Determinants of Household Food Security in Rural Uganda: An Application of a Non-Separable Agricultural Household Model

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Introduction

In 1987 after 15 years of political turmoil and economic mismanagement, the National Resistance Movement (NRM) government adopted economic reforms. Positive one digit economic growth and inflation from three digits to one have been realised. Peace and stability have been restored in most parts of the country. In contrast, the exclusive food self-sufficiency-centred, sectoral approach with trickle-down policies neglected the issues of food accessibility at the household level and more importantly, the crucial role of rural women in ensuring household food security.

More than 80 percent of the population of Uganda reside in rural areas and depend on agriculture for their livelihood, including food security. Small-scale farmers, mostly women, dominate the agricultural sector in general and the food sub-sector in particular. Much of the economic growth Uganda is enjoying today derives from this sector, and food security at all levels depends on small-scale farmers. Paradoxically, growing poverty and food insecurities in rural areas are taking place in the midst of economic growth and national food self-sufficiency.

This paper seeks to explore how food security of the rural households responds to changes in exogenous factors. The paper is set out in the following manner. The background information is discussed first followed by the model specification. Then there will be discussion of the data used, estimation procedures and techniques. The results of the study and their policy implications are explored prior to concluding remarks.

Background

Uganda appears to be lagging behind in addressing food security particularly at the household level compared to other countries in sub-Saharan Africa (SSA), in particular, those in southern Africa. This is evident from the lack of food security assessment at all levels[1] and the scanty but descriptive studies[2] on food security. Household food security is defined as the ability by all persons including the most vulnerable to gain access at all times to adequate food for an active, healthy life. This food must be culturally acceptable and derived from non-emergency sources. Inattention to food security particularly at the household level is inextricably linked to three important issues. These are: widespread misconception of the food security concept by policymakers; insufficient relevant data; and the low status of rural women.

The food security concept has evolved since the World Conference on Food in 1974 from global and national level to household and individual level and from food availability to food accessibility issues[3]. In part this explains the current misconception of the food security concept by policymakers in Uganda. Ensuring food self-sufficiency at the national level is still perceived as a necessary and sufficient condition for food security at the lower levels. In contrast, scanty evidence at the household level indicates that nearly 38 percent of children below 5 years are undernourished and 14 percent of women deliver babies of low weight[4], and feeding on wild foods by households in some localities[5]. This points to growing food insecurity at the household level and the failure on the part of policymakers to address the food accessibility issues. One would not hesitate to question the growing evidence of food insecurity among rural households in the midst of economic growth, fertile soils and national food self-sufficiency.

Currently, data pertaining to food security at the household level are insufficient, making it difficult to examine responses of households to policies that affect their food security status. Clearly, food security analysis and planning at any level would be difficult without proper and accurate data.

Researchers[6] and international organisations (notably FAO and the World Bank) concur that women in developing countries play a crucial role in ensuring household food security. The Ugandan government has also recognised the role played by women. However, the prescribed strategies to raise the productivity of women, which is seen as crucial for improving household food security, leave a lot to be desired. Firstly, such strategies have focused on their productive activities paying little attention to their role in domestic activities. Secondly, the gender disparities in terms of access to productive resources and access to social services have not been adequately addressed. The situation is exacerbated by the current neo-liberal policies followed by the government. Thirdly, the visibility of the crucial role of women is impeded by lack of gender disaggregated data.

Little research appears to exist that analytically addresses food security at the household level for effective policymaking processes in Uganda. In the light of the issues posed above, the study seeks to investigate the key determinants of household food security in rural Uganda. This is achieved through the application of the agricultural household theoretical framework that integrates both consumption and production aspects of the rural households.

Theoretical Model Specification

To examine the determinants of household food security, the agricultural household model framework[7] is employed. This framework has theoretical underpinnings from the household production theory. The model is continuing to receive a wider application in household production decisions[8], consumption decisions[9], labour decisions[10] or a combination[11]. Earlier applications of this model in developing countries either assumed perfect markets, perfect substitutability between family and hire labour, perfect substitutability of labour between wife and husband, or perfect substitutability between purchased and produced foods. These assumptions are too unrealistic for rural households in Uganda. Instead an unrestricted static, non-separable, semi-subsistence agricultural household model is suggested to achieve the objective of this paper. It takes into account the gender division of labour, making visible the woman's time allocation, and imperfections in the rural labour markets.

Each household allocates its total time $T=(T^m,T^w)$ among the productive activities $F=(F^m,F^w)$, domestic activities $H=(H^m,H^w)$ and leisure $L=(L^m,L^w)$; where superscripts *m* and *w* refer to the male and female who is either the head or spouse to the head of the household, respectively. The time constraints for the husband and wife are expressed as in Eq. 1. It is assumed that off-farm and hired labour, and on-farm labour provided by children and other adult members are fixed. It is also assumed that time allocated to different farm tasks[12] is at least fixed in the short run. The labour inputs of wife and husband are hypothesised to be imperfect substitutes.

$$T^d = F^d + H^d + L^d, \qquad \text{for d} = \text{w, m} \tag{1}$$

Rural households in Uganda grow a variety of food crops, partly for own consumption and partly for sale. Each household is postulated to produce *s* output $Q=(q^1,q^2,...,q^s)$, at price $P_q=(p_q^1,p_q^2,...,p_q^s)$; and these outputs are jointly produced with family labour inputs F^w, F^m at a shadow wage rate w^w, w^m, respectively, and *t* other farm inputs $E=(e^1,e^2,...,e^t)$ at $P_e=(p_e^1,p_e^2,....,p_e^t)$. Non-conventional factors of production such as access to productive resources are said to directly influence household production and in turn affect a household's command over food. These factors are denoted as $N=(N^1,N^2,...,N^f)$. In rural Uganda, some enterprises are operated fully by women or jointly and farm inputs are non-allocatable by neither gender nor crop. Household production is assumed to be riskless, and land and agricultural inputs application to be fixed.

Each household is postulated to maximise profit from its farm operations in the short run as expressed in Eq. 2. It is assumed to satisfy the usual profit function assumptions.

$$\underset{q \succ 0}{Max}\, P_q f(F^d, E, N) - w^w F^w - w^m F^m - P_e E = \pi(P_q, w^w, w^m, P_e; N) \tag{2}$$

Rural households consume a variety of food items derived from three sources, namely, own production, purchases and gifts or free collection[13]. The latter source was less common in the sampled districts and is hereafter dropped. Each household is postulated to consume r food items from own production $X = (x^1, x^2, ..., x^r)$, which can be purchased at $M = \pi_i(.) + S^w + S^m$; s purchased food items $Z = (z^1, z^2, ..., z^s)$ at price $P_z = (p_z^1, p_z^2, ..., p_z^s)$; and t non-food items $Y = (y^1, y^2, ..., y^t)$ at price $P_y = (p_y^1, p_y^2, ..., p_y^t)$. Additionally, the household is said to derive utility from leisure, L. To cater for the differences in the consumption patterns across households, demographic factors are taken into account. These factors may enter the utility function as separate arguments[14]. Let $C = (C^1, C^2, ..., C^k)$ denote the vector of the household socio-demographic characteristics.

