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Household Food Demand in Burkina Faso: Implications for Food Policy

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Abstract

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Chronic food production deficits since the early 1970s have prompted policymakers of Burkina Faso to emphasize technological research with the goal of increasing the production of the most-consumed locally-grown cereals: sorghum, millet and maize. Meanwhile, urban consumers have been developing preferences for rice and wheat, cereals that are primarily imported. This study estimates demand relationships among food items in Ouagadougou, Burkina. The results of the estimation suggest that prices, income, household composition, education, marital status and urbanization were jointly important in explaining household expenditure allocations. Both local and imported cereal consumption responded positively to an income increase. However, incremental income changes would lead to relatively greater consumption of locally produced cereals by low-income households whereas high-income households would consume relatively more wheat and rice. The household model is then used to demonstrate its relevance in addressing food policy issues, by forecasting the levels of urban grain demand under alternative income and demographic scenarios. With increased production due to advances in technology, the urban demand levels do not exhaust the rural surplus of local cereals, but deficits persist in the rice-wheat sector. The results underscore the importance of technological research since Burkina could become self-sufficient in at least the production of sorghum, millet and maize.

Introduction

In addressing the accelerating agricultural growth in Sub-Saharan Africa, Delgado and Mellor (1984) noted that this is the only major region of the world where food production per capita is declining and population growth rates are accelerating. Combining this with rising (urban) per-capita income has resulted in sharp increases in food staple imports. Dommen (1986) has suggested that a combination of policy reforms and investment in resources is needed to

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alleviate the problem of food shortage. Among the policy concerns are overvalued currencies which encourage food imports, subsidized staple food prices (of imports) which favor consumers, and an artificially taxed agricultural sector. Byerlee and Sain (1986) present evidence of a widespread and consistent bias in government policy toward providing low prices to urban consumers and that low consumer prices rather than low producer prices appear to have caused the rise in food grain imports in developing countries. Due (1986) has persuasively argued that both internal and external factors have contributed to the depressed agricultural situation in Sub-Saharan Africa and that several long-term policy changes are needed.

All of these concerns are evident in Burkina Faso, which over the last two decades has been hampered by major droughts, low production, and rising population and consumption. While locally grown sorghum and millet have long been the principal food products for both urban and rural consumers, the fall of production below subsistence levels has induced substitution toward other types of food. Thus, rice and wheat products, through international food aid, have become important elements of urban consumption.

While receiving food aid may be a convenient way of overcoming critical food shortages, the structural nature of the food crisis in this and many African countries warrants a different approach. Research on improved sorghum and millet production through new techniques compatible with local farming conditions has been undertaken in Burkina. This, however, creates a potential contradiction in the long run between the increased inflow of non-locally produced rice and wheat and the anticipated increase in local sorghum and millet production. If consumers are shifting their preferences toward the imported foodgrains, what is the strength of these new preferences, and how is this shift expected to impact the domestic production sector? It has been hypothesized that the low relative prices of the imported food commodities and their greater convenience (lower preparation time, pallatability) have made them attractive to urban consumers who have relatively higher opportunity costs of time (Roth and Abbott, 1983; Delgado and Miller, 1985).

The recognition that knowledge of consumption patterns is important in the development process is a recent phenomenon (Eicher and Baker, 1982). Although in the early 1960s consumption surveys have been organized in Burkina (Sanogoh, 1965), such surveys were limited in scope, with the major use being the construction of cost of living indices. Some studies have used micro-level data to estimate consumer responses to economic and non-economic variables in different parts of Africa. King and Byerlee (1977) surveyed households in rural Sierra Leone, estimated the demand relationships of a system of commodities, and found that an incremental rural income was spent first on rural produced goods, then on imported goods and little on urban-produced commodities. Strauss (1981) also used the Sierra Leone survey data to estimate a household-firm model. The consumption response of rice to own price increased with income, while the response of other cereals to own price decreased with income. Hazell and Roell (1983) investigated the locational linkages of rural food consumption in northern Nigeria. Maize was found to be an inferior good, while rice was highly income-responsive and wheat showed a more moderate response to income.

This study focuses on factors affecting urban food demand and then incorporates those findings into a broader goal, namely, to compare food supply and demand levels under alternative production and consumption scenarios. The first objective is to estimate a model of household expenditure allocation among alternative food items with particular interest on imported and locally produced cereals. Differences in the allocation process among households with different characteristics (income, demographics) are identified and quantified. The second objective is to use the model to simulate urban foodgrain demand under alternative income and demographic scenarios. Finally, supply–demand balances are projected by confronting the forecast urban demand with estimated rural surplus under alternative production assumptions.

