

**Household Demand for Sorghum and Pearl millet in Mali and Niger: An
Application of the Linear Approximate Almost Ideal Demand Systems
(LA-AIDS)**

Jupiter Ndjeunga

Principal Scientist, Agricultural Economist, ICRISAT Niamey, Niger

Boubacar I. Kounche

Institut National de la Statistique du Niger

Harouna Kore

*Professor of Economics, Department of Agronomy, Université Abdou
Moumouni of Niamey, Niger*

Yahoussa Gambo

MsC Student at the Université Abdou Moumouni of Niamey, Niger

Lamissa Diakite

Agricultural Economist, Institut d'Economie Rurale, Bamako, Mali

Table of contents

Summary.....	4
I - Introduction	6
II - Importance of sorghum and pearl millet in the livelihoods of Sahelian farmers	7
III - Demand system specification	9
IV - Data and estimation.....	11
V - Results and discussions	12
5.1. Socio-demographic and economic profile of households and per-capita consumption ...	12
5.1.1. Socio-demographic and economic profile of households	12
5.1.2. Cereal consumption per capita by poverty status and location	14
5.1.3. Expenditure shares for major cereals and legumes in Mali and Niger	15
5.2. Drivers of demand for major cereals and legumes	16
5.2.1. Demand for sorghum and pearl millet in Mali	16
5.2.2. Demand for sorghum and pearl millet in Niger.....	19
5.3. Expenditures and price elasticities of demand	22
5.3.1. Mali	22
5.3.2. Niger.....	24
VI - Conclusions and implications	26
References.....	27

List of tables

Table 1. Relative importance of sorghum and pearl millet relative to all cereal crops in the Sahelian countries.....	8
Table 3. Socio-economic and demographic profiles of households in Niger.....	13
Table 4. Socio-economic and demographic profiles of households in Mali.....	13
Table 5: Average quantities (kg) of food (cereals and/or cowpea) consumed by location and poverty status in Mali and Niger.....	14
Table 8. Expenditure shares for major cereals and cowpea in Mali and Niger.....	15
Table 9. Determinants of demand for cereals and cowpea in Mali (all sample).....	18
Table 10. Determinants of demand for cereals and cowpea in Niger (all sample).....	21
Table 11: Expenditure and price elasticities of demand for Malian households by poverty groups	22
Table 12. Expenditure and price elasticities of demand for Nigerien households by poverty groups	25

List of figures

Figure 1: Per capita consumption shares of cereals in West Africa.....	9
--	---

List of annexes

Annex 1. Income and price elasticities for Nigerian households by income class	28
Annex 2. Determinants of demand for cereals and cowpea in Mali (Urban Non-poor)	29
Annex 3. Determinants of demand for cereals and cowpea in Mali (Urban Poor)	30
Annex 4. Determinants of demand for cereals and cowpea in Mali (Rural Non-poor)	31
Annex 5. Determinants of demand for cereals and cowpea in Mali (Rural Poor)	32
Annex 6. Determinants of demand for cereals and cowpea in Niger (Urban non-poor)	33
Annex 7. Determinants of demand for cereals and cowpea in Niger (Urban poor)	34
Annex 8. Determinants of demand for cereals and cowpea in Niger (Rural non-poor).....	35
Annex 9. Determinants of demand for cereals and cowpea in Niger (Rural poor).....	36

DRAFT

Summary

Data from household expenditure surveys in Mali (4453 households) and Niger (3905 households) were used to assess the factors driving the demand for coarse grains and cowpea by location and income groups in Mali and Niger and estimate price and demand elasticities for sorghum and pearl millet. Linear Approximate Almost Ideal Demand Systems model was used. Results showed that the demand for sorghum in Mali decreases with sorghum price and with rice price, increases with cowpea price, millet price and household expenditures. The demand for sorghum is high in rural areas, among the poor, with those that are unemployed and decreases among female headed households, increases among illiterate, decreases in households with high adult equivalents and increases irrespective of age groups. The demand for pearl millet is largely explained pearl millet price, increases with sorghum price, maize price and with household expenditures. The quantity demanded of pearl millet demanded increases in rural areas, among the poor, among those that are unemployed and decreases in households with high adult equivalents and with household heads with 30 to 40 years of age.

In Niger, the demand for sorghum is not responsive to its own price but increases with increases the price of rice, with the price of cowpea, and with household expenditures. The demand for sorghum decreases with the price of maize and the price of pearl millet. In addition, the demand for sorghum increases in the rural areas, among the poor, in households with high number of adult equivalents. The demand for pearl millet increases with pearl millet price following the demand function for Giffen good, decreases with sorghum price, decreases with cowpea price, decreases with maize price, and increases with household expenditures. The quantity demanded increases in rural areas and among the poor. In addition, the quantity demanded of pearl millet increases among women, decreases in all age groups and among literate and increases among those whose major activity is agriculture.

In the 2 countries, there are differences based on location and income groups. Among the rural poor in Niger for example, the demand for pearl millet decreases with sorghum price and increases with household expenditure. It increases among the young of 30 years or less and decreases among the literate. In Mali, among the Urban Non-poor, it is noted that the demand for sorghum increases with millet price and expenditures. In addition, the demand increases in households with high number of adult equivalents, and irrespective of age groups.

Expenditure elasticities of demand in Mali showed that overall sorghum, pearl millet, cowpea and maize were luxury goods while rice is a necessity good. Own price elasticities indicate that sorghum, maize, and pearl millet are price elastic. Rice and cowpea are price inelastic and fonio is behaving as a Giffen good. For sorghum, cross price elasticities showed that sorghum is substituted by cowpea and pearl millet but is complemented by rice, maize and fonio. For pearl millet, cross-price elasticities indicate that sorghum, rice, cowpea, and maize are substitutes and fonio is a complement.

In Niger, sorghum, maize, pearl millet are expenditure elastic (expenditure elasticities greater than 1) suggesting that these crops are luxury goods whereas imported rice and local rice are necessity goods and finally cowpea is an inferior good. The values of own price elasticities indicate that imported rice and cowpea are price elastic while sorghum, local rice, maize and pearl millet are price inelastic. For sorghum, cross-price elasticities showed that sorghum is substituted by imported rice

and cowpea while local rice, maize and millet are complements. For pearl millet, cross-price elasticities indicate that all food items are complements.

A better knowledge of the demand for commodities is critical in formulating policies aimed at improving the livelihood of farmers. In the 2 countries, sorghum and pearl millet are behaving as luxury goods or superior goods implying that the demand for these food items increases more than proportionally as income rises. **Policies likely to encourage farmers to produce sorghum and pearl millet are likely to boost the demand for these crops as income rises especially in the urban areas.** A recent government policy to encourage cowpea production in Niger by raising its price may have a negative effect on pearl millet demand and endangered household food security. In fact these types of policies can affect the food security of millions of smallholder farmers whose pearl millet and sorghum remain the major staple foods.

Key words: cereal demand, cowpea, almost ideal demand system, food security, Niger, Mali.

I - Introduction

Niger and Mali as well as many other countries in the Semi-Arid Tropics of West Africa are among the least developed countries in the World. These countries have the lowest human development indices estimated to 0.309 and 0.261 respectively on the basis of low national income, weak human assets and high economic vulnerability. Agriculture accounts for about 35% of Gross Domestic Product (GDP) and remains the major source of employment. More than 51.4% and 65.9% of its population lives below the poverty line (PPP US\$1.25 per day). The populations estimated to 13.3 million and 15.9 million are rapidly with annual growth rates estimated to 2.4% and 3.7% respectively during the period 2010-15 (HDR, 2010). The rates of urbanization estimated to about 35.9% in Mali and 17.1% in Niger are increasing rapidly putting pressure on food demand in urban areas (UNDP, 2010).

The Malian and Nigerien populations like most countries in the Sahel rely mostly on sorghum and pearl millet for their rural livelihoods. These crops are the major sources of calories intake and food security. However, population growth, urbanization, and rising incomes are pushing urban consumers to shift their preferences towards other cereals such as rice and wheat. Though sorghum and pearl millet remain the major staple foods, their relative importance in the urban area is likely to decline. A better understanding of factors driving the demand for sorghum and pearl millet as well as consumer responses to prices and income levels is necessary to search for policy and institutional options for sorghum and pearl millet to remain competitive.

Estimation of demand for goods and services has attracted the attention of both the theoreticians and empiricists, and a very dense literature is now available. Several methods are also available such as the Rotterdam model (Theil, 1965) and the Translog model (Christensen et al., 1975). In this study we will use the AIDS demand system because of its flexibility and linearity and linearity ad because it is a complete system (Deaton and Muellbauer, 1980). This model will be used to identify the drivers of demand for cereal crops and cowpea in Niger and Mali and estimate the price and expenditure elasticities.

Following this brief introduction, the second section of the paper presents the importance of sorghum and pearl millet in the livelihoods of Nigerien and Malians. The third section presents the

AIDS model. The fourth section discusses the methodology and section 5 the results. The final section concludes with options to improve the competitiveness of sorghum and pearl millet.

II - Importance of sorghum and pearl millet in the livelihoods of Sahelian farmers

Sorghum and pearl millet grains are the main staple cereal crops for people in the WASAT and in Mali, Niger and Nigeria. Pearl millet is cultivated on 1,530,000 ha, 6,580,000 ha and 4,490,000 ha in Mali, Niger and Nigeria respectively. Production of pearl millet follows the same pattern. However, yields remain very low estimated to 479 kg/ha to 1,480 kg/ha in Nigeria on average in 2006-2010. Growth in production is largely explained by area growth in Mali and Niger than productivity. Growth in pearl millet production in Mali is estimated to 2.42 % per annum from 1984 to 2010 largely explained by area growth estimated to 2.23%. Similarly, in Niger growth in production is estimated to about 4.03 % per annum largely explained by area growth (2.97%). However, in Nigeria, growth in production is explained by both area (1.37%) growth and production growth (1.02%).

Likewise, sorghum follows the same trend as pearl millet. Sorghum is cultivated on 1,060,000 ha, 2,890,000 ha and 6,440,000 ha in Mali, Niger and Nigeria respectively. Sorghum production follows the same trend. Productivity of these crops remain low estimated to about 355 kg/ha in Niger to 1,171 kg per ha in Nigeria below World average. Growth in sorghum production in Mali is estimated to 2.62 % per annum from 1984 to 2010 largely explained by area growth estimated to 2.79%. Similarly, in Niger growth in production is estimated to about 4.97 % per annum largely explained by area growth (3.19%). However, in Nigeria, growth in production (2.04%) is also largely explained by area growth (1.43%).

Pearl millet and sorghum account for more than 50% of the total cereal grain area in the 3 countries. In Mali for example, sorghum and millet account for 72% of the total crop area. In Niger both crops account for 99% and in Nigeria, sorghum and millet account for 69%. The same trend is recorded on production on average in 2006-10 (Table 1). It is noted that the relative importance of these crops is decreasing. In Mali, sorghum and millet accounted for 84% of area planted in 1981-85 against 72% in 2006-10. With regard to production, sorghum and pearl millet accounted for 80% in 1981-85 and decreased significantly to 48% in 2006-10. This is largely explained by the increasing importance of maize and rice. In Nigeria, the proportion of sorghum and millet area combined accounted for 76% in 1981-85 and decreased to 65% in 2006-10. Production of both

crops accounted for 75% and dropped to 56% in 2006-10. These trends are recorded in West Africa as a whole.

