HOUSEHOLD FOOD SECURITY IN VIHIGA DISTRICT, KENYA: KEY DETERMINANTS USING AN ALMOST IDEAL DEMAND SYSTEM (AIDS)

Nyangweso P.M,
Economics and Agricultural Resource Management
Moi University
P.O. Box 1125
ELDORET, KENYA
E-mail: philoe2000@yahoo.com

Odhiambo M.O
Economics and Agricultural Resource Management
Masinde Muliro University of Science and Technology
P.O. Box 190
KAKAMEGA, KENYA
E-mail: moodhiambo@yahoo.com

Odunga P.
Economics and Agricultural Resource Management
Moi University
P.O. Box 1125
ELDORET, KENYA
E-mail: philoe2000@yahoo.com

Abstract
Vihiga, one of the poorest and densely populated districts in Kenya is perpetually food deficit (GOK, 2005). Rising population pressure coupled with intense competition for limited resource endowments has curtailed efforts to improve household food production in the district. To make matters worse, unfavorable poverty indicators hinder attainment of food security, in the district, through the demand side. About 57.6 percent of the population and more than 50 percent of households live below absolute poverty line while 57 percent of the population and households live below food poverty line. Poor welfare indicators for Vihiga district underscore the importance and urgency for addressing the basic needs of its residents. Understanding determinants of food security in Vihiga district will improve targeting, the focus and success of policies for addressing food insecurity. This paper examines determinants of food security in Vihiga district using an Almost Ideal Demand System (AIDS) to determine the demand side constraints using household survey data. Cluster sampling was used with divisions forming the main clusters in the district. Using systematic random sampling, 50 households were selected from each cluster resulting in a sample of 300. Results show that household income, dependency ratio, gender of household head, household savings/transfers characteristics, ethnicity, education, market access and nutrition awareness significantly influence household food security. Food programmes in Vihiga should pay special attention to household structure, preferences and decision dynamics for successful implementation.

Key Words: *Food security, Almost Ideal Demand System (AIDS), Vihiga, Kenya.*

Introduction

Despite having the potential to meet domestic food demand, Kenya has continued to grapple with persistent food deficits over the last two decades. Over the last six years the annual demand for maize in the country rose from 29.5 million bags to 32.9 million bags (GOK, 2004). However, production in the same period ranged between 25 and 30 million bags per year thus necessitating importation of food to meet the deficit.

Vihiga, one of the poorest and densely populated districts in Kenya with an average household land size of less than 0.4 hectares is perpetually food deficit (GOK, 2004). This has been attributed to limited land, high poverty levels, limited off-farm income, and non-adoption of recommended farm technologies. Vihiga district is a perfect case of why the Kenyan government will be unable to meet millennium development goals especially as regards eradication of extreme poverty and hunger (UN, 2005). Maize is the main staple food for residents of Vihiga district thus its insufficiency is synonymous with food insecurity. Over the last decade, the district maize demand outpaced local production worsening the already bad food deficit situation.

Food security describes a situation in which people do not live in hunger or fear of starvation. According to FAO (2003), food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. This study defines household food security as access to nutritionally adequate and safe foods by all households at all times to meet their dietary needs and food preferences for an active and healthy life.