Model specification

A model of household demand for the different types of cereals (imported and domestic) as well as other food and nonfood groups which compete for the household budget allocation requires a complete demand system framework. Because of its theoretical consistency with the postulate that households maximize utility (minimize cost) in their decision process and its flexibility to encompass broad ranges of behavior, the 'almost ideal demand system' (AIDS) was selected for modeling household behavior. Since it was introduced, the AIDS has been widely used (Ray 1980, 1982; Blanciforti and Green, 1983; Barewal and Goddard, 1985; Capps et al., 1985; and others).

AIDS Model

The basis for the AIDS approach comes from the minimization of a cost or expenditure function (Deaton and Muellbauer, 1980). The model hypothesizes that the portion of total expenditure that accrues to a particular commodity (or budget share) is related to prices and income as follows:

$$w_i = a_i^* + b_i^* \log(M/P^*) + \sum_{j=1}^{n} c_{ij} \log p_j \qquad i = 1, ..., n \tag{1}$$

where n is the number of commodities included, w_i is the average budget share of commodity i, M is total nominal expenditure on all goods, and p_j is the price of the jth good; P^* is a price index defined as:

$$P^* = a_0^* + \sum_{k=1}^{n} a_k^* \log p_k + \tfrac{1}{2} \sum_{k}^{n} \sum_{j}^{n} c_{kj} \log p_k \log p_j \tag{2}$$

The parameter a_i^* in equation (1) represents the average value of the budget share in the absence of price and income effects. The parameters b_i^* and c_{ij} represent the effects on the expenditure share of good i of a 1% change in real income or price of good j. A positive (negative) b_i^* indicates that the good has an income elasticity greater (less) than unity. Similarly, a good for which c_{ii} is negative (positive) has an own price elasticity greater (less) than 1 in absolute value. When c_{ij} is positive (negative), the goods are considered substitutes (complements).

The price index equation (2) allows the AIDS to be 'flexible', i.e., to model wide ranges of preferences. However, this form complicates the estimation procedure of the system of equation (1) which is nonlinear in the parameters. In empirical work, the following geometric price index is often used instead:

$$\log P = w_j \log p_j \tag{3}$$

where w_j is the budget share of product j. Deaton and Muellbauer and others found in their applications that Stone's index P closely approximates P^*. The present study also used P in lieu of P^*. This results in the following linear (in the parameters) demand system:

$$w_i = a_i + b_i \log(M/P) + \sum_{j}^{n} c_{ij} \log p_j \tag{4}$$

Extension of the basic model

Because household data are used to estimate the model, variables other than income and prices also play an important role in shaping consumption patterns. Empirical work has identified household size, education, urbanization and occupation as major determinants of household food consumption (Prais and Houthakker, 1955; Kinsey, 1983; Capps et al., 1985; McCracken and Brandt, 1987). Household demographics are incorporated into this demand analysis through 'scaling', which implies replacing the market price p by scaled prices, where the scale is a function of household characteristics (Ray, 1982). The extended AIDS then becomes:

$$w_i = a_i + b_i \log\ (M/P) + \sum_{j}^{n} c_{ij} \log p_j + \left(\sum_{j}^{n} c_{ij} \text{-} b_i \right) \log k(Q) \tag{5}$$

where $k(Q)$ is the scale related to adult equivalents. The scale is assumed to be commodity-independent, a restrictive assumption necessary to reduce the econometric problems associated with simultaneity. As goods are aggregated into broader groups (as in this study), this restrictiveness is of lesser concern.

A common specification of $k(Q)$ is a log–linear form such that:

$$k=\sum_{r=1}^{R} q_r^{d_r}$$

where q represents the demographic characteristics, and d are unknown parameters. Substituting this expression for $k(Q)$ and adding a disturbance term completes the equation:

$$w_{iht}=a_i+b_i \log m_{ht}+\sum_j c_{ij} \log p_{jt}+\sum_r d_{ir} \log q_{rh}+u_{iht} \qquad i=1, ..., n \qquad h=1, ..., H \qquad t=1, ..., T \tag{6}$$

where i, h and t index the commodity, household, and time period; $m=M/P$ is real income, and u is the random error.

Data

The data used to estimate the model were generated through a weekly consumer and market survey in Ouagadougou from September 1982 to August 1983. Sixty-five households were randomly selected from a larger group of 505 households chosen to reflect income and population distribution within the city based on national census data. The households provided information on quantities purchased, expenditures, demographics and income.

Three household income groups, i.e., those families with less than 30 000 CFA ($75) monthly income, households receiving monthly income between 30 000 CFA and 85 000 CFA ($212), and households with more than 85 000 CFA per month (Table 1), were used in the analysis. The lower-income group is associated with more children, a lower percentage of male heads of households, older heads, greater time living in the city, and far less education of the head than either of the other two groups. Conversely, the highest-income group has more adults per household and more education, characteristics which are likely to be associated with increased income. Other characteristics are described in greater detail in Savadogo and Brandt (1987).

