

CEREALS CONSUMPTION PATTERN IN KENYA

Ibrahim Macharia, Alastair Orr, Christin Schipmann

International Crops Research Institute for the Semi-Arid Tropics
(ICRISAT), Nairobi

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Abstract

To promote and facilitate greater consumption of sorghum and millet in Kenya, an understanding of the consumption patterns and associated consumer characteristics is needed. This report presents a detailed analysis of millet, maize and rice consumption patterns. The study also seeks to find the economic and demographic factors that would explain household consumption level of cereal crops.

The study principally uses data that was collected in 2005/2006 by Central Bureau of Statistics (the Kenya Integrated Household Budget Survey). Additional information is extracted from the production statistics at provincial report. Descriptive analyses are used to analyze cereal consumption pattern and expenditure. Heckman's two-step estimation method is applied to explore factors that explain the decision to consume and consumption levels.

The average per adult equivalent consumption of millet, maize and rice is about 33, 137 and 17 kg/adult equivalent/year respectively. Results also indicate shows that millet and rice are mainly consumed in urban areas, while maize consumption remains high in rural area. Consumption of millet and maize by rural residents increases with increase in income. However, in urban areas there is no statistical difference in consumption of millet in terms of quantity across the income levels. There are huge urban rural and interregional differences in the millet maize and rice consumption.

Socio-demographic characteristics such as household sizes, level of education, dependency ratios significantly explain both the decision to consume and the level of millet consumption. Thus targeted strategies on these variables can be effective both in attracting new consumers of millet and in increasing the level of consumption.

Table of Content

1	Introduction.....	4
1.1	Research Questions	4
1.2	Objectives of the investigation.....	5
2	Theoretical Framework.....	5
3	Data and Methodology.....	6
3.1	Analytical tools and techniques used in the present study.....	8
3.1.1	Definitions.....	9
4	Results and discussion	9
4.1	Cereal consumption patterns	9
4.2	Consumption by income and poverty.....	16
4.3	Total amount consumed	19
4.4	Demand for millets.....	20
4.5	Econometric results	23
4.5.1	Determinants of cereal consumption	23
5	Conclusions and Policy Implications.....	26
	References.....	27

1 Introduction

Millet, sorghum and maize are important staple crops in the rural Sahel (Yohannes, 1990; Reardon, 1993). Sorghum and millets are mostly recommended crops in harsh environments where other crops do poorly, as they are grown with limited rainfall and often without application of any fertilizers or other inputs. Additionally, these crops constitute the principal source of energy, protein, vitamins, and minerals for millions of the poorest people in these regions. In spite of the growing evidence highlighting the nutritional importance of these cereals, their intakes are still low in many developing countries.

In Kenya, major millet/ sorghum producers are Eastern province which accounts for 50% of the total area of 104,041 ha, Nyanza for 33%, Western for 12%, Rift Valley for 3% and the rest for 1% of the total area (MOA, 2010). Sorghum and millet are popular cereals in Kenya consumed from childhood as weaning food up to adulthood (Van Steenberg *et al.*, 1984).

Millet can be consumed as grain or millet flour. Main millets products in Kenya are in form of ‘Uji Mixes’ and are processed by large and small scale private firms (Obiliana, 2003). Appendix 1 shows the commercially available composite flour food products from millet and sorghum in Kenya local markets and peri - urban super market outlets.

There are basically four main types of maize meal products: whole or cracked maize grain, green maize, relatively expensive packaged sifted meal (with varying levels of refinement), and a less expensive and less refined loose maize meal (also with varying levels of refinement) (Muyanga *et al.*, 2005). Packaged sifted meal is produced by larger commercial mills and sold in retail outlets, while posho meal is typically obtained when consumers buy maize grain and take it to a small local hammer mill for grinding into meal. Sifted maize meal is the most common form of maize consumption in urban Kenya

This report presents a detailed analysis of millet, maize, rice and sorghum consumption patterns. The study also seeks to find the economic and demographic factors that would explain household consumption level of the four cereal crops. To better understand how food security policy should be designed in order to respond to the needs of low-income consumers, we disaggregate consumption and expenditure patterns for low, medium and high income groups.

1.1 Research Questions

The major research questions to be investigated are:

1. What are the differences in consumption patterns for millet, maize, rice and sorghum between different consumer clusters?
2. What are the differences in consumption patterns for millet, maize, rice and sorghum between different income groups?
3. What are the determinants of demand for millet, maize, rice and sorghum?
4. What is the elasticity of demand for these cereals?

5. What impact will changes in the main demand drivers have on future demand for millet and sorghum?

1.2 Objectives of the investigation

1. Describe consumption patterns for millet, maize, rice and sorghum across different consumer clusters and income groups.
2. Analyze the determinant of demand/consumption for millet and sorghum in rural and urban areas of Kenya.
3. Compute elasticities of demand for millet, maize, rice and sorghum in rural and urban Kenya.

The results will provide crucial information that can help guide policy makers to promote and facilitate greater consumption of sorghum and millet in Kenya. It would also help in designing appropriate policies related to cereal production and distribution.

The remainder of the report is structured as follows. Section 2 discusses the theoretical framework. Section 3 provides a description of data sources followed by results and discussion presented in section 4. Section 5 presents the conclusion, while providing some tentative leads for policy implications, as well as an agenda for future research.

2 Theoretical Framework

The analysis is based on the framework of modeling consumer choice under the imposition of constraints on demand parameters (Deaton and Muellbauer, 1980). Consider a consumer who derives utility from consumption of a vector of n commodities denoted by q . Assume that vector q includes broader categories of consumption goods, such as food and non-food. Let u denote the utility the consumer derives from consuming the goods. The household's utility function can be expressed as:

$$U(q;r) \tag{1}$$

where r stands for individual characteristics of the household e.g. age, preferences, members knowledge, habit and cultural norms, personal experience, among others.

The budget constraint can be written as:

$$p'q = I \tag{2}$$

where p' stand for prices; and I is the amount of income that can be spent on the different commodities. Important to note, that consumption decisions depends on total income but not on the composition or sources of income. The main objective of the household is to maximize utility by choosing q , subject to the budget constraint given in equation. Hence

by using Lagrangean multiplier the consumer's maximization problem can be rewritten as:

$$L = u(q, r) + \lambda (I - p'q) \quad (3)$$

where λ is a Lagrange multiplier. Solving we get a set of $i = 1, \dots, n$ observed demand equations:

$$q_i = q_i(p, I; r) \quad (4)$$

After differentiating with respect to income I , and prices p_j , we get n income and n^2 price slopes. Solving by multiplying the income slopes and price slopes by their respective income/quantity and price/quantity ratios, we get n and n^2 as income and price elasticities respectively.

$$\eta_i = \frac{\partial q_i}{\partial I} \frac{I}{q_i} \quad (5)$$

$$\delta_i = \frac{\partial q_i}{\partial p_j} \frac{p_j}{q_i}$$

In our analysis, the main goal is to determine how quantity demand responds to changes in the value of parameter or exogenous variables.

3 Data and Methodology

Data for this study is based on 2005/6 Kenya Integrated Household Budget Survey (KIHBS), conducted by Central Bureau of Statistics. Additional information was extracted from the production statistics at provincial report.

Data collection in the above survey was undertaken for a period of 12 months starting 16th May 2005. The Survey was conducted in 1,343 randomly selected clusters across all districts in Kenya and comprised 861 rural and 482 urban clusters. Following a listing exercise, 10 households were randomly selected with equal probability in each cluster resulting in a total sample size of 13,430 households (Table 1).

Table 1: Regional distribution of survey respondents

Province	Total	Rural	Urban
Kenya	13,430	8,610	4,820
Nairobi	700	-	700

Province	Total	Rural	Urban
Central	1,490	1,010	480
Coast	1,280	680	600
Eastern	2,410	1,840	580
North Eastern	510	310	200
Nyanza	2,140	1,440	700
Rift Valley	3,370	2,370	1,000
Western	1,520	960	560

The year-long survey was organized into 17 cycles of 21 days each, during which enumerators conducted household interviews in the clusters. Further, the districts were grouped into 22 zones that were logistically convenient for field teams to operate.

Seasonal variations were captured by randomizing the visits to selected clusters within each district throughout the year. The 10 households selected in each cluster were visited only once in the year, but the survey instruments tried to capture the total annual consumption, expenditures and incomes of each household by combining the factual observation of food consumption (and some other frequent expenses) with diaries during a week period and the purchases of other items by recall. The Survey instruments were organized in four questionnaires:

- (1) A 21 module household questionnaire;
- (2) 14-day household expenditure diaries to record consumption and purchases;
- (3) A market price questionnaire and,
- (4) A community questionnaire.

For logistical purposes, the 79 clusters were covered in each cycle by 44 field teams, each team headed by a Field Team Leader and supported by a data entry operator, an interviewer and a driver. Each team had all the necessary equipment and materials such as vehicle, laptop, GPS unit, anthropometrics instruments, questionnaires and other. Field Team Leader oversaw all the supervision and ensured collection of quality data in his/her team.

Two types of diaries were given to the households. One diary was used to keep a record of goods and services purchased by the household while the other was used to record goods and services consumed by the household. These diaries and accompanying verbal instructions were given to the household during the 2nd or 3rd day of the cycle to be completed daily over a two-week period. Because some households were illiterate or had other problems in completing the diaries, interviewers visited households at least once every two days to ensure diaries were being filled and to provide assistance if required.

