HOUSEHOLDS DEMAND FOR STAPLE CEREAL COMMODITIES IN BURKINA FASO

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Abstract

With a population increasing rapidly and agricultural yields 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 2009/10 integrated household living condition survey. A complete 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 luxury. Demand for maize, millet and sorghum are less price elastic than rice. 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 causing food riots.

Keywords: AIDS model, staple cereals demand, consumption patterns, Burkina Faso.

JEL Classifications: D12, Q11, Q18

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, this increase is still low compared to many Sub Saharan-African (SSA) countries. Although the backbone

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of the economy occupying almost 84 percent of the active population and accounting for 31 percent of the 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, cereals occupy a large portion of the area harvested (88 percent) and satisfy 70 percent of the food needs in the country (FAO, 2015).

Sorghum, millet and maize also known as "traditional cereals" are the main staple food and play central in reducing food insecurity and malnutrition, which rates remain chronically high in Burkina Faso (more than 21 percent of the population over the last decade). 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. At the same time, per capita consumption of cereals excluding beer increased from 1521 kcal/day in 1995 to 1715 kcal/day in 2010 (FAO, 2015). The most current use of maize is cooked as paste called "Tô[2]", sorghum is mainly used in the preparation of local beer (dolo) and millet is 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 national consumption of rice is estimated at 450,000 ton/year. However, with a local production of 130,000 tons/year, the country imports 30 billion F.CFA worth of rice each to satisfy demand.

The main drivers of food demand, especially staple cereals in Burkina Faso, are the high population growth (3 percent annum), the sustained pace of GDP growth and urbanization. An analysis of the structure of household spending for cereal commodities from the Integrated Households Living Conditions Survey of 2009/10 shows very different consumption patterns depending on household location (Figure 1). Urban households have a strong predominance of their cereal expenditures for rice (27.81 percent) and maize

[2] 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.

(48.87 percent) while rural households have a strong preponderance of their cereal expenditures for millet (26.01 percent) and sorghum (39.82 percent). It is 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, Elbeheri and Zoma, 2013). In regards to the changing Burkinabe diet, the difference between rural and urban cereals consumption patterns and the increasing demographic trend, it is crucial to quantify household responses to market prices and income changes.

Most studies that estimated demand for food in Burkina Faso have used either aggregate time series data (Ruijs et al., 2001) or regional or city level cross-sectional data (Savadogo and Brandt, 1988; Reardon, Thiombiano and Delgado, 1989). However, 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, the second objective is focused on the analysis of the evolution of the prices of the staple cereals and the factors that contributed to the food riots of 2007-2008. Results from this study will deepen understanding of household cereals consumption behavior and enhance food policy analysis as well as ways to avoid future food riots 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 procedure are then described. Next, the empirical results are presented, followed by an analysis of the evolution of cereals prices and factors determining food riots. The final section contains policy recommendations and conclusions.

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 published the "Almost Ideal Demand System" (AIDS) in 1980, the AIDS has been widely used in applied demand analysis because of its theoretical consistency. The AIDS[3] 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:

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

where:

[3] 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.

(2) $ln\ a(p_h) = \alpha_0 + \sum_{j=1}^{N} \alpha_{jh} \ln(p_{jh}) + 1/2 \sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{ij}\ ln(p_{ih}) ln(p_{jh})$, is the price index.

In equations (1)-(3) 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 $\varepsilon_{ih}$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:

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

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:

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

whereas homogeneity requires that

(6) $\sum_j^N \gamma_{ij} = 0$ for any *j*.

and Slutsky symmetry is given by

(7) $\gamma_{ij} = \gamma_{ji}$ for all *i* and *j*.

Data Set

Household data used within the current study are from the Integrated Household Living Conditions Survey (EICVM[4]) conducted within July 2009 to August 2010 by the National Institute of Statistics and Demographics of Burkina Faso (INSD[5]-BF). Created in 1974, the INSD is the official statistics office of Burkina Faso and its main tasks are to collect statistical, economic and demographic information, and develop tools and instruments for analysis and decision support. The EICVM is a multi-sectorial household survey whose main objective is to update the indicators of the Strategy for Accelerated Growth and Sustainable Development (SCADD) and the Millennium Development Goals (MDGs). 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). Collection instruments included a questionnaire of daily records using the accounts 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 EICVM data included a set of prices. However, it was not advisable to use these prices in the analysis after consultation with a national statistical team. The only available option was to use prices data from

[4] EICVM= Enquete Integrale sur les Conditions de Vie des Menages.
[5] INSD= Institut National de la Statistique et de la Demographie.

the National Food Security Stock Management Company (SONAGESS[6]) that collects daily prices of staple cereals at the central market of each province of the country and the prices are transmitted via radio the next day after collection.

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 expenditures. When survey data are used, zero expenditures on individual commodities is a common feature, and EICVM surveys are no exception. The dataset used for this study indicates that zero expenditures are reported for sorghum (26.12 percent), millet (28.16 percent), maize (20.84 percent) and rice (31.44 percent). The causes of zero expenditures are threefold: permanent zero expenditure, zero expenditure during the survey and optimal zero expenditures as a result to the consumer maximization problem. 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 expenditures represents one of the most challenging tasks in econometrics since there is a censored dependent variable.