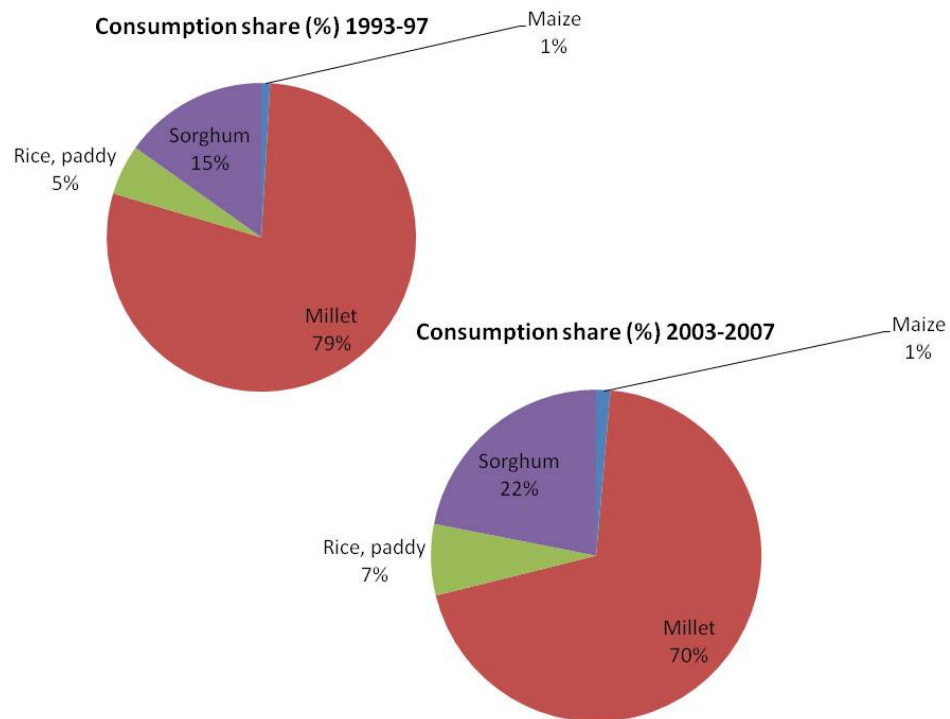
Table 1. Relative importance of sorghum and pearl millet relative to all cereal crops in the Sahelian countries

Country	Area planted (%)		Production (%)	
	1981-85	2006-10	1981-85	2006-10
Burkina Faso	92.45	82.29	88.06	72.4
Cote d'Ivoire	10.2	14.76	5.33	5.87
Ghana	41.75	30.58	33.99	21.16
Mali	83.77	72.15	80.33	47.79
Niger	99.29	99.68	96.9	98.59
Nigeria	76.49	65.06	74.58	57.27
Senegal	87.45	79.16	75.01	55.6
Togo	46.44	34.83	44.85	28.38
West Africa	72.87	68.88	64.7	52.5

Source: Constructed from FAOSTAT, 2012.

Because little production is traded in these countries, most of the production is consumed. Per capita consumption has been increasing for sorghum but decreasing for pearl millet in West Africa. Figure 1 shows that the share of per capita consumption of sorghum was estimated to 15% in 1993-97 and increased to 22% in 2003-07. This may largely explained by increasing demand from the feed sector. But for pearl millet, the share of per capita consumption decreased from 79% in 1993-97 to 70% in 2003-07.

Figure 1: Per capita consumption shares of cereals in West Africa



III - Demand system specification

There are several models for estimating food demand. The Linear Expenditure System (LES) of Stone (1954) with its major attractions such as linearity, transparency, and the parsimony of the estimated parameters, was used by many researchers for quite some time. It has been applied in many countries and is probably the dominant model used for the consumer demand in Computable General Equilibrium models of developing countries (Lluch et al. 1977, Clements et al. 1996). However, the uneasiness with some of its strong restrictions like the proportionality between price and income elasticities, and necessity goods becoming luxury ones at higher incomes opened road to the development of new models such as the Rotterdam model of Theil (1965), Translog model of Christensen et al. (1975). These models corrected some of these shortcomings; but introduced their own limitations. More recently, an alternative modeling was introduced, the Almost Ideal Demand System (AIDS) of Deaton and Muelbauer (1980) is now being used widely due to its linearity, flexibility and because it satisfies the axioms of demand theory (Heien and Wessells, 1990). It is seen as the most advanced modelling of the complete demand systems. The Almost Ideal

Demand System (AIDS) will be used to model the demand for food in this paper. The AIDS model in budget share is as follows:

$$W_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln \left[\frac{M}{P} \right]$$

Where W_i is the budget share of the i th good, P_j is the price of the j th good, γ_{ij} is the price coefficients, β_i is the expenditure coefficient, M is the total expenditures for all the commodities and P is a properly defined price aggregator or price index. The α_i parameters are the budget shares when all prices and real expenditures are equal to 1. The β_i parameters measure the changes in the i th budget share with respect to a change in real income, all else held constant. The AIDS model is based on the consumer's expenditure function and as seen clearly in equation (1), it expresses the budget share of a given commodity as a function of total expenditure and prices. Open form of the price aggregator is given by

$$\ln P = \alpha_0 + \sum_{i=1}^n \alpha_i \ln P_i + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij} \ln P_i P_j$$

where the coefficients are coming from the expenditure function of an individual household. This model gives an arbitrary first-order approximation to any demand system; it satisfies the axioms of choice, and aggregates perfectly without the requirement of the parallel linear Engel curves. As seen in equation (1), the P term makes AIDS a nonlinear model; however, in the literature, empiricists used a linear approximation for P quite often. The linear approximation most commonly employed is given by (which is known as Stone Price index).

$$\ln P = \sum_{i=1}^n \alpha_i \ln P_i$$

With the following parameter restrictions, equation (1) satisfies the adding-up, homogeneity, and symmetry properties derived from the standard demand theory: Expenditure and price elasticities then can be derived easily:

$$\sum_i \alpha_i = 0, \quad \sum_i \beta_i = 0, \quad \sum_j \gamma_{ij} = 0, \quad \sum_i \gamma_{ij} = 0 \quad \text{and} \quad \gamma_{ij} = \gamma_{ji}$$

where θ_i is the expenditure elasticity, W_i is the budget share of good i , γ_{ii} is the own price elasticity, and γ_{ij} represents the cross-price elasticity, in Marshallian terms (uncompensated). Compensated (Hicksian) price elasticities, ε_{ij} , can be derived easily by using θ_i , and δ_{ii} and the following relation:

$$\begin{aligned}\theta_i &= 1 + \frac{\beta_i}{W_i} \\ \varepsilon_{ij} &= -1 + \left(\frac{\delta_{ij}}{W_i}\right) - \beta_i \\ \varepsilon_{ij} &= \left(\frac{\delta_{ii}}{W_i}\right) - \beta_i \left(\frac{W_j}{W_i}\right) \\ e_{ij} &= \varepsilon_{ij} + \theta_i \times W_j\end{aligned}$$

The demand for food is influenced by the age composition of the household, and sex of household head, location, age groups, poverty status, household size, and various other demographic variables. To capture the effects of the demographic variables on food demand patterns, socio-economic and demographic variables will be used as explanatory variables in the share equations.

A system of share equations based on equation (1) and subject to the restrictions (adding-up, homogeneity, and symmetry) in (4) is estimated using iterative Seemingly Unrelated Regression (SUREG) method of Zellner. This method is equivalent to full Information Maximum Likelihood (FIML) estimation. The adding-up property of demand causes the error covariance matrix of system to be singular, so one of the expenditure share equations is dropped from the system to avoid singularity problems. The estimates are invariant of which equation is deleted from the system. Symmetry is imposed during the estimation of the system of equations.

IV - Data and estimation

Two data sets were used in this study. The 2007 Household Consumption and Expenditure Survey data (ENBC) of the Institut National de la Statistique (INS) of the Republic of Niger and the household consumption data of 2006 of the Institut National de la Statistique (INSTAT) in of the Republic of Mali.

In Niger, data were collected in 8 regions including Tillaberi, Zinder, Maradi, Dosso, Tahoua, Diffa, Agadez and Commune Urbaine de Niamey. This survey contains data on food consumption used at home during 2 weeks for 4,050 households. The data is stratified by location (rural and urban areas) and poverty status (poor and non-poor). Other socio-economics characteristics of the households include region, age of household head, sex of household head, marital status, and household size,

age groups of household members, number of adult equivalents, quantity of food item demanded (maize, sorghum, pearl millet, local rice, and imported rice, cowpea, etc...).

This ENBC survey was carried out on a sample of 4050 households including 1845 in urban and 2205 rural households divided in 450 survey zones (ZDs), drawn by a multi-stage, stratified probability sample of households in the 8 regions including Niamey, urban communities of Maradi, Tahoua and Zinder and urban and rural area of the seven regions. To choose the households, the 8 regions were divided into 18 strata on the basis of location (urban, rural), poverty status (poor, non-poor). However, some layers such as the department of Bilma were excluded because of the difficulties to reach it and its very low population density. This represented about 0.5% of the totality of the population of Niger (ENBC, 2007).

The data were collected by interview with the head of household. Interviewers recorded the kind, form, quantity and cost of each food and beverage purchased by the household during the last 14 days. The sample size used in the estimation was 4050. The entire sample could not be used because some members did not respond in all categories or dropped out.

In Mali, in 2006, a similar sampling scheme was used as in the case of Niger. Data was collected from 8 regions of Mali namely Koulikoro, Sikasso, Segou, Mopti, Tombouctou Gao, Kidal, and Bamako. , procedure was used in Mali in 2006. This survey contains data on food consumption used at home during 2 weeks for 4,453 households. The data is stratified by location (rural and urban areas) and poverty status (poor and non-poor). Other socio-economics characteristics of the households include region, age of household head, sex of household head, marital status, and household size, age groups of household members, number of adult equivalents, quantity of food item demanded (maize, sorghum, pearl millet, local rice, and imported rice, cowpea, etc...).

V - Results and discussions

5.1. Socio-demographic and economic profile of households and per-capita consumption

5.1.1. Socio-demographic and economic profile of households

Tables 2 and 3 present the socio-demographic and economic profile of households surveyed in Niger and Mali respectively. In Niger, a total of 3,905 households were interviewed of which 1831 poor and 2074 non-poor, 1856 households located in urban areas and 2049 located in rural areas.

The average age of household heads is 46 years with an average 5 adult equivalents and household size estimated to about 7 members. Most of the households surveyed are male accounting for 88% of the sample. More 83 % of the members of households have between 30 and 59 years old. About 74% of the surveyed households are illiterate. Agriculture is the major occupation of households for 48% and non-farm employment accounts for 34% (Table 2).

Table 2. Socio-economic and demographic profiles of households in Niger

	<i>Location/Poverty status</i>							
	Urban		Rural		Total			
	Non poor	Poor	Non poor	Poor	Non poor	Poor	Total	
Region	<i>Agadez</i>	218	31	0	0	218	31	249
	<i>Diffa</i>	77	28	122	20	199	48	247
	<i>Dosso</i>	76	54	171	309	247	363	610
	<i>Maradi</i>	142	119	78	192	220	311	531
	<i>Taboua</i>	141	116	130	139	271	255	526
	<i>Tillabery</i>	58	69	128	271	186	340	526
	<i>Zinder</i>	197	104	235	254	432	358	790
	<i>CU Niamey</i>	301	125	-	-	301	125	426
	<i>Sub-total</i>	1210	646	864	1185	2074	1831	3905
Gender	<i>Male</i>	85.54	83.75	90.86	92.57	87.75	89.46	88.55
Age (years)		45.302	49.113	42.700	46.528	44.218	47.440	45.729
Age group	<i>< 30 years</i>	9.42	5.57	21.30	10.89	14.37	9.01	11.86
	<i>30-39 years</i>	27.44	17.65	27.20	21.18	27.34	19.93	23.87
	<i>40-49 years</i>	28.35	30.19	19.33	28.44	24.59	29.06	26.68
	<i>50-59 years</i>	20.08	23.68	14.47	19.92	17.74	21.25	19.39
	<i>>59 years</i>	14.71	22.91	17.71	19.58	15.96	20.75	18.21
Adult equivalents		4.836	5.946	4.221	6.182	4.580	6.099	5.292
Household size		6.432	8.102	5.821	8.625	6.177	6.099	7.239
Illiterate (%)		51.16	76.63	81.48	90.21	63.79	85.42	73.93
Self- agric		9.09	21.83	76.74	81.27	37.27	60.29	48.07
Self- non-agr		53.72	56.66	14.12	14.43	37.22	29.33	33.52

Source: Computed from ENBC data, 2007.