Disaggregating the expenditure data into various food and one non-food categories suggests that higher-income households tend to spend more than lower-income households on both food and non-food items. However, the ratio of expenditures (high income expenditure/low income expenditure) is only 1.5 for food but 3 for non-food. Table 1 suggests that survey households spend about 73% of their total expenditures on food. The lower and middle-income groups spend a substantially greater (smaller) portion of their share on the less (more) expensive cereals (meats) than does the higher income group. Of the average expenditure on cereals, approximately 59% is allocated to im-

TABLE 1

Household characteristics by income group, Ouagadougou, Burkina Faso, 1983/84

	Sample	Income category[a]		
		low	middle	high
Number of households	65[b]	19	29	17
Household size	8.68[c]	8.16	8.93	8.82
Children 12 or younger	3.25[c]	3.37	3.38	2.88
Proportion of male heads (%)	87.6[c]	73.7	96.6	88.2
Average age of head (years)	45.0[c]	48.1	44.9	41.5
Urbanization[d]	28.8[c]	34.7	27.9	23.6
Married	53[b]	14	25	14
Single, widowed, or divorced	12[b]	5	4	3
Education, head of household				
0–6 years	48[b]	18	23	7
7–13 years	11[b]	1	4	6
14+ years	6[b]	0	2	4
School education (years)	4.4[c]	0.8	4.0	9.1
Expenditures on food (%)	73.0[c]	78.7	71.7	68.4
Expenditures on cereal (%)	20.1[c]	24.3	21.8	12.3
Expenditures on meat (%)	14.1[c]	13.5	12.4	17.8

[a]Income categories include: Low, 30 000 CFA ($75); Middle, 30 000–85 000 CFA ($212); and High, 85 000 CFA per month.
[b]Total in sample.
[c]Sample mean.
[d]Urbanization denotes the number of years the head of household has resided in the city.

ported (wheat and rice) cereals and 41% to traditional or locally produced (sorghum–millet–maize) cereals.

The commodities were aggregated into six groups: (1) domestic cereals (sorghum, millet, maize), (2) imported cereals (wheat, rice), (3) meats, (4) vegetables, (5) other food, and (6) nonfood. Prices were computed either by dividing expenditures by quantities (grains fall into this category) or by using information from a bi-monthly market survey (meat, vegetables and other food are in this category). The monthly average prices of the cereals exhibited very little variability over the 1-year period. Attempts to obtain prices for nonfood items were unsuccessful. The impact of their omission is likely to be small on the food equations (the major focus of this study).

Results

Equation (6) was estimated for each of the six commodity groups. Rather than allowing the a and b coefficients to vary by household (which leads to a

TABLE 2

Estimated effects of factors affecting food and nonfood consumption in Ouagadougou, Burkina Faso[a]

Explanatory variables	Dependent variables[b]					
	DOMCER	IMPCER	Meat	Vegetables	Other food	Nonfood
PDOMCER	−6.5 (−0.98)	−9.9 (−1.52)	2.2 (0.61)	3.4 (0.92)	12.0 (2.37)	−1.3 (−0.26)
PIMPCER	−9.2 (−1.42)	−12.5 (−2.01)	3.1 (0.87)	0.8 (0.23)	7.1 (1.44)	10.8 (2.25)
PMEAT	10.8 (3.43)	−0.8 (−0.26)	−5.3 (−3.12)	−4.5 (−2.56)	6.4 (2.68)	−6.5 (−2.81)
PVEGET	6.5 (2.79)	3.8 (1.67)	−3.3 (−2.57)	−2.4 (−1.83)	2.3 (1.30)	−6.9 (−4.02)
POTHFOOD	12.7 (5.01)	5.4 (2.21)	−4.7 (−3.40)	−6.1 (−4.33)	−1.1 (−57)	−6.2 (−3.30)
Income	1.3 (2.03)	−1.3 (−2.05)	−2.9 (−8.10)	−4.5 (−13.24)	−2.5 (−5.04)	10.1 (20.96)
DY2	−1.5 (−1.93)	0.9 (1.19)	0.5 (1.26)	0.3 (0.80)	−0.3 (−0.58)	0.1 (0.10)
DY3	−1.1 (−1.45)	2.3 (3.00)	−1.1 (−2.51)	−0.01 (−0.13)	0.01 (0.02)	−0.01 (−0.01)
Children	−0.5 (−0.64)	1.7 (2.13)	1.4 (3.20)	−1.1 (−3.12)	0.2 (0.33)	−2.4 (−4.00)
Adults	0.6 (0.67)	0.6 (0.72)	1.1 (2.27)	0.4 (0.87)	−0.2 (−0.24)	−2.7 (−3.93)
EDUC	−0.6 (−1.33)	0.2 (0.46)	0.3 (1.11)	−0.2 (−0.96)	0.8 (2.21)	−0.4 (−1.16)
URBAN	−2.6 (−3.01)	−0.2 (−0.19)	2.4 (5.02)	−0.3 (−0.64)	−0.2 (−0.24)	0.9 (1.34)
MARSTAT	3.0 (2.52)	−0.01 (−0.01)	−2.1 (−3.14)	1.2 (1.72)	0.7 (0.80)	−2.8 (−3.20)
Intercept	−107.7 (−2.23)	71.4 (1.56)	77.7 (3.00)	109.9 (4.16)	−104.7 (−2.92)	51.4 (1.47)
D2	6.5 (1.49)	−6.6 (−1.57)	−1.4 (−0.58)	−2.1 (−0.87)	3.9 (1.20)	−0.3 (−0.10)
D3	−1.7 (−0.37)	−18.6 (−4.15)	15.1 (5.95)	2.3 (0.90)	1.3 (0.38)	1.6 (0.46)
F	8.95	3.60	43.35	69.77	13.00	196.76
R^2	0.15	0.07	0.48	0.58	0.20	0.79