This paper assumes a separable utility function for food, which implies two-stage budgeting hypothesis. At stage one, households determine their expenditures on the following broad categories, namely, food, health, education, and other non-food items. At stage two, group expenditures are allocated among the items in each broad group. At this stage, a household is postulated to maximise group utility function. Therefore, the discussion that follows assumes household to maximise food group utility function. Each rural household is postulated to jointly maximise utility as expressed in Eq. 3 subject to time and income constraints expressed in Eqs. 4 and 5, respectively. The household profit is introduced in the income constraint in Eq. 5, a point of departure from traditional consumption theory. The price vectors P_q and P_x may overlap since the households consume much of their produce. The assumption of joint utility maximisation is supported in this paper on two grounds. Firstly, joint decision making dominated the male-headed households contrary to the findings of some studies[15]. Secondly, fair intra-household food distribution prevailed in most households.

$$\underset{x \succ 0}{Max}\, U_i(X, Z; L^m, L^w, C) \qquad (3)$$

subject to

$$F^d + H^d + L^d \le T^d, \qquad T^m + T^w \le T \qquad (4)$$

$$P_x X + P_z Z + w^w L^w + w^m L^m \le \pi_i(P_q, w^w, w^m, P_e; N) + S^w + S^m \qquad (5)$$

Under the local nonsatiation assumption, utility-maximising consumption bundles must meet the income constraint in Eq. 5 with equality. Given the duality that exists between the direct and indirect utility function, the household is postulated to maximise a joint indirect food utility function that gives the maximum utility achievable at given prices and income as expressed in Eq. 6.

$$V_i(P_x, P_z, w^w, w^m, M; C) = Max(X, Z, T^m - F^m - H^m, T^w - F^w - H^w, C)$$

$$\text{subject to} \qquad (6)$$

$$P_x X + P_z Z + w^w L^w + w^m L^m - \pi_i(.) - S^w = S^m$$

where $V_i(.)$ is an indirect food utility function and said to satisfy the usual assumptions; $M = \pi_i(.) + S^w + S^m$ is the household full income; and the rest of the variables are as defined before.

How does one proceed from Eq. 6 given the behaviour of the labour markets and very low application of other farm inputs especially fertilisers and improved seeds, in rural Uganda? Imperfections in the labour markets pose a major problem in the empirical estimation of an agricultural household model, especially in this case where a formal labour market does not exist. Researchers have employed different methods to impute value for labour, especially for those individuals who are self-employed including on-farm employment or household members who do not work for a wage. The first category of these studies[16] assumed the wage rate to be exogenous to the households.

The second category of these studies has assumed the shadow wage rate to be determined within the households. Studies[17] have used the marginal productivity of labour derived via the agricultural production technology as proxies for wages. In contrast, some studies[18] follow a primal approach that does not require the estimation of marginal returns. They use the optimal condition that the marginal rate of substitution of household consumption for leisure equals the marginal returns to labour to derive the shadow price for labour at the equilibrium level. Coyle[19] follows a dual approach by assuming a household to maximise an indirect utility functions and profit function conditional on the optimal choice of family labour. Like Newman and Gertler, Coyle does not derive the shadow wage rate, instead derives the first order condition for an optimal choice of family labour. This is the approach also employed in this paper.

The other farm inputs used in food production were incorporated in Eq. 6. However, application of inputs such as fertilisers and improved seeds was negligible over the sampled households. Exasperating this is the fact that very few households applied such farm inputs. All this renders P_e redundant.

In the light of the behaviour rural labour markets and negligible application of other farms inputs, let the functional form for the conditional indirect utility function, $\tilde{V}(.)$, and profit function, $\tilde{\pi}(.)$, be expressed as in Eqs. 7 and 8, respectively.

$$\tilde{V}_i(.) = \left[M^{1-\phi} + \frac{\phi - 1}{1+\beta} \prod_j (e^{\alpha} C^{\varphi} N^{\eta} F^{d\lambda} (P_j^{\beta+1} P_{j+1}^{\beta}) \right]^{\frac{1}{1-\phi}} \tag{7}$$

$$\begin{aligned} In\tilde{\pi}_i(.) = {} & \varsigma_0 + \sum_j^s \varsigma_j Inp_q^j + \sum_k \gamma_0 InC^k + \sum_d \delta_0 InF^d + \sum_f \rho_0 InN^f + \\ & \tfrac{1}{2}\sum_j^s \sum_k^s \iota_{jk} Inp_q^j Inp_q^k + \tfrac{1}{2}\sum_s^f \sum_t^f \rho_{st} InN^s InN^t + \tfrac{1}{2}\sum_s^d \sum_t^d \delta_{st} InF^s InF^t + \\ & \tfrac{1}{2}\sum_s^k \sum_t^k \gamma_{st} InC^s InC^t + \sum_j^s \sum_f \omega_{jf} Inp_q^j InN^f + \sum_j^s \sum_k \varpi_{jk} Inp_q^j InC^k + \sum_j^s \sum_d \theta_{jd} Inp_q^j InF^d \end{aligned} \tag{8}$$

Royís identity is applied to derive the demand equations, and after carrying out the necessary transformation the equations are as expressed in Eqs. 9 and 10. Hotelling's Lemma is employed to output equations as expressed in Eq. 11. The first-order conditions for optimal family labour by gender are expressed as in Eq. 12.

$$Inx_i^r = \alpha_{ir} + \sum_j \beta_{ij} InP_{ij} + \phi_i^r InM_i + \sum_k \varphi_{ikr} InC_i^k + \sum_f \eta_{ifr} InN_i^f + \sum_d \lambda_{idr} InF_i^d \tag{9}$$

$$Inz_i^s = \alpha_{is} + \sum_j \beta_{ij}^{'} InP_{ij} + \phi_i^s InM_i + \sum_k \varphi_{iks} InC_i^k + \sum_f \eta_{ifs} InN_i^f + \sum_d \lambda_{ids} InF_i^d \tag{10}$$

$$Inq_i^s = \varsigma_i + \sum_s \iota_{is} Inp_q^s + \sum_f \omega_{if} InN^f + \sum_k \varpi_{ik} InC^k + \sum_d \theta_{id} InF^d \tag{11}$$

$$InF_i^d = \delta_{oi} + \sum_j \delta_{ij} InP_j + \sum_f \mu_{if} InN^f + \sum_k \kappa_{ik} InC^k \tag{12}$$

Eqs. 9 to 12 are said to satisfy the usual consumer and producer assumptions and regularity conditions. Some researchers[20] have employed food demand equations as expressed in Eqs. 9 and 10 or expressed them in share forms to derive the price and income elasticities that are later used to derive the caloric-income and price elasticities indirectly. This approach has been criticised for introducing bias in the parameter estimates. We circumvent this problem by deriving such elasticities directly. The definition of household food security focuses on food nutritional value, which is among the many attributes that can be derived from the food consumed. Households are postulated to derive utility from the food nutritional value. The subsequent sections demonstrate how Eqs. 9 and 10 are translated into a form that directly captures household food security.

For a household to be food secure, its daily food intake from different sources combined must be greater than or equal to the recommended daily intake requirements. There is compelling empirical evidence[21] that caloric sufficiency does not translate into sufficiency of the other nutrients. Consequently, questioning the conventional use of calories intake as an overall measure for household food security. We measure household food security in terms of calories, protein and iron. Iron is chosen among the micronutrients, as its deficiency is highest in Africa[22] and more so high deficiencies are reported in Uganda[23].