As poverty levels rise, household food insecurity in the district worsens. Families with the financial resources to escape extreme poverty rarely suffer from chronic hunger; while poor families not only suffer the most from chronic hunger, but are also the segment of the population most at risk during food shortages and famines (FAO, 2003). Vihiga district has unfavorable poverty indicators as measured by food poverty, absolute poverty and hard-core poverty. About 57.6 percent of the population in Vihiga district lives below the absolute poverty line, which is set at Kshs. 2648, and Kshs. 1238 per month for urban and rural areas respectively (GOK, 2004). Similarly, more than half of the households in Vihiga, which is one of the worst hit districts in Kenya, fell below the absolute poverty line. To make matters worse, about 57 percent of both individuals and households in the district live below the food poverty line. While 45 percent of the households live in hard-core poverty, more than half of the individuals in these households live in hard-core poverty. Poverty has a twin impact on household food security. It not only reduces the capacity of households to access farm inputs due to capital limitations thus hindering expanded food production, but also prevents households from accessing food due to their low or non-existent purchasing power. Consequently, malnutrition among households has become a big issue since if basic food needs can not be met very few household would care about the quality of food they eat. Poor welfare indicators for Vihiga district underscore the importance and urgency for addressing the basic needs of its residents. Understanding determinants of dietary diversity presents an opportunity for improving targeting, the focus and success of policies for addressing food insecurity. The paper examines the major demand side constraints to food security among households in Vihiga district of Kenya. The paper is subdivided into five sections. In section one, an introductory exposition of the problem is presented. Section two reviews theoretical considerations and presents the model used for estimation. In sections three and four, methods and materials followed by results and discussions are presented. Finally, conclusions and recommendations are presented.

Theoretical Considerations

Modeling Consumption Behavior

The objective of analyzing consumer behavior is to explain the level of demand for the commodities an individual consumes given the structure of relative prices faced, real income, a set of individual characteristics such as a*g*e, education, professional status, type of household to which he belongs and the geographical environment (De Janvry, 1993). Knowledge of the demand structure assists in (1) definition of policy interventions for improving nutritional status of individuals or households ; (2) formulation of a country's strategy on food subsidies; and (3) sectoral and macroeconomic policy analysis. The theory of consumer behavior basically explains how a rational consumer chooses what to consume when confronted with various prices and limited income (Varian 1992, De Janvry, 1993, Mas-colell et al,

1995). Considering a consumer whose utility function is $u(\boldsymbol{x}, z)$, with $\boldsymbol{x}$ a vector of quantities and $\mathbf{z}$ individual characteristics, the consumer maximizes utility with respect to quantity, $\boldsymbol{x}$, subject to a budget constraint $\boldsymbol{px}=\boldsymbol{m}$. This can be re-written as:

$$\underset{\boldsymbol{x},\,\lambda}{Max}\; u(\boldsymbol{x}, z) + \boldsymbol{\lambda}(\boldsymbol{m}-\boldsymbol{px}) \qquad (1)$$

Where $\boldsymbol{p}$, $\boldsymbol{m}$ and $\boldsymbol{\lambda}$ are vectors of prices, income and the Lagrange multipliers respectively.
The first order condition which shows that the gradient of the Lagrangian function must be equal to zero is used to derive the optimal solution for utility maximization problem, which occurs when the marginal rate of substitution (MRS) between goods i and j is equal to the rate of exchange of the two goods (Varian, 1993, Mas-colell, 1995, Jehle and Reny, 1998). This can be expressed as (2) below:-

$$\nabla L(x^*,\lambda^*) = 0 \qquad (2)$$

The solution to this maximization problem is a set of n-demand equations:

$$x_i = x_i(p, m, z),\ i = 1, \ldots n \qquad (3)$$

The second order condition for utility maximization is satisfied when the bordered Hessian is positive semi-definite. Since:

$$\nabla^2 L(x^*,\lambda^*) = \begin{bmatrix} -\lambda\dfrac{\partial^2 u(x,z)}{\partial x_i x_j} \end{bmatrix} = \begin{bmatrix} -\lambda & \dfrac{\partial^2 u(x,z)}{\partial x_i x_j} \end{bmatrix} \qquad (4)$$

Expenditure function, which is the dual of the utility function, when minimized yields the same result as maximization of the utility function. Considering a consumer whose expenditure function is $e(u, \boldsymbol{p}, z)$, with u targeted utility, $\boldsymbol{p}$ a vector of commodity prices and $\mathbf{z}$ a vector of individual characteristics, the consumer's objective function is to minimize expenditure with respect to quantity, $\boldsymbol{x}$, subject to a targeted utility constraint $u(\boldsymbol{x}) = u$. This can be specified as: -

$$\underset{x,\,\gamma}{Min}\; \boldsymbol{px} + \gamma(u - u(\boldsymbol{x})). \qquad (5)$$