This study adopts the consistent two-step (CTS) approach initially proposed by Hein and Wessells (1990) and further modified by Shonkwiler and Yen (1999). Following Shonkwiler and Yen (1999), zero expenditure is modelled estimating the system of equations:

$$(7) \quad w_{ih}^{*} = f(x_{ih}, \mu_i) + u_{ih}, \qquad d_{ih}^{*} = z_{ih}'\theta_i + \vartheta_i.$$

$$d_{ih} = \begin{cases} 1 \; if \; d_{ih}^{*} > 0 \\ 0 \; if \; d_{ih}^{*} \leq 0 \end{cases}$$

[6] SONAGESS= Societe Nationale de Gestion du Stock de Securite Alimentaire.

$$w_{ih} = d_{ih} w_{ih}^{*}$$

Where *i* and *h* stand respectively for the four cereal commodities (sorghum, millet, maize and rice) and households. 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 purchasing a cereal commodity. The explanatory variables used in the probit regression are demographic variables used in equation (4), 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) 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:

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

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), $\Phi(.)$ and $\varphi(.)$ 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 and 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, Lin, and Smallwood (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:

(9) $s_n = 1 - \sum_{i=1}^{n-1} s_i$,

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 percent 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 9.4, 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:

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

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

The expenditures elasticities are derived as:

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

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

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

The Hicksian (compensated) price elasticities are given by:

$$(13) E_{ij}^c = E_{ij} + w_j A_i.$$

<u>Empirical Results</u>

The summary statistics of households and the definitions of all variables used in the probit and AIDS models are defined in Table 1.

According to the EICVM results, the vast majority of households in Burkina Faso are located in rural areas 72.1 percent, while urban households account for only 27.9 percent. The average household size is 6.8 people. This average size varies by location of residence: on average each household has 7.3 people in rural areas against 5.3 people in urban areas. Overall, the average age of household heads is 46.3 years old. This age is 48.9 years old for women heads of households and 45.4 years old for men. The average age of heads of households living in urban areas is 43.3 years old. Among urban men, it is estimated at 42.5 years old and 46.9 years old for women their counterparts. In rural areas, the average age is 46.8 years old. This age is 49.7 years old for women and 46.4 years old for men. The literacy level of household heads is low in Burkina Faso despite major efforts by the government and development partners to eradicate illiteracy. Regarding the educational level, 76 percent of household head have no level of education, 14.2 percent had primary education level, 7.8 percent had secondary education level, while

only 2 percent of household heads had a tertiary education level. Educational level of household heads varies according to location of residence. In rural areas, 87 percent of household heads have no level of education, 9.8 percent have a primary level of education, 3.1 percent a secondary and only 0.1 percent a tertiary level of education. In urban areas, almost half (50 percent) household heads have no level of education, 24.8 percent have a primary level of education, 19 percent have a secondary level and 2 percent of household heads have a tertiary level of education. In Burkina Faso, households allocate 52.3 percent of their total budget on food reflecting a very important weight of food. Further analysis shows that 47.77 percent of total food budget is spent on cereals.

Parameter estimates from the first-step probit estimation is presented in Table 2. Almost all the variables in the choice equations are statistically significant. Variables associated with household head professional occupation, education, number of children, total expenditure, location of residence and prices play an important role in household consumption of cereals in Burkina Faso. It is essential to note that household total expenditure has a significant influence on the probability of consumption of all cereals. Household total expenditure increases the probability of consuming rice and maize while it decreases the probability of choosing sorghum and millet. All own-price coefficients were statistically significant and had a negative effect on the probability on consuming the studied cereals except for rice.

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 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 1 in absolute value, implying that a change in their own-price would lead to a less than a proportionate response in demand for these products. Conversely, the Marshallian own-price for rice is greater than 1 in absolute value, suggesting that a change in the own-price of rice would lead to a more than proportionate decrease in the demand of rice. The Hicksian own-price elasticities are similar in sign and magnitude to the Marshallian elasticities, suggesting that maize, millet and sorghum are less price inelastic while rice is more price elastic.

The Marshallian cross-price elasticities indicate that among the four major cereals, substitution is detected between the maize-millet, and millet-sorghum pairs while complementarity is detected between the maize-sorghum, maize-rice, millet-rice and sorghum-rice pairs. 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.

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 percent level of significance. The expenditure elasticities range from 0.60 for sorghum, 0.74 for millet, 0.87 for maize to 1.27 for rice. The expenditure elasticities of less than 1 for maize, millet and sorghum indicate that those three cereals are necessities while rice is considered as a luxury cereal. This result is consistent with Burkinabe households' dietary habits where maize, millet and sorghum are the locally produced cereals and that rice is a superior good that is consumed during holidays.