A community questionnaire was administered in each cluster to a small group of minimum five knowledgeable community members who were selected with the assistance of local administration. Administration of the questionnaire was the responsibility of the field team leader. The community questionnaire was used to collect information about the community in which the sampled households reside. Such

information included basic physical infrastructure, access to and quality of public services, economic activities, agriculture, community welfare, security and safety.

To capture price variable a questionnaire was administered by the Field Team Leader at a market place where the sampled households reported making regular purchases. This data was collected for standardizing units and measures of commodities and purchases and also providing average valuation prices for consumption items. For more elaborated methodology see Kenya National Bureau of Statistics, 2007.

3.1 Analytical tools and techniques used in the present study

Descriptive analyses are used to analyze cereal consumption pattern and expenditure. To analyze the determinant of demand/ consumption for millet/ sorghum and maize, quantities consumed per adult equivalent are used as dependent variables. However, some of the households were observed to have not consumed either millet/ maize/ rice/ sorghum goods, at least during the period considered implying zero values for corresponding observations.

Zero expenditure or consumption can be due to a number of reasons: 1) corner solutions; 2) true non-consumption; 3) infrequency of purchase (non-consumers for the survey period). Corner solutions occur when a consumer cannot purchase the particular food item at the current prices and income. True or genuine non consumers' are those that will never consume the goods for some non-economic reason, including religious beliefs, health considerations, taste, and transaction costs. Non-consumers for the survey period i.e. no consumption because the frequency with which, they consume the good is such that the survey period is not long enough to capture it.

In modeling such zero observations a Tobit model is preferred as OLS regressions lead to biased results due to censored data. However, a general assumption of the Tobit model is that zero values are due to economic reasons (e.g. non-purchase of a product because the product is too expensive). However, other reasons might also lead to zero consumption. In addition, the Tobit model assumes that the household's decision to consume and on how much to consume are determined by the same mechanism, and this result to biased estimation.

The double hurdle model allows zero consumption due to either non-economic reasons or due to seasonality of consumption can be applied. Some empirical studies confirmed that double hurdle model is more appropriate to address the issue of zero observations in consumptions of certain food items e.g. Gao *et al.*, 1995; Yen and Jensen, 1996; Su and Yen, 1996; Yen and Huang, 1996; Yen and Jone, 1997; Angulo *et al.*, 2001. However, problem of non exposure bias arise in our situation because millet, maize, rice and sorghum might not be available for all households. Since the data does not provide enough detailed information we cannot control for this, as this is an unknown factor.

To account for the above biases Heckman's two-step estimation method is applied in this study. In the first stage, a Probit regression is computed in order to estimate the probability that a given household actually make demand. This regression is used to estimate the inverse Mills ratio for each household, which is used as an instrument in the second regression i.e. the first step models the decision to consume and the second step

models the levels of consumption. For the first step, binary/dummy variables were created for defining positive consumption of millet, maize, and rice. For the dependent variable in the second step, the log of quantities consumed on the i^{th} cereal category is computed.

Household demand for goods not only depends explicitly on prices and income but also on other socioeconomic, price of related goods, health concerns and demographic factors. We have included most of these variables as independent variables in the regression. A description of the variables included in the empirical modes is given in Table 12

3.1.1 Definitions

Total household income comes from four sources: net crop income, net livestock income and non-farm business income, and salary/remittances. Income from crop production was calculated as annual production value of farm products minus paid-out costs, which include costs on seeds, fertilizer, chemicals, hired labor and oxen rental including own oxen.

Households in the sample were ranked by income per adult equivalent and then stratified into three income terciles to assess potential differences in consumption patterns by income. The quantities consumed from own production, own stock and gifts were valued using inferred purchase prices.

A region was classified as millet production area if it totals production was over one ton.

To account for differences in the size of households, adult equivalents (AE) categorization as suggested by Anzagi and Bernard (1977) is used.

The poverty lines were calculated from the KIHBS data using the Cost-of-Basic Needs (CBN) method outlined in Ravallion (1994, 1998¹).

All variables were cross-checked for the problem of multicollinearity, through the simple correlation matrix and variance inflation factor (VIF). In addition, to check the robustness of all the models other 'restricted' models were estimated in which, subsequently insignificant variables were dropped. The statistical quality of the models, and the direction of the signs did not change, and the coefficients deviated only marginally.

4 Results and discussion

4.1 Cereal consumption patterns

The results show that nationally there are more households that consume millet and rice in the urban areas compared to rural areas, whereas the opposite hold in case of maize (Table 2). Very few households consume sorghum in both urban and rural areas. In general consumption of millet is lowest in areas near it production as compared to areas far from production areas. Additionally, consumption of millet is highest in the Central, whilst maize is consumed more in the Western region.

¹ The CBN method stipulates a consumption bundle deemed to be adequate for 'basic consumption needs', and then estimates what this bundle costs in reference prices.

The greatest consumption of sorghum is in Nyanza. Strikingly, no household was found consuming sorghum in Nairobi and Coast provinces. Due to low number of consumers of sorghum observed our presentation from this point forward will focus on millet, maize and rice only.

Table 2: Distribution of maize, millet, rice and sorghum consumers (%) n=13,212

		Full sample	Rural	Urban	Rural with millet production	Rural without millet production	Urban close to millet production	Urban far millet production
Millet	National	54	49	65***	45	51***	49	69***
	Nairobi	73		76	-	-	-	75
	Central	79	77	85***	-	77	-	85
	Coast	68	57	81***	-	57	-	81
	Eastern	57	50	77***	-	50	-	77
	North	59	47	77***	-	47	-	76
	Eastern Nyanza	55	55	56	50	59***	58	53
	Rift Valley	41	38	50***	42	31***	49	53
	Western	37	32	45***	58	29***	47	45
Maize	National	81	90	65***	93	89	85	60
	Nairobi	43		44***	-	-	-	43
	Central	68	78	47***	-	78	-	47
	Coast	56	70	40***	-	70	-	39
	Eastern	87	95	65***	-	94	-	65
	North	68	79	52***	-	79	-	52
	Eastern Nyanza	90	93	86***	89	95***	87	85
	Rift Valley	90	94	80***	95	92***	83	72***
	Western	94	95	92***	86	96***	92	92
Rice	National	58	49	75***	40	51	70	76***
	Nairobi	81	-	81	-	-	-	81
	Central	78	76	81***	-	76	-	81
	Coast	63	50	79***	-	50	-	79
	Eastern	57	49	82***	-	49	-	82
	North	75	65	91***	-	65	-	91
	Eastern Nyanza	53	45	71***	37	51***	68	72
	Rift Valley	52	43	73***	43	42	74	71
	Western	40	32	55***	22	33***	46	56*
Sorghum	National	5	6	2**	4	7	3	2
	Nairobi	0	-	0	-	-	-	0
	Central	1	1	0	-	1	-	0
	Coast	0	0	0	-	-	-	0
	Eastern	6	7	2**	-	7	-	2
	North	1	1	1	-	1	-	1
	Eastern Nyanza	13	16	8***	7	23***	6	9
	Rift Valley	2	3	1***	2	5***	1	1

	Full sample	Rural	Urban	Rural with millet production	Rural without millet production	Urban close to millet production	Urban far millet production
Western	8	10	4***	21	9***	10	3***

Table 3 presents the main sources of cereals consumed by the households. The most common forms of access for millet, maize and rice were purchase. Other forms of access such as use of old stocks, receiving food as a gift etc were also relied on but are minimal. As expected consumption from own production are more prominent in the rural areas as compared to the urban areas for all the cereal. On average no household was found consuming own produced rice.

Table 3: Sources of the cereals consumed (%)

crop	Region	Full sample				Rural				Urban			
		Purcha ses	Own production	Own stock	Gif ts	Purc hases	Own production	Own stock	Gifts	Purcha ses	Own production	Own stock	Gifts
Millet n=7,239	Kenya	66	5	23	19	59	8	20	26	76	1	28	10
	Nairobi	57	1	59	4	-	-	-	-	57	1	59	4
	Central	83	0	23	5	82	0	21	8	84	0	26	1
	Coast	84	2	16	4	87	0	9	6	82	1	21	2
	Eastern	73	6	17	21	67	3	14	26	84	0	22	10
	North Eastern	94	0	2	5	91	9	1	7	97	0	3	3
	Nyanza	40	5	21	52	26	1	21	61	68	1	21	32
	Rift Valley	57	11	30	10	47	7	32	12	75	1	27	7
Western	58	8	16	41	45	17	15	52	76	1	16	28	
Maize n=10,697	Kenya	52	19	26	40	43	24	28	44	72	7	22	30
	Nairobi	78	4	21	10	-	-	-	-	78	5	21	10
	Central	45	32	19	22	20	44	21	24	76	8	12	14
	Coast	39	19	28	34	48		33	46	77	11	18	10
	Eastern	53	18	22	48	53	24	23	54	75	8	16	23
	North Eastern	64	1	3	40	43	2	3	49	87	0	2	19
	Nyanza	51	17	26	65	44	27	25	67	69	10	28	60
	Rift Valley	52	20	35	18	48	29	37	20	73	11	28	11
Western	54	18	21	62	36	31	22	66	66	19	19	56	
Rice n=7,657	Kenya	84	0	14	4	87	0	8	6	81	0	20	3
	Nairobi	57	0	49	2	-	-	-	-	57	0	49	2
	Central	88	1	12	3	90	0	9	4	84	1	18	1
	Coast	81	1	15	7	83	1	10	10	80	1	19	5
	Eastern	90	0	10	5	91	0	8	5	88	1	16	3
	North Eastern	86	0	1	14	77	0	0	25	97	0	2	1
	Nyanza	74	0	10	5	72	1	6	5	78	0	15	4
	Rift Valley	90	0	13	2	92	0	10	2	86	0	17	1
Western	88	0	6	5	88	0	4	7	88	0	9	4	

In Figure 1 and Figure 2, two distinct features of consumption patterns between rural and urban areas are worth noting. While maize take a sizeable share of rural cereal consumption, urban consumption is dominated by other cereals with relatively high consumption of millet. It is believed that this is due to a combination of factors including the availability of a wider variety of food in urban market. Highest consumption of maize is noted in western region and lowest in Nairobi. On the other hand highest consumption share for millet is observed in Coast.