Where γ is the Lagrange multiplier.
To confirm that expenditure minimization is a dual for utility maximization first order conditions for expenditure function are derived to prove that at optimality the marginal rate of substitution (MRS) between goods i and j is equal to the price ratio of the two goods. Sufficiency conditions for expenditure minimization when $f(.)=\boldsymbol{px}$ and $g(.)=u - u(\boldsymbol{x})$, are twice differentiable and vectors $\mathbf{x}^* \in R^n$, $\boldsymbol{\lambda}^* \in R^m$ exist require that such that

$$\nabla L(x^*, \gamma^*) = 0 \qquad (6)$$

$g(\mathbf{x}^*) = 0$ occur for $p = 2,3,\ldots,n$, if the bordered Hessian of the second derivative of the Lagrange function is negative semi definite. The expenditure approach is adopted in this paper because it is practically feasible to deal with consumer expenditure behavior when doing empirical evaluation.

Model selection

A variety of models have been used to describe the allocation of consumers' expenditure that is compatible with consumers behaving according to well-defined preferences. Such models include linear expenditure system (Stone, 1954), direct and indirect translog system (Lau, 1984), quadratic expenditure System (Matsuda, 2006), Price independent generalized linearity (PIGL) demand System (Muellbauer, 1980, De Janvry, 1993), Price independent generalized logarithm (PIGLOG) demand systems (Muellbauer, 1980, 1986) Almost Ideal Demand System (AIDS)(Deaton and Muellbauer, 1980, Chalfant, 1987 Rossi, 1988, Nyang. 1999, Andersson et al, 2006). Many of the demand models are not well suited to survey data. Linear expenditure system is overly restrictive. Direct and indirect translog systems are expensive to estimate using extensive survey data. The AIDS model suffers from neither of these drawbacks (Cheser and Rees, 1987). Further, the AIDS model can be easily estimated by inexpensive non-iterative methods and be used to examine expenditure allocation within a broad food group and also between broad food groups. The AIDS model expresses the share of total expenditure allocated to good i, $w_i = y_i/x$, as a linear function of the logarithm of total expenditure, x, and of prices, p_j, j= 1…m, thus:

$$w_i = \alpha^*_i + \beta_i \log(x/P) + \sum \gamma_{ij} \ln P_j + u_i \qquad (7)$$

$j=1$

Where:

$$Log\ P = \alpha^{*}_{0} + \sum_{k=1}^{m} \alpha^{*}_{k} \log p_k + \tfrac{1}{2}\sum_{k=1}^{m}\sum_{i=1}^{m} \gamma_{kj} \log p_k \log p_i \qquad (8)$$

P is a price index.

Homogeneity and symmetry restriction of demand theory require that: α^{*}_{i}, γ, and β_j which are easily imposed and tested to meet the following conditions:

$$\sum_i \alpha^{*}_{i} = 1 \qquad \sum_i \gamma_{ij} = \sum_j \gamma_{ji} = 0 \qquad \sum_i \beta_j = 0 \qquad \gamma_{ij} = \gamma_{ji}$$

With prices constant, as they are approximately for many foods within one survey period, the model yields an income -expenditure relationship of the form:

$$w_i = \alpha_i + \beta_i \log(x) + u_i, \text{ where } \alpha_i = \alpha^{*}_{i} + \sum \gamma_{kj} \log p_j - \beta_j \log P \qquad (9)$$

This is the form of the Engel curve used by Working (1943), later developed by Leser (1963, 1976), Deaton and Muelbauer (1980) and found to perform well when faced with cross-section data. Following Deaton and Muellbauer (1986) income is expressed per capita using a simple headcount of household members and the intercept in the model is augmented to allow for influence of household composition. The estimated model is specified as (10):-

$$\mathbf{W} = \boldsymbol{\alpha} + \boldsymbol{\beta} \log (X/n) + \boldsymbol{\gamma}\mathbf{Z} + \boldsymbol{\theta}\mathbf{V} + \boldsymbol{\delta}\mathbf{Y} + \varepsilon \qquad (10)$$

Where; n = number of household members

X = household monthly total expenditure on food.