[a]Coefficients presented are 100 times their original values; t-values are in parentheses.
[b]Dependent variables are represented as budget shares.

TABLE 3

Definition of variables in the almost ideal demand system estimation

For the dependent variables	
DOMCER	Budget share of domestically produced cereals: sorghum-millet-maize
IMPCER	Budget share of cereals largely imported: wheat-rice
For the explanatory variables	
PDOMCER	Price of domestically produced cereals
PIMPCER	Price of imported cereals
PMEAT	Price of meat
PVEGET	Price of vegetables
POTHFOOD	Price of other food
Children	Number of household members age 0-12
Adults	Number of household members age 13+
EDUC	Education of head of household (years)
URBAN	Degree of urbanization of head of household (years)
MARSTAT	Marital status of head of household; 1, if head is married; 0, otherwise
Income	Total monthly expenditure of household, on all products included in the analysis
HSIZE	Uncorrected size of household
D2	Intercept shift variable: 1, if household in middle-income group; 0, otherwise
D3	Intercept shift variable: 1, if household in high-income group; 0, otherwise
DY2	Income slope shifter; 1, for middle-income group; 0, otherwise
DY3	Income slope shifter: 1, for high-income group; 0, otherwise

degrees of freedom problem), the equations were altered to allow differences only by income group. A Chow test supported this modification of the model. As a result, binary variables were included for middle and high-income groups for the intercept and income variables.

The AIDS model was estimated using ordinary least squares.[1] The results of the regressions and acronyms used to facilitate their presentation are presented in Tables 2 and 3, respectively. It is important to note the meaning of the coefficients at the outset. In the AIDS, the explanatory variables are in log

[1]Although the model was a set of disturbance-related equations (because of the adding up condition), estimation by generalized least squares on the entire system would not improve on single equation OLS since the same explanatory variables were repeated in each equation (Theil, 1971). This is true in the absence of cross-equation restrictions, such as symmetry (Johnston, 1984, p. 340). In the context of the AIDS, testing for or imposing the symmetry restriction is valid only when the theoretical price index P^* (equation 2) is used, not when an approximation index (Stone's index P) is used (Deaton and Muellbauer, 1980). Since the theoretical index P^* is not used in this study, symmetry restrictions are not tested nor imposed.

Since the data consist of monthly expenditures, the expectation is that an allocation above average in a given month for product i induces an allocation below average the following month. Products that are most likely subject to this type of correlation include cereals (e.g., rice) which households are more likely to purchase in bulk. However, serial correlation was rejected by the Durbin-Watson procedure.

form (except for 0-1 dummy variables). Each coefficient represents the effects on the dependent variables of a 1% change in the explanatory variable. Since the dependent variables are budget shares, the estimated parameters are occasionally very small. Therefore, to allow for easier interpretability, the original coefficients are multiplied by 100 (see Deaton and Muellbauer, 1980). The coefficients in table 2 thus represent 100 times the effects on budget shares of 1% change in the independent variables.

The values of the R^2s suggest mixed results. For cereals they are very low, 0.15 for domestic cereals, 0.07 for imported cereals. The other commodities fare better, with R^2s as high as 0.57 for vegetables, and 0.48 for meat. The surprisingly large R^2 of 0.79 for nonfood (where nonfood price is omitted from the regression) may be explained by the high aggregation of nonfood expenditure, which results in low variability, and perhaps to its high correlation with income.