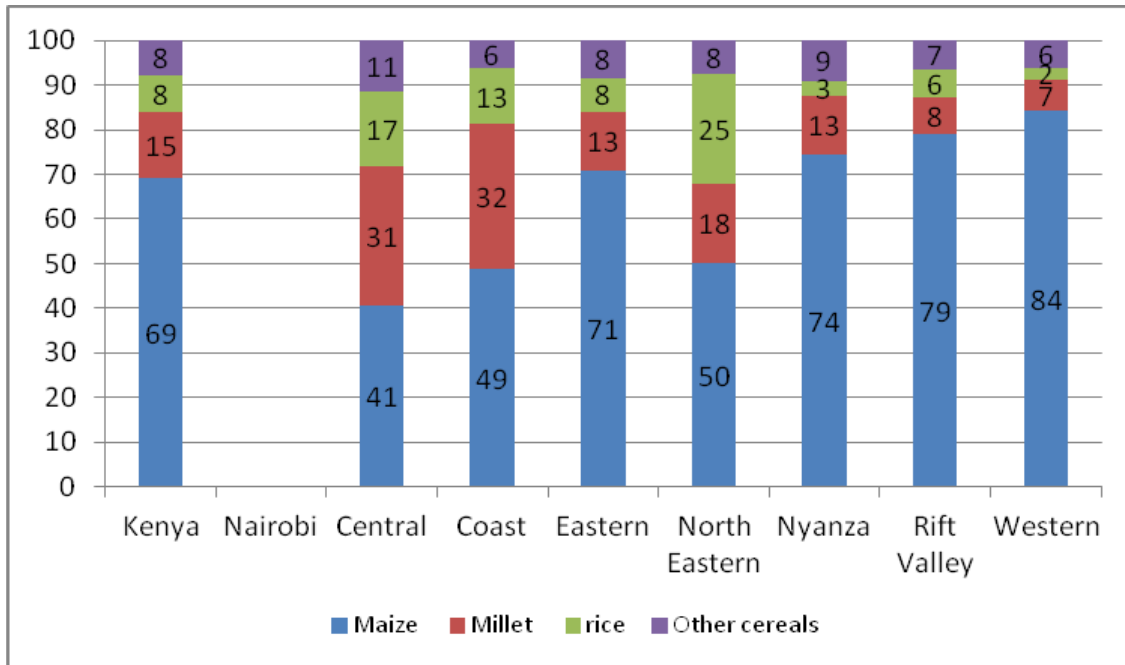


Figure 1: Percentage share of major cereals in rural Kenya (kg/AE/year)

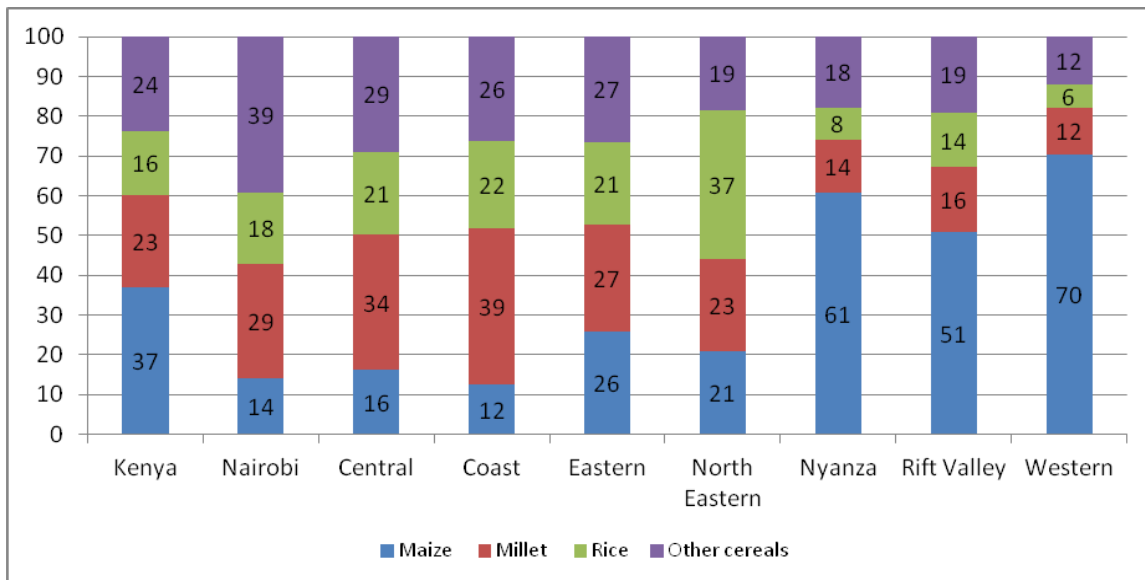


Figure 2: Percentage share of major cereals in urban Kenya (kg/AE/year)

Table 4 and Table 5 conceal considerable heterogeneity across consumption levels in both rural and urban areas for millet, maize and rice. Higher amount of millet and rice are largely consumed in urban area, whereas lower amount are consumed in rural areas. As expected, more maize is consumed in the rural areas as compared to the urban areas.

Households in rural without millet production and urban areas far from millet production areas seem to consume much more of the millet and less of maize than their counterparts. However, when running a bivariate correlation between the amount of millet produced and sold at household level, Pearson's r was positive and highly significant ($r=0.54$, 0.000 level of significance), suggesting that surplus production is generally sold out and consumed elsewhere. Again the correlation between the amount produced and consumed at household level is striking ($r=0.94$, significant at the 0.01 level). This suggests that consumption of millet is partly dependent on production particularly in the rural areas. As expected, provinces with a higher mean consumption of millet and maize also have higher value of consumption (see appendix 3), but the trend in intake and the value are not consistent, reflecting differences in prices as observed in Table 6.

Table 4: Consumption patterns for millet, maize and rice (kg/ adult equivalent/ year) n=13212

Crop	Region	Full sample	Rural	Urban
Millet	National	32.8	29.4	39.0***
	Nairobi	43.9	-	43.9
	Central	48.2	47.4	49.8
	Coast	57.0	54.2	60.3
	Eastern	33.6	28.2	50.5***
	North Eastern	18.4	17.1	20.5
	Nyanza	36.2	38.3	31.9*
	Rift Valley	20.2	17.2	27.2***
	Western	18.9	15.0	25.5
Maize	National	136.6	163.9	87.5***
	Nairobi	23.5	-	23.5
	Central	60.6	75.6	28.7***
	Coast	58.2	87.8	23.3***
	Eastern	125.0	146.8	56.2***
	North Eastern	35.6	46.1	19.5***
	Nyanza	215.1	237.8	168.6***
	Rift Valley	156.5	176.2	110.0***
	Western	226.5	242.4	198.9***
Rice	National	17.0	13.0	24.1***
	Nairobi	24.7	-	24.7
	Central	26.8	25.8	29.1*
	Coast	22.3	16.6	29.0***
	Eastern	18.1	13.0	34.4***
	North Eastern	27.2	22.7	34.1***
	Nyanza	10.9	8.4	16.1***
	Rift Valley	14.7	11.3	22.7***
	Western	7.8	5.2	12.4***

Table 5: Consumption patterns for millet, maize and rice in different consumer clusters (kg/ adult equivalent/year)

Crop	Region	Rural with millet production	Rural without millet production	Urban close to millet production	Urban far millet production
Millet	National	22.0	31.9***	28.6	41.9***
	Nairobi	-	-	-	43.9
	Central	-	47.4	-	49.8
	Coast	-	54.2	-	60.3
	Eastern	-	28.2	-	50.5
	North Eastern	-	17.1	-	20.5
	Nyanza	32.6	42.5***	38.7	27.4**
	Rift Valley	17.2	17.2	25.1	32.0**
	Western	26.9	13.8***	23.8	25.8
Maize	National	187.6	156.0***	130.2	75.4***
	Nairobi	-	-	-	23.5
	Central	-	75.6	-	28.7
	Coast	-	87.8	-	23.3
	Eastern	-	146.8	-	56.2
	North Eastern	-	46.1	-	19.5
	Nyanza	218.7	252.0***	171.3	166.7
	Rift Valley	179.0	171.5	105.7	120.2
	Western	115.6	255.6***	199.8	198.7
Rice	National	10.1	14.0***	18.1	25.8***
	Nairobi	-	-	-	24.7
	Central	-	25.8	-	29.1
	Coast	-	16.6	-	29.0
	Eastern	-	13.0	-	34.4
	North Eastern	-	22.7	-	34.1
	Nyanza	7.4	9.1*	15.2	16.7
	Rift Valley	11.7	10.5	20.4	28.1***
	Western	2.5	5.4**	8.7	13.0*

* - significant at the 0.1 level; ** - significant at the 0.05 level; *** - significant at the 0.01 level

As indicated in Table 6 the average prices differ by type of the cereal and the magnitude of processing. Millet and maize flour are sold at relatively high prices than the grains, while rice grade 1 has the highest prices as compared to grade 2.

