
Food expenditure per adult equivalent (FRW)						
Rural	6,147	8,046	9,586	12,415	17,256	10,690
Urban	11,064	17,883	22,537	28,964	52,340	26,374
Food as percent of total expenditures						
Rural	88.2	85.4	83.5	84.4	75.4	83.4
Urban	80.2	73.2	62.0	54.2	46.7	63.3
Home production as percent of total expenditures						
Rural	64.0	66.0	70.2	71.9	66.6	67.8
Urban	28.5	19.3	7.9	7.5	3.6	13.4
FRW per 1,000 kilocalories						
Rural	10.8	11.6	11.6	11.7	14.2	12.0
Urban	23.9	27.3	32.4	35.3	41.5	32.0
Percent below 2,100 calories per day per adult equivalent						
Rural	82.9	62.7	28.8	14.6	9.2	39.7
Urban	92.2	80.4	68.8	64.4	50.4	71.3
Percent below 1,680 calories per day per adult equivalent						
Rural	44.3	26.0	14.0	3.0	1.9	17.9
Urban	71.8	47.5	45.4	33.7	21.4	44.0
Calories per day per adult equivalent						
Rural	1722	2069	2369	2874	3214	2448
Urban	1485	1762	1968	2069	2952	2040
Home production calorie share						
Rural	69.1	73.6	76.6	79.2	78.1	75.3
Urban	27.1	21.4	7.7	8.4	4.6	13.9
Rural landholdings						
Hectares	1.3	1.1	1.4	1.2	1.4	1.3
Meters^2/adult equivalent	24.5	23.2	30.4	29.8	44.7	30.5
Rural household size						
Number	5.6	5.7	5.1	4.4	4.2	5.0
Adult equivalent	5.1	5.1	4.6	3.9	3.6	4.5
Urban household size						
Number	6.5	5.8	6.4	5.6	4.1	5.7
Adult equivalent	5.9	5.0	5.8	5.0	3.7	5.1

Source: MINIPLAN (n.d.).

Notes: Rural: N = 264 households; urban: N = 297 households. Undeflated prices are used to calculate these figures.

A related phenomenon is the tendency for price paid per calorie to increase across income strata. Urban prices (FRW per 1,000 calories) rise 74 percent from lowest to highest quintile, while rural prices increase only 30 percent. This represents two processes at work. First, higher calorie prices are associated with increased market purchases (i.e., less dependence on home production). This is clearly evidenced by the rapid rise in calorie prices across urban quintiles where home production shares fall to insignificant levels. Second, as incomes increase, households seek to diversify their diets and improve the quality of their food purchases by paying higher unit prices per calorie.

Focusing more on the rural results, one sees that over two-thirds of food expenditure and three-fourths of calories for rural households come from home production. Furthermore, household home production levels (in calorie terms) appear to have a positive correlation with calorie availability per adult equivalent, particularly for the lower four quintiles, as they dampen the vulnerability associated with greater market dependence by ensuring a steady source of calories.

One would expect that increased home production is, in part, a function of household landholdings. Not surprisingly, there is a tendency for landholdings per adult equivalent (measured in squared meters) to increase across income quintiles, although the trend is not monotonic. No such pattern exists for absolute levels of landholdings, which suggests that the observed smaller household size (both in absolute numbers, as well as in adult equivalent terms) across income quintiles is crucial to a household's ability to produce sufficient food per capita from its limited land base.

A further important result suggested by Table 17 is the apparent lower calorie availability per adult equivalent for urban households relative to rural households. Over 70 percent of urban households fail to meet the minimum recommended standard of 2,100 calories per day per adult equivalent (MINAGRI 1988) compared with 40 percent for rural households. This disparity appears to widen for the level of 1,680 calories per day per adult equivalent (80 percent of 2,100) where 44 percent of urban households incur calorie deficits versus only 18 percent of rural households. Ironically, this disparity in calorie availability between rural and urban households exists despite dramatically higher urban incomes. Of course rural to urban transportation, greater levels of commodity processing, and other marketing factors contribute to significantly higher urban food prices.[23] In addition to price differences, energy

23 See Minot (forthcoming) for a recently derived set of price indices for rural and urban areas using the NBCS data. Minot's food price index, which accounts for both spatial and temporal price differences, shows the cost of living to be nearly 50 percent higher in urban areas.