Excluding the intercepts, 38 (42) of 90 coefficients in Table 2 are statistically significant at the 5 (10) percent level. The income coefficients are significant, including those on cereals. As incomes rise, consumption shifts to the preferred wheat and rice commodities in a significant way. The meat equation produces the best results: ten coefficients are significantly different from zero, including the price of meat. For the domestic cereals equation, six coefficients are significant. The own price in the imported cereals equation is statistically significant which seems somewhat surprising given the low variability in the price of this product noted earlier. The own price in the domestic cereals equation is insignificant. The cross price effects between domestic and imported cereals are negative (but insignificant at the 5% level), implying complementarity rather than the expected substitution. Thus, the model fails to estimate expected cross-price effects. The raw data revealed that grain prices were characterized by very low month-to-month and market-to-market variability. The coefficients were below 10% for millet and sorghum, and below 5% for maize and rice.

The model indicates that prices and income along with demographic variables affect consumer behavior. If prices are insignificant, the AIDS system collapses to a system of Engel functions (Working, 1943). The results of an F test suggest that the null hypothesis of absence of price effects is rejected at the 5% level for all commodities. Estimating Engel curves would therefore entail a misspecification despite the apparent weakness of the price data.

The demographic variables appear important in explaining household budget allocation. The effects of children are significant at the 5% level for the imported cereal, meat, vegetables and nonfood equations. The effects of adults are significant for the meat and nonfood equations. Increasing the number of adults by 10% increases the budget share of both traditional and new-type cereals by 6%. In contrast, increasing the number of children by 10% entails a decrease in the budget share of traditional cereals by 5%, and a statistically

TABLE 4

Household size elasticities by income group

Goods	Sample mean	Income level		
		low	middle	high
DOMCER	0.28	0.22	0.23	0.66
IMPCER	0.08	0.06	0.08	0.10
MEAT	−0.05	−0.05	−0.06	−0.04
VEGET	−0.29	−0.25	−0.31	−0.29
OTHFOOD	−0.14	−0.14	−0.14	−0.14

significant increase by 17% in the share of new-type cereals. Informal discussions with family members from the survey suggested that children had a much stronger preference for rice than for sorghum and that the heads of households typically attempted to meet those preferences when possible.

The urbanization index of the head of household suggests that the longer people have lived in Ouagadougou, the less local cereal products they tend to eat. Also, a 1% increase in residency in town increases the budget share for meat. This has important implications for forecasting future demand for these products where there is much rural to city migration.

When per-capita income is held constant and an increase in household size leads to a less than proportionate increase in consumption, economies of size in consumption are present. Household size elasticities are per-capita income compensated, measuring the effect of an additional household member on consumption holding per-capita income constant. The results in Table 4 suggest economies of scale in consumption are associated with large households at all income levels. The size elasticities generally appear small for imported cereals, but are relatively large for domestic cereals. The negative size elasticities for vegetables, meat and other food indicate that households at all income levels

TABLE 5

Income elasticities by income group

Goods	Sample mean	Income level		
		low	middle	high
DOMCER	0.94	1.13	0.99	0.63
IMPCER	1.02	0.91	0.97	1.21
MEAT	0.80	0.79	0.81	0.81
VEGET	0.75	0.77	0.74	0.75
OTHFOOD	0.86	0.88	0.86	0.86

would substitute away from these commodities toward less expensive food items (cereals) when a member is added.

The results in Table 5 show the inelastic income effects in the consumption of sorghum–millet–maize at the sample mean, as opposed to the elastic effects for wheat–rice. The elasticities for domestic cereals decrease with rising income while those for imported cereals increase with income. The cereals' elasticities are higher than those for other types of food (meat, vegetables) for low-income households. At the highest income level, meat and vegetables have larger responses than sorghum–millet–maize, but the response of wheat–rice is much larger than either, suggesting that consumers in this sample are upgrading their diets from less preferred local cereals to more preferred imported cereals with increases in income.

Conditional food demand and supply forecasts

The estimated parameters in table 2 can be used to forecast consumption levels of the various food groups under different scenarios which allow income, education, household size and composition, and the other explanatory variables to change. Here alternative scenarios are outlined which compare the levels of urban demand and rural marketable surplus of the major food grains for the year 1995 relative to the base year 1983 when the urban data were collected. The emphasis is on the direction of food policy changes needed to reach various goals (e.g., self-sufficiency) rather than on forecasts of specific food demands.

Urban demand

Three scenarios of urban population growth are considered. In the first, the urban population grows at a low rate of 3.4% per year, a rate suggested by Zachariah and Conde (1981). In the second, the urban population grows at a rate of 5.8% per year, corresponding to the average rate of growth in West Africa (Zachariah and Conde, 1981). The third scenario considers a high rate of growth of 7.5% per year, similar to the official figures used by the Institut National de la Statistique et de la Démographie (INSD, 1978). Such a high rate includes a large migration component. Household size is kept constant at the 1983 sample mean.