Generally, there is minimal variation of price for rice and loose maize flour in Nairobi, Central and Coast.

Table 6: Prices of sorghum, millet and maize by location (Ksh/ kg)

	Millet		Maize			Rice		
	Grain	Flour	Grain	Green	Loose flour	Sifted flour	Grade2	Grade 1
National	33.6	40.8	18.2	25.8	22.3	29.3	41.5	62.3
Nairobi	-	50.0	30.0	30.0	24.0	27.0	36.1	69
Central	-	42.5	19.6	18.5	24.6	25.5	40.0	62.5
Coast	-	48.8	16.0	40.0	24.5	27.4	43.2	69.0
Eastern	28.3	34.1	17.7	40.3	23.2	31.0	43.3	62.2
North Eastern	-	35.0	29.7	18.7	34.0	39.5	44.0	-
Nyanza	-	45.0	15.5	17.2	18.4	30.0	36.7	-

	Millet		Maize			Rice		
	Grain	Flour	Grain	Green	Loose flour	Sifted flour	Grade2	Grade 1
Rift Valley	42.0	39.1	18.2	16.4	20.8	29.8	42.5	48.8
Western	23.8	50.0	16.0	20.0	20.0	28.0	45.0	-

*

4.2 Consumption by income and poverty

The income group wise consumers and level of consumption of the three major cereals are reported in Table 7 and Table 8. Table 7 shows that there are more consumers of the millet and rice in the upper income stratum as compared to the low income group in both rural and urban localities. The same hold true for the physical quantities consumed with low consumption trend observed with low income group and highest with upper income group (Table 8). However, mixed information is found in the urban areas where no statistical difference is found in the consumption of millet, while middle income household consume more of the maize.

Table 7: Households consuming millet, maize, and rice consumers by income grouping (%)

Crop	Region	Full sample			Rural			Urban		
		Low	Middle	Upper	Low	Middle	Upper	Low	Middle	Upper
Millet	National	55	49	59	48	46	54	65	61	67
	Nairobi	71	75	77	-	-	-	71	75	77
	Central	80	79	79	78	76	76	83	88	86
	Coast	66	68	70	52	63	58	79	80	81
	Eastern	54	49	65	45	46	60	78	66	80
	North	59	51	69	49	42	45	72	75	94
	Eastern									
	Nyanza	56	54	55	57	53	55	55	55	54
	Rift Valley	41	33	47	38	28	44	48	48	55
	Western	39	32	38	35	30	30	45	40	48
Maize	National	79	86	80	89	90	90	63	73	65
	Nairobi	43	68	35	-	-	-	57	32	65
	Central	63	75	71	76	81	79	57	44	50
	Coast	57	58	52	73	68	68	59	64	61
	Eastern	86	92	85	95	94	94	36	22	39
	North	68	76	58	78	79	81	48	33	65
	Eastern									
	Nyanza	91	91	89	93	93	92	13	15	15
	Rift Valley	88	93	90	93	96	94	22	20	19
	Western	92	94	96	94	95	97	10	9	5
Rice	National	58	49	65	47	42	56	73	72	79
	Nairobi	76	81	89	-	-	-	76	81	89
	Central	75	76	81	74	74	79	78	83	86
	Coast	63	62	66	53	53	44	72	84	85
	Eastern	57	46	66	49	40	58	80	83	84
	North	76	75	74	65	70	52	90	88	97
	Eastern									
	Nyanza	54	45	59	43	40	51	71	65	73
	Rift Valley	49	41	62	40	33	53	68	70	82
	Western	40	33	47	29	28	40	58	46	57

Table 8: Consumption for sorghum and finger millet by income groups (kg/ adult equivalent/year)

Crop	Region	Full sample			Rural			Urban		
		Low	Middle	Upper	Low	Middle	Upper	Low	Middle	Upper
Millet	National	32.7	29.5	35.4***	27.7	27.6	33.1***	40.2	35.5	39.0
	Nairobi	44.1	49.8	42.2	-	-	-	44.1	49.8	42.2
	Central	48.9	46.5	48.3	47.4	45.7	48.4	51.2	49.0	48.1
	Coast	58.6	56.6	55.7	49.8	57.5	56.7	67.4	54.8	54.7
	Eastern	32.0	25.8	42.0***	24.7	24.2	36.5***	51.9	35.1	55.8**
	North	18.6	15.2	22.7	17.3	15.3	19.9	20.4	14.6	25.4
	Eastern Nyanza	37.1	38.1	34.0	39.1	39.4	36.6	34.3	33.3	29.3
	Rift Valley	21.6	13.0	23.0***	18.6	9.7	21.0***	27.9	25.0	27.1
	Western	19.9	16.5	19.8	17.7	13.9	12.7	23.7	23.3	28.8
Maize	National	124.2	155.2	138.7***	156.3	168.6	169.1**	76.9	112.2	90.3***
	Nairobi	25.9	53.3	11.5***	-	-	-	25.9	53.3	11.5
	Central	53.8	69.1	63.6**	72.2	80.4	76.1	25.6	35.0	30.6
	Coast	58.5	68.3	49.6**	91.0	87.6	83.9	25.7	24.6	20.0
	Eastern	118.2	130.3	128.8*	139.4	141.4	161.1**	60.8	66.5	46.5
	North	34.1	44.8	30.2*	43.8	50.3	51.4	20.2	28.6	9.1*
	Eastern Nyanza	209.1	225.6	211.0	236.4	241.6	234.9	169.3	165.1	169.5
	Rift Valley	153.7	159.7	158.5	177.2	165.4	183.1	104.5	138.7	105.5
	Western	214.4	239.8	229.4	243.5	245.1	237.8	165.9	225.6	218.6***
Rice	National	17.4	13.4	19.1***	13.0	11.1	14.9***	24.0	20.8	25.8***
	Nairobi	22.9	25.5	27.4*	-	-	-	22.9	25.5	27.4*
	Central	25.0	25.5	29.5**	23.3	25.5	28.2*	27.7	25.3	33.1*
	Coast	22.9	20.8	22.9	19.0	17.5	12.1**	26.8	28.3	32.2
	Eastern	19.1	13.2	21.1***	13.1	10.4	15.4***	35.4	29.0	35.7
	North	27.2	27.3	27.0	21.4	27.2	21.3	35.4	27.8	32.8
	Eastern Nyanza	11.5	9.0	11.9**	8.3	7.8	8.9	16.1	13.6	17.2
	Rift Valley	14.2	10.4	18.1***	10.6	7.8	14.9**	21.8	20.2	25.1
	Western	7.4	6.4	9.6***	4.4	5.1	6.3	12.4	9.9	13.8

* - significant at the 0.1 level; ** - significant at the 0.05 level; *** - significant at the 0.01 level

Table 9 presents the distribution of consumer per poverty grouping. In general a big proportion of millet and rice consumers are found in the non- poor group, while the opposite hold true for maize consumption where significantly more consumer of maize are found in the poor group particularly in the urban area. However, no statically difference was found between the poor and non- poor in the rural areas.

Similarly in Table 10 it is observed that the non-poor households also consume significantly more millet, maize and rice than their counterpart. Less maize consumption by the non-poor is observed in Nairobi while highest is witnessed in Nyanza.

Table 9: Poor and non-poor cereal consumption (%) (n=13,212)

	Region	Full sample		Rural		Urban	
		Non-poor	Poor	Non-poor	Poor	Non-poor	Poor
Millet	National	63	42***	58	38***	71	54***

	Region	Full sample		Rural		Urban	
		Non-poor	Poor	Non-poor	Poor	Non-poor	Poor
	Nairobi	77	72	-	-	77	72
	Central	83	68***	81	65***	89	73***
	Coast	70	65**	60	54	80	82
	Eastern	69	40***	63	35***	83	64***
	North Eastern	69	52***	61	39***	81	73
	Nyanza	60	46***	61	46***	58	48**
	Rift Valley	51	28***	47	26***	59	34***
	Western	42	31***	32	31	59	30***
Maize	National	79	84***	90	90	63	72***
	Nairobi	43	50	-	-	43	50
	Central	70	63**	79	75	49	41
	Coast	55	57	72	68	40	38
	Eastern	85	91***	95	94	63	72**
	North Eastern	58	74***	69	85***	43	57*
	Nyanza	91	90	94	90***	84	90**
	Rift Valley	87	94***	93	96***	76	87***
	Western	95	94	97	94***	90	94**
Rice	National	69	43***	60	33***	80	66***
	Nairobi	86	72***	-	-	86	72
	Central	82	66***	81	62***	85	73***
	Coast	70	55***	56	44***	82	76***
	Eastern	68	42***	62	34***	83	79
	North Eastern	88	67***	83	54***	96	88*
	Nyanza	63	36***	57	26***	75	62***
	Rift Valley	63	36***	55	26***	77	65***
	Western	50	29***	40	21***	67	41***

