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HOUSEHOLDS DEMAND FOR STAPLE CEREAL COMMODITIES AND ANALYSIS OF THE EVOLUTION OF STAPLE CEREALS' PRICES IN BURKINA FASO

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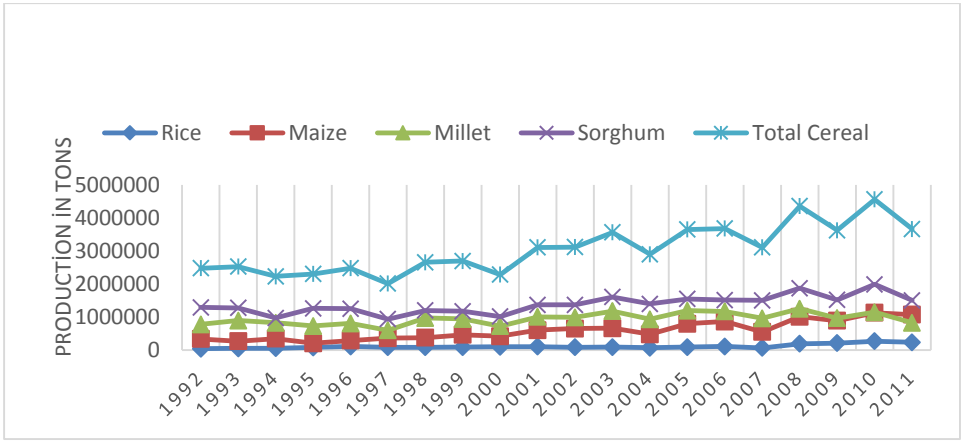
Abstract

With a population increasing rapidly and agricultural yields almost stagnant over the years, access to food is a major challenge in Burkina Faso. This study investigates households demand for staple cereal commodities in Burkina Faso, using data from the 2009-2010 Integrated Household Living Condition Survey. A complete almost ideal demand system (AIDS) model is estimated taking into account demographics and zero consumption. Results show that maize, millet and sorghum are necessities while rice is considered a superior cereal commodity. Demand for maize, millet and sorghum are less price elastic than rice and these results are consistent for most households except for wealthy, educated households living in urban areas where rice becomes a necessity. The analysis of the evolution of cereal prices shows an overall increase leaving many people in food insecurity and the country in political instability. Therefore, the country must adopt agricultural reforms to boost production and productivity by exploiting unfarmed land, building more storage facilities, roads and rural infrastructure, using improved seeds and more fertilizer, and installing irrigation systems.
Keywords: *Food consumption patterns, AIDS model, staple cereals, Burkina Faso.*
JEL Codes: D12, Q11, Q18

1. Introduction

Since the structural adjustment programs in the agricultural sector launched in 1991, Burkina Faso's agriculture has become more modernized and mechanized. The increased use of tractors, chemical fertilizers and improved seeds has been followed by an increase in yields, hence production. However, the increase in yields is still low compared to many Sub Saharan-African (SSA) countries. Although the backbone of the economy occupying almost 84% of the active population and accounting for more than 31% of the gross domestic product (GDP), agriculture in Burkina Faso is dominated by small scale family farms, specialized in the production of subsistence crops and heavily dependent on rainfalls (INSD, 2010). Like in most SSA countries, cereal commodities occupy a large portion of the area harvested (88%) and satisfy 70% of the food needs in the country (FAO, 2015).



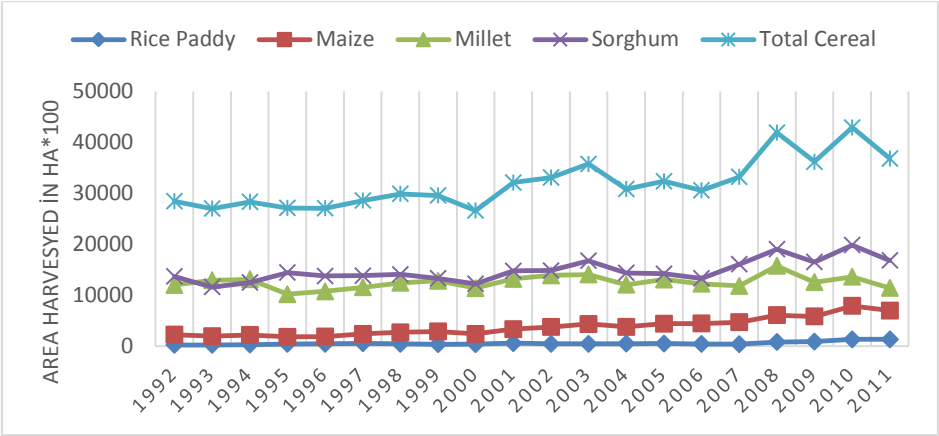
Source: Author based on FAOStat, SONAGESS and INSD data.

Figure 1. Evolution of Staple Cereals' Production

Sorghum, millet and maize also known as "traditional cereals" or "dry cereals" are the main staple food and play a central role in reducing food insecurity and malnutrition, which rates remain chronically high in Burkina Faso (21% of the total population were undernourished in 2015 according to FAO Food Hunger Map). Over the last two decades, traditional cereals production has almost doubled passing from 2.43 million tons in 1992 to 4.29 million tons in 2010 (Figure 1) as a result of an increase in areas harvested (Figure 2) rather than a substantial increase in yields (Figure 3). At the same time, per capita consumption of cereals excluding beer increased from 1,521 kcal/day in 1995 to 1,715 kcal/day in 2010 (FAO, 2015). The most common use of cereals is cooked as paste called "Tô[1]", sorghum is mainly used in the preparation of local beer called "dolo" and millet is mainly consumed in the northern part of the country. In addition to the traditional cereals, it is essential to mention the importance of rice in households' consumption habits especially in urban areas. Rice is the fourth consumed cereal in Burkina Faso and the national consumption of rice is estimated at 450,000 tons/year for a population of 15 million (INSD, 2010). However, with a local production of 130,000 tons/year, the country imports 30 billion FCFA (50 million USD) worth of rice each year to satisfy its demand.