In Mali, a total of 4,453 households were interviewed of which 2,701 poor and 1,752 non-poor, 2,558 households located in urban areas and 2,895 households are located in rural areas. The average number of adult equivalents is estimated to 7 and household size estimated to about 9 members. About 93% of the surveyed households are illiterate. Agriculture is the major occupation of households for 51% and non-farm employment accounts for 15% (Table 3).

Table 3. Socio-economic and demographic profiles of households in Mali

	<i>Location/Poverty status</i>		
	Urban	Rural	Total

		Non poor	Poor	Non poor	Poor	Non poor	Poor	Total
Region	<i>Kayes</i>	132	36	254	172	386	208	594
	<i>Koulikoro</i>	163	40	400	348	563	388	951
	<i>Sikasso</i>	110	70	53	381	163	451	614
	<i>Segou</i>	183	79	316	312	499	391	890
	<i>Mopti</i>	130	20	149	151	279	171	450
	<i>Tombouctou</i>	79	16	169	89	248	105	353
	<i>Gao</i>	65	12	52	7	117	19	136
	<i>Kidal</i>	29	1	42	0	71	1	72
	<i>Bamako</i>	375	18	0	0	375	18	393
	<i>Sub-total</i>	1266	292	1435	1460	2701	1752	4453
Gender	<i>Male (%)</i>	88.55	94.29	88.70	96.64	88.58	95.47	93.06
Age group	<i>Group 1 (%)</i>	29.02	24.05	29.22	18.56	29.13	19.47	25.27
	<i>Group 2 (%)</i>	31.93	28.52	26.99	27.88	29.32	27.98	28.78
	<i>Group 3 (%)</i>	21.67	24.40	20.89	24.73	21.25	24.67	22.62
	<i>Group 4 (%)</i>	17.38	23.02	22.90	28.84	20.30	27.87	23.33
Adult equivalents		5.902	8.215	5.974	8.458	5.845	8.417	6.873
Household size		7.679	10.928	7.763	11.441	7.724	11.356	9.176
Illiterate (%)		35.81	65.29	85.00	90.27	61.86	86.12	71.56
Self- agric (%)		10.51	36.08	65.69	73.42	39.73	67.22	50.72
Self- non-agr (%)		28.54	25.43	10.34	4.45	18.90	7.94	14.52

Source: Computed from INSTAT data, 2006.

5.1.2. Cereal consumption per capita by poverty status and location

On average in Mali, it is estimated that cereal is consumed at 291 kg/person/year on a per capita basis. Millet accounts for 24% of cereal consumption, 26% of sorghum consumption, 27% of maize consumption, 13% of rice consumption and 11% of fonio consumption. Non-poor households consume significantly more cereals than poor and more cereals is consumed in urban areas than rural areas.

In Niger, it is estimated that cereal is consumed at 174 kg/person/year on a per capita basis. Millet accounts for 24% of cereal consumption, 26% of sorghum consumption, 27% of maize consumption, 13% of rice consumption and 11% of fonio consumption. Non-poor households consume significantly more cereals than poor and more cereals is consumed in urban areas than rural areas.

Table 4: Average quantities (kg) of food (cereals and/or cowpea) consumed by location and poverty status in Mali and Niger

<i>Product</i>	<i>Urban</i>	<i>Rural</i>	<i>Total</i>
----------------	--------------	--------------	--------------

	Non-poor	Poor	Non-poor	Poor	
<i>Mali</i>					
Millet	90.183	49.86	82.419	39.758	68.504
Sorghum	98.044	53.806	88.423	44.014	74.328
Maize	104.212	58.041	91.839	46.909	78.409
Rice	48.905	25.595	44.424	20.613	36.656
Fonio	43.725	24.137	41.051	18.853	33.424
Cowpea	47.196	24.298	41.362	19.51	34.737
Total cereals	385.068	211.439	348.157	170.147	291.322
<i>Niger</i>					
Sorghum	5.472	6.476	24.094	18.605	13.743
Millet	30.345	49.199	203.427	174.026	115.360
Maize	9.475	12.315	17.177	12.677	12.620
Imp rice	59.810	27.994	21.718	4.964	29.475
Local rice	0.788	2.156	7.874	2.214	3.015
Total cereals	105.890	98.140	274.290	212.486	174.214

Source: Computed from INSTAT data, Mali 2006 and ENBC data, Niger 2007.

In Niger, the average quantity of cereal consumption is estimated to 174 kg/person/year. Sorghum accounts for only 8% of the total cereals, 66% of pearl millet, 7% of maize, 17% of imported rice and 2% of local rice. More cereals are consumed in rural areas.

5.1.3. Expenditure shares for major cereals and legumes in Mali and Niger

In terms of food expenditures, in Mali, it is estimated that sorghum accounts for 14% of the cereals and cowpea expenses, rice accounts for 44%, millet for 28%, maize accounts for 10%, fonio for 1% and cowpea for 10%.

Table 5. Expenditure shares for major cereals and cowpea in Mali and Niger

<i>Product</i>	<i>Urban</i>		<i>Rural</i>		<i>Average</i>
	<i>Non-poor</i>	<i>Poor</i>	<i>Non-poor</i>	<i>Poor</i>	
<i>Mali</i>					
Sorghum	7.50%	11.50%	14.30%	18.60%	13.60%
Rice	65.00%	48.80%	43.50%	25.50%	44.00%
Cowpea	3.40%	3.40%	4.00%	5.40%	4.20%
Maize	5.20%	12.50%	7.80%	15.10%	9.80%
Millet	18.10%	23.40%	30.00%	34.50%	27.70%
Fonio	0.90%	0.50%	0.40%	0.90%	0.70%
<i>Niger</i>					
Sorghum	1.417%	3.296%	6.239%	7.557%	4.658%
Imp rice	75.369%	48.417%	20.870%	6.741%	38.026%
Local rice	0.576%	2.673%	3.518%	1.299%	1.793%
Cowpea	6.451%	8.130%	7.121%	4.339%	6.236%
Maize	3.834%	8.013%	4.915%	5.585%	5.296%
Millet	12.353%	29.471%	57.337%	74.479%	43.991%

In Niger, it is estimated that millet accounts for 44% of cereals and cowpea expenses, imported rice for 38%, sorghum for 5%, 2% for local rice and 5% for maize.

5.2. Drivers of demand for major cereals and legumes

5.2.1. Demand for sorghum and pearl millet in Mali

Demand for sorghum

Table 7 summarizes the results for the household demand for sorghum. It indicates that using the entire sample, the demand for sorghum in Mali is largely explained by both price and non-price factors. The quantity of sorghum demanded decreases as sorghum price increases following the standard demand function for normal good, decreases with rice price (-) and increases with cowpea price (+), millet price (+), and household expenditures (+). The quantity demanded increases with location (1=urban, 2=rural) i.e. for those living in rural areas, increases with the poor (+), increases among those that are unemployed (+), decreases (0=male, 1=female) with gender with less women demand for sorghum, increases among illiterate (+), decreases in households with high adult equivalents (-) and increases irrespective of age groups (+).

The situation is somewhat different by location and income group. Among the **Urban Non-poor**, it is noted that the demand for sorghum increases with millet price and expenditures. In addition, the demand increases in households with high number of adult equivalents, and irrespective of age groups. Among the **Urban Poor**, the demand for sorghum is explained the price of rice (-), the cowpea (+) and maize (+) prices. Among **rural non-poor**, the demand for sorghum is explained by the price of fonio (+), household expenditures (+). The demand increases among those unemployed (+), decreases among female (-), decreases irrespective of marital status, increases among illiterate (+) and decreases with higher number of household adult equivalents (-). Finally among **rural poor**, the demand for sorghum decreases with the price of rice (-), increases with the price of cowpea, increases with expenditures (+), increases among unemployed (+), gender among female consumers (-), increases among divorced people (+), decreases in households with high adult equivalents (-), and increases irrespective of age groups.

Demand for pearl millet

Table 7 summarizes the results for the household demand for pearl millet. It indicates that using the entire sample, the demand for pearl millet in Mali is largely explained by both price and non-price factors. The quantity of pearl millet demanded decreases with pearl millet price following the standard demand function for normal good, increases with sorghum price, increases with maize price (+) increases with household expenditures (+). The quantity demanded increases with location (1=urban, 2=rural) i.e. for those living in rural areas, increases with the poor (+), increases among those that are unemployed (+), decreases in households with high adult equivalents (-) and decreases significantly for those having 30 to 40 years (-).

The situation is somewhat different by location and income group. Among the **Urban Non-poor**, it is noted that the demand for pearl millet decreases with millet price, increases with sorghum price (+), decreases with rice price (-), increases with cowpea price (+), increases with maize price (+), and increases with expenditures (+). In addition, the demand increases in households whose main activity is agriculture, decreased with high number of adult equivalents, and decreases with with consumers having less than 40 years of age. Among the **Urban Poor**, the demand for pearl millet increases with expenditure (+), increases among those unemployed (+), increases with gender especially women. Among the **rural non-poor**, the demand for pearl millet is significantly increases with household expenditures (+) and decreases in households with high number of adult equivalents (-). Finally among the **rural poor**, the demand for pearl millet decreases with pearl millet price (-), increases with the price of rice (+), decreases with the price of cowpea (-), increases with fonio price (+) and increases with expenditures (+). In addition, the demand for pearl millet decreases among unemployed (-), decreased among female consumers (-), and decreases among households between 30 and 40 years of age.

Table 6. Determinants of demand for cereals and cowpea in Mali (all sample)

	<i>Sorghum</i>			<i>Rice</i>			<i>Cowpea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std rr	Z	Coef.	Std rr	Z	Coef.	Std Err	Z	Coef.	Std Err	Z	Coef.	Std Err	Z
Ln(sorghum price)	-0.088	0.041	-2.160	-0.046	0.025	-1.810	0.038	0.023	1.670	-0.010	0.021	-0.450	0.117	0.035	3.330
Ln(rice price)	-0.046	0.025	-1.810	-0.208	0.035	-5.980	0.083	0.022	3.780	0.194	0.019	10.070	-0.012	0.028	-0.430
Ln(Cowpea price)	0.038	0.023	1.670	0.083	0.022	3.780	-0.193	0.028	-6.830	0.062	0.013	4.860	0.003	0.022	0.150
Ln (Maize price)	-0.010	0.021	-0.450	0.194	0.019	10.070	0.062	0.013	4.860	-0.611	0.023	-27.010	0.337	0.022	15.060
Ln (Millet price)	0.117	0.035	3.330	-0.012	0.028	-0.430	0.003	0.022	0.150	0.337	0.022	15.060	-0.430	0.044	-9.830
Ln (Fonio price)	-0.012	0.009	-1.270	-0.011	0.008	-1.510	0.007	0.008	0.800	0.026	0.006	4.420	-0.015	0.010	-1.490
Ln (Expenditures)	0.042	0.003	13.170	-0.085	0.005	-18.360	-0.034	0.002	-21.780	0.019	0.003	6.770	0.061	0.004	14.750
Location	0.030	0.008	3.960	-0.123	0.011	-11.240	0.010	0.004	2.710	-0.004	0.007	-0.530	0.086	0.010	8.830
Poverty status	0.045	0.006	6.910	-0.153	0.009	-16.320	-0.009	0.003	-2.910	0.033	0.006	5.610	0.082	0.008	9.840
indepagric~e	0.004	0.008	0.430	-0.044	0.012	-3.630	0.001	0.004	0.220	0.012	0.007	1.580	0.030	0.011	2.810
indepnonag~c	0.004	0.009	0.420	0.017	0.014	1.230	-0.003	0.005	-0.700	-0.002	0.008	-0.280	-0.014	0.012	-1.170
Unemployed	0.033	0.011	3.040	-0.016	0.016	-1.050	-0.004	0.005	-0.660	-0.008	0.010	-0.830	-0.004	0.014	-0.270
Gender	-0.034	0.016	-2.130	0.012	0.023	0.500	0.010	0.008	1.320	0.003	0.014	0.240	0.009	0.021	0.420
Monogamus	-0.005	0.023	-0.240	-0.001	0.033	-0.030	0.004	0.011	0.380	-0.004	0.020	-0.200	0.002	0.029	0.060
Polygamus	-0.011	0.023	-0.490	0.012	0.034	0.350	0.009	0.011	0.790	0.005	0.021	0.250	-0.020	0.030	-0.670
Divorced	0.031	0.026	1.190	-0.010	0.038	-0.270	-0.013	0.013	-1.030	-0.006	0.023	-0.270	-0.005	0.034	-0.160
Illiterate	0.015	0.007	2.020	-0.036	0.010	-3.480	0.006	0.004	1.550	0.010	0.006	1.490	0.008	0.009	0.890
Adult equivalent	-0.002	0.001	-2.460	0.003	0.001	2.340	0.004	0.000	8.980	-0.002	0.001	-2.130	-0.003	0.001	-3.100
nnhage1	0.021	0.009	2.380	0.001	0.013	0.090	-0.004	0.004	-0.910	0.001	0.008	0.100	-0.019	0.012	-1.640
nnhage2	0.028	0.008	3.370	0.007	0.012	0.540	0.000	0.004	-0.040	-0.011	0.007	-1.510	-0.024	0.011	-2.240
nnhage3	0.020	0.008	2.440	-0.010	0.012	-0.820	-0.002	0.004	-0.580	-0.009	0.007	-1.230	0.002	0.011	0.140
Region	-0.017	0.001	-12.590	0.033	0.002	17.740	-0.005	0.001	-7.420	-0.019	0.001	-16.000	0.006	0.002	3.830
Constant	-0.140	0.042	-3.350	1.293	0.059	21.870	0.337	0.022	15.010	-0.244	0.036	-6.700	-0.265	0.053	-5.030