(continued...)

requirements may vary greatly between the rural and urban regions. This is most obvious when comparing the energy needs required for performing field preparation work versus office work. Yet many urban laborers undertake strenuous construction and transportation activities. Unfortunately, these data do not permit a distinction between the different activity levels and their energy requirements for the two samples, but it is possible that much of the apparent difference in calorie availability relative to needs could be captured by such information.

The disparity in calorie acquisition behavior is clearly revealed by the cumulative distribution patterns of calorie availability across urban and rural households, presented in Figure 7.

FOOD CONSUMPTION BEHAVIOR MODEL

The descriptive statistics of Table 17 suggest that household income and demographic characteristics are strong influences of food consumption behavior, while home production assumes an important role for rural households.

In order to gain further insight into the nature of household consumption behavior, four key measures reflecting different aspects of household food expenditure and nutrient acquisition behavior are studied using a multivariate framework. These include the household food expenditure per adult equivalent, food share of the household budget, price paid per calorie acquired, and household calorie availability per day per adult equivalent. This approach has been used widely to examine the effects of household socioeconomic characteristics on household food consumption behavior.[24]

The first two measures — food expenditure per adult equivalent and the food share of the household budget — are estimated as budget equations:

$$\text{food share of income} = f(Y,P,X), \qquad (3)$$

$$\text{food expenditures per adult equivalent} = g(Y,P,X), \qquad (4)$$

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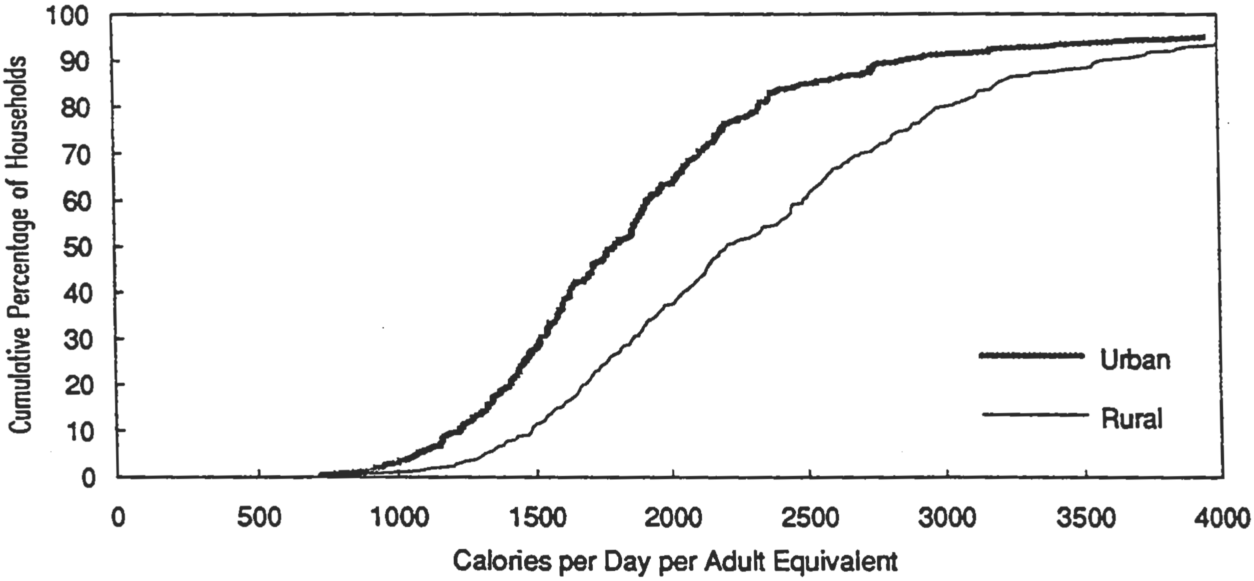
[23](...continued)

Cities	**Index**	**Rural Zone**	**Index**
Kigali	100.00	Northwest	53.37
Butare	93.55	Southwest	59.44
Gisenyi	103.85	North Central	56.18
Ruhengeri	83.24	South Central	68.60
		East	62.17

[24] For examples, see Behrman and Wolfe (1984), Horton (1985), Horton and Campbell (1991), and Shah (1983).