* - significant at the 0.1 level; ** - significant at the 0.05 level; *** - significant at the 0.01 level

Table 10: Consumption patterns for millet, maize and rice by rural urban (kg/ adult equivalent/year)

	Region	Full sample		Rural		Urban	
		Non-poor	Poor	Non-poor	Poor	Non-poor	Poor
Millet	National	42.4	18.1***	38.9	16.5***	47.9	21.9***
	Nairobi	47.8	35.2**	-	-	47.8	35.2***
	Central	55.5	27.3***	54.5	26.3***	57.6	29.4***
	Coast	66.2	44.6***	66.8	40.6***	65.7	51.4*
	Eastern	47.3	14.4***	41.0	12.9***	62.7	22.0***
	North Eastern	27.9	12.8***	27.4	11.0***	28.6	15.7***
	Nyanza	43.6	23.7***	46.0	26.3***	39.0	17.2***
	Rift Valley	29.0	7.8***	25.5	6.7***	36.0	11.1***

	Region	Full sample		Rural		Urban	
		Non-poor	Poor	Non-poor	Poor	Non-poor	Poor
	Western	24.9	11.8***	17.6	12.0**	37.9	11.4***
Maize	National	156.5	107.1***	197.4	119.0***	92.3	79.7***
	Nairobi	22.8	30.7*	-	-	22.8	30.7
	Central	66.6	43.6***	83.2	52.8***	29.9	25.7
	Coast	63.9	50.6**	104.7	69.4***	26.1	18.4
	Eastern	140.7	103.7***	173.8	114.9***	58.9	49.9
	North Eastern	40.8	32.5**	55.5	40.5**	18.5	20.1
	Nyanza	249.5	156.6***	286.4	162.6***	181.5	141.6***
	Rift Valley	186.9	114.2***	216.6	125.8***	126.2	80.6***
	Western	278.3	166.7***	308.2	164.8***	225.2	170.0***
Rice	National	22.9	7.9***	18.6	5.4***	29.6	13.8***
	Nairobi	27.8	16.0***	-	-	27.8	16.0***
	Central	31.4	13.6***	30.6	11.2***	33.2	18.3***
	Coast	29.2	12.6***	22.6	10.0***	35.4	17.1***
	Eastern	25.5	7.7***	19.5	5.1***	40.5	20.2***
	North Eastern	44.6	16.8***	39.8	12.6***	51.9	23.4***
	Nyanza	14.6	4.5***	11.9	2.8***	19.6	8.8***
	Rift Valley	20.8	6.0***	17.0	4.0***	28.6	11.9***
	Western	11.3	3.6***	7.5	2.3***	18.1	5.8***

4.3 Total amount consumed

Total amount consumed² for the three cereals were estimated at 694, 4273 and 380 million kg for millet, maize and rice respectively (Table 11). About 43% of millet is consumed in the urban areas, with high proportion (70%) consumed by the non-poor. Over 71% of maize and about 53% of the total rice are consumed in the rural areas.

Table 11: Total production (million kg/ year)

Crop	Region	Total	Rural	Urban	Non-poor	Poor
Millet	National	694.0	399.7	294.3	485.1	208.9
	Nairobi	101.0	-	101.0	82.6	18.4
	Central	167.5	110.4	57.1	131.3	36.2
	Coast	128.2	58.5	69.7	78.4	49.7
	Eastern	107.8	72.6	35.2	76.6	31.1
	North Eastern	25.0	12.2	12.7	11.0	14.0
	Nyanza	108.2	72.8	35.4	74.3	33.9
	Rift Valley	83.6	53.4	30.3	60.6	23.1
	Western	30.0	16.5	13.5	18.5	11.5

² The proportion of sample that consumed the specified cereals was multiplied with the total population to arrive at the total estimated number of consumers per province. The number was then multiplied with the average amount consumed per adult equivalent to arrive at the approximate amount consumed.

Crop	Region	Total	Rural	Urban	Non-poor	Poor
Maize	National	4,273.3	3,038.3	1,235.0	2,542.6	1,730.7
	Nairobi	31.5	-	31.5	26.1	5.5
	Central	181.0	141.1	39.8	127.7	53.2
	Coast	107.9	73.0	34.8	64.8	43.1
	Eastern	618.5	507.7	110.8	424.8	193.7
	North Eastern	56.0	39.3	16.7	27.1	28.8
	Nyanza	1,058.1	728.7	329.4	656.8	401.4
	Rift Valley	1,403.0	1,032.6	370.4	1,043.8	359.2
Rice	National	380.2	204.6	175.7	270.4	109.9
	Nairobi	62.6	-	62.6	42.1	20.5
	Central	91.4	67.1	24.4	55.4	36.1
	Coast	47.1	34.5	12.5	23.4	23.6
	Eastern	58.6	52.6	6.0	25.6	33.0
	North Eastern	47.3	40.5	6.8	8.3	39.0
	Nyanza	31.5	25.0	6.5	15.6	16.0
	Rift Valley	75.7	63.0	12.7	34.5	41.2
Western	13.5	9.8	3.7	6.1	7.4	

4.4 Demand for millets

Table 12 gives the variable definition while Table 13 presents descriptive statistics for all the covariates used in the subsequent model analysis.

Millet consumers on average are younger, more educated particularly at secondary school level, have small family size and harvest more millet. Similarly, they have the highest formal schooling completed by their spouse. Additionally, they are less poor.

Surprisingly, millet consumers have less number of children as compared to non consumer. No statistical difference was found between the consumer and non-consumer on gender, level of income, number of breastfeeding children in the household and presence of a member with health problems. This may suggests that these variables might be uncorrelated with decision to consume.

Table 12: Definition of variables used in empirical estimations

Variable	Definition
<i>Dependent variable</i>	
CMILLET	Millet amount consumed (kg/AE/year)
CMAIZE	Maize amount consumed (kg/AE/year)
CRICE	Rice amount consumed (kg/AE/year)
<i>Independent variables</i>	
AGE	Age of household head (years)
AGESQ	Age of household head squared (years)
GENDER	1, if the household head is male; 0, otherwise
EDUCATION0	1, if the household head have no formal education; 0, otherwise (omitted category)
EDUCATION1	1, if the household head have attained primary education; 0, otherwise

Variable	Definition
EDUCTION2	1, if the household head have attained secondary education; 0, otherwise
EDUCTION3	1, if the household head have attained college education; 0, otherwise
SEDUCTION0	1, if the spouse have no formal education; 0, otherwise (omitted category)
SEDUCTION1	1, if the spouse have attained primary education; 0, otherwise
SEDUCTION2	1, if the spouse have attained secondary education; 0, otherwise
SEDUCTION3	1, if the spouse have attained college education; 0, otherwise
DIVORCED	1, if the household head is divorced or separated; 0, otherwise (omitted category)
NMARRIED	1, if the household head have never been married; 0, otherwise
MARRIED	1, if the household head is currently married; 0, otherwise
FAMLYSIZE	Number of family members in adult equivalent living in the household (count)
DRATIO	Dependency ratio (proportion over 64 and under 15years of age
CHILDREN	Number of children in the Household (count)
BCHILDREN	Number of children that are breastfed (count)
OLD	Number of elderly people- over 64 year (count)
OWN	1, if the household head main employment is own/private; 0, otherwise
GOVT	1, if the household head main employment is government; 0, otherwise
TSC	1, if the household head main employment is TSC ; 0, otherwise
NGO	1, if the household head main employment is NGOs ; 0, otherwise
INCOME	Household income (Ksh/AE/year)
PRICEMIL	Price of millet (Ksh/kg)
PRICEMAI	Price of maize (Ksh/kg)
PRICERICE	Price of rice (Ksh/kg)
POVERTY	1, if the household is non-poor; 0, otherwise
FEXPENDITURE	Food total expenditure (Ksh/AE/year)
HARVESTMIL	Millet own production (kg/AE/year)
HARVESTMAI	Maize own production (kg/AE/year)
HARVESTRICE	Rice own production (kg/AE/year)
HEALTH	Proportion of family members with health problems treated in hospital treated health problems in the last 12 month per household
NORELIGION	1, if no religion; 0, otherwise
CHRISTIAN	1, if the household head is a Christian; 0, otherwise
MUSLIM	1, if the household head is a Muslim; 0, otherwise
URBAN	1, if the household is located in the urban area; 0, otherwise
WOMEN	Number of female in the household.
PARTICIPATION	1, if participated in nutritious programs of children below 60 month; 0, otherwise
LMILLET	1, if the household is located in millet growing area; 0, otherwise
Nairobi	1, if located in Nairobi province; 0, otherwise
Central	1, if located in Central province; 0, otherwise
Coast	1, if located in Coast province; 0, otherwise
Eastern	1, if located in Eastern province; 0, otherwise
Northeastern	1, if located in North Eastern province; 0, otherwise
Nyanza	1, if located in Nyanza province; 0, otherwise

Variable	Definition
Rift valley	1, if located in Rift valley province; 0, otherwise
Western	1, if located in Western province; 0, otherwise