Source: Calculated from INSTAT data, 2006.

The largest expenditure elasticity is 1.94 for both the education and transportation services. Except health, education, tourism services, and possibly clothing all commodity aggregates are in the inelastic region of their demand curves at the sample mean.

5.2.2. Demand for sorghum and pearl millet in Niger

Demand for sorghum

Table 9 summarizes the results for the household demand for sorghum in Niger. It indicates that using the entire sample, the demand for sorghum in Niger is not responsive to its own price but increases with increases the price of rice (+), increases with the price of cowpea (+), decreases with the price of maize (-) and the price of pearl millet (-) but increases with household expenditures (+). In addition the demand increases in the rural area, among the poor, in households with high number of adult equivalents.

The situation is somewhat different by location and income group. Among the **Urban Non-poor**, it is noted that the demand for sorghum increases with millet price (+), with cowpea price (+), decreases with maize (-) and pearl millet prices (-) and increases with expenditures (+). In addition, the demand increases among the young of less than 30 years of age; decreases among literate (-), increases among those households whose main occupation is agriculture. Among the **Urban Poor**, the demand for sorghum is explained the price of cowpea (+) and household expenditures (+). Among **rural non-poor**, the demand for sorghum is explained by household expenditures (+). Finally among **rural poor**, the demand for sorghum increases with the price of rice (+), decreases with maize price (-) and millet price (-). In addition, the demand for sorghum increases among illiterate (+), those with major occupation in the non-farm sector, increases in households with high adult equivalents (+).

Demand for pearl millet

Table 9 summarizes the results for the household demand for pearl millet. It indicates that using the entire sample, the demand for pearl millet in Niger is largely explained by both price and non-price factors. The quantity of pearl millet demanded increases with pearl millet price following the demand function for Giffen good, decreases with sorghum price, decreases with cowpea price (-),

decreases with maize price (-), and increases with household expenditures (+). The quantity demanded increases with location (1=urban, 2=rural) i.e. for those living in rural areas, increases with the poor (+). In addition, the quantity demanded of pearl millet increases among women, decreases in all age groups (-), decreases among literate (-), and increases among those whose major activity is agriculture (+).

The situation is somewhat different by location and income group. Among the **Urban Non-poor**, it is noted that the demand for pearl millet decreases with sorghum price, decreases with maize price (+) and increases with expenditures (+). In addition, the demand for pearl millet decreases irrespective of age groups (-), decreases among literate (-), increases in households whose main activity is agriculture (+), and decreases with consumers having less than 40 years of age. Among the **Urban Poor**, the demand for pearl millet increases millet price (+), decreases with cowpea price (-), decrease s with pearl millet price (-), and increases with household expenditure (+). It increases among women (+), decreases among consumers between 30 and 50 years old, and decreases among literate (-). Among the **rural non-poor**, the demand for pearl millet decreases with millet price (-), increases with rice price (+) and increases with household expenditures (+). It decreases in age groups of more than 30 years old, decreases among literate (-), and increases among households whose main activity is agriculture. Finally among the **rural poor**, the demand for pearl millet decreases with sorghum price (-) and increases with expenditure (+). It increases among the young of 30 years or less and decreases among the literate.

Table 7. Determinants of demand for cereals and cowpea in Niger (all sample)

	<i>Sorghum</i>			<i>Imported Rice</i>			<i>Cowpea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std. Err.	z	Coef.	Std. Err.	z	Coef.	Std. Err.	z	Coef.	Std. Err.	z	Coef.	Std. Err.	z
lnprixsorg~m	0.020	0.016	1.240	0.062	0.019	3.320	0.039	0.011	3.510	-0.014	0.003	-5.150	-0.108	0.023	-4.730
lnprixmrice	0.062	0.019	3.320	-0.153	0.042	-3.650	0.082	0.018	4.610	0.013	0.005	2.790	-0.003	0.041	-0.080
lnprixlorice	-0.002	0.001	-1.180	-0.010	0.002	-4.490	0.006	0.001	4.790	-0.004	0.001	-3.720	-0.002	0.002	-0.900
lnprixniebe	0.039	0.011	3.510	0.082	0.018	4.610	-0.083	0.015	-5.570	0.002	0.002	0.910	-0.040	0.020	-2.040
lnprixmais	-0.014	0.003	-5.150	0.013	0.005	2.790	0.002	0.002	0.910	0.008	0.003	2.990	-0.009	0.005	-1.820
lnprixmil	-0.108	0.023	-4.730	-0.003	0.041	-0.080	-0.040	0.020	-2.040	-0.009	0.005	-1.820	0.160	0.052	3.060
lndepccere~es	0.015	0.003	5.180	-0.075	0.005	-14.910	-0.065	0.002	-26.910	0.016	0.003	5.350	0.110	0.005	20.250
Urru	0.028	0.006	4.520	-0.289	0.011	-26.470	0.029	0.005	5.540	-0.064	0.006	-10.170	0.297	0.012	25.140
Pauvre	0.015	0.005	3.110	-0.144	0.008	-17.600	-0.010	0.004	-2.640	0.004	0.005	0.910	0.140	0.009	15.740
Sexe	-0.007	0.007	-1.010	-0.012	0.012	-1.010	-0.003	0.006	-0.490	0.003	0.007	0.430	0.021	0.013	1.650
trancheage1	0.004	0.008	0.510	-0.002	0.014	-0.170	0.007	0.007	1.080	0.000	0.008	-0.050	-0.004	0.016	-0.290
trancheage2	0.001	0.007	0.120	0.044	0.012	3.650	-0.011	0.006	-1.860	0.007	0.007	1.050	-0.042	0.013	-3.280
trancheage3	0.005	0.006	0.770	0.022	0.011	2.010	-0.004	0.005	-0.840	0.011	0.006	1.720	-0.030	0.012	-2.440
trancheage4	0.004	0.007	0.610	0.014	0.012	1.220	0.002	0.006	0.360	0.011	0.007	1.580	-0.026	0.013	-2.020
Illiterate	-0.003	0.006	-0.550	0.076	0.010	7.900	-0.011	0.005	-2.350	0.001	0.006	0.150	-0.067	0.010	-6.400
lndepagric~e	0.006	0.007	0.880	-0.101	0.013	-8.050	0.008	0.006	1.320	0.026	0.007	3.610	0.044	0.014	3.250
lndepnonag~c	0.006	0.006	0.980	-0.056	0.011	-5.050	-0.001	0.005	-0.100	0.011	0.006	1.660	0.036	0.012	2.990
Adeq	0.002	0.001	2.060	-0.001	0.001	-0.810	-0.003	0.001	-4.340	0.003	0.001	4.070	-0.001	0.001	-0.550
Diffa	0.001	0.013	0.040	0.094	0.023	4.020	-0.004	0.012	-0.320	0.070	0.013	5.430	-0.171	0.025	-6.870
Dosso	-0.025	0.011	-2.220	-0.139	0.020	-7.020	-0.019	0.010	-1.970	0.166	0.011	15.130	0.020	0.021	0.950
Maradi	-0.003	0.012	-0.250	-0.140	0.023	-5.970	-0.002	0.011	-0.170	0.057	0.011	5.340	0.091	0.024	3.800
Tahoua	0.039	0.012	3.320	-0.154	0.021	-7.450	-0.018	0.010	-1.770	0.036	0.011	3.240	0.134	0.022	6.090
Tillaberi	0.020	0.013	1.580	-0.117	0.022	-5.350	-0.036	0.011	-3.380	0.108	0.012	8.950	0.002	0.023	0.100
Zinder	0.029	0.013	2.330	-0.106	0.024	-4.400	-0.025	0.011	-2.210	0.059	0.010	5.590	0.048	0.024	1.980
Cuniamey	0.011	0.012	0.940	0.102	0.021	4.880	-0.040	0.010	-3.950	0.051	0.012	4.260	-0.076	0.023	-3.370
_cons	-0.154	0.024	-6.480	1.518	0.045	33.820	0.322	0.020	15.690	-0.049	0.020	-2.400	-0.643	0.048	-13.520

Source: Authors' calculation based on INSTAT Data, Mali 2006.

5.3. Expenditures and price elasticities of demand

5.3.1. Mali

Table 10 summarizes the expenditure and price elasticities of demand for surveyed households in Mali. For the whole sample, the values of own price elasticities indicate that sorghum, maize, and pearl millet are price elastic. Rice and cowpea are price inelastic and fonio is behaving as a Giffen good. Sorghum, cowpea, maize, pearl millet and fonio are expenditure elastic (income elasticities greater than 1) suggesting that these crops are luxury goods whereas rice is a necessity good. For sorghum, cross price elasticities showed that sorghum is substituted by cowpea and pearl millet but is complemented by rice, maize and fonio. For pearl millet, cross-price elasticities indicate that sorghum, rice, cowpea, and maize are substitutes and fonio is a complement.

This is somewhat different by location and income group. Among **Urban non-poor**, it is estimated that sorghum, cowpea, maize, and millet are price elastic while rice and fonio are price inelastic. Pearl millet, maize and sorghum are luxury goods; rice, cowpea and fonio are necessity goods. For sorghum, all other food items are complements while pearl millet is substitute for sorghum. For pearl millet, sorghum, cowpea, maize are substitutes while rice and fonio are complements. Among **Urban poor**, all food items are price elastic. Sorghum, maize and millet are luxury goods. Rice is a necessity good and cowpea and fonio are inferior goods. Cross-price relationships showed that cowpea, fonio and maize are sorghum substitutes whereas rice and pearl millet are complements. For pearl millet, rice and maize are substitutes and sorghum, cowpea and fonio are complements. Among **Rural non-poor**, all food items except sorghum are price elastic. Sorghum and pearl millet are luxury goods, rice, cowpea, maize are necessity goods and fonio is an inferior good. Cross-price elasticities showed that for sorghum, fonio and rice are substitutes while cowpea, maize, and pearl millet are complements. For pearl millet, rice, cowpea, maize and fonio are substitutes whereas sorghum is a complement. Among the **Rural poor**, all food items are price elastic. Sorghum, maize and pearl millet are luxury goods and rice, cowpea are necessity goods and fonio behaves as an inferior good. Cross-price relationships showed that for sorghum, rice is a complement and other food items are substitutes. For pearl millet, sorghum, rice, maize and fonio are substitutes while cowpea is a complement.