Figure 7 — Rwanda: Cumulative Percentage of Households, by Calorie Availability per Day per Adult Equivalent



Source: Calculated from NBCS data.

where Y is per adult equivalent income, P is a vector of prices, and X is a vector of household demographic characteristics.

Calorie availability per adult equivalent and cost per calorie are treated as derived demands and estimated according to similar specifications:

$$\text{cost per calorie} = h(Y,P,X), \tag{5}$$

$$\text{calorie per adult equivalent} = l(Y,P,X). \tag{6}$$

The natural log of total expenditures per adult equivalent is used to represent household permanent income. It enters the equation in quadratic form in order to allow for the possibility that the demand elasticities are inverse functions of income. Substantial evidence exists to support such a relationship between calorie acquisition and income; however, there is no a priori reason to suppose that such a relationship holds for the other choice variables.[25] Therefore, a log-linear income specification is used in the event of a nonsignificant quadratic income variable.[26]

Since cross-sectional data are used, regional price dummies are included to capture price effects.

Two variables are included to reflect different aspects of household size: the total number of persons in the household and the ratio of the number of children to the number of adults (14 or older) in the household.

With respect to the household size, constant economies of scale in household food consumption are assumed by transforming the income figure in terms of per adult equivalent units. Under this assumption, any subsequent changes in household food consumption behavior would be attributable purely to the change in household size above and beyond the per adult equivalent income effect. As household size increases, the decisionmaker reallocates resources according to changes in the household's perceived needs, e.g., fuel, food, clothing, housing, schooling, etc., to accommodate the new household size.

The household head's gender is included to capture differences in food consumption behavior based on intrahousehold resource control, while controlling for the level of household income. Von Braun, de Haen, and Blanken (1991) have found female-headed Rwandan households from their study area (Giciye commune) to

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[25] See Behrman and Wolfe (1984) for an example and for references to other similar studies.

[26] Food expenditure and calorie acquisition enter the equations as natural logarithms making the functional form of equations (4) and (6) double logarithmic in income, whereas equations (3) and (5) retain a semilogarithmic functional form with respect to household permanent income.

show a significantly greater propensity to allocate household resources to food consumption than male-headed households.

The household head's age is added under a quadratic specification to reflect life cycle phenomenon.

Parental education dummies should reflect household background wealth and current wage potential, while occupational dummies are included to reflect realized wages, the importance of nonfarm income, and the greater stability in revenue from salaried occupations.

A final variable designed to represent the degree of consumption from home production is added to the rural model. Von Braun et al. (1991) have shown that an increased subsistence orientation is associated with greater overall allocation of resources to food consumption, holding income constant.

The value share of consumption from home production is generally not included as a regressor because this measure of subsistence represents an observed behavior of households that is an endogenous choice variable. The failure to account for such endogenicity results in biased estimates; however, the number of exogenous variables available for use as instruments for the household's subsistence orientation proved inadequate.[27] Estimation results proved to be fairly robust with respect to the elimination of the subsistence orientation variable. Furthermore, lack of on-farm storage facilities coupled with isolated and seasonal markets (particularly in the early 1980s) may limit the household decisionmaker's choices in disposing of agricultural food crops, i.e., farmers must either sell at harvest or refrain from selling. Nearly half of the calories consumed by rural households are derived from tubers and bananas rather than the more marketable cereals or legumes (MINIPLAN 1988b).

Variable definitions and descriptive statistics are presented in Tables 10 and 18, respectively. Regression results for rural and urban areas are given in Tables 19 and 20.

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[27] A similar problem exists for the household size variable. For more detail, refer to Sahn (1990).