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 was first fitted to ascertain the extent to which demand responses vary 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 is higher in urban areas where rice is not considered as a luxury good. 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 5 presents the Marshallian, Hicksian and expenditure elasticities among income groups. Maize, millet and sorghum are necessities across households, while rice is a luxury 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. More or less own-price elasticities are observed across commodities but 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 income groups Q1 to Q3 and own-price elastic to the Q4 and Q5 income groups.

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 luxury good 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, but they show that maize, millet and sorghum (locally produced cereals) are necessities while rice is a luxury 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.

Evolution of cereals prices between 1992 and 2009 and analysis of factors contributing to food riot of 2007-2008

Figure 4 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 that is due to the fact that maize, millet and sorghum 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, prices of cereals have fluctuated but increase overall over the period 1996-2009 in Burkina Faso. These fluctuations can be divided into four phases:

• The period 1996-1998: characterized an average increase of prices by 17 percent;

• The period 1998-2000: characterized by an average drop of 19 percent in prices of cereals;

• The 2000-2007 period marked by significant price fluctuations. High prices were observed until 2002 before a decrease between the second half of 2003 and the first half of 2004. Prices reached their highest level in 2005. The average price of cereal kilogram peaked at 112 FCFA/kg in 2005 before decreasing in 2007. The high commodity prices in 2005 were the result of a locust attack and a bad harvest season. It was followed by a decrease in production and an alarming food situation in the country.

• The period 2007-2009 characterized by another increase in cereal prices. This period covers the crisis in food prices that has affected most food and energy products including cereals. Indeed, between 2007 and 2008, the rate of increase of prices cereals was about 33 percent.

In 2007, prices of major agricultural food commodities rose sharply and reach their level record in almost 30 years during the first quarter of 2008. By February 2008, the price of maize had increased by 43 percent, while the prices of millet increased by 18 percent, and that of sorghum by 25 percent. The high international price of rice, in combination with low domestic supply drove up the price of rice by 14%.

Although, they have fluctuated in the same direction, producer prices (Figure 5) 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 suffer from a low bargaining power with wholesaler buyers (Guissou et al., 2012).

Like in most Sub-Saharan African countries, the rise of food prices has had important social repercussions in Burkina Faso. Because the majority of the population was not able to feed themselves properly and regularly, scene of riots took place in several cities of the country in late 2007 and early 2008. To mitigate the high food prices, the Government of Burkina Faso adopted short-term trade oriented and market-based policy measures. For example, major cereals from the national grain reserve were sold at reduced prices

and voucher were distributed to the poorest segments of the population. Also, custom duties and taxes were suspended on a number of important food products such as milk, rice and wheat. Measures designed to boost domestic production through the distribution of improved seeds, the provision of NPK and chemical fertilizers at a subsidized price were adopted as well.

It is not clear to what extent these measures were successful in decreasing basic food prices, but one thing is clear: it was the food riots that forced the Burkinabe government to act. Therefore, this section attempts to assess the economic, demographic, political and institutional factors that contributed to food riots and civil unrest in Burkina Faso. Burkina Faso is an interesting case to study for several reasons: its response to the food crisis in 2007/2008, its changed political situation since then, and its high vulnerability to climatic conditions. We adopt an approach developed by Berazneva and Lee (2013) to analyze the determinants of food riots in Africa[7] using a logit model of the form:

$$Riot_i = \beta_0 + \beta_1 HPI_i + \beta_2 Urban\ Agglomaration_i + \beta_3 Food\ Production\ Index_i +$$
$$\beta_4 \Delta Food\ Production\ Index_i + \beta_5 Political\ Rights\ Index_i + \beta_6 Civil\ Liberties\ Index_i +$$
$$\beta_7 Ln(Food\ aid\ per\ capita_i) + \beta_8 Ln(Government\ aid\ per\ capita_i) + \varepsilon_i.$$

Where Riot$_i$ is a binary dependent variable (=1 indicating riot; 0 otherwise); HPI_i is the Human Poverty Index taken from the UNDP 2009 report; Urban Agglomeration is a dichotomous variable (=1 indicating the presence of an urban agglomeration of more than 1 million inhabitants); domestic food production, relative to the base period of 1999–2001, is measured by the per capita Food Production Index (FPI) for 2007 from FAOSTAT; ΔFood Production Index, measuring the percentage change in FPI per capita from 2006 to 2007; PRI is Political Rights Index from 2007; CLI is the Civil Liberties Index incorporating 14

[7] Between 2007 and 2008, 13 African countries experienced food riots. Data for 50 African countries were collected from UNDP, World Development Indicators, FAO, Freedom House, and Africa Development Indicators.

different measures of personal freedoms at the country level, ln(Food aid per capita) is gross aid disbursements for developmental food aid and food security assistance, and ln(Government aid per capita) is gross aid disbursement for general government and civil society support, which includes aid allocated towards support for such things as legal and judicial development, strengthening civil society, and supporting elections and human rights. Both aid components are in current US dollars and taken from the Africa Development Indicators database (2011). The error term, ε_i, is assumed to be independently and identically distributed.