Let $x_{ij} = (x_i^r + z_i^s)$ for $j = r + s$ denote the quantity of the j^{th} food item consumed by the i^{th} household for all sources combined; $p_{ij} = (P_x, P_y)$ food prices; d_j^n, the n^{th} nutritional value *(n = calories, protein, iron*) per unit derived from the consumption of the j^{th} food item; and then A_i^n the reported daily n^{th} nutritional food intake by the i^{th} household expressed as in Eq. 13.

$$A_i^n \quad = \quad \sum_j d_j^n x_{ij} \qquad (13)$$

The demand expressions in Eqs. 9 and 10 (ignoring the *In* for simplicity) are substituted for x_{ij} into Eq. 13 to derive Eq. 14.

$$A_i^n = \alpha_{ij} + \sum_j \tilde{\beta}_{ij} p_{ij} + \phi^j M_i + \sum_k^{k-1} \varphi_{ik} C_i^k + \sum_f \eta_{ij} N^f + \sum_d \lambda_{id} F_i^d + \sum_s \gamma_{is} h_{is} \quad (14)$$

The expression in Eq. 14 predicts the impact of a change in the exogenous variables on the household food intake, in terms of calories, protein and iron. The i^{th} household composition is included by sex as h_s, for s=(f = female and m = male). As discussed above, for a household to be secure the actual daily food intake must be greater than or equal to the recommended daily requirements. The recommended daily food requirements are given at an individual level and can easily be translated into a household level. Let the recommended daily n^{th} food intake (R_i^n) weighted by sex for the i^{th} household be expressed as in Eq. 15.

$$R_i^n \quad = \quad \omega_{if} . r_f^n H_{if} + \omega_{im} . r_m^n H_{im} \qquad (15)$$

where ω_s is the proportion of the s^{th} sex, H_s is the corresponding head count and r_s^n the corresponding recommended n^{th} daily intake weighted by age for the i^{th} household. Assume that $\omega_s r_s^n = \gamma_s$ (from Eqs. 14 and 15), that is, the sex impact on both the recommended and actual n^{th} food intake is the same. Then Eq. 15 for the i^{th} household can be re-expressed as in Eq. 16.

$$G_i^n \equiv A_i^n - R_i^n = \alpha_{ij} + \sum_j \tilde{\beta}_{ij} p_{ij} + \phi^j M_i + \sum_k \varphi_{ik} C_i^k + \sum_f \eta_{if} N^f + \sum_d \lambda_{id} F_i^d \qquad (16)$$

Re-introducing *In*, G_i^n measures the n^{th} actual food intake as a proportion of the recommended intake for the i^{th} household; and $\alpha, \tilde{\beta}, \phi, \varphi, \eta$ and λ are parameters to be estimated. The lower the proportion of the actual daily intake to recommended daily intake the more food insecure the household. The price variables in Eq. 16 are the price of the food item but not the price per nutrient, since government policies directly affect the former.

Data, Estimation Procedures and Techniques

The data used were collected from a cross-section survey of 300 households from three districts in rural Uganda, from Feb to July 1996[24]. The data offer unique opportunities to study household food security in rural Uganda. Firstly, data on consumption[25] and production were collected from the same households. This is an important issue in the estimation of a complete agricultural household model. Secondly, data were collected directly from women, the key players in ensuring food security. Thirdly, some data variables such as time allocation and asset ownership were disaggregated by gender. Fourthly, the coverage of the survey ensured price variability across households to circumvent the conventional demand analysis using cross section data, where prices are omitted.

The rural households covered in the survey as a group reported consumption of over 50 food items such that some degree of aggregation was inevitable. This was necessary to limit the parameters to be estimated to a manageable number. Assuming weak separability, the food items consumed were then aggregated into 7 groups[26]. The meat group included beef, pork, chicken, goat's meat, mutton, eggs and milk. The cereal group included flour of maize, millet, and sorghum, and rice. The legumes group included groundnuts, fresh beans, dried beans, peas, soybeans and simsim. The oils group consisted mainly of ghee and general purpose cooking oils. The tubers group included sweet potatoes, Irish potatoes, fresh cassava and dried cassava. The miscellaneous foods group included passionfruit, orange, onions, cabbage, pumpkins and pineapple. Matooke constituted the last group. For each food group a weighted group price was derived on the items reported to have been consumed by the household.

In converting food quantities into their nutritional value some assumptions were made. Firstly, the food losses during the preparation process up to the consumption stage were negligible. Secondly, no quality differences existed between different types of the same food item. Thirdly, household daily food intake was the same over the 30-days period. Fourthly, households had neither lactating nor pregnant mothers. Fifthly, moderate activity was assumed for caloric intakes. The foods were converted into their nutritional values using the

Uganda Nutri-Guide System (undated), and *The Composition of Foods Commonly Eaten in East Africa* by West et al. (1988). On the production side, household food production was converted into a single aggregate crop and output prices aggregated into 3 to 5 groups according to district.

Comment [.1]: put in notes

Empirical Model

The system of equations estimated was based on an unrestricted static, non-separable agricultural household model as expressed in Eqs.17 to 19. The components of the model appear below:

$$InG_i^n = \alpha_n + \sum_g \beta_{ng} In\overline{P}_i^g + \phi_n InM_i + \sum_k \varphi_{ink} C_i^k + \sum_f \eta_{\inf} N_i^f + \sum_d \lambda_{ind} F_i^d + \varepsilon_{ni} \quad (17)$$

$$In\overline{q}_i = \overline{\varsigma}_i + \sum_q \iota_{iq} In\overline{p}_q + \sum_f \omega_{if} InN^f + \sum_k \varpi_{ik} InC^k + \sum_d \theta_{id} InF^d + \nu_i \quad (18)$$

$$InF_i^d = \delta_i + \sum_j \delta_{ij} In\overline{p}_{ij}^s + \sum_f \mu_{if} N_i^f + \sum_k \kappa_{ik} C_i^k + \tau_i \quad (19)$$

where:

G_i^n = measure of the i^{th} household food security (%) in the n^{th} food intake for n = calories, protein and iron,

$\overline{P}_i^g$ = g^{th} weighted food group price (Ug.Shs/kg) (g = *meat and related products, cereal, oils, tubers, legumes, matooke and other foods* consumed by the i^{th} household,

$\overline{P}_i^q$ = q^{th} weighted group output price (Ug.Shs/kg) (q = *matooke, tubers, all other foods*) for the i^{th} household,

$\overline{q}_i$ = aggregate output (kg) for the i^{th} household,

M_i = real total food expenditure (Ug.Shs) for the i^{th} household as a proxy for permanent income,

N_r = vector of productive resources *(credit, extension services, farming land, farming equipment, improved seeds and labour),*

C_k = vector for socio-demographic variables *(k = $Size_i$, Cw_i, Educ1, Educ2, Market, $Share_i$, $Hwom_i$, $Hmem_i$, $Head_i$, Age_i, $Type_i$)*

$Size_i$ = head count as a proxy for household size for the i^{th} household,

Cw_i = consumer:worker ratio as a proxy for the i^{th} household life cycle,

Educ1 = 1 if a woman respondent never attended school

= 0 else,

Educ2 = 1 if a woman respondent had primary education

= 0 else,

Educ3 = 1 if a woman respondent education higher than primary

= 0 else,

Market = distance to the nearest produce market in kilometres,

$Share_i$ = percentage share of a woman's assets value in total i^{th} household asset value,

$Hwom_i$ = 1 if a woman sick during the last 30 days in the i^{th} household prior to the survey

= 0 else,

$Hmem_i$ = 1 if other members of the household sick during the last 30 days in the i^{th} household prior to the survey

= 0 else,

$Head_i$ = 1 if i^{th} household is headed by a male

= 0 otherwise,

F_i^d = number of daily man-hours spent on productive activities by d (= m w) in the i^{th} household,

Age_i = woman's age in completed years in the i^{th} household,

$Type_i$ = 1 if the i^{th} household derives much of its consumption from own production

= 0 otherwise, and

$\varepsilon_i, \nu_i, \tau_i$ = disturbance terms to take account of the excluded variables and assumed to be normally distributed.