Table 13: Descriptive statistic of variable used in the econometric

Variable	Full sample	Non-consumer	Millet consumers
CMILLET	32.8 (0.5)	-	59.9
CMAIZE	136.6 (1.5)	171.5	107.9***
CRICE	17.0 (0.2)	10.9	22.0***
AGE	44.5 (0.1)	45.5	43.7***
AGESQ	2.2 (0.1)	2,334.7	2,135.4***
GENDER	70	45	55
EDUCTION1	42	46	54*
EDUCTION2	29	35	65***
EDUCTION3	3	30	70***
SEDUCTION1	45	46	54**
SEDUCTION2	20	44	67***
SEDUCTION3	2	38	62*
FAMLYSIZE	5.1 (0.0)	5.2	4.9***
DRATIO	0.9 (0.0)	1.0	0.9***
CHILDREN	2.1 (0.0)	2.2	2.0***
BCHILDREN	0.3(0.0)	0.3	0.3
OLD	0.2 (0.0)	0.2	0.2***
INCOME	31.7 (7.0)	36,876.3	27,416.3
PRICEMIL	57.0 (1.3)	62.8	52.3***
PRICEMAI	19.7 (0.0)	18.9	20.3***
PRICERICE	60.2 (0.9)	62.4	58.5**
HARVESTMIL	8.6 (0.8)	6.6	10.2**
HARVESTMAI	395.5 (63.4)	534.6	280.6**
HARVESTRICE	4.8 (1.6)	3.0	6.2
HEALTH	50	45	55
CHRISTIAN	83	45	55**
NORELIGION	5	58	42***
MUSLIM	12	43	57**
URBAN	36	35	65***
POVERTY	61	37	63***
WOMEN	2.8 (0.0)	2.6	2.5**
DIVORCED	19	48	52***
NMARRIED	7	42	58**
MARRIED	74	55	45
EMPLOYOWN	26	41	59***
EMPLOYGOVT	6	36	64***
EMPLOYTSC	3	34	66***
EMPLOYNGO	1	39	61
EMPLOYOTHER	49	47	53***
PARTICIPATION	7	45	55
LMILLET	24	53	47***
Nairobi	6	27	73***
Central	11	21	79***

Variable	Full sample	Non-consumer	Millet consumers
Coast	10	32	68***
Eastern	18	43	57**
Northeastern	4	41	59*
Nyanza	16	45	55
Rift valley	25	59	41***
Western	12	63	37***

4.5 Econometric results

4.5.1 Determinants of cereal consumption

As presented in Table 14 it is clear that some variables affect consumption decision but do not affect the level of consumption. For instance, gender of the households head and family size negatively affect decision on whether to consume the three cereals but positively affect the level of amount consumed.

The household decision to either consume millet, maize or rice is also positively and strongly related to the education level of household head, spouse education level, health status, number of breastfeeding children and number of women in the household. Household with formal education are more likely to consume millet and rice as compared to those with no formal education. This is consistent with the conviction that higher educated people may be better informed about healthy diets.

The quantity of the harvested millet and rice positively affect the decision to consume but have no statistical significant to the level of consumption apart from millet. Non- poor households are also more likely to decide to consume the three cereals.

The positive association between the income and rice indicate that rice consumption increases with high income. However, though a positive sign exist for millet and maize no statistically significant relationship was established. Consistent to expectation prices negatively affect the decision to consume millet and maize. However, a positive relationship is observed in the case of rice. As the modeling was done using a log-linear specification these coefficients can be interpreted as elasticities. However, given the low levels of significance in the income variable, it is difficult to make inferences about the consumption elasticities.

Households with higher dependency ratio have a lower probability to consume millet and higher probability to consumer maize and rice. This might be a reflection of the fact that maize is a cheaper source of energy and due to poverty levels many household may opt to consume it.

It was also found that households with unmarried head were less likely to consume millet than households' head that were married, divorced or separated.

The results also show that the presence of breast feeding children, being located in millet production areas and the presence sick members of the family increases the probability of consuming millet,

Households located in the urban areas have a higher probability of consuming millet and rice and lower probability to consume maize, meaning that producers of millet could target urban consumers to extract more sales. Two decades ago, households' preference for cereals differed sharply between income groups in Nairobi with poor households allocating an overwhelming

proportion of their cereal budget to maize and much less to wheat and rice (Muyanga *et.al.*, 1995).

Location controls reveal that households living in the central are more likely to consume millet while those living in the Eastern, Nyanza, Rift Valley and Western are more likely to consume Maize.

In summary, the estimated results indicated that socio-demographic characteristics such as household sizes, level of education, own production were significant in explaining both the decision to consume and the level of millet consumption. Thus, targeted strategies on these variables can be effective both in attracting new consumers of millet and in increasing the level of consumption.

Table 14: Factors influencing millet, maize and rice consumption

Variable	Decision to consume model			Level of consumption model		
	Millet	Maize	Rice	Millet	Maize	Rice
AGE	0.00 (0.00)	0.01* (0.01)	-0.02*** (0.00)	0.01 (0.00)	0.01** (0.00)	0.01* (0.00)
AGESQ	0.00 (0.00)	0.00 (0.00)	0.00*** (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
GENDER	-0.08** (0.03)	-0.10** (0.04)	-0.14*** (0.04)	0.08** (0.04)	0.05** (0.03)	0.04 (0.03)
EDUCATION1	0.18*** (0.03)	-0.09** (0.05)	0.18*** (0.04)	-0.13*** (0.04)	0.11*** (0.03)	-0.10*** (0.04)
EDUCATION2	0.28*** (0.04)	-0.24*** (0.05)	0.30*** (0.04)	-0.27*** (0.05)	0.01 (0.04)	-0.14*** (0.04)
EDUCATION3	0.32*** (0.09)	-0.27** (0.10)	0.35*** (0.10)	-0.52*** (0.09)	-0.27** (0.09)	-0.10 (0.08)
SEDUCATION1	0.09*** (0.03)	0.17*** (0.04)	0.25*** (0.03)	-0.24*** (0.03)	-0.04** (0.02)	-0.30*** (0.03)
SEDUCATION2	0.19*** (0.04)	0.17*** (0.05)	0.45*** (0.04)	-0.38*** (0.04)	-0.20*** (0.03)	-0.37*** (0.04)
SEDUCATION3	-0.14 (0.12)	-0.21* (0.12)	0.63*** (0.15)	-0.16 (0.12)	-0.18** (0.10)	-0.48*** (0.10)
FAMLYSZE	0.03*** (0.01)	0.08*** (0.01)	0.06*** (0.01)	-0.15*** (0.01)	-0.11*** (0.01)	-0.13*** (0.01)
OLD	0.02 (0.04)	-0.16*** (0.05)	-0.05 (0.04)	-	-	-
DRATIO	-0.04** (0.02)	0.19*** (0.03)	0.07*** (0.02)	-0.06** (0.02)	-0.04** (0.02)	-0.08*** (0.02)
CHILDREN	-0.02 (0.02)	-0.10*** (0.02)	-0.11*** (0.02)	0.14*** (0.02)	0.10*** (0.01)	0.13*** (0.02)
BCHILDREN	0.07** (0.03)	0.07** (0.04)	-0.04 (0.03)	-0.05 (0.03)	0.01 (0.02)	0.04 (0.03)
INCOME	0.00 (0.00)	0.00 (0.00)	0.00* (0.00)	0.00 (0.00)	0.00 (0.00)	0.00* (0.00)
PRICE ^a	-0.00*** (0.00)	-0.02*** (0.00)	0.00** (0.00)	0.00*** (0.00)	-0.05*** (0.00)	0.00*** (0.00)
POVERTY	0.51***	0.13***	0.70***	-	-	-