For simplicity and ease of interpretation, we retained and reported the marginal effects[8] of the explanatory variables, evaluated at the values for Burkina Faso, are reported and presented in Table 7. The results suggest that higher levels of poverty are associated with the incidence of food riots in Burkina Faso; the coefficients of HPI is significant at the 1% level. For example, a 1% increase in HPI increases the likelihood of riot by 6.1%. Results, also, suggest that a potential contributing factor to the Burkina Faso riots of 2007 could be its large urban population (Ouagadougou and Bobo-Dioulasso being the country urban centers with more than 1 million inhabitant). The presence of urban agglomeration increases the likelihood of riots by almost 49%. As expected, changes in domestic food supplies are significantly associated with the risk of food riots: 1% decrease in domestic food production index increases the occurrence of riot by 1.2%. Decrease in percentage change in Food Production Index increases food riots by 4.5%. The marginal effect at a value of Political Right Index (PRI) is negative, while that of Civil Liberties Index (CLI) is positive, but none is not statistically significant. This means that as political representation increases and government functioning improves, a country is less likely to experience food

[8] Marginal effects are commonly estimated at the mean, but in order to determine a country effect, we evaluated the marginal effects at the country values.

riots. However, the positive sign associated to CLI suggests that "civil society development and greater civil liberties are associated with a higher likelihood of rioting" (Berazneva and Lee, 2013).

In October 2014, a series of demonstrations and riots spread to multiple cities to what is known as "the Burkinabe uprising". They began in response to attempts at changing the constitution to allow President Blaise Compaoré to run again and extend his 27 years in office. Protesters then gathered at Ouagadougou's central Place of Nation and outside the army headquarters amidst reports of a tense standoff at the latter with chants of "fulfill your responsibilities or we will do so ourselves". These civil protests led ultimately to the end of the 27-year rule of President Blaise Compaoré.

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. Share of household expenditure for rice increases as households move from low (7 percent) to high (24.16 percent) income group and from no education to tertiary education (Figure 2 and 3). One interesting result is that staple cereals in Burkina Faso are produced locally and auto-consumed (only 15 to 20 percent of the production is traded in the market). This result suggests that inflation of staple cereal prices in Burkina Faso is imported (energy and fertilizer price mainly) and any policy targeted to help the poor should be targeted towards the three main locally produced cereals (sorghum, millet and maize) and rice to some extent. With a population increasing at the rate of 3 percent per annum and agricultural yields being stagnant over the years (Figure 7), food security and food safety is 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 prices. For example, the Burkinabe Government should keep its promises and

provides at least 10 percent of budget allocation annually towards agricultural development and intensify agricultural research[9]. Moreover, developing technological infrastructures, increasing supply side factors and providing farmers better incentives to enable them to access to improved seeds, fertilizers and production technologies as well as financing agricultural related business plans should be the priority of the country. Finally, the government should take advantage of the extension programs in most developed countries like the USA where agricultural specialists from research institutions and universities work directly with farmers to improve their livelihoods.

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 prices in Burkina Faso. Descriptive statistics show that households spend on average 52.3 percent of their total budget in food and 47.77 percent of their food expenditure in cereals. Estimates of the demand system at the national level show that sorghum, millet and maize are necessities while rice is still considered as a luxury commodity. 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.

Results of the analysis show that prices have fluctuated over the last two decades to reach their pick in the first quarter of 2008. Consequently, the Government adapted a battery of measures such as the suspension of customs duties and VAT on a number of imported products such as rice to help the poor mitigate the impact of the food price increases. Nevertheless, prices of basic staple foods (maize, millet, sorghum and rice) sore leaving millions of people malnourished and/or undernourished. Since the

[9] African Heads of State committed their countries to providing at least 10 per cent of their national budgetary resources for implementation of the Comprehensive Africa Agriculture Development Program (CAADP) at the 4th Summit of ACP Heads of State and Government meeting in Maputo, Mozambique in 2004

adoption and effectiveness of any food policy should be based on the knowledge of the demand structure, this paper serves a benchmark for future policy analysis.

Without knowledge of the consumption pattern of the other food commodities for which customs duties and VAT taxes were suspended, it is difficult to analyze the government policies but it seems like for the most important staple foods these policies were not well targeted favoring the rich at the expense of the poor. In light of households' consumption structures, it is important to focus in 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. To avoid future food riots, the country needs to develop poverty reduction strategies, and promote/increase youth employment.

This study was limited by the lack of reliable price dataset to estimate a complete demand system for the whole range of food commodities in Burkina Faso. Further analysis is therefore needed to estimate demand for all food commodities. Also, analysis should be taken on the supply side to estimate supply elasticities. This will help implement effective food policies that will increase food supply and help the country improve its food security level.