The non-separability behaviour that was assumed to exist between household production and consumption decisions leads the error terms ε_i, ν_i and τ_i to be contemporaneously correlated. To consistently estimate the parameters, Eqs. 17 to 19 are estimated as a system using Three Stages Least Squares (3SLS) method. It yields efficient estimates as long as the variance-covariance matrix of the error terms is not diagonal[27] and the system is overidentified. The Lagrange Multiplier (LM) statistic was employed to test the null hypothesis of a diagonal variance-covariance matrix, which was rejected.

The B-P-G test statistic was employed to test for heteroscedasticity equation by equation. The weighted least square method[28] was used to correct for heteroscedasticity, where found. While the presence of multicollinearity among explanatory variables does not violate regression assumptions, it does affect the size, standard errors and signs of the parameter estimates[29]. Paradoxically, the various tests suggested for detecting multicollinearity are only suggestive, failing to provide a way forward to solving the problem once detected. Despite the weaknesses of the simple correlation analysis[30] it was used to detect pair-wise correlations among the explanatory variables. In addition, auxiliary regressions were run to detect multicollinearity among the explanatory variables.

Comment [.2]:

The major problem in using cross-section data in food demand and supply studies is the occurrence of zero consumption/production of some food items, and the subsequent zero prices/quantities. Treatment of such zero prices/quantities has varied considerably across studies[31]. In this paper, aggregation across food item minimised the bias introduced by zero prices/quantities. On the other hand, for the female-headed households, zero values appeared for husband's socio-demographic variables. Following the arguments advanced by Battese (1997), some would argue that inclusion of the headship dummy in the model minimised the bias.

Estimated Results on the Consumption Side

The results of the consumption side of the household model by district[32] are presented in Table 1. The parameter estimates in these tables are elasticities with t-statistic reported in parentheses. Generally speaking, the impact of the changes in exogenous factors varied considerably across household food security measures and from district to district.

Effects of Real Income

In all districts and for all measures of household food security, real income was positive and statistically significant, but inelastic. As their income increases, households in Kiboga significantly consume more foods richer in iron than either calories or protein. On the contrary, increasing income of the households in Pallisa and Mbarara districts significantly improves their daily calorie intake more than either daily iron or protein intakes. Overall, households in Mbarara were more responsive to changes in real income than those in the other two districts, except for iron security. The households in Pallisa recorded the least household food security improvements from changes in real income.

There appear some possible explanations for a positive sign on the income variable. Since most of these households depend heavily on their own production, increases in their full income may induce them to invest more in activities that improve their overall productivity and hence leading to improvements in food availability. This does not singularly increase food availability, but also leads them to have a surplus to sell. The income may also be used to purchase those foods, for which the household derives from the market, such as meat.

The magnitudes of income elasticities derived were sizeable, ranging from 0.36-0.70, for all measures of household food security in all the three districts. The food security of the households is still below the satiation levels as demonstrated by the results. However, this has to be interpreted cautiously across districts. The caloric-income elasticity derived in this study are within the range reported in previous studies carried out elsewhere in Africa and other developing countries[33]. For instance, Kennedy (1989) reported caloric-income elasticity of 0.15 for Kenya and Strauss (1986) 0.82 for Sierra Leone.

Table 1

Results on the Consumption Side of the Unrestricted, Static Non-Separable Agricultural Household Model by District

	Kiboga			Mbarara			Pallisa		
Variable	Calories as % RDI	Protein as % RDI	Iron as % RDI	Calories as % RDI	Protein as % RDI	Iron as % RDI	Calories as % RDI	Protein as % RDI	Iron as % RDI
InMeat	0.06	0.11	0.07	-0.00	0.00	0.03	0.07	0.03	0.10
	(2.36*)	(2.82*)	(2.06*)	(-0.23)	(0.07)	(1.36)	(1.69*)	(037)	(1.65*)
InCereal	0.01	-0.01	-0.02	-0.04	0.03	0.00	0.01	0.03	-0.01
	(0.31)	-0.45	(-0.66)	(-1.19)	(0.74)	(0.007)	(0.44)	(0.91)	(-0.43)
InOils	0.02	-	-	0.00	-	-	-0.18	-	-
	(2.45*)			(0.48)			(-1.80*)		
InTubers	-0.00	0.03	0.02	0.03	-0.00	0.08	-0.05	-0.23	-0.06
	(-0.04)	(0.68)	(0.49)	(1.61)	(-0.12)	(3.36*)	(-1.16)	(-3.38*)	(-1.00)
InLegumes	0.09	0.27	0.01	-0.00	0.00	-0.06	0.00	0.08	0.02
	(1.18)	(2.35*)	(0.08)	(-0.03)	(0.07)	(-1.13)	(0.06)	(1.62)	(0.46)
InMatooke	-0.08	-0.11	-0.10	-0.10	-0.13	-0.09	-0.06	0.20	-0.23
	(-2.33*)	(-2.13*)	(-2.10*)	(-3.74*)	(-4.58*)	(-2.35*)	(-0.23)	(0.54)	(-0.70)
InMiscellaneous	0.06	0.10	0.07	-0.03	-0.02	-0.04	0.14	0.07	0.18
	(1.90*)	(2.02*)	(1.60)	(1.05)	(-0.69)	(-1.10)	(1.61)	(0.49)	(1.55)
InIncome	0.62	0.45	0.70	0.64	0.56	0.40	0.46	0.36	0.36
	(9.03#)	(4.73#)	(6.64#)	(11.82#)	(8.87#)	(4.95#)	(11.47#)	(6.18#)	(6.73*)
InSize	-0.80	-0.61	-0.78	-0.84	-0.74	-0.65	-0.44	-0.41	-0.43
	(-8.64#)	(-4.37#)	(-5.92#)	(-11.66#)	(-8.96#)	(-6.19#)	(-5.46#)	(-3.26#)	(-3.87#)
Educ2	0.04	0.08	-0.15	0.13	0.17	0.14	0.08	0.15	0.07
	(0.32)	(0.49)	(-0.87)	(1.83#)	(2.14#)	(1.34#)	(1.41#)	(1.68#)	(0.92)