Table 18 —Rwanda: Food Consumption Behavioral Equations —Urban and Rural Variable Descriptive Statistics

	Rural		Urban	
Variable Names	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
SEXHD	0.79	0.41	0.83	0.38
AGEHD	48.32	16.22	40.90	14.25
AGEHDSQ	2,597.08	1,661.78	1,875.26	1,360.69
EDM1	0.15	0.36	0.30	0.46
EDM2	0.08	0.28	0.16	0.37
EDP1	0.23	0.42	0.43	0.50
EDP2	0.19	0.39	0.21	0.40
CH_0_6	1.40	1.21	1.42	1.33
CH_7_13	0.95	1.04	0.87	1.13
M_14_19	0.39	0.65	0.41	0.71
M_20_59	0.84	0.68	1.24	0.92
M_60	0.18	0.39	0.10	0.30
F_14_19	0.37	0.63	0.44	0.70
F_20_59	1.00	0.57	1.06	0.76
F_60	0.14	0.35	0.06	0.24
HHSIZE	5.28	2.32	5.68	3.18
DEP_RAT	0.93	0.80	1.56	1.38
TX/AQ	12,971.00	6,579.00	44,740.00	39,850.00
FDX/AQ	10,558.00	4,675.00	23,248.00	14,960.00
CAL/AQ	2,429.00	923.00	2,059.00	1,212.00
LN(TX/AQ)	9.37	0.42	10.45	0.70
LN(FDX/AQ)	9.18	0.39	9.92	0.49
LN(CAL/AQ)	7.73	0.36	7.53	0.40
FD_SHARE	83.58	10.97	62.94	19.89
PRICE_CAL	11.96	3.22	31.33	10.96
SUBSIST	67.00	18.88	-	-
RURAL				
OCC_ART	0.44	0.50	-	-
OCC_OTH	0.23	0.42	-	-
ZNW	0.13	0.34	-	-
ZSW	0.17	0.38	-	-
ZNC	0.20	0.40	-	-
ZSC	0.24	0.43	-	-
URBAN				
OCC_AGR	-	-	0.13	0.33
OCC_ART	-	-	0.28	0.45
OCC_OTH	-	-	0.24	0.43
OCC_COM	-	-	0.10	0.30
OCC_PBSL	-	-	0.13	0.33
RUH_GSY	-	-	0.22	0.42

Source: MINIPLAN (n.d.).

Note: Rural: N = 260; urban: N = 297.

Table 19 —Rwanda: Determinants of Rural Food Expenditure and Calorie Acquisition Behavior

Variable Names	Food[a] Expenditure	Calorie[a] Acquisition	Food Share	Price per Calorie
CONSTANT	-5.382*	-10.412*	202.733***	142.783***
	(2.900)	(5.404)	(17.768)	(54.847)
SEXHD	0.041*	-0.023	3.209*	0.677
	(0.025)	(0.046)	(1.775)	(0.467)
AGEHD	-0.0077**	-0.013*	-0.586**	0.020
	(0.0037)	(0.007)	(0.266)	(0.070)
AGEHDSQ	0.727[b]**	1.185[b]*	0.0060**	-1.472[b]
	(0.350)[b]	(0.653)[b]	(0.0025)	(6.623)[b]
EDM1	0.025	-0.003	0.966	-0.350
	(0.027)	(0.050)	(1.925)	(0.506)
EDM2	-0.046	-0.022	-3.486	-0.100
	(0.033)	(0.062)	(2.381)	(0.626)
EDP1	0.002	0.047	0.350	-0.414
	(0.024)	(0.044)	(1.701)	(0.448)
EDP2	-0.036	-0.008	-1.635	0.065
	(0.028)	(0.053)	(2.045)	(0.537)
ZNW	-0.038	0.027	-3.040	-0.999*
	(0.029)	(0.054)	(2.102)	(0.552)
ZSW	-0.061**	-0.085	-4.528*	-0.749
	(0.029)	(0.054)	(2.087)	(0.550)
ZNC	-0.019	0.054	-1.572	-1.399***
	(0.027)	(0.050)	(1.937)	(0.508)
ZSC	-0.049*	-0.067	-3.896*	-0.428
	(0.026)	(0.048)	(1.872)	(0.492)
OCC_ART	-0.033	-0.086**	-2.478*	-0.009
	(0.020)	(0.038)	(1.457)	(0.384)
OCC_OTH	-0.029	-0.130***	-2.188	0.407
	(0.025)	(0.047)	(1.832)	(0.481)
HHSIZE	-0.012**	-0.017*	-0.844**	0.140
	(0.005)	(0.009)	(0.344)	(0.090)
DEP_RAT	0.006	-0.012	0.882	0.208
	(0.013)	(0.024)	(0.938)	(0.246)
SUBSIST	0.0012**	0.0016	0.095***	-0.077***
	(0.0005)	(0.0010)	(0.037)	(0.010)
LN(TX/AQ)	2.300***	3.424***	-11.361***	-29.835**
	(0.614)	(1.143)	(1.603)	(11.606)
LN(TX/AQ)^2	-0.077***	-0.154**	—[c]	1.735***
	(0.032)	(0.060)		(0.611)
Adjusted R^2	0.884	0.514	0.233	0.389