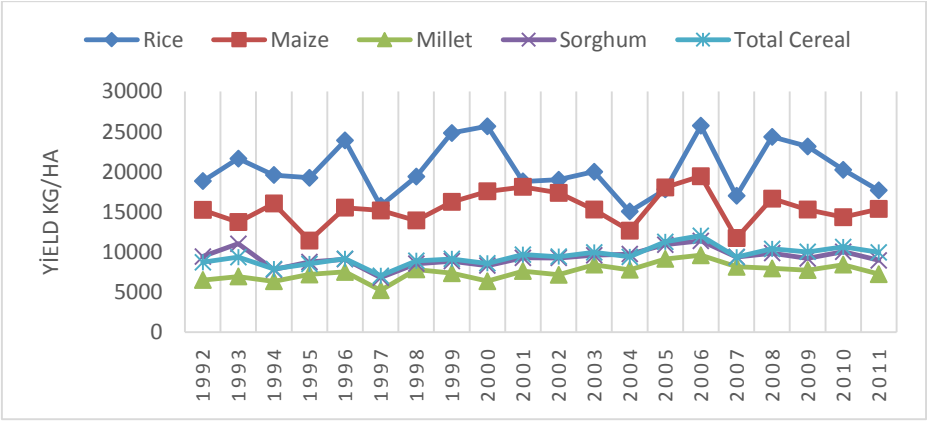
The main drivers of food demand, especially staple cereals in Burkina Faso, are the high population growth (3% annum), and the sustained pace of GDP growth (5% per year). An analysis of the structure of household spending for cereal commodities from the Integrated Households Living Conditions Survey of 2009-2010 shows very different consumption patterns depending on household location (Figure 4). Urban households have a strong predominance of their cereal expenditures for rice (27.81% of total cereal expenditures) and maize (48.87% of total cereal expenditures) while rural households have a strong preponderance of their cereal expenditures for millet (26.01% of total cereal expenditures) and sorghum (39.82% of total cereal expenditures). It was also shown that households (mainly urban) food demand is shifting to higher quality products and imported processed food with an increasing consumption of meats, fruits and vegetables, and drinks (Kaminski et al., 2013).

[1]Tô is the traditional meal in Sahelian countries such as Burkina Faso, Mali and Niger, and is consumed as a paste of hulled cereals with sauce.



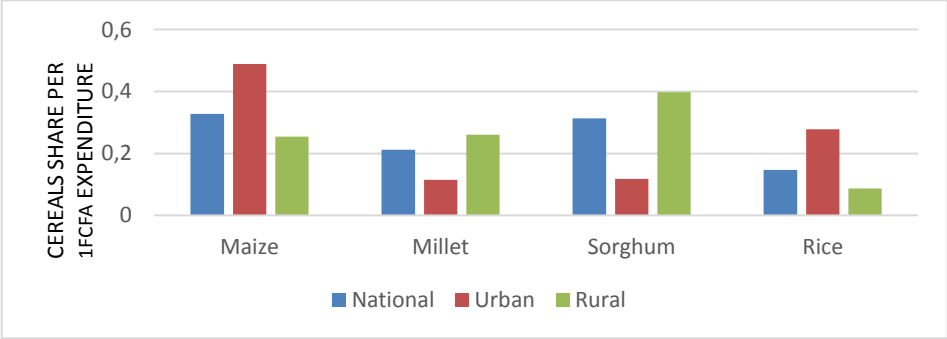
Source: Author based on FAOStat, SONAGESS and INSD data.

Figure 2. Evolution of Staple Cereals' Areas Harvested



Source: Author based on FAOStat, SONAGESS and INSD data.

Figure 3. Evolution of Staple Cereals' Yields



Source: Author based on EICVM, 2009-2010.

Figure 4. Share of Staple Cereals' Expenditure by Household Location

An analysis of the evolution of staple food prices shows that prices have fluctuated over the last decade and the highest prices were recorded in 2008. The rise of food prices in 2008

has had important social, economic and political repercussions in Burkina Faso. Consequently, the government adopted short-term trade oriented policy measures, including the release of cereal emergency stock onto the market, the suspension of customs duty on several imported foods such as rice, wheat, oil and sugar, the negotiations with importers and wholesalers to establish recommended ceiling prices for staple foods, the establishment of community grain banks to ensure food security at the community level, the handling of vouchers for food and the ban of cereal exports. Although beneficial, these policy measures did not hold for long and staple food prices increase after few months.

In regards to the changing Burkinabe diet, the difference between rural and urban cereals consumption patterns, the volatility of basic food prices and the increasing demographic trend, it is fundamental to quantify how household adjust to various shocks to market prices and commodity supplies. These adjustments in demand are particularly important in Burkina Faso, where many households are poor, depending on a few staple crops and rises in prices can be devastating.

Most studies that have estimated demand for food in Burkina Faso have either used aggregate time series data (Ruijs et al., 2001) or regional/city level cross-sectional data (Savadogo & Brandt, 1988; Reardon et al., 1989). Only a few studies have analyzed the demand for individual staple cereals, namely sorghum, millet, maize and rice at the national level. This study contributes to the limited literature on household demand for food in Burkina Faso by analyzing the impact of both economic and demographic variables on the consumption of staple cereals using recent household survey data.

Therefore, the overall objective of this study is to estimate the effects of economic factors (prices and expenditures) and noneconomic factors (demographic variables such as location, size and education) on Burkina Faso's household demand for staple cereals. Specifically, the study has two objectives. The first objective is to estimate a complete demand system for the four staple cereals: sorghum, millet, maize and rice. In light of the unprecedented spike in food prices in Burkina Faso in 2008, the second objective focuses on analyzing of the evolution of staple cereals' prices and evaluating the impact of a price strike on cereal consumption. Results from this study will deepen understanding of household cereals consumption behavior and provide benchmarks for future food policy analyses and recommendations in Burkina Faso.