Variable	Decision to consume model			Level of consumption model		
	Millet	Maize	Rice	Millet	Maize	Rice
	(0.03)	(0.03)	(0.03)			
HARVEST ^a	0.00*** (0.01)	0.00 (0.00)	0.00** (0.00)	0.00** (0.00)	0.00* (0.00)	0.00** (0.00)
HEALTH	0.07** (0.02)	0.17*** (0.03)	0.08*** (0.03)	-0.03 (0.03)	-0.01 (0.02)	-0.08*** (0.02)
CHRISTIAN	0.07 (0.05)	0.30*** (0.05)	-0.31*** (0.05)	0.14** (0.05)	0.22*** (0.04)	-0.08* (0.00)
NORELIGION	-0.06 (0.07)	-0.04 (0.08)	-0.66*** (0.07)	0.31*** (0.08)	0.46*** (0.07)	0.18** (0.08)
URBAN	0.35*** (0.03)	-0.49*** (0.04)	0.68*** (0.03)	-0.22*** (0.03)	-0.24*** (0.03)	-0.25*** (0.03)
WOMEN	0.03** (0.01)	0.02 (0.02)	0.08*** (0.01)	-0.03** (0.01)	-0.02** (0.01)	-0.05*** (0.01)
NMARRIED	-0.17*** (0.06)	-0.18** (0.07)	-0.09 (0.06)	0.01 (0.06)	0.10** (0.06)	0.01 (0.05)
MARRIED	0.00 (0.04)	0.11** (0.05)	0.20*** (0.04)	-0.06 (0.04)	-0.05* (0.03)	-0.14*** (0.04)
EMPLOYOWN	0.03 (0.03)	0.00 (0.03)	-0.05 (0.03)	0.02 (0.03)	-0.00 (0.02)	0.05* (0.00)
EMPLOYGOVT	0.03 (0.05)	-0.05 (0.06)	0.06 (0.06)	-0.03 (0.05)	-0.07* (0.05)	0.07 (0.05)
EMPLOYTSC	0.12 (0.08)	-0.03 (0.10)	0.26** (0.09)	-0.15* (0.08)	0.01 (0.06)	-0.05 (0.07)
EMPLOYNGO	-0.12 (0.14)	-0.03 (0.15)	-0.11 (0.15)	-0.06 (0.14)	0.04 (0.11)	-0.07 (0.12)
PARTICIPATION	0.05 (0.05)	0.05 (0.06)	0.14*** (0.05)	-0.14*** (0.05)	0.06** (0.03)	-0.09** (0.04)
LMILLET	0.06** (0.04)	0.03 (0.05)	-0.13*** (0.04)	-0.12*** (0.04)	0.03 (0.03)	-0.04 (0.04)
Nairobi	-0.21** (0.09)	-0.27** (0.10)	-0.52*** (0.11)	0.56*** (0.09)	0.16** (0.08)	0.07 (0.08)
Central	0.21** (0.08)	-0.21** (0.09)	-0.08 (0.09)	0.31*** (0.09)	-0.01 (0.07)	0.07 (0.07)
Coast	-0.04 (0.07)	-0.27*** (0.08)	-0.53*** (0.08)	0.79*** (0.08)	0.41*** (0.06)	0.22*** (0.07)
Eastern	-0.32*** (0.08)	0.44*** (0.09)	-0.55*** (0.08)	0.44*** (0.08)	0.32*** (0.08)	0.20*** (0.07)
Nyanza	-0.53*** (0.08)	0.50*** (0.10)	-0.88*** (0.09)	0.76*** (0.09)	0.79*** (0.07)	0.16** (0.08)
Rift Valley	-0.81*** (0.08)	0.58*** (0.09)	-0.66*** (0.09)	0.61*** (0.09)	0.45*** (0.07)	0.21** (0.07)
Western	-0.95*** (0.08)	0.78*** (0.10)	-1.19*** (0.09)	0.82*** (0.00)	0.72*** (0.08)	0.18** (0.08)
Constant	-0.23* (0.13)	-0.32* (0.16)	0.26** (0.14)	4.54*** (0.15)	5.42*** (0.13)	4.48*** (0.12)

* - significant at the 0.1 level; ** - significant at the 0.05 level; *** - significant at the 0.01 level

5 Conclusions and Policy Implications

This analysis was set out to describe consumption patterns for millet, maize, rice and sorghum across different consumer clusters and income groups and analyze the determinant of demand/consumption for millet, maize, rice and sorghum in rural and urban areas of Kenya. We have used a two stage Heckman model to estimate the determinant of consumption for the three cereals. The motivation for pursuing the Heckman model was to deal with the problem of zero consumption reported in the survey and problem of non-exposure bias.

Millet and rice are mainly consumed in urban areas, while maize consumption remains high in rural area. Consumption of millet and maize in rural regions increases with increase in income. However, in urban areas there is no statistical difference in consumption of millet in terms of quantity across the income levels.

There are huge urban rural and interregional differences in the millet maize and rice consumption. Socio-demographic characteristics such as household sizes, level of education, own production were significant in explaining both the decision to consume and the level of millet consumption. Thus, targeted strategies on these variables can be effective both in attracting new consumers of millet and in increasing the level of consumption. Additionally, advertisement putting emphasis on the nutritional effect of millet may contribute to increases in its consumption.

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Appendix 1. Commercially available composite flour food products from finger millet, pearl millet, and sorghum with other components in the Kenyan.

Name	Company	Uses	Packaging	Ingredients
Baby porridge	Proctor & Allan Box 18218 Nairobi	Porridge for young babies and children	1-2kg	Maize, sorghum, soya and finger millet
Ken-Uji Sour	Mt. Kenya Food Products Ltd Box 42 Nkubu	Porridge	1kg	Finger millet, Wheat, Sorghum, Pearl millet and Lemon extract
Nana Porridge	Super Foods Box 1578 Eldoret	Porridge	0.5kg	Finger millet, Cassava, Groundnuts, Soya and Greengrams
KIDS Flour	JOA Spices Ltd. Box 123 Eldoret	Porridge for children	0.5kg	Finger millet, Sorghum, Soya, Maize, Fish powder, Greengrams, Groundnuts
Liwah Porridge	Liwah Industries Box 7834 Eldoret	Porridge for Children	0.5-2kg	Finger millet, Sorghum, Soya, Cassava, Groundnuts, Milk powder, fine maize flour
Elna	Arid Products Enterprises Box 19791 Nairobi	Porridge	1kg	Sorghum, Finger millet, Soya, Wheat and Lemon extract
Jelly Porridge	Favourke Farm Products Kitengela Box 57629 Nairobi	Porridge	1kg	Finger millet, Cassava
Uji kwa watu wote	Money Saver Millers Box 434 Busia	Porridge	0.5-1.0kg	Maize, Sorghum, Pearl millet, Soya, Groundnuts

Obuji Flour	Massellah Food Products Box 44550 Nairobi	Porridge	0.5kg	Sorghum, Finger millet, Soya, Cassava, Groundnuts, Greengrams, Milk powder Sorghum
Cerevita Instant sorghum porridge	Nestle Foods Kenya Ltd Box 30265, Nairobi	Porridge	1.0	
Famila Ujimir (sour porridge)	Unga Ltd. Box 30386, Nairobi	Porridge	1.0	Finger millet, maize flour, souring agent
Famila pure wimbi porridge mix	Unga Ltd. Box 30386, Nairobi	Porridge	1.0	Finger millet, calcium
Special	Jambo millers Box 783, Nakuru	Porridge	1.0	Millet, sorghum, pearl millet, greengrams, groundnuts Millet
Jambo uji flour	Jambo millers Box 783, Nakuru	Porridge	1.0	
Maizena-Nutra plus	CPC Kenya Ltd. Box 41045, Nairobi	Porridge	0.5	Maize, soya, millet, sorghum, citric acid, vitamins, minerals

Source: Obilana, 2003.

Appendix 2: Consumption expenditure for millet, maize rice and sorghum in different consumer clusters (KSh per adult equivalent/year)

Crop	Region	Full sample	Rural	Urban	Rural with millet production	Rural without millet production	Urban close to millet production	Urban far from millet production
Millet	National	-	705.0	1,108.9***	419.5	800.9***	754.7	1,208.9***
	Nairobi	1,280.0	-	1,280.0	-	-	-	1,280.0
	Central	1,360.6	1,325.4	1,435.5	-	1,325.4	-	1,435.5
	Coast	1,581.3	1,508.5	1,666.8	-	1,508.5	-	1,666.8
	Eastern	985.7	800.8	1,571.2***	-	800.8	-	1,571.2
	North Eastern	627.6	599.1	671.5	-	599.1	-	671.5
	Nyanza	595.3	504.3	781.8***	472.1	528.4	915.1	693.4
	Rift Valley	542.9	439.2	787.6***	403.6	498.2**	724.0	936.4***
Western	426.6	273.8	692.8***	319.8	269.0**	457.1	731.7*	
Maize	National	-	2,483.8	1,398.5***	2,537.0	2,465.9	1,938.3	1,246.0***
	Nairobi	517.6	-	517.6	-	-	-	517.6
	Central	1,121.6	1,368.1	596.3***	-	1,368.1	-	596.3
	Coast	1,342.7	1,980.0	594.0***	-	1,980.0	-	594.0
	Eastern	2,389.1	2,792.3	1,112.7**	-	2,792.3	-	1,112.7
	North Eastern	908.8	1,208.8	445.2***	-	1,208.8	-	445.2
	Nyanza	2,704.1	2,885.2	2,332.6***	2,547.4	3,137.0***	2,248.4	2,388.5
	Rift Valley	2,395.8	2,614.5	1,880.0***	2,615.7	2,612.5	1,766.2	2,145.8
Western	2,818.4	2,931.0	2,622.4	1,208.1	3,109.6***	2,351.8	2,667.1	
Rice	National	-	1,498.9	-	467.2	627.5***	934.0	1,353.5***
	Nairobi	1,498.9	1,398.3	1,067.0***	-	-	-	1,498.9
	Central	1,172.8	1,670.2	724.7***	-	1,067.0	-	1,398.3
	Coast	1,159.4	1,607.6	554.6***	-	724.7	-	1,670.2
	Eastern	807.4	1,533.5	1,051.5***	-	554.6	-	1,607.6
	North Eastern	1,240.9	942.1	461.2***	-	1,051.5	-	1,533.5
	Nyanza	618.8	1,119.6	522.5***	355.0	540.3***	758.8	1,063.8***
	Rift Valley	700.3	615.2	239.2***	535.9	500.4	1,059.3	1,260.6**
Western	-	2,931.0	2,622.4	123.1	251.3**	453.6	641.9	

* - significant at the 0.1 level; ** - significant at the 0.05 level; *** - significant at the 0.01 level

Appendix 3: Expenditure for, millet, maize, rice and sorghum by poverty levels, (KSh per adult equivalent)