The number of years of formal education is the index of education. The numbers of teachers and students and expenditures on education have steadily increased over the period 1970–1982. Enrollment in primary school increased from 12% in 1970 to 22% in 1982. These trends are likely to continue in the future, given the present low level of education and the commitment of the present government to improve the education sector. As a result, the average number of years of education is likely to increase from its sample level of 4 years. By 1995, the average resident of Ouagadougou is assumed to have completed 6 years of schooling.

Household income is the product of household size and income per individual member. Under the assumption of constant size, the relative change in household income is identical to the relative change in per-capita income. Real income growth is assumed to be the same for all income classes. In the first scenario, household income (expenditure) grows at a rate equal to past trends, 1.8% annually. The second scenario assumes that household income grows at a moderately lower pace than past trends, 1.0% annually. The third scenario is one of high income growth, a rate of 3.5% per year.

Table 6 shows cereal consumption levels under the various alternatives. If income increases moderately at 1.8% per year, demand for both traditional and new type cereals in 1995 will exceed base case (1983) levels by 24%. Changes in the educational level have a very small effect on the projected demand for cereals, consistent with Table 2. Under medium population growth, the demand for maize–sorghum–millet almost doubles between 1983 and 1995, and likewise for wheat–rice. One may note that the forecast results are not additive, due to the nature of the demand model. Thus, a combination of low population, medium income growth and education increases implies levels of demand of

TABLE 6

Projected consumption of cereals (t) in Ouagadougou, 1995: effects of income, education and population growth[a]

Scenario	Sorghum-Millet-Maize	Wheat-Rice
Base period	13 203	10 726
Income growth	14 799	12 137
low (+1% per year)	(112.1)	(113.1)
trend (+1.8% per year)	16 344	13 306
	(123.8)	(124.1)
high (+3.5% per year)	20 128	16 140
	(152.5)	(150.5)
Educational progress	12 879	10 790
From 4 to 6 years	(97.5)	(100.6)
Urban population growth		
low (+3.4%)	19 721	16 021
	(149.4)	(149.4)
medium (+5.8%)	25 973	21 100
	(196.7)	(196.7)
high (+7.5%)	31 447	25 548
	(238.2)	(238.2)

[a]The base period is 1983 consumption (average education is 4 years). The parenthetical figures represent the ratios to base case projections in percentages.
t, metric tonne = 1000 kg.

31 359 t and 26 329 t for the traditional and new type grains. This is visibly different from the numbers obtained by adding the individual scenario results (48 944 t and 45 146 t, respectively).

Rural surplus

Rural marketable surplus, defined as total production minus rural home consumption (including security stocks), is the domestic source of urban supply of grains. Forecasting marketable surplus is based on independent projections of total production and rural consumption. Projected levels of production under technological change will be compared to projected levels based on an extrapolation of past trends. Technological change yields are based on research on maize, millet, and sorghum conducted by the Farming System Unit of the Semi-Arid Food Grain Research and Development in selected Burkinable semi-arid zones.[2]

In the absence of technological amelioration, the assumption is that rural consumption increases at the same rate as the rural population (1.7% per year), so that per-capita consumption remains constant. In case of a technological change increasing production, however, the income effect from increased sales may significantly alter the consumption mix of rural households. The implied new equilibrium consumption levels will depend both on the relative increase in rural incomes due to technology and the magnitude of the income elasticity of demand.

Table 7 shows surpluses available for marketing under alternative scenarios of rural income growth and demand elasticities. Without technological improvement, rural production of both traditional and new type cereals will likely fall short of rural consumption needs by 30 000 and 40 000 t, respectively. One notes an important qualitative change under technological improvement: rural production is able to generate a surplus for the traditional cereals, but not for the new type cereals. The surplus persists even after allowing for large rural consumption responses to the increased income. The importance of technological research is clearly demonstrated in these findings: the rural sector will become self-sufficient in at least one group of cereals, as opposed to deficits in both groups of cereals in the absence of technological change.

[2]Research suggested annual rates of yield increases of 4.3% for maize, 4.9% for sorghum, and 3.7% for rice were possible under technological improvement (e.g., tied ridges in combination with fertilizer). These rates of increase recognize that farmers may not reach the top of their learning curve over the forecast period and thus are discounted by a factor of 25% from their optimal levels. Millet yields were not responsive to technological advances because millet is typically grown on marginal land (sandy soils) where tied ridging performs poorly. As a result, trend yields were used (SAFGRAD Farm System Unit, 1985).

Supply–Demand balances

The estimation of urban demand for the total urban population was accomplished by extending the demand levels in Ouagadougou to the rest of the urban population. Ouagadougou accounted for approximately 40% of the total urban and semi-urban population in 1975 (INSD, 1978, p. 5). By 1955, Ouagadougou is still expected to account for 40% of all urban population. Accordingly, the quantities demanded in Ouagadougou will be extended to the total urban population by multiplying by a factor of 2.5.