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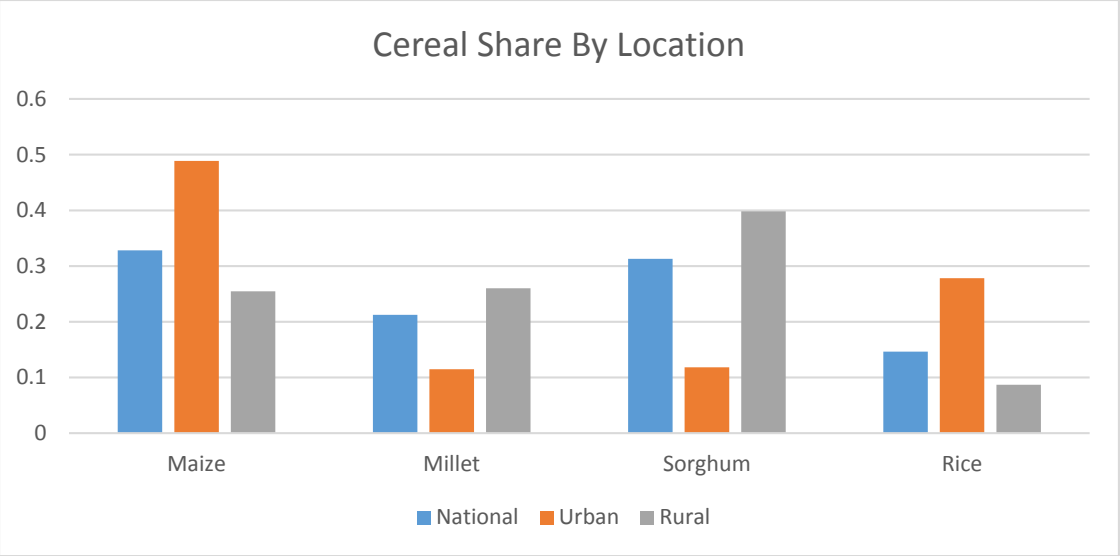
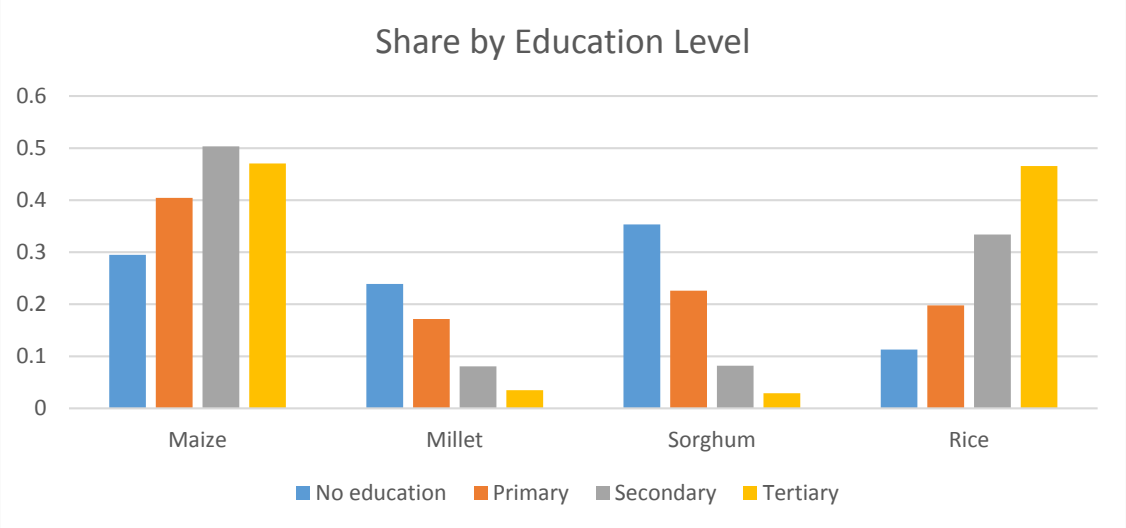
Figure 1. Share of cereal expenditure by location.



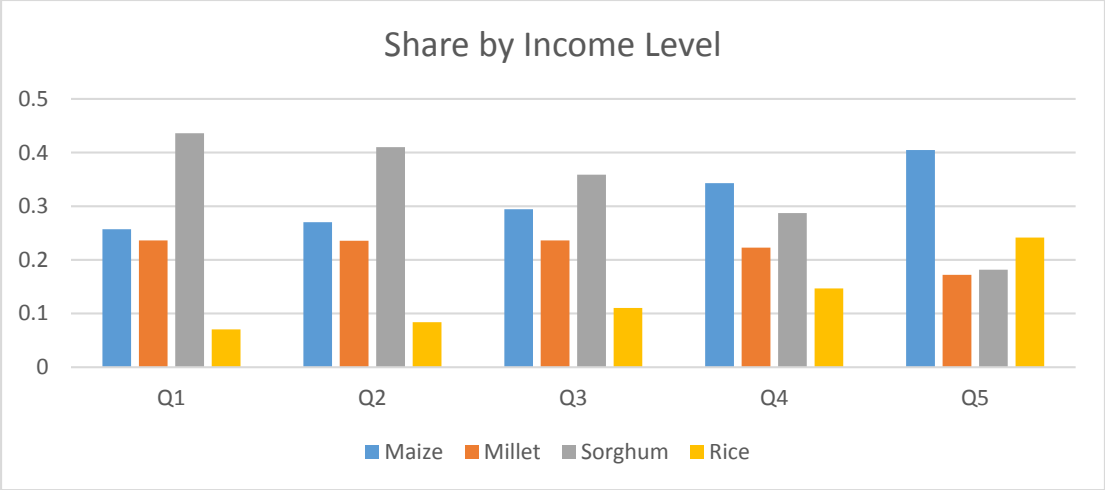
Source: Author based on EICVM, 2009/10.