The rest of the paper is organized as follows. The next section introduces the model specification. Data employed in the analysis and the estimation procedures are then described. Next, the empirical results are presented, followed by an analysis of the evolution of cereals prices and the impact of price increases on cereal consumption. The final section contains policy recommendations and conclusions.

2. Model Specification

A model of household demand for different types of cereals as well as other food and nonfood groups that compete for household budget allocation requires a complete demand system framework. A major concern in the estimation of demand systems is that the functional form used should be consistent with observed consumer behavior. Also, the choice of the functional form should not only be based on practical criteria of fit, but also on the principles of demand theory (adding-up, homogeneity and symmetry restrictions).

Since Deaton and Muellbauer (1980), researchers widely use the Almost Ideal Demand System (AIDS) in applied demand analysis because of its theoretical consistency. The

AIDS[2]model is used to estimate a complete demand system for cereals at the household level in Burkina Faso. Assuming weakly separable preferences, the share of total cereal budget allocated to the *i*-th cereal by household *h* is given as:

$$w_{ih} = \alpha_{ih} + \sum_{j=1}^{N} \gamma_{ij} \ln(p_{jh}) + \beta_i \ln\left[\frac{m_h}{a(p_h)}\right] + \varepsilon_{ih} \quad (1)$$

where:

$$\ln a(p_h) = \alpha_0 + \sum_{j=1}^{N} \alpha_{jh} \ln(p_{jh}) + \frac{1}{2\sum_{i=1}^{N}\sum_{j=1}^{N} \gamma_{ij}\, ln(p_{ih}) ln(p_{jh})} \quad (2)$$

In equations (1) and (2) subscripts *i* and *j* indicate cereal commodities (maize, millet, sorghum and rice); *h*= 1,…,*H* represents the number of household; γ_{ij}, and β_i is a parameter to be estimated; p_{jh} is the price of the *j*-th cereal commodity; m_h is the *h*-th household total expenditure on cereals, and ε_{ih} is an error term.

Under the hypothesis that socio-economic and demographic factors influence cereal consumption patterns, variables such as household head education, marital status, professional occupation, household size and number of children are incorporated in the model using the demographic translating approach proposed by Pollak and Wales (1981). That is:

$$\alpha_{ih} = \rho_{i0} + \sum_{k=1}^{K} \rho_{ik} d_{kh} \quad (3)$$

where ρ_{i0} and ρ_{ik} are parameters to be estimated and d_{kh} represents socio-economic and demographic variables considered in the study.

The adding up conditions are imposed as:

$$\sum_i^N \rho_{i0} = 1, \sum_i^N \rho_{ik} = 0, \sum_i^N \gamma_{ij} = 0, \text{ and } \sum_i^N \beta_i = 0 \quad (4)$$

Whereas homogeneity requires that:

$$\sum_j^N \gamma_{ij} = 0 \text{ for any } j \quad (5)$$

And Slutsky symmetry is given by:

$$\gamma_{ij} = \gamma_{ji} \text{ for all } i \text{ and } j \quad (6)$$

3. Data and Descriptive Statistics

Household data used within the current study are from the Integrated Household Living Conditions Survey conducted between July 2009 and August 2010 by the National Institute of Statistics and Demographics of Burkina Faso (EICVM/INSD[3]-BF). The EICVM collected nationwide information on households' education, employment, income, health, nutrition, access to and utilization of basic facilities/services. In contrast to other previous surveys conducted by the National Statistics Institute, the EICVM was the first survey to collect information on consumption and other expenditures of households. The household consumption expenditure data represents the value of acquired consumer goods and services (used or paid) by a household to meet the needs of its members: through direct monetary purchases in the market; through the market but without using money as a means of payment (barter, income in kind) or by self-production within the household (own-production).

[2] The quadratic almost ideal demand system (QUAIDS), developed by Banks, Blundell and Lewbel (1997), was first fitted but the test of the joint hypothesis of the quadratic was not significant, therefore the AIDS was accepted as the preferred model for analysis.

[3] EICVM/INSD is the Enquete Integrale sur le Conditions de Vie des Menages/Institut National de la Statistique et de la Demographie, Burkina Faso.

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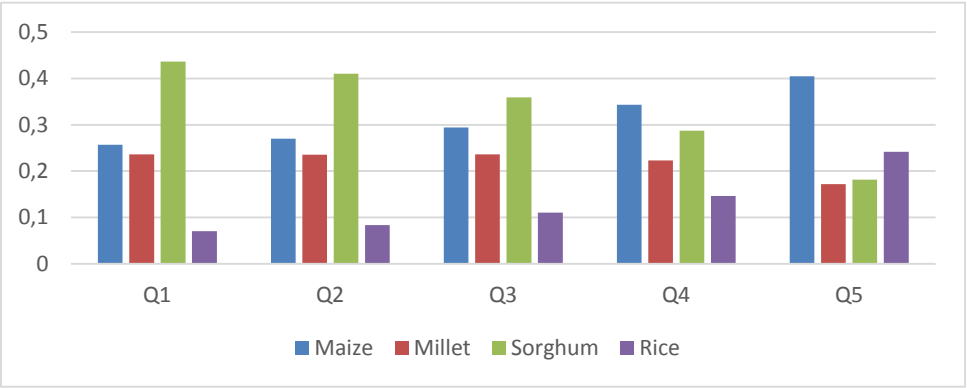
Table 1. Summary Statistics