Educ3	0.02	0.10	-0.16	0.03	0.11	0.07	-0.01	0.26	-0.05
	(0.19)	(0.52)	(-0.88)	(1.60#)	(1.10)	(0.53)	(-0.09)	(1.26)	(-0.28)
lnAge	-	-	-	-0.32	-0.35	-0.20	-0.27	-0.36	-0.14
				(-3.58#)	(-3.38#)	(-1.50#)	(-2.81#)	(-2.34#)	(-1.04)
Hwom	-0.09	-0.20	-0.09	-	-	-	-0.21	-0.23	-0.19
	(-1.51#)	(-2.18#)	(-1.01)				(-2.73#)	(-1.98#)	(-1.79#)
Hmem	-	-	-	-0.14	-0.14	-0.11	-	-	-
				(-2.50#)	(-2.22#)	(-1.33#)			
lnFwom	-0.45	-0.93	-0.37	-0.48	-0.43	-0.70	-0.58	-0.91	-0.62
	(-2.20*)	(-3.10*)	(-1.22)	(-4.11*)	(-3.17*)	(-3.96*)	(1.31)	(-1.36)	(-1.04)
lnFman	0.19	0.48	0.06	0.11	0.10	0.04	0.29	0.59	0.45
	(2.11*)	(3.78*)	(0.44)	(2.17*)	(1.66*)	(0.53)	(3.34*)	(4.48*)	(3.82*
Type	-0.16	-0.20	-0.29	-0.07	-0.11	-0.01	-0.07	-0.08	-0.01
	(-2.60*)	(-2.29*)	(-3.04*)	(-1.21)	(-1.64)	(-0.12)	(-1.18)	(-1.00)	(-0.06)
Head	-0.32	-0.90	-0.03	-0.41	-0.42	-0.37	-0.47	-0.80	-0.55
	(-1.64)	(-3.17*)	(-0.11)	(-3.57*)	(-3.21*)	(-2.16*)	(-2.54*)	(-2.85*)	(-2.23*)
lnSharew	0.02	0.05	0.05	0.00	0.04	-0.00	-	-	-
	(1.29#)	(2.19#)	(2.01#)	(0.24)	(0.64)	(-0.06)			
lnCons	-	-	-	-	-	-	-	-0.10	-0.04
								(-2.25*)	(-1.08)
Constant	2.38	2.73	2.86	5.52	6.07	6.63	5.18	5.15	4.57
	(4.63*)	(3.48*)	(3.90*)	(8.87*)	(8.55*)	(7.00*)	(3.49*)	(2.55*)	(2.59*)
$\bar{R}^2$	0.58	0.07	0.49	0.66	0.59	0.36	0.67	0.27	0.37

Notes: #Significant at 90% level of significance for a one tailed t-test or better level; *Significant at 90% level of significance for a two tailed t-test or better level. and RDI = Recommended daily dietary intake.

The variations in nutrient-income elasticities are due to methodological differences[34]. These differences point to the non-systematic considerations in data collection, modelling and estimation issues that have characterised food demand analyses.

The implications of the results with respect to income are enormous particularly to those households whose food security is at risk[35]. For households at risk of food insecurity to have at least 75.0 percent of the recommended daily dietary intakes, their incomes have to improve considerably. The households at risk of caloric insecurity require their monthly incomes to increase from the existing levels by 41.5 percent, 45.0 percent and 121.3 percent for Mbarara, Kiboga and Pallisa, respectively. This will enable the households in Mbarara, Kiboga and Pallisa to reach at least 1,728 kcal, 1,655 kcal and 1,720 kcal, respectively. The households at risk of protein insecurity require a monthly increase in their monthly income to increase from the current levels by 44.4 percent, 42.3 percent, and 117.9 percent in the case of Mbarara, Kiboga and Pallisa, enabling them to reach 25.98 gm, 23.10 gm and 21.40 gm respectively. The households at risk of iron insecurity require their monthly incomes to increase from the existing levels by 62.5 percent, 36.9 percent and 87.2 percent, for Mbarara, Kiboga and Pallisa, enabling the households to reach 7.09 mg, 6.87 mg and 6.93 mg, respectively. Taking the food sub-sector growth as a proxy for rural income growth of 4.4 per annum for the period 1987/88-1995/96, it will take several years for these households to achieve 75 percent of their recommended dietary intakes, *ceteris paribus*.

Effects of Household Size

In all the three districts, the effect of household size was negative and statistically significant for all the three measures of household food security. The negative sign is consistent with the findings of B. L. Wolfe and J. R. Behrman but contrary to the findings of B. L. Rogers[36] of a positive sign for the Dominican households. In all districts, the impact of household size was significantly higher in daily calorie security than the other two measures of household food security.

Given that the rural households derive much of their consumption from own production, some would argue that the larger the household size the higher the food production, and the subsequent improvements in overall household food accessibility. However, the overall results for all the three districts suggest the opposite. There are possible explanations for this finding. In part, the high youth dependency ratio that characterised the sampled areas may have contributed to such a finding. On the other hand, the increase in household size, *ceteris paribus*, may have led to re-allocation of food away from nutritionally richer to less rich foods. To some extent the life cycle of the members of the household determines the extent of the re-allocation. Even in the absence of such re-allocations, an increase in household size if not followed by a proportionate increase in the available food is likely to result in reduced intakes.

Effects of Food Prices

The results derive from a model that treat household production and consumption simultaneously, such that the signs on food prices differ from the expected ones as postulated by traditional consumption theory. Hence, the subsequent interpretation of the price elasticities. It is evident from Table 1 that the effect of prices on the three measures of food security was not uniform, in terms of sign and magnitude. Despite deriving much of their consumption from their own production, the rural household's food security indicated responsiveness to changes in food group prices. This may be due to the fact that some of these food group prices affect both the food demand and supply side among the rural semi-subsistence farmers.

There might be a possible explanation for the negative sign of the matooke price variable in Mbarara and Kiboga, and tubers in Pallisa. A rise in the price of matooke/tubers may have increased its sale at the expense of household food consumption, especially by the poorest of the poor. This is as expected since matooke and tubers play a key role in household dietary intake and at the same time a source of income in the respective districts. This implies that the households may have engaged in the sale of these foods from their own subsistence, consequently worsening the household food security. The positive sign on the legumes and miscellaneous food groups is ascribed to the profit effect through the household full income. The positive elasticities on the price of legumes are consistent with Bezuneh et al. (1988) findings for millet and sorghum group in Kenya.

Worth noting was the positive sign on the price of the meat group. Generally, meat is taken as a side dish and most households depended on the markets for supply. Overall, a rise in the price of meat discouraged its consumption, the subsequent substitution toward more nutritionally richer (in terms of calories, protein and iron) but less expensive food items improved the household food security. In other words, a price increase in meat resulted in a sufficiently large increase in demand for other relatively richer foods. The increase was large enough to offset the direct decrease in calories, protein and iron resulting from reduction in meat consumption. This reflects a strong cross-price substitution effect between meat and other foods consumed by the rural households. The positive sign on the price of meat in the caloric security is consistent with Strauss (1986, p.138) findings in Sierra Leone for the fish and animal products food group.