Figure 2. Share of cereal expenditure educational group.



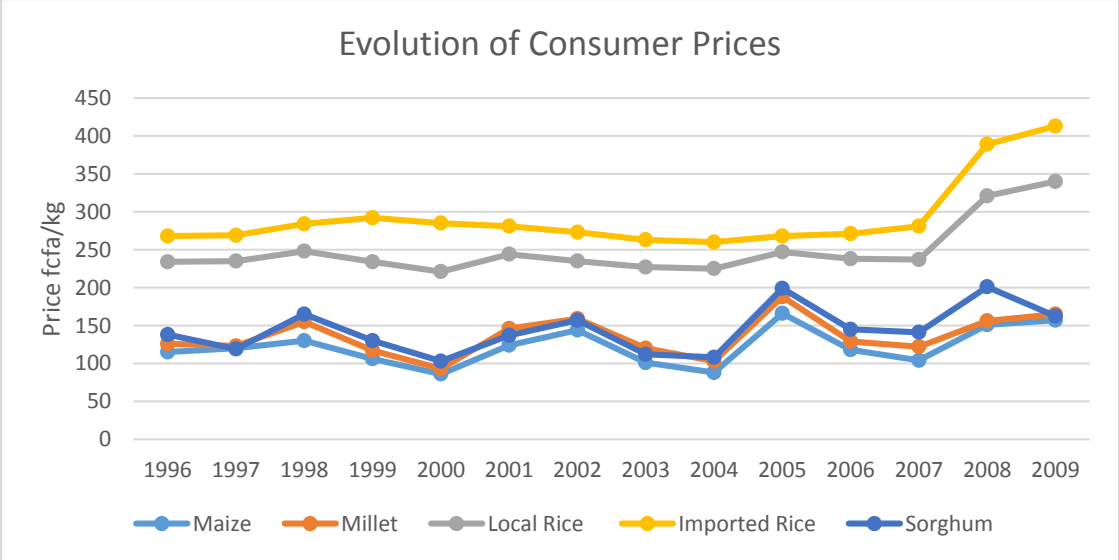
Source: Author based on EICVM, 2009/10.

Figure 3. Share of cereal expenditure income group.



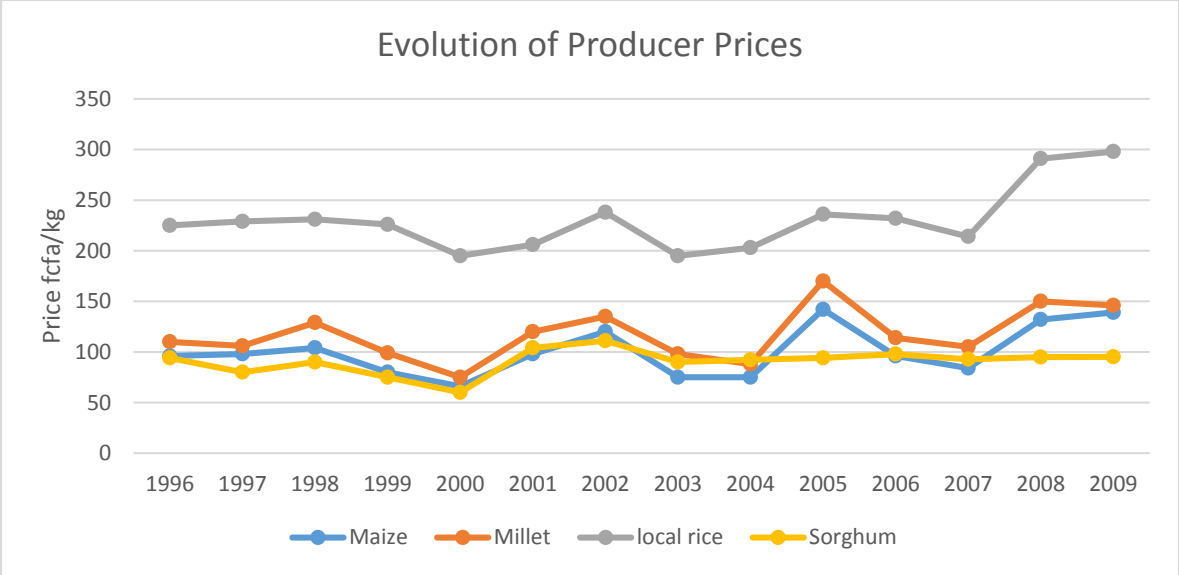
Source: Author based on EICVM, 2009/10.