Variable	Description	N	Mean	Std. Dev	Min.	Max.
Marital Status	(1=Married; 0= otherwise)	7,056	0.63	0.324	0	1
Gender	(1=Male;0=Female)	7,056	0.86	0.34	0	1
Occupation	(1=Agriculture; 0=otherwise)	7,056	0.9184	0.273	0	1
Location	(1=Urban;0=Rural)	7,056	0.279	0.344	0	1
Education	Primary	7,056	0.142	0.344	0	1
	Secondary	7,056	0.078	0.019	0	1
	Tertiary	7,056	0.002	0.139	0	1
Age	HH head age	7,056	46.28	14.7	16	99
Size	HH Size	7,056	6.8145	4.0392	1	57
Children	Number of children	7,056	3.8016	2.8573	0	22
Expenditure in FCFA	1. Maize	7,056	51,559.23	86,988.48	5,000	732,166
	2.Millet	7,056	46,842.14	97,549.89	4,500	730,000
	3.Sorghum	7,056	69,455.36	119,632.2	7,000	735,750
	4.Rice	7,056	22,440.17	52,192.11	3,500	584,000
Prices in FCFA	1.Maize	7,056	165.4391	15.15596	114	198
	2.Millet	7,056	185.0095	19.82518	143	229
	3.Sorghum	7,056	168.0668	18.62734	114	209
	4.Rice	7,056	392.7622	30.07558	327	488

Source: Author based on EICVM, 2009-2010 and SONAGESS prices data.

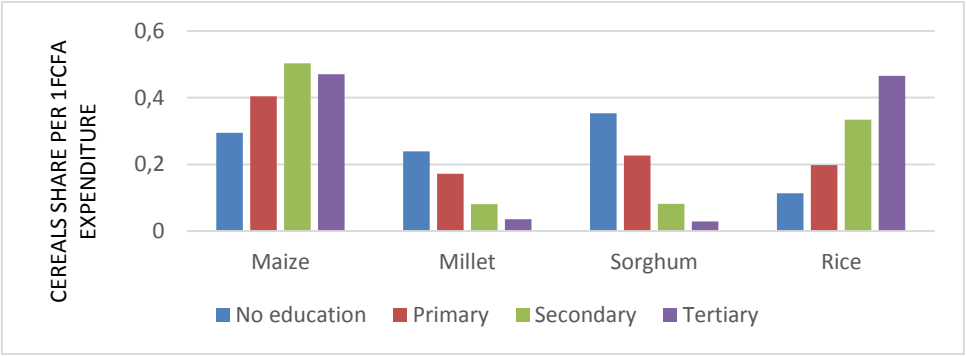
Collection instruments included a questionnaire of daily records using the account books distributed to eligible household members, retrospective questionnaires where the reference periods were either quarterly (three months prior to the survey) or semi-annual (six months) or yearly (last twelve months) depending on whether the good could be considered as durable or semi- durable. The EICVM covered a nationwide sample of 7,056 households living in both rural and urban areas (INSD, 2010). The summary statistics of household and the definitions of all variables used in the probit and AIDS models are defined in Table 1.

In Burkina Faso, households allocate 52.3% of their total living expenditure on food reflecting a very important weight of food on household budget. Total budget share for food is a decreasing function of the level of education of the household head. Indeed, it is 57.4% for households whose heads have no education level, 48.7% for primary, 35.9% for secondary and 25.6% for households whose heads have a tertiary education level. An analysis of budget shares for food according to area of residence indicates that 59.5% of household total expenditure in rural areas is towards food and 39.5% for urban areas. Furthermore, it is shown that 78.8% of all food commodities and 100% of the three main cereals (millet, sorghum and maize) are locally produced.



Source: Author based on EICVM, 2009-2010.

Figure 5. Share of Staple Cereals' Expenditure by Income Group



Source: Author based on EICVM, 2009-2010.

Figure 6. Share of Staple Cereals' Expenditure by Educational Group

Further analysis of household total expenditure shows that 47.77% of total food budget is spent on cereal commodities. It is also shown that urban households have a strong predominance of their cereal expenditures for rice (27.81%) and maize (48.87%) while rural households have a strong preponderance of their cereal expenditures for millet (26.01%) and sorghum (39.82%). Share of household expenditure for rice increases as households move from low (7%) to high (24.16%) income group and from no education to tertiary education (Figure 5 and 6).

4. Estimation Procedures

This section describes the key elements of the estimation strategy employed in this paper. The strategy is adopted to address the issue of zero expenditure. When survey data are used, zero expenditure on individual commodities is a common feature, and EICVM surveys are no exception. The dataset used for this study indicates that zero expenditure is reported for sorghum at 16.12%, millet at 8.16%, maize at 10.84%, and rice at 31.44 %. The causes of zero expenditure are fourfold: permanent zero expenditure, zero expenditure during the survey, optimal zero expenditures as a result to the consumer maximization problem and error during the data entry process. Households reporting zero-expenditures can be categorized as genuine non-consumers, non-consumers during the survey and potential consumers (Tafere et al., 2010). The problem of zero expenditure represents a challenging task in econometrics since there is a censored dependent variable.

This study adopts the consistent two-step (CTS) approach initially proposed by Hein and Wessells (1988) and further modified by Shonkwiler and Yen (1999). Following Shonkwiler and Yen (1999), zero expenditure is modeled estimating the system of equations:

$$w_{ih}^{*} = f(x_{ih}, \mu_i) + u_{ih}, \qquad d_{ih}^{*} = z_{ih}'\theta_i + \vartheta_i \tag{7}$$
$$d_{ih} = \begin{cases} 1 \; if \; d_{ih}^{*} > 0 \\ 0 \; if \; d_{ih}^{*} \leq 0 \end{cases}$$
$$w_{ih} = d_{ih} w_{ih}^{*}$$

where w_{ih}^{*} and d_{ih}^{*} are the latent variables corresponding respectively to observed expenditure shares and the indicator of whether household h consumed the i-th cereal commodity; x_{ih} and z_{ih} are vectors of explanatory variables, μ_i and θ_i are the vector of parameters to be estimated, and u_{ih} and v_{ih} are the random disturbances.

To consistently estimate the system of equation (7), Shonkwiler and Yen (1999) proposes a two-step procedure: the first step of CTS procedure involves estimating a probit regression to determine the probability of a household purchasing a cereal commodity. The explanatory variables used in the probit regression are demographic variables used in equation (3), logarithms of the prices for the four cereals under study, and household total expenditure on food and non-food commodities. From the probit estimation, the standard normal cumulative distribution function (cdf) and the standard normal density function (pdf) of $(z_{ih}'\theta_i)$ are calculated for each cereal commodity and by households.