Source: MINIPLAN (n.d.).

[a] Natural logarithm.
[b] $\times 10^{-4}$.
[c] Estimated using log-linear income specification since quadratic term is not statistically significant.

Note: Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***. Standard errors in parentheses.

Table 20 —Rwanda: Determinants of Urban Food Expenditure and Calorie Acquisition Behavior

Variable Names	Food[a] Expenditure	Calorie[a] Acquisition	Food Share	Price per Calorie
CONSTANT	-6.707***	-1.573	284.076***	-41.396***
	(2.540)	(3.203)	(17.392)	(12.609)
SEXHD	0.048	0.035	0.614	-0.181
	(0.051)	(0.064)	(2.476)	(1.795)
AGEHD	-0.0125*	-0.0008	-0.417	-0.515**
	(0.0064)	(0.0080)	(0.312)	(0.226)
AGEHDSQ	1.317[b]**	-0.193[b]	0.005	0.0053**
	(0.662)[b]	(1.835)[b]	(0.003)	(0.0024)
EDM1	-0.012	0.065	-0.351	-2.555**
	(0.033)	(0.042)	(1.627)	(1.181)
EDM2	-0.088*	-0.093	-4.111*	0.512
	(0.048)	(0.060)	(2.336)	(1.693)
EDP1	0.062	0.071	2.540	-0.405
	(0.044)	(0.056)	(2.155)	(1.562)
EDP2	0.068	0.051	1.557	0.851
	(0.056)	(0.071)	(2.750)	(1.993)
RUH_GSY	-0.002	-0.029	-0.416	-1.082
	(0.036)	(0.045)	(1.746)	(1.265)
OCC_AGR	0.130*	0.270***	11.044***	-4.908**
	(0.067)	(0.085)	(3.292)	(2.387)
OCC_ART	0.031	0.081	2.408	-2.225
	(0.054)	(0.068)	(2.632)	(1.908)
OCC_OTH	-0.030	-0.054	-0.323	0.411
	(0.052)	(0.066)	(2.550)	(1.849)
OCC_COM	0.009	-0.070	0.722	2.995
	(0.065)	(0.081)	(3.161)	(2.292)
OCC_PBSL	0.070	0.127	6.152**	-2.430
	(0.062)	(0.078)	(3.019)	(2.189)
HHSIZE	-0.033***	-0.039***	-1.699***	0.045
	(0.006)	(0.008)	(0.298)	(0.216)
DEP_RAT	0.027*	0.015	-0.989	0.237
	(0.015)	(0.018)	(0.714)	(0.517)
LN(TX/AQ)	2.643***	1.416**	-19.960***	8.183***
	(0.029)	(0.602)	(1.375)	(0.996)
LN(TX/AQ)^2	-0.0970***	-0.051*	—[c]	—[c]
	(0.022)	(0.028)		
Adjusted R^2	0.766	0.433	0.652	0.398

Source: MINIPLAN (n.d.).

[a] Natural logarithm.
[b] x 10^{-4}.
[c] Estimated using log-linear income specification since quadratic term is not statistically significant.

Note: Statistical significance levels of .10, .05, and .01, respectively, are *, **, and ***. Standard errors in parentheses.