Table 8: Expenditure and price elasticities of demand for Malian households by poverty groups

Overall sample	Product					
	Sorghum	Rice	Cowpea	Maize	Millet	Fonio
Sorghum	-1.68	-0.44	-4.55	3.36	0.20	12.49
Rice	-0.46	-0.69	1.36	0.27	0.26	-30.02
Cowpea	0.26	0.46	-0.93	0.18	0.29	-46.89
Maize	-0.10	0.00	0.13	-1.07	0.10	-1.72
Millet	0.76	0.05	-0.87	0.24	-1.08	-12.50
Fonio	-0.09	-0.19	0.24	0.12	-0.01	9.92
Expenditure	1.30	0.72	1.24	1.33	1.11	2.13
<i>Urban non-poor</i>						
Sorghum	-1.95	0.00	-0.38	-0.73	0.72	-0.46
Rice	-0.24	-0.81	-0.53	2.93	-1.37	1.11
Cowpea	-0.19	-0.04	-3.19	0.72	0.49	-1.15
Maize	-0.51	0.24	1.12	-8.66	1.26	1.97
Millet	1.70	-0.32	2.70	4.40	-2.29	-1.30
Fonio	-0.06	0.01	-0.31	0.34	-0.07	-0.97
Expenditure	1.25	0.92	0.60	1.00	1.27	0.76
<i>Urban poor</i>						
Sorghum	-1.84	-0.46	6.32	1.15	-0.46	14.10
Rice	-2.05	-2.08	6.86	3.51	0.46	0.55
Cowpea	1.81	0.44	-11.06	-0.18	-0.37	5.14
Maize	1.26	0.91	-0.48	-8.84	1.74	0.89
Millet	-0.91	0.30	-2.23	3.19	-2.26	-15.80
Fonio	0.58	-0.01	0.73	0.02	-0.33	-3.46
Expenditure	1.14	0.88	-0.14	1.29	1.25	-2.13
<i>Rural non poor</i>						
Sorghum	-0.68	0.10	-0.05	-0.82	-0.35	22.38
Rice	0.12	-1.41	1.33	2.64	0.24	-47.31
Cowpea	-0.05	0.11	-1.52	-0.58	0.06	2.69
Maize	-0.48	0.51	-1.11	-5.46	0.12	58.52
Millet	-0.77	0.25	0.62	0.48	-1.32	8.07
Fonio	0.55	-0.47	0.22	2.77	0.10	-39.27
Expenditure	1.31	0.90	0.51	0.98	1.17	-7.71
<i>Rural poor</i>						
Sorghum	-1.50	-0.97	3.93	0.26	0.18	3.03
Rice	-1.46	-2.54	4.56	1.79	0.50	-2.02
Cowpea	1.08	0.94	-5.27	0.03	-0.53	-3.69
Maize	0.20	1.11	0.19	-6.51	1.53	-2.02
Millet	0.31	0.83	-3.15	3.46	-3.40	21.40
Fonio	0.12	-0.09	-0.65	-0.15	0.57	-16.13
Expenditure	1.25	0.72	0.38	1.15	1.16	-1.35

Source: Computed from INSTAT data, Mali, 2006.

5.3.2. Niger

Table 11 summarizes the expenditure and price elasticities of demand for surveyed households in Niger. For the whole sample, the values of own price elasticities indicate that imported rice and cowpea are price elastic while sorghum, local rice, maize and pearl millet are price inelastic. Sorghum, maize, pearl millet are expenditure elastic (expenditure elasticities greater than 1) suggesting that these crops are luxury goods whereas imported rice and local rice are necessity goods and finally cowpea is an inferior good. For sorghum, cross-price elasticities showed that sorghum is substituted by imported rice and cowpea while local rice, maize and millet are complements. For pearl millet, cross-price elasticities indicate that all food items are complements.

This is somewhat different by location and income group. Among **Urban non-poor**, it is estimated that cowpea and millet are price elastic. Sorghum, imported and maize are price non-elastic whereas local rice is Giffen good. All food items are luxury goods while local rice is a necessity good. Cross-price elasticities showed that for sorghum, local, imported rice and local rice are substitutes. For pearl millet, all food items are complements while sorghum is a substitute. Among **Urban poor**, all food items are price inelastic except for local rice behaving as a Giffen good and imported rice is price elastic. Cross-price relationships showed that all food items are complements except for cowpea which is a substitute. cowpea, fonio and maize are sorghum substitutes whereas rice and pearl millet are complements. For pearl millet all food items are complements except sorghum which is a substitute. Among **Rural non-poor**, all food items except sorghum are price elastic except for local rice and maize which are price inelastic. Sorghum, maize and pearl millet are luxury goods, imported rice and local rice are necessity goods and cowpea is an inferior good. Cross-price elasticities showed that for imported rice, cowpea and millet are sorghum substitutes while local rice and maize are sorghum complements. For pearl millet, sorghum and imported are substitutes and whereas all food items are complements. Among the **Rural poor**, imported rice, cowpea and pearl millet are price elastic. Sorghum, local rice and maize are price non-elastic. Sorghum, maize and pearl millet are luxury goods. Local rice is a necessity good and imported rice and cowpea are inferior goods. Cross-price relationships showed that for sorghum, imported rice and cowpea are substitutes and other food items are complements. For pearl millet, sorghum, local rice and maize are complements whereas imported rice and cowpea substitutes.

Table 9. Expenditure and price elasticities of demand for Nigerien households by poverty groupsⁱ

<i>Overall sample</i>	<i>Product</i>					
	<i>Sorghum</i>	<i>Imp rice</i>	<i>Loc. rice</i>	<i>Cowpea</i>	<i>Maize</i>	<i>Millet</i>
Sorghum	-0.578	0.172	0.002	0.678	-0.272	-0.256
Imported rice	1.204	-1.329	0.014	1.318	0.127	-0.102
Local rice	-0.038	-0.024	-0.271	0.107	-0.089	-0.009
Cowpea	0.823	0.228	0.002	-2.267	0.033	-0.108
Maize	-0.311	0.044	0.002	0.088	-0.863	-0.130
Millet	-2.452	0.078	0.016	-0.192	-0.299	-0.746
Expenditures	1.320	0.803	0.963	-0.038	1.293	1.250
<i>Urban non-poor</i>						
Sorghum	-0.231	0.050	-24.227	-0.033	0.279	0.639
Imported rice	0.612	-0.963	-18.177	-0.104	-0.191	-0.696
Local rice	0.173	-0.121	17.182	-0.226	-0.055	-0.005
Cowpea	4.678	-0.012	0.300	-1.076	0.670	-0.764
Maize	-1.491	0.044	-2.873	-0.099	-0.877	-0.134
Millet	-5.928	0.039	8.243	-0.180	-0.019	-1.084
Expenditures	2.368	1.033	0.884	1.306	1.501	2.292
<i>Urban poor</i>						
Sorghum	-0.719	0.068	-2.861	-0.197	0.159	0.126
Imported rice	-2.360	-1.339	7.152	0.146	0.058	-0.027
Local rice	-0.104	-0.118	1.378	0.039	-0.011	-0.019
Cowpea	3.522	-0.092	0.946	-0.822	0.681	-0.560
Maize	-0.178	-0.034	-1.052	0.343	-0.784	-0.051
Millet	-1.910	0.145	-6.371	0.190	-0.007	-0.507
Expenditures	1.662	0.879	0.975	0.056	1.430	1.305
<i>Rural non poor</i>						
Sorghum	-2.137	0.149	0.001	0.396	-0.063	0.027
Imported rice	0.405	-2.757	0.004	1.531	-0.103	0.382
Local rice	-0.007	-0.104	-0.388	0.201	-0.066	-0.017
Cowpea	0.334	0.538	0.001	-2.294	0.001	-0.070
Maize	-0.059	-0.011	0.001	0.073	-0.975	-0.106
Millet	0.237	1.293	0.011	0.380	0.099	-1.538
Expenditures	1.229	0.782	0.981	-0.436	1.044	1.204
<i>Rural poor</i>						
Sorghum	-0.725	1.113	0.004	0.539	-0.362	-0.134
Imported rice	0.906	-3.745	0.003	1.533	0.092	0.054
Local rice	-0.059	0.013	-0.330	0.124	-0.098	-0.007
Cowpea	0.242	1.039	0.002	-3.513	0.027	0.026
Maize	-0.259	0.156	0.003	0.120	-0.960	-0.121
Millet	-1.250	1.613	0.038	1.665	-0.023	-1.123
Expenditures	1.087	-0.191	0.948	-0.462	1.237	1.178

Source: calculated from the ENBD data, Niger 2007.

VI - Conclusions and implications

This study used household consumption surveys carried out in Mali and Niger in 2006 and 2007 respectively to identify the drivers of consumption of pearl millet and sorghum and compute the price and expenditure elasticities of sorghum and pearl millet. Price of substitutes and expenditure are major drivers of demand for sorghum and pearl millet. Sorghum and millet are luxury goods for many households in the Sahel. Sorghum and millet are substitutes. There are however differences based on income groups and location.

The coefficients derived from this study may be biased because many of the goods have zero consumption. Techniques that do not account for zero consumption may yield biased results. However a simultaneous multivariate tobit model was used to correct for the bias and inconsistency but did not converge. Continuing efforts to look for appropriate models is warranted.

References

- Akinleye & MAY Rahji (2006) Nutrient elasticities among Nigerian Households differentiated by income, *Agrekon*, Vol. 46 (2):274-288.
- J. Banks, R. Blundell, and A. Lewbel (1997). Quadratic engel curves and consumer demand. *Review of Econ. and Stat.*, 4:527-539.
- Christensen, L.R., D.W. Jorgensen, and L.J. Lau (1975). Transcendental logarithmic utility functions,. *Amer. Econ. Rev.*, 65:367-83.
- Deaton, A. (1988). Quality, quantity, and spatial variation of price. *Amer. Econ. Rev.*,78:418-30.
- Deaton, A. and J. Muellbauer. (1980). *Economics and Consumer Behavior*. Cambridge University Press, Cambridge., 1980.
- ENBC. Troisieme enquete nationale sur le budget et la consommation des ménages. Technical report, NER-INS-ENBC, 2007.
- HDReport (2010). The Real Wealth of Nations: Pathways to Human Development. Technical Report, Human Development Report: United Nations Development Program, 2010.
- C. Llach, A. Powell, and R. Williams (1977). *Patterns in Household Demand and Savings*. Oxford University Press.
- Theil, H. (1965). The information approach to demand analysis. *Econometrica*, 33:67-87.