In the second step, the calculated cdf and pdf from the first step are included to generate the following AIDS specification:

$$s_{ih} = \Phi(z_{ih}'\theta_i) * w_{ih} + \delta_i * \varphi(z_{ih}'\theta_i) + \xi_{ih} \tag{8}$$

where s_{ih} is the observed share of total grain expenditure allocated to the i-th grain commodity for household h, w_{ih} is the determinant part of equation (1), $\Phi(\cdot)$ and $\varphi(\cdot)$ are the calculated standard normal cdf and pdf for household h for commodity i from the first-step

estimation respectively, $z'_{ih}$and θ_i are defined as above and obtained from the probit estimation,δ_i represents the covariance between the error term in AIDS model and error term of probit model (Shonkwiler & Yen, 1999) and is also the parameter to be estimated in equation above, and ξ_{ih} is the heteroscedastic error term. Shonkwiler and Yen (1999) showed, using Monte Carlo simulation that their two-step procedure for system equations with limited dependent variables yields consistent estimators and behaves better than procedures using inverse Mills ratios as an additional explanatory variable in a demand system.

One issue with the use of CTS procedure is that it is not possible to impose the adding up condition via parametric restrictions as in the case of the uncensored demand system (Drichoutis et al., 2008). To address this problem, the approach first recommended by Yen et al. (2003) is adopted. The procedure involves treating the *n*-th good as a residual category and estimating the $n-1$ equations along with the following identity:

$$s_n = 1 - \sum_{i=1}^{n-1} s_i \tag{9}$$

where s_n is defined as the budget share of cereal *n* as a residual share. For this study, rice fits into the residual good category because it only accounts for only 14.65% of household total expenditure for the four staple cereals in Burkina Faso.

Therefore, equation (8) is estimated for sorghum, millet and maize simultaneously using the Full Information Maximum Likelihood (FIML) procedure of SAS version 9.4 (SAS Institute Inc., Cary, NC), with homogeneity and symmetry imposed. Parameters estimates for rice equation are derived using equation (9).

The Marshallian (uncompensated) own and cross-price elasticities are given as:

$$E_{ij} = \Phi(z'_{ih}\theta_i) * \frac{[\gamma_{ij} - \beta_i(\alpha_i + \sum_k^N \gamma_{ik} lnp_k)]}{w_i^0} - \delta_{ij} \tag{10}$$

where $\delta_{ij}$is the Kronecker delta taking the value of 1 if $i = j$and 0 otherwise.

The expenditures elasticities are derived as:

$$A_i = 1 + \frac{\Phi(z'_{ih}\theta_i) * \beta_i}{w_i^0} \tag{11}$$

Price and expenditure elasticities for rice are derived using the adding-up restriction (equation 9) specified as:

$$\sum_{i=n}^N w_i A_i = 1,\ \sum_{i=n}^N w_i E_{ij} = -w_j, \text{ and } \sum_{i=n}^N E_{ij} + A_i = 0 \tag{12}$$

The Hicksian (compensated) price elasticities are given by:

$$E_{ij}^c = E_{ij} + w_j A_i \tag{13}$$

5. Empirical Results

Parameter estimates from the first-step probit estimation are presented in Table 2. Almost all the variables in the choice equations are statistically significant. Household total expenditure increases the probability of consuming rice and maize while it decreases the probability of choosing sorghum and millet.

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Table 2. Parameter Estimates of the Probit Regression

	Maize		Sorghum		Millet		Rice	
Variable	Estimates	Std. Err.	Estimates	Std. Err.	Estimates	Std. Err.	Estimates	Std. Err.
Constant	15.4697**	1.1292	-6.5853**	1.2144	-9.1608**	1.0807	-0.4112*	1.0603
HH Marital status	-0.0483	0.0452	0.0808	0.0473	-0.0596	0.0444	-0.0898	0.0441
HH Education	-0.0111	0.0619	-0.4990**	0.0720	-0.4779**	0.0629	-0.0617	0.0571
HH Occupation	-0.1078**	0.0393	0.3258**	0.0394	0.2121**	0.0385	-0.0443	0.0387
HH Age	-0.0010	0.0011	0.0044**	0.0011	0.0039**	0.0011	-0.0015	0.0011
Number of Children	-0.0311**	0.0150	0.0328*	0.0153	0.0260*	0.0145	-0.0016	0.0146
HH Size	0.0035	0.0110	0.0045	0.0112	-0.0116	0.0106	-0.0194	0.0107
Location of Residence	0.3264**	0.0404	-0.6530**	0.0408	-0.3301**	0.0397	0.3451**	0.0391
Ln Total Expenditure	0.2976**	0.0271	-0.1313**	0.0276	0.1341**	0.0262	0.3333**	0.0265
Ln maize price	-5.0986**	0.2276	3.2691**	0.2240	3.3259**	0.2122	-0.5089**	0.2088
Ln millet price	0.4631	0.2738	-3.1469**	0.2807	-0.1905	0.2669	0.8662**	0.2711
Ln sorghum price	1.2800**	0.2888	0.8133**	0.2962	-1.2694**	0.2807	-1.2957**	0.2815
Log of rice price	-0.3438	0.1299	0.5704**	0.1690	-0.4119**	0.1222	-0.0805	0.1143

Source: Author based on EICVM, 2009/10.