Supply–Demand balances under trend scenario for domestic production. Quantities supplied by the rural area are assumed to change according to past trends, and urban demand according to the various income, demographic and education scenarios. The deficits that were shown to exist at the rural level (Table 7) are reinforced when the urban sector is added (column 1, Table 8). For both types of cereals, the largest deficits will occur with high urban population growth, reaching 110 000 t for the coarse grains and 106 000 t for the superior grains. The lowest deficits occur for the education scenario, since, as seen earlier, education tends to reduce the consumption of food grains. Under the income

TABLE 7

Projections of rural marketable surplus for 1995 under alternative production growth and rural income response scenarios, Burkina Faso

Scenario	Sorghum-Millet-Maize	Wheat-Rice
Production (t) *available for consumption*[a]		
Trend extrapolation	1 149 109	23 434
Technology growth	1 575 339	35 660
Projected rural marketed surplus[b]		
No rural income growth	−31 191	−42 325
Rural income growth		
low income elasticity	+325 836	−37 518
high income elasticity	+161 849	−47 192

[a]For sorghum-millet-maize, production available for consumption was computed by adjusting gross production for seeds and losses (15% as used by FAO). For rice, total production was first adjusted for seeds and losses (15%), then the results were converted into clean rice equivalent (using a conversion rate of 65 kg of rice for 100 kg of paddy).

[b]Estimated as production available for consumption minus rural consumption. Under 'no rural income growth', the trend extrapolation of production is used. Under 'rural income growth', the production levels implied by technology change are used, together with rural consumption under the alternative rural income elasticities.

TABLE 8

Grain supply-demand balances under alternative domestic production and demand scenarios, Burkina Faso, 1995

Urban demand scenario	Trend production (t) scenario	Production (t) under technological improvement	
		low income elasticity[a]	high income elasticity[a]
Sorghum-Millet-Maize balances[b]			
Base period	64 199	−292 829	−128 842
Income growth scenario			
low	68 189	−288 839	−124 852
medium	72 051	−284 976	−120 989
high	81 511	−275 516	−111 529
Educational increase scenario	63 389	−293 639	−129 652
Population growth scenario			
low	80 494	−276 534	−112 547
medium	96 124	−260 219	−96 917
high	109 809	−247 219	−83 232
Wheat-Rice balances[b]			
Base period	69 140	64 333	74 007
Income growth scenario			
low	72 668	67 861	77 535
medium	75 590	70 783	80 457
high	82 675	77 868	87 542
Educational increase scenario	69 300	64 493	74 167
Population growth scenario			
low	82 378	77 571	87 245
medium	95 075	90 268	99 942
high	106 195	101 388	111 062

[a]Rural income elasticities of 0.20 (low income) and of 0.69 (high income) are used for the traditional cereals, 0.40 (low) and 0.92 (high) for the imported cereals.
[b]A positive number means deficits in domestic production and a negative number implies surpluses.

scenarios, deficits range from 68 000 to 81 000 t for sorghum-millet-maize, and 73 000 to 83 000 t for wheat-rice. Compared to the average import levels over 1980–82 (13 500 t for the coarse grains and 52 000 t for wheat–rice), the lower-income scenario results imply an increase of import requirements by 400% for sorghum–millet–maize and 40% for wheat–rice. Thus without technological improvement, the local cereals sector will be the most affected.

Supply–Demand balances under technological innovation in domestic production. If yield-increasing technological improvement occurs and is adopted rapidly by farmers, the supply-demand balances are significantly altered (Table 8, columns 2 and 3). Burkina Faso would become self-sufficient in traditional cereal consumption, even when allowing for a substantial increase in rural consumption. If rural income elasticity of demand assumes a low value of 0.20, excess production over demand ranges from 247 000 t under high urban population growth to 293 000 t with higher educational levels. Under low urban income growth, the excess supply reaches 289 000 t and falls to 275 000 t when high income growth occurs.

If, however, rural income elasticity assumes a higher value of 0.69, the surpluses significantly decrease, being absorbed by an increased rural demand. They are nonetheless still positive, ranging from 83 000 t under high urban population growth to 129 000 t at the higher educational levels. Thus, if technology growth occurs as assumed in the projections, Burkina Faso can become self-sufficient in the production of traditional cereals.

Such excess supply may have depressing effects on prices which may discourage production and disrupt the effects of technology advance. However, increases in urban incomes are likely to result in increased demand for meat products. Under these conditions, excess production of sorghum may be used as livestock feed, thus raising the probability of meeting the higher meat demand. Other outlets may include the flows of grains from Burkina Faso to Niger and Ghana, but the future of such flows will depend on the dynamics of comparative advantage in the respective countries.