Figure 4. Evolution of Consumer Prices



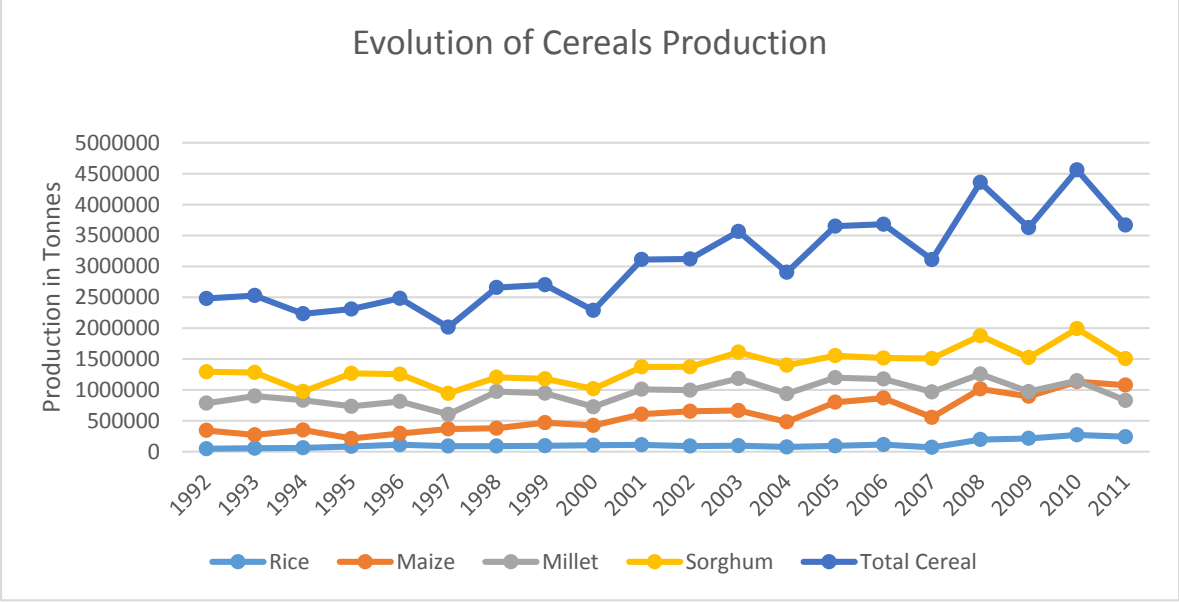
Source: Author based on EICVM, 2009/10.

Figure 5. Evolution of Producer Prices



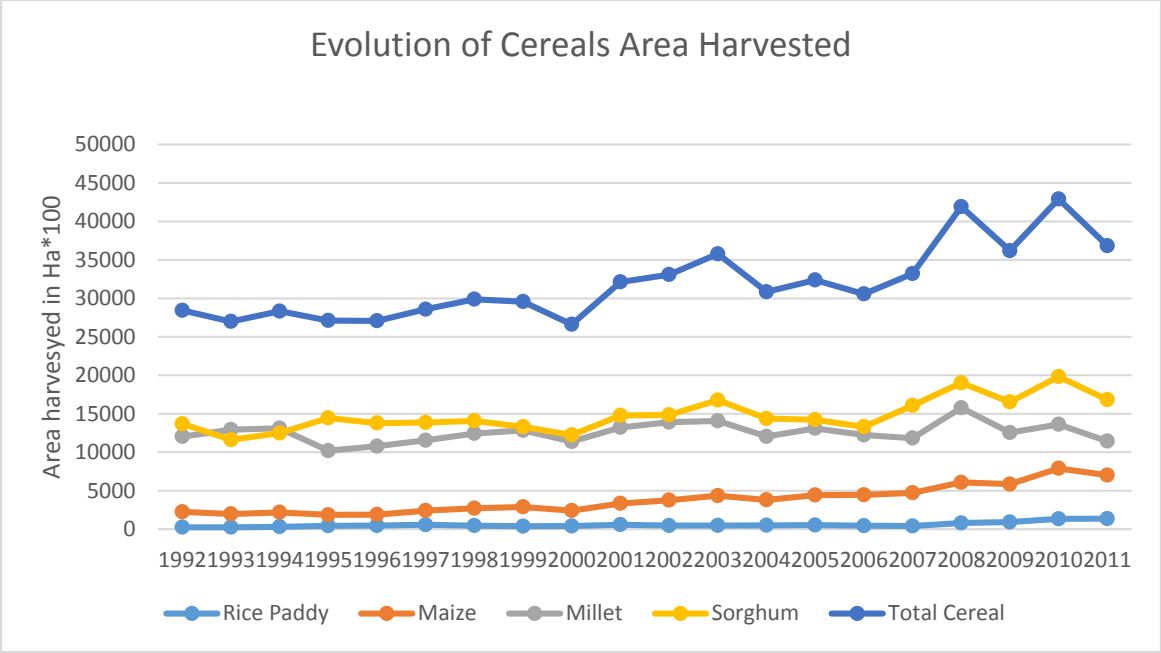
Source: Author based on EICVM, 2009/10.

Figure 6. Evolution of cereals production.