The magnitude of the food prices (below 0.30), in absolute terms, was sizeable for legumes in Kiboga, for tubers and miscellaneous groups in Pallisa and matooke in Mbarara. To some extent the magnitude of the price elasticities reflected the importance of the food group(s) in the overall household daily dietary intake. Overall, households in Kiboga were more sensitive to individual food prices than those in the other two districts. The higher responsiveness observed could partly be attributed to its proximity to Kampala, the capital city. Like income elasticities, as discussed above, it is difficult to draw plausible generalisations on the numerical value of elasticities with respect to food prices and hence comparison across studies. Notwithstanding these shortcomings, the range of the food group prices elasticities in this paper does not differ much from those reported by Strauss (1986, p.138) in Sierra Leone when profits are allowed to vary. They are lower than the price elasticities reported by Bezuneh et al. (1988) for Kenya as expected since these were food quantity-price elasticities.

The insignificance of some individual prices was not necessarily due to severe multicollinearity among the variables. This prompted performing a joint test with a null hypothesis test that all food prices combined did not affect food security. Results suggest that a joint test on all prices was statistically significant (with p-value < 0.08) for caloric and protein security in Mbarara; and for only protein security (with p-value < 0.01) in Kiboga. Worth noting was that although Mbarara recorded the highest number of insignificance parameters in terms of individual prices, it performed best in terms of a joint test. On the contrary, results suggest that a joint test on all prices was not statistically significant for Pallisa for all the three household food security measures.

Effects of Woman-Specific Variables

The age of a woman was consistently negative across the measures of household food security, ranging from 0.14 to 0.36. In Mbarara and Pallisa the impact of age of a woman was consistently negative and statistically significant, except for iron in the latter. Overall, protein security was more responsive to changes in age than the other two measures of household food security in Mbarara and Pallisa. The former showing a higher response than the latter for all household food security measures. The age of the woman indicated a higher response than all food prices and other women-specific variables other than time, in absolute terms. The possible explanation of the negative sign on age is twofold. First, as a woman gets older, the food security of her household members deteriorates as her productivity declines both on the farm and in the household. Second, most of the elderly women respondents had no education. This could have negatively influenced their knowledge of nutrients derived from various foods. Consequently, the older a woman the less knowledge she had of the nutritional value derived from different foods.

Results suggest that with primary education a woman is to some extent informed on the importance of adequate dietary intakes. That is, knowledge associated with primary education can substantially improve nutritional education and hence improve household food security. The impact was slightly higher in terms of protein security. The elasticities with respect to secondary education were positive and statistically significant for calories in Mbarara and protein Pallisa. The overall elasticity with respect to a woman's education ranged from 0.07 to 0.17. The range is comparable to that of Alderman and Garcia (1992) for Pakistan, but relatively higher than that of Behrman and Wolfe (1984) for Nicaragua.

The impact of poor health of a woman in Kiboga and Pallisa was consistently negative and significant except for iron security in the former. The impact was slightly higher on protein security. The possible explanation for a negative sign on health status is as follows. Since a woman is responsible for collecting food from the field and preparing it, fetching water and collecting firewood to name a few tasks, when sick she may not be able to perform all these tasks. This may result in members having one meal per day or even eating less. In the long run, a woman's poor health may affect her productivity not only in the household but also on the farm. This results in less food available and hence threatens food accessibility.

The health of other members of the households displayed a negative and statistically significant impact on all measures of household food security, with a slightly higher impact on protein security in the case of Mbarara. There are specific explanations for this response in Mbarara. Firstly, in some households with AIDS victims, notably a head of the household, the respondents reported excessive sale of food, and to some extent other household assets, to meet medical bill. This obviously affects household food accessibility. Secondly, since women care for the sick, the time they spend impinges on the time they have for other activities, consequently affecting food security. For all districts, the elasticities ranged from 0.09 to 0.23.

The elasticities with respect to the time a woman spends on productive activities were consistently negative and statistically significant for all districts. Spending more time on productive activities by a woman exacerbated the overall household food security. Given a trade-off in terms of time, this deducts from the time a woman would have devoted to domestic work, including food preparation. The impact was slightly higher on iron and protein security. This is not surprising given that the main sources of protein and iron are beans that are said to be time- and fuel-consuming in terms of the preparation method. The elasticities with respect to a woman's time spent on productive activities range from 0.45-0.93.

Surprising to note was the positive and significant elasticities of time allocated to productive activities by the husbands, ranging from 0.11 to 0.59. Spending more time on productive activities by husbands led to improvements in household food security in all districts, except for iron in the case of Kiboga and Mbarara. However, time spent on productive activities by a woman showed a significantly (with p-value < 0.06) higher impact on proxies of household food security than that of a man in all districts, except for iron in

Kiboga. The finding portrays imperfect substitution between labour of a woman and a man. A joint test of all women-specific variables was also carried out. In Mbarara and Kiboga, the joint test was highly significant (with p-value < 0.04) for all household food security measures. On the contrary, a joint test was only statistically significant (with p-value < 0.06) in the case of calorie security in Pallisa.

The results demonstrate that caloric intake is not an overall measure for household food security. Clearly, considerable variations were noted on the impact of exogenous variables on all the three measures. Cautiously, policies aimed at improving caloric intake may fail to address the deficiencies in other nutrients.

Estimated Results on the Production Side

Results on the production side of the non-separable agricultural household model are reported in Table 2. Generally most food prices were not statistically different from zero. In part, the level of aggregation of food prices may have affected their significance. On the other hand, the omission of some variables[37] such as land degradation and post-harvest technologies may stand culpable for the low significance of some parameter estimates.

Table 2

Results on the Production Side of the Non-Separable Agricultural Household Model

	Kiboga		Mbarara		Pallisa	
Variable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
*In*CSP	-0.06	-0.81	0.05	2.29*	0.15	2.45*
*In*NBP	-0.04	-0.98	-0.04	-1.08	0.03	0.75
I*n*SMP	0.02	0.54	-0.02	-0.59	0.03	0.53
*In*Map	0.07	1.04	0.48	17.31*	-	-
Extension service	0.38	1.47#	-	-	-0.30	-1.64#
Hired labour	0.27	1.34#	0.51	1.10	-	-
Improved seed	-	-	0.52	1.23	0.32	1.01
Credit facilities	-0.53	-1.88#	-0.09	-0.17	-	-
Farming land	0.31	1.80#	-0.10	-0.25	-0.28	-1.71#
Farming equipment	-	-	0.09	0.20	-	-
Educ2	0.17	0.57	0.95	2.15*	0.73	4.19#
Educ3	0.06	0.17	0.65	1.13	0.61	1.63*
*In*Age	-	-	-0.50	-2.95#	0.67	2.66#
Hmem	-	-	-0.30	-0.79	-0.04	-0.27
*In*Fwom	0.30	0.86	0.11	2.24*	1.16	1.49*
I*n*Fman	0.03	0.12	0.14	2.85*	0.41	1.29

Head	-0.15	-0.29	-0.24	-0.61	-0.24	-0.39
*ln*Size	0.68	3.48	0.90	7.12*	-	-
*ln*Cons	-	-	-	-	-0.11	-0.94
*ln*Distance	-	-	-0.17	-2.56*	-	-
Constant[a]	3.27	4.17*	4.18	4.70*	-1.15	-0.68
$\overline{R}^2$	0.36		0.27		0.37	

Notes: *Significant at 90% level of significant or better using a two-tailed t-test, #Significant at 90% level of significant or better using a one tailed t-test.
[a] Estimate for the constant in case of Mbarara is not the true constant. It is a variable estimate for the corrected heteroscedastic output equation.