FOOD CONSUMPTION BEHAVIOR REGRESSION RESULTS

Food expenditure and calorie acquisition elasticities with respect to income (reported in Table 21) are significantly higher in rural areas (0.85 and 0.54, respectively) than in urban areas (0.62 and 0.34, respectively), reflecting in part greater overall poverty in rural areas, but also reflecting the greater availability of consumer goods in urban areas.[28,29] Urban consumers are confronted with more opportunity for diversity in their budget allocation decisions.

The rural poor (a standard deviation below the mean) orient the majority of their income toward food acquisition as a 10.0 percent increase in income, which is accompanied by a 9.2 percent increase in food expenditure and a 6.7 percent increase in calories. Higher income rural households (with income levels a standard deviation above the mean) have food expenditure and calorie acquisition elasticities very similar to those of lower income urban households. This demonstrates the disparity in nominal wealth levels between rural and urban areas.

As expected, increases in income are associated with declines in food budget share. The percentage rate of decline in food budget share is constant for both rural and urban households. However, the overall effect is greater in urban areas where greater income dispersion and lower levels of home production prevail. A 10.0 percent rise in income results in a 3.2 percent decline in the mean urban food budget share, but only a 1.4 percent fall in the rural food budget share.

Similarly, rises in income are associated with increases in the price paid (including home production valued at imputed market prices) per calorie consumed. At mean levels there is very little difference between the rural and urban samples as a 10.0 percent rise in income results in a 2.6 percent rise in the price paid per urban calorie and a 2.4 percent rise in rural calorie prices paid. However, the quadratic income term's importance for the rural sample suggests an increasing elasticity of prices paid with respect to rural incomes. This may reflect a smaller asset base and a greater dependence on home production for the poorer rural households, thus limiting their participation in market purchases, whereas higher income rural households may have greater mobility and more diversified sources of wealth than their lower income counterparts, thus

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[28] The mean levels of the distribution of the natural logarithm of income are used to calculate the elasticities since they produce a better representation of the actual distribution (Behrman and Wolfe 1984).

[29] Williamson-Gray (1982) found similar results in her study of Brazilian households. Poor urban Brazilian households had lower income elasticities for calorie intake (0.229) than their rural counterparts (0.465) despite the more severe calorie deficits occurring in urban households.

Table 21 —Rwanda: Food Expenditure and Calorie Acquisition Elasticities in Response to Income

Variable Names	Food[a] Expenditure	Calorie[a] Acquisition	Food Share	Price per Calorie
Rural				
Subsistence orientation	0.077	0.107[b]	0.065	-0.433
Household size	-0.061	-0.088	-0.052	0.062[b]
Total expenditure[a]				
at mean - 1 S.D.	0.917	0.671	—[c]	0.101
at mean	0.851	0.540	-0.136	0.224
at mean + 1 S.D.	0.786	0.410	—[c]	0.348
Urban				
Household size	-0.186	-0.221	-0.155	0.005[b]
Total expenditure[a]				
at mean - 1 S.D.	0.753	0.415	—[c]	—[c]
at mean	0.617	0.343	-0.317	0.261
at mean + 1 S.D.	0.482	0.272	—[c]	—[c]

Source: MINIPLAN (n.d.).

[a] Natural logarithm per adult equivalents.
[b] Not statistically significant.
[c] Undefined in a semilogarithmic functional form when the quadratic term is not statistically significant.

Note: The mean and standard deviation are from the distribution of ln(income) since it provides a better reflection of the true distribution.

increasing the range of their market choices. Urban households' choices are constrained principally by income, not by market alienation and limited choice.

The value of consumption from home production as a percentage of total expenditures (i.e., the household's subsistence orientation) is positively associated with food expenditure per adult equivalent and food budget shares, and negatively associated with prices paid per calorie acquired for rural households. A fall from the mean rural subsistence level of 67 percent to 50 percent (a 25 percent fall) would result in declines of FRW 227 in food expenditure per adult equivalent, 1.4 percentage units in food budget share (from 83.6 to 82.2 percent), while producing a rise of FRW 1.9 per average price paid per calorie.