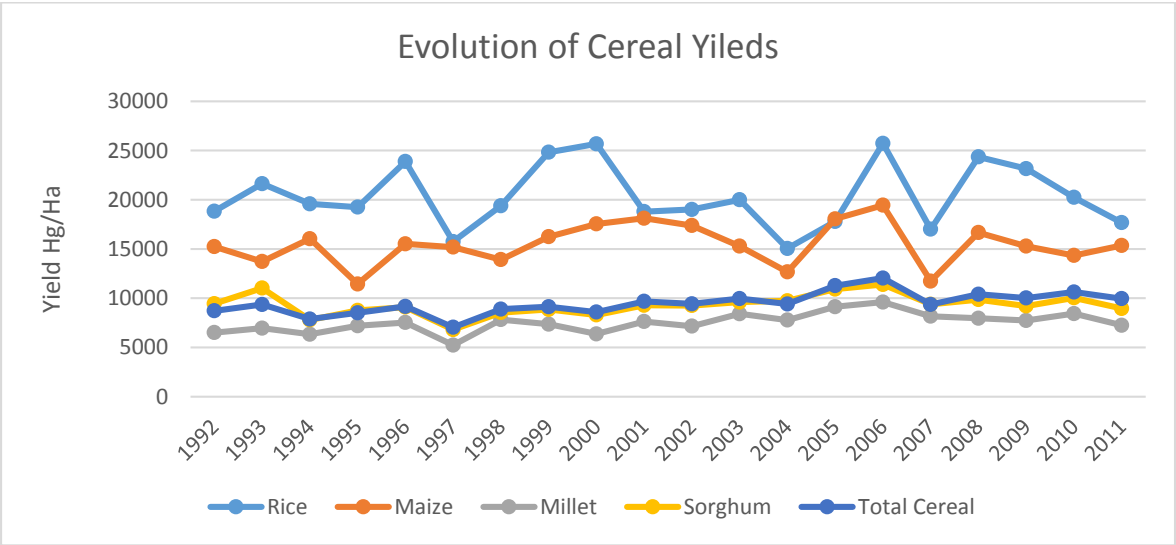
Source: Author based on EICVM, 2009/10.

Figure 7. Evolution of areas harvested



Source: Author based on INSD, 2013 and FAOSTAT, 2012.

Figure 8. Evolution of cereals yields.



Source: Author based on INSD, 2013 and FAO, 2012.

Table 1. Summary Statistics

Variable		Observation	Mean	Std. Deviation	Min.	Max.
Marital Status	0= Single	1043				
	1=Married	6013				
Gender	0=Female	953				
	1=Male	6103				
Occupation	1=Agriculture	4649				
	0=Other	2407				
Location	0=Rural	5087				
	1=Urban	1969				
Education	No education	5363				
	Primary	1002				
	Secondary	550				
	Tertiary	141				
Age	HH head age	7056	46.2778	14.7	16	99
Size	HH Size	7056	6.8145	4.0392	1	57
Children	Number of children	7056	3.8016	2.8573	0	22
Expenditure in fcfa	1. Maize	7056	51559.23	86988.48	5000	732166
	2.Millet	7056	46842.14	97549.89	4500	730000
	3.Sorghum	7056	69455.36	119632.23	7000	735750
	4.Rice	7056	22440.17	52192.11	3500	584000
Prices in fcfa	1.Maize	7056	165.4391	15.1559612	114	198
	2.Millet	7056	185.0095	19.8251763	143	229
	3.Sorghum	7056	168.0668	18.627337	114	209
	4.Rice	7056	392.7622	30.0755791	327	488

Source: Author based on EICVM, 2009/10 and SONAGESS prices data.

Table 2. Parameter Estimates of the Probit Regression.

	Maize		Sorghum		Millet		Rice	
Estimates	**Parameter**	**SE**	**Parameter**	**SE**	**Parameter**	**SE**	**Parameter**	**SE**
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.

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	-0.916	-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, 2009/10.

Table 4. AIDS Elasticities at Urban and Rural

	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, 2009/10.

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, 2009/10.

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	1.000	0.909	0.772
Millet	-0.983	-0.964	-1.044	-0.917	-0.768	-0.792	-0.985	-0.889	0.898	1.000	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, 2009/10.

Table 7. Marginal Effects of Logit Analyses of Food Riots in Burkina Faso, 2007-2008.

Variables	dy/dx	Std Err.
Human Poverty Index	0.061**	0.022
Urban Agglomeration	0.489*	0.230
Food Production Index per Capita	-0.012**	0.003
% Change in Food Production Index	0.045*	0.163
Political Rights Index	-0.097	0.123
Civil Liberties Index	0.436	0.119
Ln(Food Aid per Capita)	0.018	0.026
Ln(Government Aid per Capita)	0.043	0.073
Observations	50	
Pr(Riot) (Predicted)	0.52	

Source: Author based on UNDP, World Development Indicators, FAO, Freedom House, and Africa Development Indicators and Berazneva and Lee (2013).

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

*Not*e: Marginal Effects are computed at the country level not at the mean as it is done usually. Data were collected for 50 African countries.

APPENDIX

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	0.0001	0.0001	0.0001
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	0.0806	0.2027
Observations	7056	7056	7056

Source: Author based on EICVM, 2009

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