W = a vector of ratio of survey month expenditure on each food item to household monthly total food expenditure.

Z, V, and **Y** are vectors of household characteristics, environmental factors and ethnic, savings/transfer characteristics while **α, β, γ, θ** and **δ** are corresponding vectors of parameters to be estimated, and **ε** is a normally distributed random error term. The specific variables contained in the vectors **Z, V,** and **Y** are shown in the appendix. Foods for which $\boldsymbol{\beta < 0}$ are necessities and as total expenditure increases become inferior once $\boldsymbol{\beta + w < 0}$.

Materials and Methods

Sampling Design

The study targeted all farm households in Vihiga district. Cluster sampling was adopted on the basis of the six divisions. Using systematic random sampling procedure, 50 households were selected from each cluster generating a total sample of 300 respondents.

Data Types and Sources

Both primary and secondary data were used. The data encompassed expenditure on various commodity groups, commodity prices, household characteristics (education, age, family size, gender of head of household, employment, business income, ethnic origin, savings/ transfer behavior, highest education level, market access, geographical location, monthly household consumption. Primary data was collected through a survey while secondary data was acquired by perusal of annual agricultural reports, economic surveys, statistical abstracts and development plans.

Data Collection Methods

Both interviews and questionnaires were used as instruments for data collection. Interviews were used to supplement questionnaires. To validate survey instruments, 10 questionnaires were pre-tested in one of the divisions, revised and forwarded to enumerators. Trained enumerators were used to administer the questionnaires. Focused group discussion was used to elicit information from key informants who included district agricultural officer, district development officer, heads of district non-governmental organizations, divisional agricultural extension officers, field extension workers and local administration. Observation was used to countercheck some of the findings.

Data Analysis

Descriptive statistics such as bar charts, cross tabulations and measures of central tendency were used to describe emerging relationships between variables. Multiple regression analysis was used to estimate a system of budget share equations from the survey data using Statistical Package for Social Sciences (SPSS) version 11.5. Multi-collinearity was tested using Pearson's correlation coefficient.

Results and Discussion

Results (table 1) show that a bundle of food necessities for residents of Vihiga district consist of maize grain, sugar, cabbage, kale, oranges and vegetable oil. However, none of the foods become inferior as levels of income for the residents improve. That shows that levels of income recorded in the district even when they improve only manage to improve accessibility to basic foods, but is not good enough for locals to start perceiving some of the foods as inferior.

On the other hand a bundle of normal goods whose consumption is significantly influenced by the level of income includes maize meal, wheat meal, bread, rice, sorghum, millet, Irish potatoes, peas, green grams, black night shade(sucha), spider plant(saka), fish and beef. This clearly shows how households will exclude some food items from their budgets if they are non-affordable even when such actions result in escalation of malnutrition among households. It is therefore critical to fight poverty as a means of ensuring households access food not only in the right amount but also in the appropriate quality.

The dependency ratio, number of adults, gender of household head, education, employment and ethnicity significantly influence budget shares for some commodities with mixed results. As the dependency ratio and number of adults increase more budget share is allocated to basic foods which tend to be cheaper. On the contrary more expensive foods such as beef get less allocation. Male household heads significantly influence choice of more expensive foods such as beef while female counterparts tend to go for lower-priced commodities so long as diversity of the food stuffs is achieved. Education and employment which are associated with status positively influence consumption of goods that go with status and negatively influence foods that are considered inferior. Different ethnic groups such as Banyore, Maragoli, Tiriki and others exhibit different preferences for different food commodities. Consequently, while one ethnic group might increase budgetary allocation for one commodity the other group may be doing the reverse. The results show consistency since they satisfy homogeneity and symmetry requirements of demand theory.