Annex 1. Income and price elasticities for Nigerian households by income class

Food Items	Income elasticities	Price elasticities						
		Rice	Millet	Sorghum	Yam	Corn	Garri	Maize
<i>Low income – earning households</i>								
Rice	2.56	0.24	0.19	-0.16	-0.09	0.16	0.03	-0.19
Millet	0.21	-0.54	-1.19	-0.12	0.94	0.63	0.36	0.97
Sorghum	0.42	1.16	0.49	-2.70	-0.72	-0.49	0.83	0.90
Yam	1.12	0.13	0.07	-0.05	-0.69	0.16	-0.27	-0.14
Corn	0.46	-0.67	-0.45	-0.09	-0.51	0.27	0.12	0.67
Garri	0.14	0.33	-0.38	-0.36	-0.05	-0.85	-1.38	0.20
Maize	0.38	0.43	0.73	-0.02	0.50	0.94	0.51	-0.43
<i>Average income - earning households</i>								
Rice	1.21	0.25	-0.23	-0.05	-0.48	0.27	0.34	0.17
Millet	1.21	1.21	-0.85	-0.27	0.60	0.77	0.70	0.01
Sorghum	0.86	-0.13	1.09	-2.41	1.00	0.21	1.36	1.04
Yam	1.01	0.53	0.07	0.16	-0.34	-0.17	0.25	-0.09
Corn	-0.12	-0.69	0.08	-0.03	0.05	-0.35	-0.32	0.53
Garri	-0.31	-0.05	0.62	-0.12	-0.73	-1.46	-0.13	-1.10
Maize	0.49	0.64	-0.54	-0.41	0.30	0.28	0.41	-0.57
<i>High income – earning households</i>								
Rice	0.82	-0.06	-0.27	0.01	0.48	-0.64	0.33	-0.42
Millet	0.21	-0.32	-0.37	0.10	0.29	0.52	1.02	-0.48
Sorghum	0.21	-1.25	1.43	-2.70	0.63	-1.12	-0.59	-0.41
Yam	0.56	0.37	0.12	-0.01	0.40	-0.20	-0.06	-0.20
Corn	-0.04	-0.41	-0.10	0.05	0.34	-0.12	0.38	-0.43
Garri	-0.12	0.95	-1.01	-0.52	0.18	0.41	0.61	-1.22
Maize	-0.23	-0.41	0.20	0.12	0.98	0.50	-0.52	-0.33

Source: Table 2 from page 283 in Akinleye & MAY Rahji (2006) Nutrient elasticities among Nigerian Households differentiated by income, *Agrekon*, Vol. 46 (2):274-288

Annex 2. Determinants of demand for cereals and cowpea in Mali (Urban Non-poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Cowpea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std Err	Z	Coef.	Std Err	Z	Coef.	Std Err	Z	Coef.	Std Err	Z	Coef.	Std Err	Z
Ln(Sorghum price)	-0.071	0.045	-1.570	-0.006	0.036	-0.160	-0.014	0.028	-0.510	-0.038	0.028	-1.360	0.134	0.044	3.060
Ln(Rice price)	-0.006	0.036	-0.160	0.088	0.058	1.530	-0.027	0.030	-0.910	0.153	0.030	5.060	-0.217	0.044	-4.900
Ln(Cowpea price)	-0.014	0.028	-0.510	-0.027	0.030	-0.910	-0.076	0.037	-2.020	0.038	0.018	2.090	0.090	0.029	3.140
Ln (Maize price)	-0.038	0.028	-1.360	0.153	0.030	5.060	0.038	0.018	2.090	-0.400	0.035	-11.590	0.230	0.035	6.660
Ln (Millet price)	0.134	0.044	3.060	-0.217	0.044	-4.900	0.090	0.029	3.140	0.230	0.035	6.660	-0.225	0.064	-3.490
Ln (Fonio price)	-0.004	0.012	-0.360	0.009	0.012	0.740	-0.011	0.012	-0.870	0.018	0.010	1.790	-0.012	0.016	-0.770
Ln (Expenditures)	0.019	0.005	3.590	-0.052	0.009	-6.010	-0.014	0.002	-5.720	0.000	0.005	0.010	0.049	0.007	6.880
indepagric~e	0.006	0.013	0.440	-0.041	0.021	-1.970	-0.002	0.006	-0.360	-0.004	0.011	-0.330	0.045	0.017	2.640
indepnonag~c	0.006	0.010	0.630	-0.021	0.016	-1.330	0.001	0.004	0.280	0.013	0.008	1.590	0.000	0.013	0.040
Unemployed	0.021	0.015	1.410	-0.012	0.024	-0.480	-0.006	0.007	-0.850	0.006	0.013	0.480	-0.007	0.020	-0.350
Gender	0.000	0.019	0.020	-0.024	0.030	-0.780	-0.007	0.008	-0.790	0.017	0.016	1.070	0.012	0.025	0.500
Monogamus	-0.023	0.026	-0.910	-0.039	0.041	-0.960	0.020	0.011	1.730	0.016	0.022	0.710	0.018	0.034	0.550
Polygamus	-0.010	0.027	-0.370	-0.034	0.044	-0.780	0.025	0.012	2.060	0.020	0.024	0.840	-0.011	0.036	-0.300
Divorced	-0.020	0.030	-0.660	-0.023	0.049	-0.470	0.027	0.013	2.000	0.004	0.026	0.150	-0.001	0.040	-0.020
Illiterate	0.014	0.009	1.620	-0.005	0.014	-0.340	0.008	0.004	2.050	0.002	0.007	0.270	-0.017	0.011	-1.520
Adult equivalent	0.002	0.001	1.650	0.000	0.002	0.080	0.002	0.001	3.180	0.000	0.001	-0.260	-0.004	0.002	-2.370
nnhage1	0.027	0.015	1.820	0.013	0.024	0.550	0.005	0.007	0.760	-0.006	0.013	-0.470	-0.041	0.020	-2.100
nnhage2	0.035	0.014	2.510	0.003	0.023	0.150	0.002	0.006	0.310	0.000	0.012	-0.010	-0.043	0.019	-2.340
nnhage3	0.024	0.014	1.680	0.003	0.023	0.150	-0.004	0.006	-0.670	-0.007	0.012	-0.610	-0.013	0.019	-0.700
Region	-0.005	0.001	-3.760	0.006	0.002	3.010	-0.002	0.001	-2.540	-0.003	0.001	-3.040	0.003	0.002	1.700
Constant	-0.059	0.056	-1.040	1.031	0.089	11.580	0.191	0.029	6.520	-0.159	0.049	-3.230	-0.018	0.073	-0.250

Source: Calculated from INSTAT data, 2006.

Annex 3. Determinants of demand for cereals and cowpea in Mali (Urban Poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Cowpea</i>			<i>Maize</i>			<i>Millet</i>		
lnprixsorg~m	-0.095	0.154	-0.610	-0.229	0.099	-2.320	0.209	0.090	2.310	0.148	0.086	1.720	-0.101	0.135	-0.750
lnprixmrice	-0.229	0.099	-2.320	-0.553	0.142	-3.900	0.213	0.095	2.240	0.439	0.081	5.430	0.135	0.112	1.210
lnprixniebe	0.209	0.090	2.310	0.213	0.095	2.240	-0.341	0.125	-2.730	-0.021	0.047	-0.450	-0.084	0.092	-0.920
lnprixmais	0.148	0.086	1.720	0.439	0.081	5.430	-0.021	0.047	-0.450	-0.975	0.095	-10.240	0.407	0.091	4.480
lnprixmil	-0.101	0.135	-0.750	0.135	0.112	1.210	-0.084	0.092	-0.920	0.407	0.091	4.480	-0.279	0.178	-1.570
lnprixfonio	0.067	0.043	1.570	-0.005	0.034	-0.140	0.025	0.037	0.660	0.002	0.030	0.080	-0.077	0.053	-1.460
lndepcere~es	0.016	0.012	1.390	-0.057	0.018	-3.170	-0.038	0.005	-7.300	0.037	0.012	2.950	0.057	0.015	3.940
lndepagric~e	0.033	0.030	1.100	-0.038	0.046	-0.840	-0.014	0.013	-1.010	-0.022	0.032	-0.690	0.029	0.037	0.770
lndepnonag~c	-0.011	0.031	-0.350	0.100	0.048	2.090	-0.022	0.014	-1.550	-0.045	0.033	-1.330	-0.023	0.039	-0.600
sansemploi	-0.041	0.043	-0.950	0.023	0.066	0.360	-0.025	0.019	-1.310	-0.065	0.046	-1.430	0.122	0.053	2.290
Hgender	-0.011	0.069	-0.150	-0.198	0.105	-1.890	-0.007	0.031	-0.220	0.048	0.073	0.650	0.161	0.086	1.880
monogamus	0.123	0.110	1.120	-0.255	0.167	-1.530	-0.010	0.049	-0.200	0.078	0.116	0.670	0.073	0.136	0.530
polygamus	0.141	0.111	1.270	-0.248	0.169	-1.470	-0.005	0.050	-0.100	0.091	0.118	0.770	0.016	0.138	0.110
Divorced	0.174	0.119	1.470	0.014	0.181	0.080	0.004	0.053	0.080	-0.030	0.126	-0.240	-0.154	0.147	-1.050
Illiterate	-0.008	0.023	-0.360	0.012	0.036	0.350	-0.016	0.010	-1.550	-0.004	0.025	-0.180	0.016	0.029	0.560
adeq	0.001	0.003	0.350	-0.008	0.004	-1.860	0.004	0.001	3.110	-0.004	0.003	-1.410	0.005	0.003	1.520
nnhage1	-0.006	0.036	-0.180	0.016	0.055	0.290	-0.015	0.016	-0.940	-0.025	0.038	-0.660	0.051	0.044	1.160
nnhage2	0.001	0.034	0.030	0.064	0.052	1.240	-0.006	0.015	-0.420	-0.020	0.036	-0.550	-0.020	0.042	-0.470
nnhage3	0.032	0.034	0.930	0.059	0.053	1.130	0.003	0.015	0.190	-0.049	0.037	-1.350	-0.023	0.043	-0.540
region	-0.008	0.006	-1.330	0.027	0.008	3.220	-0.006	0.003	-2.210	-0.019	0.006	-3.230	0.007	0.007	0.970
_cons	-0.130	0.187	-0.700	1.493	0.282	5.300	0.426	0.094	4.530	-0.510	0.195	-2.620	-0.387	0.230	-1.680

Source: Calculated from INSTAT data, 2006.

Annex 4. Determinants of demand for cereals and cowpea in Mali (Rural Non-poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Cowpea</i>			<i>Maize</i>			<i>Millet</i>		
lnprixsorg~m	0.054	0.072	0.750	0.036	0.041	0.870	-0.005	0.036	-0.140	-0.067	0.042	-1.580	-0.100	0.066	-1.510
lnprixmrice	0.036	0.041	0.870	-0.192	0.058	-3.300	0.046	0.035	1.310	0.212	0.034	6.270	0.094	0.049	1.940
lnprixniebe	-0.005	0.036	-0.140	0.046	0.035	1.310	-0.022	0.048	-0.460	-0.047	0.030	-1.540	0.019	0.037	0.530
lnprixmais	-0.067	0.042	-1.580	0.212	0.034	6.270	-0.047	0.030	-1.540	-0.359	0.046	-7.830	0.038	0.043	0.880
lnprixmil	-0.100	0.066	-1.510	0.094	0.049	1.940	0.019	0.037	0.530	0.038	0.043	0.880	-0.083	0.081	-1.020
lnprixfonio	0.081	0.023	3.550	-0.197	0.018	-10.900	0.009	0.017	0.530	0.223	0.018	12.170	0.031	0.025	1.230
lndepcere~es	0.045	0.005	8.690	-0.042	0.008	-5.200	-0.020	0.003	-7.450	-0.002	0.004	-0.420	0.052	0.007	7.420
lndepagric~e	0.003	0.015	0.210	-0.039	0.024	-1.670	0.011	0.007	1.500	0.018	0.011	1.720	0.028	0.020	1.400
lndepronag~c	-0.008	0.019	-0.430	0.096	0.031	3.110	-0.006	0.010	-0.660	-0.030	0.014	-2.140	-0.026	0.027	-0.990
lnsansemploi	0.043	0.020	2.140	0.003	0.032	0.100	0.005	0.010	0.460	-0.007	0.015	-0.470	-0.014	0.028	-0.510
lnHgender	-0.082	0.024	-3.450	0.311	0.038	8.280	0.091	0.012	7.480	-0.083	0.017	-4.800	-0.051	0.032	-1.590
lnmonogamus	-0.072	0.031	-2.270	0.428	0.049	8.670	0.058	0.016	3.560	-0.037	0.023	-1.590	-0.122	0.043	-2.860
lnpolygamus	-0.061	0.033	-1.830	0.395	0.052	7.540	0.060	0.017	3.490	-0.035	0.024	-1.460	-0.113	0.045	-2.510
lnDivorced	-0.001	0.042	-0.030	0.190	0.068	2.810	-0.013	0.021	-0.620	0.014	0.030	0.470	-0.050	0.058	-0.860
lnIlliterate	0.026	0.013	1.930	-0.056	0.022	-2.590	0.010	0.007	1.430	0.012	0.010	1.210	0.027	0.018	1.450
lnAdeq	-0.005	0.002	-3.290	0.007	0.003	2.790	0.003	0.001	3.280	-0.001	0.001	-0.940	-0.006	0.002	-2.490
lnnhage1	0.015	0.014	1.050	0.045	0.023	1.970	0.011	0.007	1.560	-0.014	0.010	-1.390	-0.025	0.020	-1.260
lnnhage2	0.019	0.014	1.340	0.015	0.022	0.660	0.016	0.007	2.270	-0.015	0.010	-1.480	-0.014	0.019	-0.720
lnnhage3	-0.001	0.014	-0.090	-0.004	0.023	-0.180	0.008	0.007	1.050	0.003	0.010	0.250	0.000	0.020	0.020
lnRegion	-0.036	0.003	-11.380	0.078	0.004	18.130	-0.009	0.002	-5.140	-0.030	0.002	-12.250	0.001	0.004	0.290
_cons	(omitted)			(omitted)			(omitted)			(omitted)			(omitted)		

Source: Calculated from INSTAT data, 2006.