***=1% level of significance, **=5% level of significance and *=10% level of significance.

Parameter estimates of the demand system for cereal commodities are estimated using the AIDS specification developed by Deaton and Muellbauer (1980). All elasticities are evaluated at sample means and based on parameter estimates and explanatory variables. Table 3 reports the estimated uncompensated (Marshallian) and compensated (Hicksian) own/cross price and expenditure elasticities at the national level. As predicted by theory, all own-price elasticities are negative and significant for all commodities. The Marshallian own-price elasticities for maize, millet, sorghum and rice are -0.94, -0.87, -0.76 and -1.44 respectively. Similarly, the Hicksian own-price elasticities are negative and -0.79, -0.69, -0.61 and -1.24 for maize, millet, sorghum and rice respectively. The Marshallian and Hicksian own-price elasticities for maize, millet and sorghum are less than one in absolute value. Conversely, the Marshallian own-price elasticity for rice is greater than one in absolute value. The Hicksian own-price elasticities are similar in sign and magnitude to the Marshallian elasticities. The Marshallian cross-price elasticities indicate that among the four major cereals, maize-millet and millet-sorghum are substitutes while maize-sorghum, maize-rice, millet-rice and sorghum-rice are complements. For the Hicksian cross-price elasticities, maize, millet and sorghum are all net substitutes, while rice is a net complement for all other cereal commodities.

Table 3. AIDS Estimates at the National Level

Marshallian Elasticities					
Item	Maize	Millet	Sorghum	Rice	Expenditure Elasticities
Maize	-0.941	0.533	-0.629	-0.012	0.867
Millet	1.625	-0.870	0.961	-0.372	0.744
Sorghum	-0.634	0.347	-0.763	-0.412	0.608
Rice	-0.069	-0.568	-0.196	-1.443	1.275
Hicksian Elasticities					
Item	Maize	Millet	Sorghum	Rice	
Maize	-0.790	0.696	0.388	-0.012	
Millet	1.902	-0.690	0.696	-0.248	
Sorghum	0.369	0.176	-0.611	-0.294	
Rice	-0.612	-0.127	-0.266	-1.240	

Source: Author based on EICVM, 2009-2010.

The estimated expenditure elasticities are also reported in Table 3. The estimated expenditure elasticities are positive (all four cereal are normal commodity) and significant at the 5% level of significance. The expenditure elasticities are from 0.60 for sorghum, 0.74 for millet, 0.87 for maize and 1.27 for rice. The inelastic expenditure elasticities for maize, millet and sorghum indicate that those three cereals are necessities while rice is considered as a superior cereal. This result is consistent with Burkinabe households' dietary habits where maize, millet and sorghum are the locally produced and most consumed cereals. Rice is a superior cereal commodity that is consumed during holidays.

6. Further Disaggregated Analysis

Since demographic variables play a major role in household cereal demand, the AIDS model was fitted to explore consumption behavior of different demographic groups. The AIDS model was first fitted to determine demand responses between rural and urban households.

Table 4 compares the estimated expenditure and own-price Marshallian/Hicksian elasticities between the two household groupings. Important differences can be observed: expenditure elasticities for maize are higher in urban areas where rice is not considered as a superior cereal. The demand for rice seems to be more price sensitive in rural areas compared to urban areas. More varied and stronger cross-price effects were detected within and between each household group. Specific demand elasticities by income groups and educational levels can be used to evaluate the effects of alternative income and price policies. This is important for designing food policies to improve the adequacy of diets for specific groups. Therefore, we calculated elasticities for five income groups representing the five quintiles, and three household educational levels.

Table 4. AIDS Elasticities at Urban and Rural Areas

	Marshallian		Hicksian		Expenditure	
Item	Urban	Rural	Urban	Rural	Urban	Rural
Maize	-0.976	-0.968	-0.517	-0.771	0.939	0.775
Millet	-1.018	-0.968	-0.909	-0.742	0.750	0.871
Sorghum	-0.928	-0.224	-0.829	0.117	0.830	0.856
Rice	-1.008	-1.177	-0.902	-1.099	0.946	1.063

Source: Author based on EICVM, 2009-2010.

Table 5 presents the Marshallian, Hicksian and expenditure elasticities by income groups. Maize, millet and sorghum are necessities across households, while rice is a superior cereal for the first three income groups but a necessity for the fourth and fifth income group. This suggests that consumption of rice increases as household income increases. Own-price elasticities show that maize, sorghum and millet are all price inelastic for all income groups. Contrasting results were found for rice with the commodity being own-price inelastic across the low income groups (Q1 to Q3) and own-price elastic to the high income groups (Q4 and Q5).

Marshallian, Hicksian and expenditure elasticities by household head educational levels are presented in Table 6. Overall, the expenditure elasticities show that maize, millet and sorghum are necessities regardless of household head educational level. However, rice is a superior cereal among households with no education or primary educational level while it is a necessity for more educated household. The Marshallian own-price elasticities show that maize, millet and sorghum are price inelastic across households while rice is price elastic. Taking into account the income effect, the Hicksian elasticities show similar results as their counterpart Marshallian elasticities except that rice becomes price elastic as household head educational level increases.

Our results are not directly comparable with other regional or city level studies that were conducted in Burkina Faso (Ruijs et al., 2001; Reardon, Thiombiano & Delgado, 1989; Savadogo & Brandt, 1988), but they show that maize, millet and sorghum (locally produced cereals) are necessities while rice is a superior cereal whose consumption increases as household income increases. Specific demand estimation by location, income and educational levels show consistent results and similar consumption patterns among households suggesting the robustness of the analysis. Additionally, the results suggest that poorer and uneducated households living in rural areas are much responsive to changes in prices than are the wealthier and educated ones living in urban areas.