However, the household's subsistence orientation (in value terms) fails to show any statistical association with calorie availability under a log-quadratic income specification.[30] Calories derived from food produced at home are cheaper than calories derived from food purchased in the market place. This difference shows up only as a positive nominal monetary effect of subsistence orientation on food expenditure, budget share, and prices paid per calorie.

Increasing household size has a negative influence on household food expenditure, calorie acquisition, and food budget share for both rural and urban areas. An additional member to the mean household size results in a decline of FRW 112 (or 1.1 percent) in food expenditure and 38 calories (or 1.7 percent) for the rural sample, and corresponding declines of FRW 655 (3.2 percent) and 71 calories (3.8 percent) for the urban sample.[31] Thus, the impact of changes in family size are felt more strongly in urban areas where overall income and price levels are much higher, but where home production is much lower.

The regional price dummy variables (Table 15) indicate that households from the southwest and south central zones (where agricultural production is generally lower and market prices higher) have lower levels of food expenditure per adult equivalent and lower food budget shares than households from the rest of the country. On the other hand, households from the northwest and north central (where generally abundant production of potatoes, sweet potatoes, and beans prevail with subsequent lower food price levels) pay lower prices per calorie acquired.

Occupational status appears to be an important determinant of household food consumption behavior. While controlling for income and subsistence orientation, rural nonagricultural handicrafts (*OCC_ART*) and commerce and salaried workers

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[30] Although the subsistence orientation variable is significant at a 5 percent level under a log-linear income specification, it is apparently not very robust.

[31] Expenditures and calories are in per adult equivalent units for the elasticity calculations for both rural and urban samples.

(*OCC_OTH*) experience lower levels of calorie acquisition than agriculturalists.[32] In urban settings (Table 20) households with agricultural orientations have higher overall levels of food expenditures, calorie acquisition, and food budget shares, while paying less per calorie acquired than other households. The exception is public salaried workers, who have higher levels of calorie availability and food budget shares than private salaried or other nonagricultural households.

An unexpected result emerged with respect to the influence of head of household gender: male-headed households appear to have significantly greater levels of food expenditure per adult equivalent and greater food budget shares. Previous studies in Rwanda (Von Braun et al. 1991) and in other African countries have indicated that it is female-headed households that traditionally allocate greater amounts of household resources to food acquisition. The parameter estimates suggest that male-headed households spend FRW 407 per adult equivalent more on food (with a consequent 3.2 percentage units higher food budget share) than female-headed households, while holding income constant. However, no difference appears with respect to calorie availability per adult equivalent. This would suggest that, although more is spent on food per se, the increased food expenditures emanating from male-headed households are not used to acquire more calories, but rather to acquire more expensive calories. Considerable anecdotal evidence exists to suggest that this added expenditure for male-headed households represents consumption of alcoholic beverages and food away from home, and thus does not benefit overall household nutrition.

The results indicate that a quadratic age effect exists for the head of household, whereby the level of household resources allocated to food acquisition tends to decline until around the age of 53 (53 for food expenditure; 55 for calorie acquisition; and 52 for food share) when they begin to curve upward. The age of head of household is generally thought to encompass household life cycle effects, i.e., household demographic composition and asset structure.[33]

Parental education shows little influence on rural food acquisition, while in the urban areas a somewhat unexpected result emerges. Maternal education levels beyond the fifth year of primary schooling are associated with lower food expenditure (proportional change of -0.09) and lower food budget shares (4.1 percentage units lower) while controlling for income; however, no change in household calorie acquisition occurs. Thus, it appears that changes in purchase efficiency result from higher maternal education levels as the household acquires

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[32] An agriculturalist is defined as deriving at least 75 percent of value added from agricultural activities. For handicrafts, commerce, and salaried workers the cutoff is 50 percent of value added.

[33] Clearly, during a household's child bearing years, food acquisition competes with different perceived needs, e.g., clothing, education, and household asset acquisition. As children eventually leave the household, total expenditures may decline with the loss of earning power, and food expenditure may assume greater importance in the household budget.

the same amount of calories, but with a lower total food expenditure. These maternal education results are not robust across different income specifications.

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