Annex 5. Determinants of demand for cereals and cowpea in Mali (Rural Poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Conpea</i>			<i>Maize</i>			<i>Millet</i>		
lnprixsorg~m	-0.085	0.185	-0.460	-0.260	0.069	-3.750	0.204	0.081	2.530	0.043	0.067	0.650	0.074	0.157	0.470
lnprixmrice	-0.260	0.069	-3.750	-0.409	0.066	-6.170	0.236	0.053	4.450	0.271	0.039	6.870	0.186	0.067	2.770
lnprixniebe	0.204	0.081	2.530	0.236	0.053	4.450	-0.231	0.070	-3.320	0.005	0.035	0.160	-0.180	0.072	-2.490
lnprixmais	0.043	0.067	0.650	0.271	0.039	6.870	0.005	0.035	0.160	-0.830	0.045	-18.330	0.531	0.058	9.210
lnprixmil	0.074	0.157	0.470	0.186	0.067	2.770	-0.180	0.072	-2.490	0.531	0.058	9.210	-0.807	0.150	-5.370
lnprixfonio	0.024	0.043	0.550	-0.024	0.023	-1.060	-0.035	0.024	-1.430	-0.022	0.019	-1.140	0.195	0.041	4.710
lndep cere~es	0.047	0.005	8.900	-0.071	0.006	-11.140	-0.033	0.003	-11.410	0.022	0.005	4.650	0.056	0.006	8.830
lndep agric~e	0.006	0.021	0.270	0.012	0.025	0.480	0.028	0.011	2.440	0.021	0.019	1.080	-0.024	0.025	-0.940
lndep nonag~c	0.007	0.032	0.230	-0.006	0.040	-0.160	0.021	0.018	1.160	0.022	0.030	0.720	-0.011	0.040	-0.290
sansemploi	0.056	0.025	2.260	0.016	0.030	0.520	0.019	0.014	1.410	0.021	0.023	0.910	-0.074	0.030	-2.430
Hgender	-0.075	0.036	-2.060	0.193	0.045	4.330	0.126	0.020	6.210	0.026	0.034	0.780	-0.075	0.045	-1.670
monogamus	0.044	0.048	0.900	0.388	0.058	6.660	0.203	0.028	7.370	-0.169	0.044	-3.860	-0.064	0.059	-1.090
polygamus	0.014	0.050	0.290	0.426	0.060	7.100	0.203	0.028	7.170	-0.151	0.045	-3.340	-0.094	0.060	-1.570
Divorced	0.116	0.064	1.810	0.282	0.079	3.580	0.113	0.036	3.160	-0.173	0.060	-2.910	-0.035	0.079	-0.450
Illiterate	0.007	0.018	0.380	-0.026	0.022	-1.170	0.024	0.010	2.480	0.013	0.017	0.810	0.002	0.022	0.080
Adeq	-0.003	0.001	-1.920	0.005	0.002	2.970	0.003	0.001	4.710	-0.004	0.001	-3.070	-0.002	0.002	-1.390
nnhage1	0.029	0.017	1.650	0.020	0.021	0.920	-0.001	0.010	-0.120	0.018	0.016	1.090	-0.032	0.021	-1.520
nnhage2	0.040	0.015	2.680	0.020	0.019	1.070	-0.005	0.008	-0.560	-0.012	0.014	-0.840	-0.033	0.019	-1.790
nnhage3	0.038	0.015	2.510	-0.029	0.019	-1.540	-0.007	0.008	-0.820	0.004	0.014	0.310	0.003	0.019	0.170
Region	-0.036	0.005	-7.490	0.083	0.005	16.230	-0.019	0.003	-7.290	-0.053	0.004	-13.320	0.035	0.005	6.460

Source: Calculated from INSTAT data, 2006.

Annex 6. Determinants of demand for cereals and cowpea in Niger (Urban non-poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Conpea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z
lnprixsorg~m	0.011	0.030	0.370	0.023	0.027	0.850	0.068	0.018	3.740	-0.020	0.003	-6.070	-0.082	0.041	-1.990
lnprixmrice	0.023	0.027	0.850	-0.130	0.089	-1.470	0.022	0.033	0.670	0.038	0.010	3.680	0.047	0.077	0.610
lnprixlorice	0.003	0.001	1.710	-0.006	0.005	-1.260	0.002	0.002	1.170	-0.005	0.002	-2.780	0.000	0.004	0.080
lnprixniebe	0.068	0.018	3.740	0.022	0.033	0.670	-0.050	0.025	-1.980	0.002	0.004	0.400	-0.041	0.036	-1.130
lnprixmais	-0.020	0.003	-6.070	0.038	0.010	3.680	0.002	0.004	0.400	0.014	0.005	2.850	-0.033	0.009	-3.690
lnprixmil	-0.082	0.041	-1.990	0.047	0.077	0.610	-0.041	0.036	-1.130	-0.033	0.009	-3.690	0.108	0.096	1.130
lndepccere~es	0.019	0.003	6.850	-0.091	0.009	-9.800	-0.023	0.004	-6.410	0.028	0.004	6.910	0.063	0.008	8.200
Sexe	-0.001	0.006	-0.170	-0.007	0.019	-0.390	-0.002	0.007	-0.260	-0.010	0.008	-1.190	0.024	0.016	1.550
trancheage1	0.018	0.009	2.060	0.034	0.028	1.200	-0.007	0.011	-0.630	0.009	0.012	0.690	-0.046	0.024	-1.950
trancheage2	0.011	0.007	1.560	0.032	0.022	1.450	-0.014	0.008	-1.720	0.017	0.010	1.680	-0.039	0.019	-2.110
trancheage3	0.006	0.006	0.990	0.025	0.021	1.200	-0.004	0.008	-0.460	0.011	0.009	1.190	-0.031	0.017	-1.780
trancheage4	0.004	0.007	0.680	0.031	0.022	1.450	-0.006	0.008	-0.690	0.007	0.010	0.750	-0.026	0.018	-1.430
Illiterate	-0.016	0.004	-3.770	0.062	0.014	4.340	-0.009	0.005	-1.690	-0.002	0.006	-0.310	-0.039	0.012	-3.300
lndepagric~e	0.015	0.007	2.050	-0.149	0.024	-6.130	0.020	0.009	2.140	0.026	0.011	2.400	0.081	0.020	4.010
lndepnonag~c	-0.007	0.004	-1.520	-0.037	0.014	-2.580	-0.001	0.005	-0.200	0.005	0.006	0.850	0.034	0.012	2.850
Adeq	0.001	0.001	1.160	-0.001	0.002	-0.350	-0.002	0.001	-1.760	0.002	0.001	1.610	0.000	0.002	0.180
Diffa	-0.002	0.011	-0.230	0.069	0.033	2.080	-0.007	0.014	-0.510	0.019	0.014	1.400	-0.084	0.028	-3.010
Dosso	0.021	0.011	1.950	-0.098	0.032	-3.050	-0.027	0.012	-2.210	0.107	0.013	8.020	0.003	0.027	0.120
Maradi	0.007	0.013	0.560	-0.067	0.040	-1.670	0.012	0.015	0.800	0.042	0.011	3.780	0.009	0.035	0.270
Tahoua	0.005	0.011	0.460	-0.133	0.032	-4.210	-0.032	0.013	-2.420	0.023	0.013	1.770	0.160	0.027	5.950
Tillaberi	0.002	0.013	0.170	-0.161	0.038	-4.230	-0.037	0.015	-2.520	0.150	0.016	9.490	0.017	0.032	0.530
Zinder	0.017	0.014	1.260	-0.050	0.043	-1.160	-0.029	0.016	-1.760	0.038	0.011	3.480	0.027	0.036	0.750
Cuniamey	-0.014	0.009	-1.500	0.094	0.030	3.190	-0.038	0.011	-3.430	0.048	0.013	3.720	-0.062	0.025	-2.500
_cons	-0.118	0.026	-4.460	1.280	0.084	15.250	0.202	0.031	6.490	-0.158	0.026	-6.080	-0.204	0.074	-2.740

Annex 7. Determinants of demand for cereals and cowpea in Niger (Urban poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Compea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z
lnprixsorg~m	0.010	0.036	0.270	-0.067	0.050	-1.350	0.118	0.029	4.080	-0.004	0.007	-0.590	-0.057	0.054	-1.040
lnpriximrice	-0.067	0.050	-1.350	0.122	0.161	0.760	0.106	0.061	1.730	0.031	0.020	1.550	-0.192	0.140	-1.370
lnprixlorice	-0.003	0.003	-1.010	-0.006	0.009	-0.710	0.000	0.004	0.010	0.000	0.004	0.120	-0.009	0.008	-1.130
lnprixniebe	0.118	0.029	4.080	0.106	0.061	1.730	-0.071	0.045	-1.590	0.001	0.009	0.100	-0.154	0.060	-2.580
lnprixmais	-0.004	0.007	-0.590	0.031	0.020	1.550	0.001	0.009	0.100	0.029	0.012	2.480	-0.057	0.018	-3.130
lnprixmil	-0.057	0.054	-1.040	-0.192	0.140	-1.370	-0.154	0.060	-2.580	-0.057	0.018	-3.130	0.460	0.156	2.940
lndepccere~es	0.022	0.005	4.530	-0.059	0.015	-3.940	-0.077	0.006	-12.620	0.034	0.008	4.240	0.090	0.013	6.960
Sexe	-0.006	0.011	-0.540	-0.049	0.033	-1.510	-0.019	0.013	-1.390	-0.001	0.018	-0.030	0.073	0.028	2.570
trancheage1	0.045	0.018	2.460	-0.021	0.056	-0.380	0.012	0.023	0.510	-0.027	0.031	-0.890	-0.023	0.049	-0.470
trancheage2	0.001	0.013	0.040	0.053	0.039	1.360	0.001	0.016	0.070	-0.006	0.021	-0.260	-0.062	0.034	-1.830
trancheage3	-0.001	0.010	-0.050	0.020	0.032	0.610	0.008	0.013	0.630	0.014	0.018	0.790	-0.051	0.028	-1.830
trancheage4	0.005	0.011	0.420	-0.005	0.034	-0.130	0.022	0.014	1.570	0.021	0.019	1.150	-0.042	0.029	-1.430
Illiterate	-0.015	0.009	-1.630	0.074	0.029	2.550	-0.007	0.012	-0.610	0.000	0.016	0.000	-0.049	0.025	-1.980
lndepagric~e	0.008	0.012	0.670	-0.117	0.036	-3.280	-0.010	0.015	-0.660	0.055	0.019	2.850	0.040	0.031	1.290
lndeponag~c	0.009	0.010	0.910	-0.060	0.030	-2.010	-0.010	0.012	-0.830	0.020	0.016	1.230	0.036	0.026	1.370
Adeq	0.001	0.001	0.790	-0.004	0.004	-1.030	-0.003	0.002	-2.010	0.010	0.002	4.260	-0.003	0.004	-0.930
Diffa	0.036	0.028	1.290	0.103	0.084	1.230	-0.009	0.036	-0.240	0.051	0.044	1.170	-0.158	0.072	-2.180
Dosso	0.010	0.023	0.430	-0.229	0.071	-3.240	-0.022	0.030	-0.750	0.194	0.037	5.300	0.012	0.061	0.190
Maradi	0.054	0.026	2.070	-0.343	0.081	-4.210	0.029	0.032	0.890	0.090	0.033	2.700	0.172	0.070	2.440
Tahoua	0.035	0.023	1.510	-0.300	0.070	-4.260	0.036	0.030	1.220	0.015	0.036	0.400	0.274	0.060	4.540
Tillaberi	0.031	0.025	1.210	-0.271	0.075	-3.640	0.030	0.031	0.990	0.015	0.039	0.400	0.146	0.064	2.270
Zinder	0.096	0.029	3.350	-0.229	0.090	-2.550	-0.012	0.036	-0.340	0.116	0.034	3.380	0.029	0.076	0.380
Cuniamey	-0.005	0.023	-0.210	0.124	0.070	1.770	-0.007	0.028	-0.240	0.080	0.038	2.090	-0.150	0.060	-2.470
_cons	-0.073	0.050	-1.470	0.899	0.156	5.780	0.391	0.060	6.460	-0.254	0.060	-4.230	0.007	0.140	0.050