Results further show that savings/transfers, market access and nutrition awareness influence budget shares for an assortment of commodities. While savers are likely to go for status commodities, non-savers are likely to go for more traditional basic food stuff. Transfers received by some households from relatives and friends boost their ability to access food and in some cases can result in change of consumption behavior. Nutrition awareness of dietary requirements has both positive and negative impact on consumption. For households with enough resources awareness results in higher consumption. However, for resource poor household's, awareness results in concentration on basic food stuff thus reducing budget shares of some commodities. Market access is crucial for commodities that have to be purchased from the market.

Table 1: Estimated budget share parameters

Commodity i	α_i	Income β_i	Depend. ratio γ_{i1}	No. of adults γ_{i2}	H.Head γ_{i3}	Business income γ_{i4}	Educat. γ_{i5}	Employ. γ_{i6}	Ethnicity Φ_{i1}	Savings Φ_{i2}	Transfers Φ_{i3}	Urban-rural δ_{i1}	Market access δ_{i2}	Nutr. awareness δ_{i3}	R	R^2
Maize grain	0.693[a]	-0.078[a]	0.003	-0.002	0.011	-0.019[b]	-0.004	0.001	-0.011[b]	0.001	-0.004	0.012	0.017[b]	-0.015	**0.57**	**0.32**
Maize meal	-0.038	0.012[b]	0.002	0.003	-0.006	(-0.005)	0.001	-0.009	-0.006	-0.009	-0.009	-0.003	-0.018[a]	0.005	**0.30**	**0.09**
Wheat meal	-0.056[a]	0.008[a]	-0.001	0.001	0.003	0.004	0.002	0.008[b]	-0.001	0.001	0.002	0.002	0.005	0.005	**0.39**	**0.15**
Bread	-0.098[a]	0.018[a]	-0.001	(0.000)	0.002	0.011[b]	0.001	0.014[b]	-0.008[a]	0.001	-0.004	0.012[a]	0.003	-0.006	**0.42**	**0.17**
Rice	-0.038	0.006[b]	-.002	0.001	-.002	.004	0.005[a]	-.002	0.003	0.01[a]	0.005	0.001	0.005	-0.002	**0.44**	**0.19**
Sorghum	-0.017	0.004[b]	0.000	0.000	-0.002	-0.001	0.002[b]	-0.003	0.002[b]	-0.001	0.000	-0.003	0.002	-0.006[b]	**0.31**	**0.10**
Millet	-0.01	0.004[b]	0.001	0	-0.007[a]	-0.001	0	0.001	0.001	0.001	0.001	-0.002	-0.002	-0.004	**0.25**	**0.10**
I/potatoes	-0.023	0.005[b]	0	0.001	-0.001	0.004[b]	0.002[b]	-0.005[b]	0	0.003	-0.003	0.002	-0.002	-0.002	**0.31**	**0.10**
S/potatoes	0.039	(-0.002)	0.005	-0.002	0.005	-0.009	-0.006	-0.017[b]	0.010	0.002	0.001	0.003	0.007	0.014	**0.26**	**0.10**
Sugar	0.369[a]	-0.026[a]	-0.005	-0.001	0.003	-0.005	0.003	-0.004	-0.01[b]	-0.012	0.001	-0.005	-0.01	-0.016	**0.33**	**0.11**