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Table 5. AIDS Elasticities by Income Level

	Marshallian					Hicksian					Expenditure				
Item	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5
Maize	-1.002	-0.978	-0.966	-0.937	-0.744	-0.790	-0.753	-0.729	-0.671	-0.592	0.831	0.805	0.805	0.774	0.870
Millet	-0.908	-1.005	-1.007	-0.374	-0.987	-0.675	-0.775	-0.788	-0.168	-0.803	0.896	0.727	0.827	0.923	0.689
Sorghum	-0.790	-0.827	-0.992	-0.948	-0.965	-0.440	-0.501	-0.641	-0.744	-0.806	0.879	0.677	0.774	0.708	0.676
Rice	-1.628	-1.563	-1.427	-1.196	-0.992	1.382	-1.361	-1.002	-0.883	-0.860	1.220	1.127	1.018	0.900	0.893

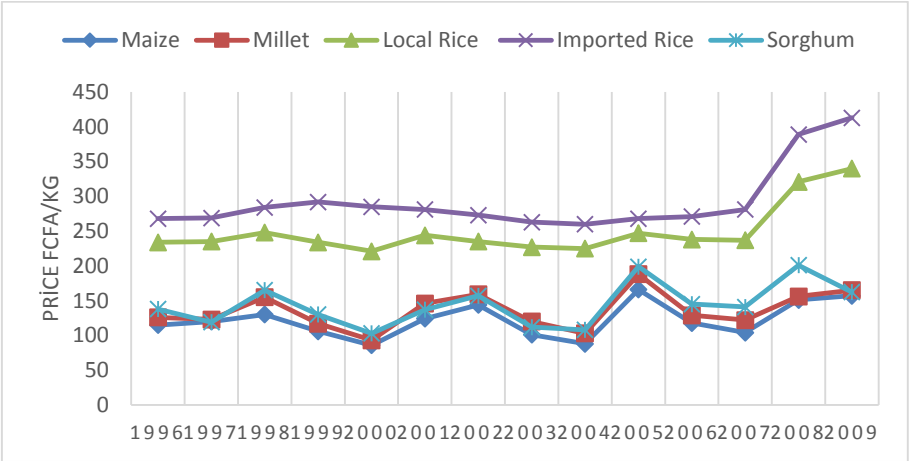
Source: Author based on EICVM, 2009-2010.

Table 6. AIDS Elasticities by Educational Level

	Marshallian				Hicksian				Expenditure			
Item	**No education**	**Primary**	**Secondary**	**Tertiary**	**No education**	**Primary**	**Secondary**	**Tertiary**	**No education**	**Primary**	**Secondary**	**Tertiary**
Maize	-0.972	-1.027	-0.941	-0.875	-0.726	-0.622	-0.484	-0.512	0.833	1.300	0.909	0.772
Millet	-0.983	-0.964	-1.044	-0.917	-0.768	-0.792	-0.985	-0.889	0.898	1.500	0.735	0.792
Sorghum	-0.896	-0.917	-1.044	-0.987	-0.588	-0.691	-0.972	-0.983	0.872	0.971	0.880	0.155
Rice	-1.706	-1.645	-1.126	-1.257	-1.249	-1.160	-0.841	-0.933	1.572	1.001	0.999	0.896

Source: Author based on EICVM, 2009-2010.

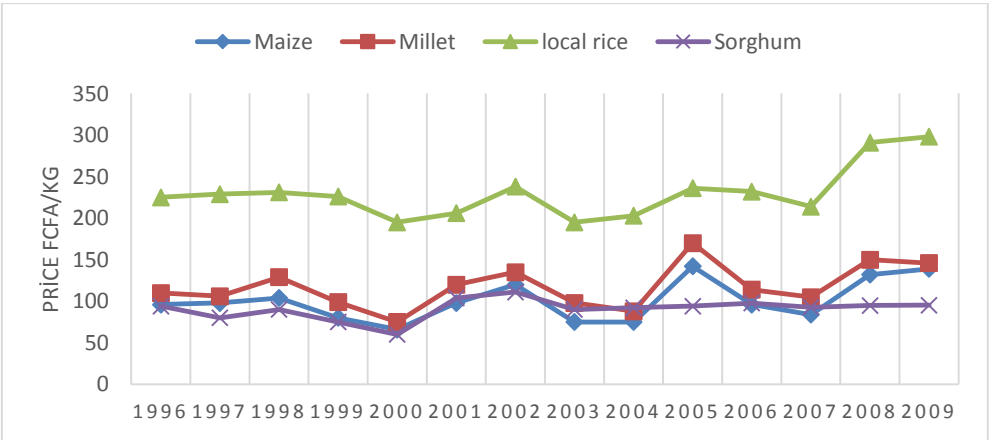
7. Evolution of Cereals Prices between 1996 and 2009 and Implications of Food Price Changes



Source: Author based on FAOStat, SONAGESS and INSD data

Figure 7. Evolution of Consumer Prices of Staple Cereals

Figure 7 depicts the evolution of consumer prices of maize, millet, sorghum and rice over the period 1996-2009. There is an almost identical evolution of prices of maize, millet and sorghum due to the fact that they have the same production cycle. Price of rice is usually higher than the price of the three other cereals because it is mainly imported. In general, consumer prices of cereals have fluctuated but increased overall over the period 1996-2009 in Burkina Faso. Although, they have fluctuated in the same direction, producer prices (Figure 8) rose less compared to consumer prices. This imperfect transmission between producer and consumer prices is explained by the relative rigidity of producer prices compared to consumer prices. In fact, producers can rarely influence cereal prices because they have a low bargaining power with wholesalers (Guissou et al., 2012).



Source: Author based on FAOStat, SONAGESS and INSD data

Figure 8. Evolution of Producer Prices of Staple Cereals

Like in most SSA countries, the rise of food prices has had important social, economic and political repercussions in Burkina Faso. Because the majority of the population was not able to feed themselves properly and regularly, scenes of riots took place in several cities of the country (among them, the four biggest cities: Ouagadougou, Bobo-Dioulasso, Banfora, Ouahigouya) in late February 2008. Government buildings, shops and gas stations were damaged; roads blockages were erected and set on fire; and hundreds of people were arrested for stoning government officials. In most demonstrations, protesters have expressed anger not only over high food and fuel prices, but also dissatisfaction with the way the country's political system functions. From 1987 to 2014, a semi-authoritarian leader, who provided little room for opposition, ran Burkina Faso. Protesters argued that if problems such as the high cost of living are to be addressed, there must be political change and greater democracy. Therefore many people saw in these protests the opportunity to exercise their potential political power, put pressure on the government and force them to act.