Crop	Region	Full sample		Urban		Rural	
		Non-poor	Poor	Non-poor	Poor	Non-poor	Poor
Millet	National	1,133.6	413.4***	1,378.5	591.5***	977.5	335.7***
	Nairobi	1,399.6	1,002.8***	1,399.6	1,002.8***	-	-
	Central	1,575.4	741.9***	1,671.0	814.1***	1,532.0	704.6***
	Coast	1,876.8	1,175.4***	1,834.4	1,378.5**	1,922.5	1,056.8***
	Eastern	1,415.5	383.4***	1,962.6	652.7***	1,193.9	327.3***
	North Eastern	960.8	429.1***	927.4	517.9***	982.5	371.9***
	Nyanza	787.5	268.0***	984.5	358.4***	680.5	231.6***
	Rift Valley	797.9	182.9***	1,045.7	315.0***	676.5	137.7***
	Western	608.0	214.2***	1,062.9	269.8***	351.8	181.6***
Maize	National	2,443.1	1,576.4***	1,515.4	1,193.7***	3,034.7	1,743.2***
	Nairobi	512.2	631.6	512.2	631.6		
	Central	1,242.6	775.8***	617.0	545.3	1,526.5	894.8***
	Coast	1,497.2	1,137.6***	672.2	453.4*	2,387.3	1,537.0***
	Eastern	2,721.4	1,934.9***	1,203.7	903.4*	3,336.0	2,149.8***
	North Eastern	1,072.4	811.4***	418.1	461.4	1,499.0	1,036.8***
	Nyanza	3,234.6	1,800.7***	2,563.3	1,850.5***	3,599.0	1,780.7***
	Rift Valley	2,905.5	1,685.9***	2,137.9	1,410.9***	3,281.3	1,780.1***
	Western	3,623.2	1,883.0***	3,155.4	2,026.0***	3,886.6	1,799.2***
Rice	National	1,138.9	349.9***	1,594.7	618.5***	848.2	232.9***
	Nairobi	1,734.7	772.6***	1,734.7	772.6***		
	Central	1,383.9	563.5***	1,634.3	775.0***	1,270.3	454.3***
	Coast	1,592.5	548.5***	2,137.6	771.3***	1,004.5	418.5***
	Eastern	1,150.9	326.1***	1,941.1	826.6***	830.8	221.8***
	North Eastern	2,081.2	740.4***	2,454.4	981.0***	1,837.9	585.3***
	Nyanza	840.1	242.1***	1,169.7	466.7***	661.1	151.8***
	Rift Valley	1,012.2	260.2***	1,434.6	543.2***	805.4	163.3***
	Western	560.7	160.1***	918.5	268.9***	359.2	96.3***
Sorghum	National	53.1	30.0***	19.9	10.8	74.2	38.3***
	Nairobi	0.5	0.0	0.5	0.0		
	Central	4.9	2.8	1.0	1.0	6.7	3.7
	Coast	0.0	0.0	0.0	0.0	0.0	0.0
	Eastern	79.8	42.4***	29.0	0.0	100.3	51.3***
	North Eastern	0.8	1.6	2.0	1.1	0.0	2.0
	Nyanza	173.7	83.9***	78.3	36.5	225.4	102.9***
	Rift Valley	15.4	17.2	1.7	13.9***	22.2	18.3
	Western	58.6	31.6***	41.0	14.2*	68.5	41.8*

Appendix 4: Expenditure for millet, maize, rice and sorghum by income groups (Ksh per adult equivalent)

Crop	Region	Urban			Rural		
		Low	Middle	Upper	Low	Middle	Upper
Millet	National	1,152.9	995.6	1,104.5*	688.4	610.1	813.5***
	Nairobi	1,255.3	1,410.4	1,291.5			
	Central	1,488.8	1,373.2	1,380.0	1,319.2	1,272.5	1,359.3
	Coast	1,861.3	1,505.8	1,516.6	1,386.6	1,544.6	1,642.9
	Eastern	1,633.8	1,047.8	1,731.9***	715.4	639.2	1,062.6***
	North Eastern	667.4	481.0	838.3	603.3	526.1	738.6

Crop	Region	Urban			Rural		
		Low	Middle	Upper	Low	Middle	Upper
	Nyanza	909.4	823.4	655.2	528.6	495.8	496.0
	Rift Valley	802.0	747.5	784.0	475.3	250.0	532.4**
	Western	624.1	669.5	780.0	308.3	264.6	236.5
Maize	National	1,287.2	1,752.8	1,386.2***	2,444.1	2,504.9	2,514.6
	Nairobi	552.3	1,118.5	295.1			
	Central	541.3	760.5	607.4	1,282.0	1,472.3	1,391.7
	Coast	658.5	607.0	512.8	2,034.8	2,035.0	1,845.7
	Eastern	1,187.3	1,290.5	951.6	2,678.3	2,657.0	3,065.6
	North Eastern	469.8	623.9	191.7	1,149.6	1,324.1	1,340.2
	Nyanza	2,459.3	2,250.1	2,264.6	2,906.8	2,953.1	2,800.6***
	Rift Valley	1,829.4	2,357.8	1,742.9*	2,724.6	2,437.8	2,590.3
	Western	2,159.0	2,952.3	2,926.4***	2,966.5	2,910.6	2,905.9
Rice	National	1,259.9	1,013.9	1,377.3**	580.2	493.5	682.5**
	Nairobi	1,344.90	1,288.60	1,811.1*			
	Central	1,295.10	1,242.50	1,634.3*	968.3	1,040.0	1,172.1*
	Coast	1,714.70	1,369.90	1,766.70	839.5	741.9	546.4**
	Eastern	1,655.20	1,269.10	1,703.70	578.1	425.1	655.8***
	North Eastern	1,598.80	1,207.60	1,480.60	988.8	1,281.0	944.4
	Nyanza	947.8	764.7	1,020.20	421.7	438.1	512.7
	Rift Valley	1,081.20	1,023.90	1,219.90	481.5	353.5	712.6***
	Western	638.6	452.4	685.3	211.9	222.5	297.8
Sorghum	National	14.8	11.7	21.7	44.0	84.3	53.8***
	Nairobi	0.0	0.0	1.2			
	Central	0.5	0.0	2.1	5.6	2.0	8.3
	Coast	0.0	0.0	0.0	0.0	0.0	0.0
	Eastern	36.7	17.6	3.5	43.5	107.3	89.8**
	North Eastern	1.0	0.0	4.3	1.8	0.0	0.0
	Nyanza	55.6	36.0	85.9	221.6	206.8	115.9**
	Rift Valley	9.7	5.7	0.5	11.5	38.0	19.9***
	Western	21.8	11.8	45.3	54.5	55.3	59.8

* - significant at the 0.1 level; ** - significant at the 0.05 level; *** - significant at the 0.01 level

Appendix 5: Quantities of millet consumed at district level (kg/adult equivalent)

Province	District	Percent	Total amount (kg/AE/year)
Nairobi	Nairobi	73.4	43.9
Central	Kiambu	89.9	57.4
	Kirinyaga	69.5	36.5
	Muranga	85.6	63.8
	Nyandarua	58.4	26.3
	Nyeri	82.7	46.3
	Thika	85.0	54.4
	Maragua	77.1	49.6
Coast	Kilifi	75.1	99.2
	Kwale	87.6	89.8
	Lamu	62.4	39.5
	Mombasa	87.1	61.9
	Taita Taveta	40.1	21.0

	Tana River	50.6	22.6
	Malindi	61.8	63.0
Eastern	Embu	80.5	40.3
	Isiolo	47.3	18.5
	Kitui	46.9	31.3
	Makueni	54.8	29.5
	Machakos	66.9	41.3
	Marsabit	14.5	6.6
	Mbeere	50.6	31.6
	Meru Central	75.4	44.3
	Moyale	20.0	5.1
	Mwingi	57.6	38.4
	Nyambene	76.0	47.8
	Tharaka	75.9	64.9
	Meru South	56.8	29.4
	North Eastern	Garissa	84.0
Mandera		51.2	12.8
Wajir		40.6	12.7
Nyanza	Gucha	43.8	29.4
	Homa Bay	58.8	37.2
	Kisii	56.7	38.1
	Kisumu	52.8	33.9
	Kuria	49.1	35.4
	Migori	59.7	34.8
	Nyamira	51.7	34.9
	Rachuonyo	58.8	38.4
	Siaya	48.7	30.2
	Suba	65.8	56.5
	Bondo	69.2	39.3
	Nyando	45.3	29.1
Rift Valley	Baringo	41.8	15.6
	Bomet	49.7	16.1
	Keiyo	48.2	20.9
	Kajiado	69.3	55.9
	Kericho	50.0	17.9
	Koibatek	34.7	12.5
	Laikipia	50.0	25.2
	Marakwet	45.1	25.5
	Nakuru	46.1	26.9
	Nandi	40.0	17.7
	Narok	52.7	25.2
	Samburu	11.3	3.5

	Trans Mara	39.2	15.7
	Trans Nzoia	37.5	15.5
	Turkana	10.6	3.4
	Uasin Gishu	43.3	17.7
	West Pokot	19.0	13.4
	Buret	47.1	25.7
Western	Bungoma	34.1	16.1
	Busia	53.0	25.5
	Mt. Elgon	23.5	10.8
	Kakamega	34.1	21.3
	Lugari	24.7	9.4
	Teso	60.2	36.4
	Vihiga	29.6	14.0
	Butere/Mumias	37.8	19.1