Dry beans	-0.016	0.006	0.004[b]	0.001	-0.013[a]	-0.002	-0.005[b]	0.002	0.008[a]	0.001	-0.008	-0.009	-0.004	0.021[a]	**0.38**	**0.15**
Peas	-0.007[b]	0.001[b]	0.001[a]	0.00004	0.000	-0.001	0.00002	-0.001	0.000	0.000	0.001[a]	0.0001	.000	0.000	**0.33**	**0.11**
Green grams	-0.069[a]	0.009[a]	0.003[b]	0.001[b]	-0.007[a]	0.005[b]	0.002	0.003	0.005[a]	0.001	-0.003	0.002	-0.002	-0.002	**0.45**	**0.20**
Cabbage	0.085[a]	-0.008[b]	0	-0.001	0.003	0	0.001	-0.001	0.003	-0.006	-0.001	-0.005	0.002	-0.012[b]	**0.26**	**0.10**
Kale	0.085[a]	-0.008[b]	0	-0.001	0.003	0	0.001	-0.001	0.003	-0.006	-0.001	-0.005	0.002	-0.012[b]	**0.35**	**0.12**
Fresh cowpeas	-0.005	0.006	0.004	0.001	-0.003	-0.003	-0.001	-0.004	0	-0.003	0.001	-0.008	0.005[b]	0.004	**0.25**	**0.10**
Sucha	-0.032[b]	0.006[b]	0.001	0.001	-0.002	-0.002	0.001	-0.001	0	-0.005[b]	0.002	-0.001	-0.000	0.000	**0.26**	**0.10**
Saka	-0.046[a]	0.008[a]	0.003[a]	0.001[b]	-0.003	-0.002	0.0001	0.006[b]	-0.001	-0.009[a]	0.003	-0.001	-0.002	0.003	**0.35**	**0.12**
Miro	0.01	0	0.002	0	-0.006[a]	-0.001	-0.001	0	0.001	-0.001	0.003	0.002	0.001	0	**0.29**	**0.10**
Bananas	0.092	0.002	-0.007	-0.002	0.01	0.001	-0.005	-0.018[b]	-0.012[a]	-0.004	-0.005	0.01	0.005	0.002	**0.29**	**0.10**
Oranges	0.059[a]	-0.007[a]	-0.002	-0.001[b]	-0.001	-0.001	0.002	0	0	0.007[b]	0.001	0.001	0.001	0.006	**0.30**	**0.10**
Avocadoes	0.037	-0.002	-0.002	0	-0.001	0.002	-0.004[a]	0.001	0.004	-0.003	-0.002	0.006[b]	-0.003	0.007	**0.26**	**0.10**
Mangoes	-0.003	0.005	-0.001	-0.001	-0.001	-0.002	0	0.002	0	0.002	0.002	-0.001	-0.003	-0.01	**0.24**	**0.10**
Fish	-0.055	0.014[b]	0.001	0.002	0.003	-0.003	-0.001	-0.007	-0.005	0.005	0.002	-0.005	0.008	0.002	**0.22**	**0.05**
Beef	-0.201[a]	0.029[a]	-0.007[b]	0.002	0.02[b]	0.012[b]	0.003	0.004	0.013[a]	0.013	-0.015[a]	0.003	0.001	0.017	**0.50**	**0.25**
Chicken	0	0.004	-0.001	-0.003[b]	-0.007	0.003	0.001	0.012[b]	0.009[a]	-0.007	0.009[a]	-0.016[a]	0.016[a]	-0.006	**0.37**	**0.14**
Milk	0.123[a]	-0.007	-0.001	-0.001	0.002	0.009	0.003	0	-0.002	0.007	0.005	0.097	0.003	-0.014	**0.24**	**0.06**
Vegetable oil	0.072[a]	-0.006[b]	0	-0.001	0	-0.003	0	0.006	-0.002	0.002	0.003	-0.002	-0.002	0.012[a]	**0.29**	**0.08**
Total	**1.005**	**0.005**	**0.005**	**0.001**	**-0.009**	**0.003**	**-0.0009**	**-0.003**	**-0.009**	**-0.011**	**-0.017**	**0.087**	**0.018**	**-0.015**		