The price of the cereal and matooke groups in Mbarara and cereal group in Pallisa indicated significantly positive effects on the overall household food production. The increase in price raises household’s income that may in turn be utilised to improve production of not only the foods in these groups but also other crops produced by the household. The elasticities with respect to food prices on both sides of the model were notably within the same range. Matooke price in Mbarara district affected not only household food production but also household food consumption as discussed above. This is indicative of the non-separable nature of household consumption and production in terms of matooke price. On the contrary, cereals affected food production but not consumption in Pallisa; and price of legumes affected household food consumption but not production in Kiboga. A joint test on all food prices was statistically significant (with p-value <0.03) in the case of Mbarara and Pallisa.

Results suggest that access to productive resources, individually, by the rural woman varied greatly in terms of signs and magnitudes. This finding is inconsistent with those reported in previous non-empirical studies[38] that perceived the impact to be the same. A woman’s access to productive resources was hypothesised to improve food production. However, it is evident in Table 2 that some productive resources negatively affected household food production contrary to expectation. In Mbarara and Pallisa districts, accessibility to improved seeds positively affected household food production, albeit insignificantly.

The elasticity with respect to access to formal credit was negative and significant in the case of Kiboga. In part, the fact that formal credit was tied to the non-food crops could have contributed to such a finding. Whereas access to farming land significantly increased household production in Kiboga, it led to a decline in the same in the case of Pallisa. Access to marginal land by women in Pallisa could partly explain the decline. In Kiboga district, woman's access to hired labour, extension services and farming land positively affected the overall household food production, with a slightly higher response for the extension services.

Women's education results indicate significant positive effects on the overall household food production in Mbarara and Pallisa. Educated women have a capability to process and apply the information passed to them, such as better farming methods and seed selection. Overall, the primary education of the woman had a higher impact on household food production than the other variables in the case of Mbarara. Women's education affected not only household food production but also household food security.

Unlike the consumption side of the model, time spent on productive activities by a woman was positive and significantly affected household food production except for Kiboga. The impact was slightly higher for Pallisa. Despite differences in signs time spent on production activities by a rural woman affects both her household production and consumption decisions. A joint test on all women-specific variables was statistically significant (p-value < 0.09) for all districts. The elasticity with respect to the time a man spent on productive activities was highly significant and positive for Mbarara and Pallisa.

Women Labour Supply

The results of labour supply from a non-separable agricultural household model are reported in Table 3. The number of significant variables varied from district to district. More than 50 percent of the variables were found significant for Kiboga and Mbarara and only less than 50 percent for Pallisa.

Table 3

Results form the Non-separable Agricultural Household Model for Women Family Labor Supply

	Kiboga		**Mbarara**		**Pallisa**	
Variable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
*In*Meat	0.03	1.20	-0.02	-1.11	-0.02	-0.48

*In*Cereal	0.01	0.27	-0.10	-2.48*	0.00	0.20
*In*Oils	-	-	0.02	1.35	0.03	0.23
*In*Tubers	0.00	0.11	0.03	1.30	0.03	0.96
*In*Legumes	0.28	6.13*	-0.02	-0.51	-0.04	-1.91*
*In*Matooke	0.01	0.43	-0.03	-1.16	0.25	1.45
*In*Miscellaneous	-0.02	-0.68	0.04	1.24	0.05	0.90
Extension services	0.29	3.54#	-	-	-0.02	-0.28
Hired labour	-0.03	-0.46	-0.05	-0.65	0.08	1.71#
Improved seeds	-	-	0.00	-0.00	0.03	0.43
Credit facilities	-0.02	-0.29	-0.10	-1.16	-	-
Farming land	-0.00	-0.08	-0.11	-1.65#	-	-
Farming equipment	-	-	0.17	2.32#	-	-
Educ2	0.34	3.42#	0.16	1.83#	0.00	0.10
Educ3	0.28	2.36#	0.20	1.82#	0.10	1.03
*In*Age	-	-	-0.23	-2.10#	-0.06	-0.82
Hwom	-0.10	-1.64#	-	-	-0.09	-1.92#
Hmem	-	-	-0.15	-2.11#	-	-
Head	-0.13	-1.69*	-0.29	-3.05*	-0.05	-0.69
*In*Size	0.14	1.78*	-	-	0.11	2.63*
*In*Cons	-	-	-0.07	-1.53#	-0.01	-0.41
Constant	-0.57	-1.18	3.30	4.93*	0.24	0.20
$\overline{R}^2$	0.45		0.28		0.24	

Notes: *Significant at 90% level of significant or better using a two-tailed t-test & #Significant at 90% level of significant or better using a one tailed t-test.

The impact of exogenous variables on a woman labour supply varied considerably from district to district. The elasticity with respect to a woman's access to extension services had a higher impact on her labour supply than any other variable in the case of Kiboga. In Mbarara, headship had a higher impact and size in the case of Pallisa than any other variables included in the model. Primary education showed a higher influence than health variable in Kiboga and Mbarara. Furthermore non-separability of woman labour supply and household production showed up in different variables across the districts, for instance, cereal and matooke price in Mbarara and extension services in Kiboga. The significance of the joint test on women-specific variables for woman labour supply and household food production in the case of Kiboga further confirm the non-separability. There is also evidence to justify the non-separability of household food security and a woman labour, although it varied considerably across the districts. Such variables include education of a woman, size and matooke price in Mbarara district and joint test on women-specific variables in Kiboga.

Men Labour Supply

The results of the men labour supply are reported in Table 4. The education and age variables included were those for men. Results suggest that as a man gets older, his labour allocated to productive activities increases in the case of Kiboga and Mbarara contrary to expectations. The age of a man significantly affected his labour supply in Kiboga and Mbarara. In absolute terms, the impact of age was slightly higher in Mbarara. The positive sign on the age of a man was contrary to that of a woman in Mbarara. The explanation for the positive sign could be as follows. The younger men were more likely to be involved in activities other than farming than the older ones. The poor health of other members of the household negatively affected the time the men spent on productive activities in Pallisa. The explanation may be that since men were mostly responsible for settling the medical bills, they had to put in more time so as to earn more.