Consequently, the government adopted short-term trade oriented and market-based policy measures, including the release of cereal emergency stock onto the market, the suspension of customs duty on several imported foods such as rice, wheat, oil and sugar, the negotiations with importers and wholesalers to establish recommended ceiling prices for staple foods, the establishment of community grain banks to ensure food security at the community level, the handling of vouchers for food and the ban of cereal exports. Measures designed to boost domestic production through the distribution of improved seeds, the provision of fertilizers at a subsidized price were adopted as well without much success.

To assess the impact of changes in cereal prices on cereal consumption levels, we run different scenarios using the estimated parameters of Table 3. Using the base consumption level of 2015, we consider four scenarios[4] in which the prices of all commodities (maize, millet, sorghum and rice) increase by 10%. Table 7 shows cereal consumption level under the various alternatives. With other conditions remaining constant, a 10% increase in maize price leads to a 3.57% decrease in the consumption of staple cereals. If millet price increases by 10%, demand for staple cereals increases by 5.33%. This result is due to the fact that maize and sorghum are both substitutes of millet, therefore their consumption increases when the price of millet goes up. Also, since millet is more nutritious than maize and sorghum, people will have to consume more maize and sorghum to get the same nutritional values that are in millet, hence an increase in total cereal demand. The consequences of this increase are that if production of maize and sorghum does not increase, many people will not be able to satisfy their food needs. Increases in sorghum and rice price by 10%, lead to a decrease in staple cereals consumption by 4.31% and 3.4%.

Table 7. Projected Demand for Staple Cereals in Burkina Faso: Effects of Maize, Millet, Sorghum and Rice Prices Increase

Scenario	Maize	Millet	Sorghum	Rice	Total Cereals	Change(%)
Base period 2015 consumption (Tones*1,000)	950	1,000	1,800	450	4,200	-
10% increase in maize price	-89.4	53.3	-113.22	-0.54	-149.86	-3.57
10% increase in millet price	154.38	-87	172.98	-16.74	223.62	5.33
10% increase in sorghum price	-60.23	34.7	-137.34	-18.54	-181.41	-4.31
10% increase in rice price	-6.56	-56.8	-35.38	-64.94	-163.58	-3.4

Source: Author based on own estimation and FAO data.

[4]Due to the nature of the AIDS model, one cannot estimate the effect of a simultaneous increase in the prices of all staple cereals.

These results suggest that when cereal prices rise, people adjust their consumption by reducing their daily calories intake, which have negative impact on their health especially children. For producers without access to international markets, a decrease in demand means less income. As stated earlier, most farmers in Burkina Faso rely solely on their farm income and any decrease on that income may have devastating consequences because farmers may not be able to pay their family members' hospital fees or their children's school fees.

8. Policy Implications

Results of the analysis show that, although consumption structure is shifting towards high quality food products and processed food in urban areas and for wealthy households, maize, millet and sorghum are necessities and rice is still a luxury cereal and consumed in complement with the other staple cereals for the majority of household in Burkina Faso. One interesting fact is that staple cereals consumed in Burkina Faso are locally produced; only rice is mainly imported and consumed by wealthiest households. This result suggests that increases in staple cereals prices in Burkina Faso is mainly due to low production and any policy targeted to help the poor should be targeted towards the three main locally produced cereals (sorghum, millet and maize). With a population increasing at the rate of 3% per annum and agricultural yields slowly increasing over the years, food security will be the main issue hindering the development and political stability of Burkina Faso. Therefore, the country must adopt aggressive agricultural reforms to increase domestic production and stabilize domestic food prices. Moreover, the country can increase agricultural yields by exploiting unfarmed land, building more storage facilities, roads and rural infrastructure, using improved seeds and more fertilizer, and installing drip irrigation. Farm loans, crop insurance and saving schemes can help farmers increase productivity to meet the challenge of food scarcity.

9. Conclusion

The objectives of this paper were to estimate a complete demand system for major staple cereals (maize, millet, sorghum and rice) and analyze the evolution of cereals' prices in Burkina Faso. Descriptive statistics show that households spend on average 52.3% of their total budget in food and 47.77% of their food expenditure in cereals. Results show that cereal prices have fluctuated over the last two decades and reached their pick in the first quarter of 2008. Consequently, the Government adopted a battery of measures such as the suspension of customs duties and ad valorem tax on a number of imported food products to help the poor meet their basic food needs. Nevertheless, prices of basic staple foods (maize, millet, sorghum and rice) did not come down for a long time and millions of people were food unsecured months later. Since the adoption and effectiveness of any food policy should be based on the knowledge of the demand structure, this paper shows that sorghum, millet and maize are necessities while rice is still considered as a superior commodity nationwide. Further disaggregation of the data confirms that sorghum, millet and maize are necessities but the elasticity of rice varies depending on income groups, and level of education. In light of households' consumption structures, it is important to adopt policy measures that will increase domestic supply of basic foods. This will help tremendously farmers in terms of revenue as well as consumers in terms of access to food.

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Appendix 1. Parameter Estimates of the AIDS Model

Variables	Maize	Millet	Sorghum
Intercept	0.1961	-5.0978	2.2765

Marital Status	0.0288*	-0.0036	-0.0311
Education	0.0175	-0.1683*	0.1189
HH Head Occupation	-0.0400	0.0941	-0.0742
Number Children	0.0086**	-0.0027*	-0.0139
Household Size	0.0012*	0.0501***	0.00291**
Log of price of Maize	-0.0081***	1.1373***	-0.0321***
Log of price of Millet	0.0114***	-0.0905***	-0.0179***
Log of price of Sorghum	-0.0321***	-0.0179*	-0.0266**
Log of price of Rice	-0.0100	-0.0013	-0.0203
Log of (income-price index)	-0.0107***	-0.0495***	-0.0884***
Adjusted R-Squared	0.2193	0.1506	0.2027
N	7,056	7,056	7,056

Source: Author based on EICVM, 2009/10.
Notes: ***=1% level of significance, **=5% level of significance and *= 10% level of significance.