Source: *Author's compilation from cross-sectional survey, 2007.* [a]*-significant at 1 percent,* [b]*-significant at 5 percent.*

Conclusion and Recommendations

Vihiga, one of the poorest and densely populated districts in Kenya is perpetually food deficit. Poor welfare indicators for district underscore the importance and urgency for addressing the basic needs and the need to document determinants of food security in Vihiga district to improve targeting, focus and success of food programmes.

An attempt is made to evaluate demand side constraints to food security in Vihiga district using an Almost Ideal Demand System (AIDS) through a household survey. Household income, dependency ratio, gender of household head, household savings/transfers characteristics, ethnicity, education, market access and nutrition awareness are critical when addressing household food security. It is therefore recommended that food programmes in Vihiga should pay special attention to household structure, preferences and decision dynamics for successful implementation. This is critical since structure and preferences of household reflect the level and diversity of consumption, while decision dynamics reflect how consumption decisions are made whether through negotiated or dictatorial consensus.

References

Andersson M., A. Envall and A. Kokko (2006): "Determinants of poverty in Lao PDR". Working paper 223, march 2006. Stockholm School of Asian Studies. Stockholm School of Economics.

Chalfant J.A (1987): "A Globally Flexible, Almost Ideal Demand System". *Journal of Business & Economic Statistics*, Vol. 5, No. 2 (Apr., 1987), pp. 233-242.

Chesher A. and H. Rees (1987): "Income elasticities of Demands for Foods in Great Britain. *Poverty*, Food Security Status and Farmland allocation to various crops*"*. *Journal of Agricultural Economics*, Vol. 38 No.3.

De Janvry S. and Alain De Janvry, (1993): Demand Analysis. *Quantitative Development Policy Analysis.*
GOK (2005): Economic Survey. Ministry of Planning and National Development.
_____(2004): Economic Survey. Ministry of Planning and National Development.
_____(2004): Strategy for Revitalizing Agriculture. Ministry of Agriculture.
_____ (2004): Vihiga District Development Plan. Ministry of Planning and National Development.
_____ (2005): Vihiga District Development Plan. Ministry of Planning and National Development.
_____ (2004): Statistical Abstract. Ministry of Planning and National Development.

Jehle G.A. and P J. Reny(1998): *Advanced Microeconomic Theory.* Addison Wesley Longman, Inc.

Mas-colell A, M. D. Whinston and J.R. Green(1995): Microeconomic Theory. Oxford University Press.

Matsuda T. (2006): "Linear approximations to the quadratic almost ideal demand system". *Journal of Empirical Economics Volume 31, Number 3 / September 2006.*

Muellbauer J. (1974): "Household composition, Engel curves and welfare comparisons between households. A duality approach". *European Economic Review Volume 5, Issue 2 , August 1974, Pages 103-122.*

*Nyang F.O (1999): "*Responsiveness in household demand for fuels: an application of the almost ideal demand system*". Household Energy Demand and Environmental Management in Kenya.*

Rossi N. (1988): "Budget share demographic translation and the aggregate Almost Ideal Demand System". *European Economic Review Volume 32, Issue 6, July 1988, Pages 1301-1318.*

Varian H.R (1992): *Microeconomic Analysis* 3rd Ed. W.W. Norton & Company, New York.

Walpole R. E and R.H Myers (1978): *Probability and statistics for Engineers and Scientists*. 2nd Ed.

UN (2005): Website development: UN Web Services Section, Department of Public Information, United Nations.

Appendix I

Table 2: Variables and definitions

Variable	Definition and comment
Dependent variable	
Consumption per capita	**Expenditure share which is proxy for real per capita consumption**
Independent variables	
Household characteristics	
Dependency ratio	**Ratio of dependents, below 18 years and above 59, versus adults 18-59**
Adults	**Number of adults in household**
Gender of head of household	**1 if male head of household; 0 if female head of household**
Household income	**Total household food expenditure as proxy for income**
Household business	**1 if household run business, 0 otherwise**
Highest education index	**0 if highest educational attainment in household is pre-primary, 1 if primary, 2 if secondary, 3 if vocational training, 4 if university/college**
Employment status	**1 if head of household is employed, 0 otherwise**
Ethnic/savings/transfer characteristics	
Ethnic origin	**1 if Tiriki, 2 if Mnyore, 3 if Maragoli and 4 if non-Luhya**
Savings	**1 if make any savings from salary or business, 0 otherwise**
Transfers	**1 if get any transfers from relatives or friends, 0 otherwise**
Environmental factors	
Rural /urban cluster	**1 if household is in urban center, 0 otherwise**
Access to muddy season road	**1 if village is accessible by truck during rain season, 0 otherwise.**
Awareness of nutritional needs	**1 if aware of balanced meal, 0 otherwise.**