Annex 8. Determinants of demand for cereals and cowpea in Niger (Rural non-poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Cowpea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z
lnprixsorg~m	-0.070	0.046	-1.510	0.028	0.042	0.670	0.022	0.028	0.780	-0.003	0.005	-0.590	0.023	0.061	0.380
lnprixmrice	0.028	0.042	0.670	-0.376	0.084	-4.490	0.109	0.038	2.840	-0.005	0.008	-0.540	0.244	0.083	2.920
lnprixlorice	0.000	0.003	0.020	-0.023	0.005	-5.100	0.011	0.003	4.190	-0.003	0.002	-1.570	-0.006	0.005	-1.190
lnprixniebe	0.022	0.028	0.780	0.109	0.038	2.840	-0.099	0.034	-2.940	0.000	0.005	0.030	-0.032	0.049	-0.650
lnprixmais	-0.003	0.005	-0.590	-0.005	0.008	-0.540	0.000	0.005	0.030	0.001	0.004	0.320	0.006	0.009	0.680
lnprixmil	0.023	0.061	0.380	0.244	0.083	2.920	-0.032	0.049	-0.650	0.006	0.009	0.680	-0.241	0.125	-1.930
lndepccere~es	0.014	0.006	2.220	-0.046	0.011	-4.060	-0.102	0.006	-17.250	0.002	0.005	0.400	0.117	0.012	10.010
Sexe	-0.010	0.018	-0.570	-0.005	0.031	-0.170	0.002	0.016	0.150	0.025	0.015	1.670	0.000	0.032	-0.010
trancheage1	-0.001	0.016	-0.070	-0.022	0.028	-0.790	0.027	0.015	1.830	0.031	0.014	2.280	-0.028	0.029	-0.950
trancheage2	-0.003	0.015	-0.180	0.076	0.026	2.880	-0.006	0.014	-0.460	0.032	0.013	2.510	-0.110	0.027	-4.020
trancheage3	0.011	0.016	0.690	0.041	0.027	1.510	0.004	0.014	0.270	0.012	0.013	0.870	-0.071	0.029	-2.500
trancheage4	-0.011	0.017	-0.650	0.033	0.029	1.110	0.019	0.015	1.200	0.018	0.014	1.280	-0.065	0.031	-2.130
illiterate	-0.007	0.014	-0.500	0.096	0.024	4.010	-0.020	0.013	-1.580	-0.019	0.012	-1.610	-0.061	0.025	-2.440
lndepagric~e	0.004	0.018	0.220	-0.182	0.031	-5.830	0.001	0.017	0.060	0.001	0.015	0.080	0.157	0.033	4.810
lndeponag~c	-0.017	0.021	-0.800	-0.146	0.037	-3.940	0.001	0.020	0.050	0.000	0.018	-0.010	0.173	0.039	4.460
adeq	0.002	0.002	0.700	-0.002	0.004	-0.600	-0.005	0.002	-2.600	0.004	0.002	2.400	0.001	0.004	0.380
dosso	-0.048	0.023	-2.030	-0.345	0.039	-8.840	0.070	0.022	3.250	0.135	0.018	7.380	0.236	0.041	5.710
maradi	0.022	0.027	0.820	-0.294	0.046	-6.380	0.057	0.025	2.300	-0.005	0.021	-0.240	0.265	0.049	5.380
tahoua	0.035	0.023	1.520	-0.320	0.040	-7.970	0.064	0.022	2.950	-0.013	0.019	-0.680	0.316	0.042	7.510
tillaberi	0.011	0.025	0.440	-0.289	0.041	-7.070	0.036	0.023	1.540	0.056	0.019	2.970	0.197	0.043	4.530
zinder	0.053	0.023	2.330	-0.281	0.040	-7.000	0.048	0.021	2.270	-0.018	0.017	-1.050	0.244	0.043	5.690
_cons	-0.062	0.055	-1.140	1.187	0.100	11.820	0.491	0.050	9.810	-0.045	0.037	-1.220	-0.534	0.101	-5.280

Annex 9. Determinants of demand for cereals and cowpea in Niger (Rural poor)

	<i>Sorghum</i>			<i>Rice</i>			<i>Compea</i>			<i>Maize</i>			<i>Millet</i>		
	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z	Coef.	Std. Err.	Z
lnprixsorg~m	0.021	0.028	0.760	0.069	0.024	2.920	0.019	0.017	1.100	-0.019	0.005	-3.500	-0.090	0.035	-2.540
lnprixmrice	0.069	0.024	2.920	-0.190	0.050	-3.810	0.067	0.026	2.600	0.006	0.005	1.210	0.049	0.051	0.970
lnprixlorice	-0.004	0.003	-1.540	0.000	0.003	-0.050	0.005	0.002	2.250	-0.005	0.002	-2.400	-0.003	0.004	-0.770
lnprixniebe	0.019	0.017	1.100	0.067	0.026	2.600	-0.112	0.025	-4.490	0.002	0.003	0.510	0.025	0.029	0.870
lnprixmais	-0.019	0.005	-3.500	0.006	0.005	1.210	0.002	0.003	0.510	0.003	0.005	0.650	0.009	0.008	1.040
lnprixmil	-0.090	0.035	-2.540	0.049	0.051	0.970	0.025	0.029	0.870	0.009	0.008	1.040	0.007	0.071	0.100
lndepccere~es	0.007	0.008	0.840	-0.080	0.007	-11.550	-0.063	0.004	-14.140	0.013	0.006	2.070	0.132	0.012	11.260
sexe	-0.007	0.021	-0.350	-0.010	0.018	-0.550	-0.004	0.012	-0.370	0.018	0.017	1.080	0.004	0.031	0.140
trancheage1	-0.011	0.020	-0.540	0.001	0.018	0.030	0.000	0.012	0.020	-0.030	0.016	-1.820	0.052	0.030	1.730
trancheage2	-0.004	0.017	-0.250	0.001	0.015	0.070	-0.010	0.009	-1.030	-0.008	0.013	-0.630	0.025	0.025	0.990
trancheage3	0.002	0.015	0.140	-0.011	0.013	-0.830	-0.011	0.009	-1.280	0.011	0.012	0.880	0.023	0.023	1.020
trancheage4	0.008	0.016	0.500	-0.008	0.014	-0.540	-0.008	0.009	-0.870	0.010	0.013	0.750	0.009	0.025	0.360
illiterate	0.041	0.018	2.310	0.033	0.016	2.050	0.016	0.010	1.550	0.015	0.015	1.050	-0.121	0.027	-4.490
lndepagric~e	0.034	0.026	1.340	-0.013	0.023	-0.560	0.003	0.015	0.220	0.019	0.021	0.930	-0.037	0.039	-0.960
lndepnomag~c	0.064	0.029	2.230	-0.035	0.025	-1.380	-0.011	0.016	-0.650	0.001	0.023	0.050	-0.001	0.043	-0.030
adeq	0.004	0.002	2.120	-0.001	0.002	-0.550	-0.002	0.001	-1.960	0.001	0.002	0.410	-0.003	0.003	-0.990
diffa	(omitted)			0.898	0.069	12.980	(omitted)			-0.002	0.050	-0.030	-0.193	0.102	-1.890
dosso	-0.001	0.045	-0.010	0.668	0.067	9.970	-0.038	0.026	-1.440	0.014	0.049	0.280	0.026	0.100	0.260
maradi	0.011	0.045	0.240	0.681	0.074	9.180	-0.028	0.027	-1.050	-0.106	0.049	-2.160	0.112	0.105	1.070
tahoua	0.112	0.046	2.420	0.687	0.071	9.660	-0.041	0.027	-1.540	-0.110	0.051	-2.160	0.034	0.104	0.330
tillaberi	0.061	0.045	1.360	0.692	0.068	10.220	-0.058	0.027	-2.170	-0.034	0.049	-0.690	-0.006	0.100	-0.060
zinder	0.068	0.045	1.530	0.702	0.074	9.490	-0.035	0.026	-1.350	-0.101	0.048	-2.090	0.035	0.103	0.340
_cons	-0.120	0.064	-1.860	(omitted)			0.397	0.041	9.650	(omitted)			(omitted)		

ⁱ Income elasticity of demand (IEoD) measures the responsiveness of the demand for a good to a change in the income of the people demanding the good. It is calculated as the ratio of the percentage change in demand to the percentage change in income. If Income Elasticity of Demand (IEoD) > 1 then the good is a Luxury Good and Income Elastic. If $IEoD < 1$ and $IEoD > 0$ then the good is a Normal Good and Income Inelastic and if $IEoD < 0$ then the good is an Inferior Good and Negative Income Inelastic.

An **inferior good** is a good that decreases in demand when consumer income rises, unlike normal goods for which the opposite is observed. Normal goods are those for which consumers' demand increases when their income increases.

A **necessity good** is a type of normal good. Like any other normal good, when income rises, demand increases. But the increase for a necessity good is less than proportional to the rise in income, so the proportion of expenditure on these goods falls as income rises. The income elasticity of a necessity good is thus between zero and one. Necessity goods are goods that we can't live without and won't likely cut back on even when times are tough.

A **luxury good** is a good for which the demand increases more than proportionally as income rises, and is a contrast to a necessity good, for which demand is not related to income. Luxury goods are often synonymous with superior goods. Luxury goods are said to have high income elasticity of demand as people become wealthier, they will buy more and more of the luxury good. This also means, however, that should there be a decline in income its demand will drop.

Price elasticity of demand (PED or E_d) is a measure to show the responsiveness, or elasticity, of the quantity demanded of a good or service to a change in its price. More precisely, it gives the percentage change in quantity demanded in response to a one percent change in price (holding constant all the other determinants of demand, such as income). Only goods which do not conform to the law of demand such as Veblen and Giffen goods, have a positive PED. In general, the demand for a good is said to be *inelastic* (or *relatively inelastic*) when the PED is less than one (in absolute value): that is, changes in price have a relatively small effect on the quantity of the good demanded. The demand for a good is said to be *elastic* (or *relatively elastic*) when its PED is greater than one (in absolute value): that is, changes in price have a relatively large effect on the quantity of a good demanded.

A **complementary good** is one with a negative cross elasticity of demand, in contrast to a substitute good. This means that the demand for a good is decreased when the price of another good is increased.

A **substitute good**, is a one with a positive cross elasticity of demand. This means that the demand for a good is increased when the price of another good is increased and conversely.

Cross-price elasticities

The cross-price elasticity of demand (CPEoD) is used to see how sensitive the demand for a good is to a price change of another good. A high positive cross-price elasticity tells us that if the price of one good goes up, the demand for the other good goes up as well. A negative tells us just the opposite. A small value (either negative or positive) tells us that there is little relation between the two goods. In general, if $CPEoD > 0$ then the two goods are substitutes. If $CPEoD = 0$ then the two goods are independent (no relationship between the two goods and if $CPEoD < 0$ then the two goods are complements.