The increase in production resulting from the assumed technological change is not enough to eliminate the need of importing wheat and rice. Import requirements remain at high levels, even with the low rural income elasticity. However, an important part of the deficit is attributable to wheat which is basically an import crop and is expected to remain so in the near future. In the case of rice, Burkina would become self-sufficient in production only if yields would double from the assumed level of 1400 kg/ha, to 2700 kg/ha, with constant area and under medium urban population growth. This is unlikely. Lower yield levels would be expected if area cultivated were expanded more rapidly than in the past. For example, if the area cultivated in rice could be expanded to 65 200 ha (i.e., 14 times the trend projection), an average yield of 1980 kg/ha (i.e., 1.4 times the assumed level under technological amelioration) would be enough to ensure near self-sufficiency with an implied production level of 130 000 t of paddy rice. Such yield levels are technically feasible but unlikely and imply significant departure from present farming practices. Whether this happens depends on government commitment and policies (pricing, marketing, input supplies) and is subject to the general financial constraints faced by the country.

While the analysis thus far has considered each scenario individually, in reality, variables are likely to change together. Table 9 presents the supply–demand balances under the combined effects of simultaneous changes in the forecasts of income, population and education. Scenario 1, which combines low

TABLE 9

Combined effects of income, population, and education on grain supply-demand balances, projected to 1995, Burkina Faso[a]

	Low urban demand[b] (t)		High urban demand[c] (t)
	Low income growth Low population growth No education change		High income growth High population growth Education increase
	1		2
Technology growth[d]	– 106 586	Sorghum-Millet-Maize	– 44 919
	90 512	Wheat-Rice	143 867
	3		4
Trend production growth[e]	86 454	Sorghum-Millet-Maize	148 121
	85 645	Wheat-Rice	139 000

[a]A positive number means deficits in domestic production and a negative number means surpluses.
[b]Assumes a simultaneous low growth in income (+1% per year), in population (+3.4%), and no change in years of education from the 1983 level.
[c]Assumes a simultaneous high growth in income (+3.5% per year), in population (+7.5%), and an increase in average years of education from 4 to 6 years.
[d]Under technology growth, rural consumption is allowed to increase in response to increased rural income, with elasticities of 0.69 for sorghum-millet-maize and 0.92 for wheat-rice.
[e]Under trend growth, rural consumption increases only with population, no shift in per-capita demand is assumed.

urban demand with technology growth in agriculture, provides an expected upper bound for national self-sufficiency under changing income, population and education. Surpluses of 106 000 t in sorghum–millet–maize are implied, the maximum expected surplus if the forecast variables moved together. Likewise, scenario 1 implies imports 90 000 t of wheat–rice, which constitutes the expected lower bound for import needs. Alternatively, scenario 4 (trend production, high urban demand) provides upper bounds for import requirements. Thus 287 000 t of sorghum–millet–maize and wheat–rice represent the maximum expected deficit if all forecast variables were to change together. Scenarios 1 and 4 represent extreme situations and therefore bracket the conditions likely to occur in 1995. Quantifying the comprehensive interaction of the exogenous shocks on cereal demand generates a different interpretation relative to the individual shocks illustrated in Table 8, which were not additive.

Implications

Income, education, household size and composition are important determinants in food and nonfood consumption in Burkina Faso. Consumers respond significantly toward greater purchases of imported cereals with rising incomes. Incremental changes in the income levels of low-income households leads to larger purchases of locally produced cereals. Thus a policy designed to shift income from high-income households to low-income households would increase the demand for traditional cereals and reduce the need for imported cereals.

Estimating the AIDS model and interpreting the results requires some caveats. It was anticipated that traditional and imported cereals would appear as substitutes in the crops product price coefficients. The results, although insignificant, suggested complementarity. Consequently, analysis of alternative pricing policies is left for a later analysis when additional price variability is likely and a larger sample of households is possible.

Assuming the same rate of growth for the three income classes ignored possible distortions that might occur in income distribution. The demographic scenarios were forced to keep household size constant due to the lack of reliable data. Finally, the assumed levels of technology are high and based on a rapid and total diffusion in the long run. Lower growth rates would imply lower surplus levels for the traditional cereals.

Notwithstanding these caveats, self-sufficiency in the traditional cereals is feasible with improved technology in production and a comprehensive diffusion of this technology to farmers, while self-sufficiency in the usually imported cereals (wheat and rice) would require greater technological changes. The overall implication is that important policy changes may be necessary (both at the producer and consumer levels) if reducing the gap between supply and demand is a goal. In the absence of production policies leading to technological change at the farm level, deficits are likely to reach staggering levels for both domestically grown and imported cereals. This result is significant as it suggests to policymakers that research in sorghum, millet and maize production can prove worthwhile in the long run.

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