Table 4

Results form the Non-separable Agricultural Household Model for Men Family Labor Supply

	Kiboga		Mbarara		Pallisa	
Variiable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
*In*Meat	-0.00	-0.07	-0.03	-0.66	0.03	0.38
*In*Cereal	0.03	0.68	0.16	1.66*	-0.04	-1.09
*InO*ils	-	-	0.00	0.00	0.43	1.56
*In*Tubers	-0.04	-0.62	0.03	0.62	0.04	0.47
*In*Legumes	-0.08	-0.69	-0.05	-0.44	-0.08	-1.67*
*In*Matooke	0.05	0.70	0.10	1.45	-0.04	-0.11
*In*Miscellaneous	-0.02	-0.34	0.08	0.86	0.22	1.52
Educh1	0.41	0.74	-	-	-	-
Educh2	0.05	0.34	0.48	1.76#	0.17	1.40#
Educh3	-	-	0.40	1.37#	0.04	0.27
*In*Ageh	0.49	9.18*	0.32	3.86*	-0.03	-0.18
Hmem	0.53	1.72*	-	-	-0.14	-1.41
*In*Size	-0.40	-2.10*	0.05	0.24	0.03	0.27
*In*Cons	-	-	0.18	1.54#	0.07	0.93
*In*Distance	0.07	1.18	-0.05	-0.48	-	-
Extension service	0.18	1.01	-	-	-	-
Hired labour	0.28	1.87*	-0.28	-1.57	-	-
Improved seeds	-	-	-	-	0.51	2.64*
Credit facilities	-	-	0.58	2.74*	-	-
Farming land	-0.10	-0.80	-	-	-	-
Farming equip.	-	-	-	-	0.16	1.31
Constant	0.74	0.69	-1.18	-0.96	-4.00	-1.25
$\bar{R}^2$	0.65		0.48		0.58	

Notes: *Significant at 90% level of significant or better using a two-tailed t-test and #Significant at 90% level of significant or better using a one tailed t-test

Results suggest that household size was negative and significantly affected a husband's labour supply in Kiboga. On the contrary, household size was not statistically different from zero in Mbarara and Pallisa, although positive. However, the consumer:worker ratio in the case Mbarara increased a husband's labour supply as expected.

Results suggest that a woman's access to hired labour significantly increased a husband's labour supply in the case of Kiboga. The reverse was true for Mbarara district. In Pallisa, a woman's access to improved seeds significantly increased the husband's labour supply. In Mbarara, a woman's access to credit facilities significantly increased a husband's time. This was contrary to what was observed for a woman labour supply in the same district.

Policy Implications

The results provide significant implications for food security planning in Uganda. No single policy can be prescribed for improving food security, instead a mix of policies has to be followed. Notably, the impact of these variables was not uniform across districts, suggesting that such variations should be taken into account in planning and designing policies for food security.

The conventional positive effect of income on household food security is supported by the findings. Raising real income will be a top strategy for increasing caloric intake especially in Mbarara and Pallisa, with a higher percentage of caloric insecure households. The study shares the popular view from previous studies[39] that raising income is a long-term strategy for improving food security at least in developing countries. This is especially so for those households already unable to reach 75 percent of the daily dietary intakes, especially in Pallisa district. At the current one-digit economic growth rate of Uganda, *ceteris paribus*, it will take several years for these households to be food secure.

The current efforts to fight rural poverty through the trickle-down policies by the Ugandan government leave a lot to be desired. The growing rural poverty[40] in the midst of strong economic growth reflects that such policies are instead deleterious to the welfare of the population. Policies that will lead to growth through poverty reduction with a human welfare perspective by creating gainful employment directly or indirectly, effective access to productive resources and social services, in particular to the most vulnerable persons should be adopted.

By extension, in pursuit to broaden its economic base and raise incomes of the rural poor, the government is promoting an export diversification policy. The policy seeks to shift reliance on traditional agricultural exports (such as coffee, tea and cotton) to non-traditional agricultural exports (such as beans, maize and simsim). This is an appealing policy on its face value, but its practicability without perpetuating household food insecurity is questionable. This is especially so if the current food crop yields remain unchanged. The negative sign on some of the food prices was to some extent reflective of households' involvement in food sale from their own subsistence. Therefore, mechanisms need to be put in place to ensure that raising income does not jeopardise improving household food security.

Another significant finding of the paper is that rural households in Uganda can no longer be treated as being at the level of subsistence production. They are not “uncaptured peasants” operating outside the money economy[41]. They respond to changes in food prices despite deriving much of their consumption from own production. The positive sign on some food prices suggests that increasing production of these particular food crops will increase the incomes of these rural households and in turn household food security. In other instances where the sign was negative some would argue that government should intervene and subsidise food prices for the vulnerable persons. Unlike some African countries (such as Zambia and Zimbabwe), the Uganda government exercises no control over food prices. Consequently, a solution to improving food security may not lie in food price regulation *per se*. The solution could follow from seeking policies that remove the current constraints that hinder rural women’s efforts to increase food production and in fulfilling other household obligations.

The most significant finding of the study is that the status of rural women’s status indubitably influences the overall household’s command over food. The impact of women specific-variables was higher compared to some other variables included in the model. Thus improving the status of rural women is central to improving household food security and production.

Clearly, there is a need to address time constraints faced by the rural women. Although increases in time spent on productive activities increased overall household production, it exasperated household food security with a higher impact on protein and iron. Improvement and development of appropriate technologies skewed toward indigenous technologies would be among such strategies aimed at improving the efficiency of women both on the farm and domestic activities.

The current education policy focuses on formal education, which is a long-term policy, paying little attention, if any, to non-formal education. The results have demonstrated that a household with a woman with no education stands a higher risk of insecurity. Thus, there is a need to promote non-formal education aimed at targeting those women who were unable to attend school and girls that dropped out of school early. These programs should go beyond mastering writing and reading skills to include skills in crop cultivation, post-harvest technologies, nutrition education to name a few. On the issue of formal education, the current emphasis by the government on primary education was supported by the results. With primary education a woman is to some extent informed about the importance of adequate dietary intakes. Such knowledge can substantially improve nutritional education and hence improve household food security. However, mechanisms must be put in place to ensure gender balance, which may have implications for girls' access to primary education.

The health policy emphasises preventive care[42]. Although very appealing to the rural population, it falls short in terms of implementation. The introduction of the user fee scheme has aggravated the rural population's access to health services. The implications for household food security are enormous, as the findings of the paper have demonstrated. Exempting the rural population from the user fee scheme, in the short-run, would do a lot of justice to household food security and to overall welfare of the household members. On the other hand, the government should increase its investment in the health of the entire rural community if food security improvements are to be realised. This is contrary to those studies (including IFPRI, World Bank and FAO) that have continued to advocate for such investments in women only.

Undoubtedly, improving women's access to productive resources is crucial for raising food production and in turn household food security. Rural women lack effective access to land. This calls for far-reaching agrarian reform policies. These policies should emphasis equity and empowerment of the stakeholders in agriculture in particular women *vis-a-vis* landlords. Rural women should be empowered to enable them to fully participate in the country's development.

The government also has a role to play in promoting rural financing, where private sector involvement is still insignificant. The government can provide credit to rural farmers in terms of agricultural inputs. This will minimise the rampant misuse of loans for consumption purposes. Linkages among farmers should be encouraged, where farmers could share knowledge on better soil conservation and farming practices, and food preservation methods. However, this should not be taken as a substitute for agricultural extension services provided by the government.

Although the current government liberalisation policies toward the agricultural input and output markets were not explicitly captured by the model, there is no doubt that such policies have indirect implications for household food security that are worth noting. Unfortunately participation in these markets by the private sector has not increased significantly as a result of liberalisation. This is partly due to the uncertainties in these markets. As a result the prices for inputs are reasonably high for the farmers, who are already living under poverty. Domestic food distribution from surplus to deficit areas is solely left to the private sector, whose main motive is profit maximisation. Intuitively, the private sector would not engage in such activities if they were not viable. Thus, government's intervention in the agricultural markets through provision of agricultural inputs in terms of credit or imposing a zero tariff on imports, and distribution of food to deficit areas is still important at least in the short term.

Conversely, inadequate rural infrastructure has partly contributed to the low participation in the agricultural sector by the private sector. This has also worked against rural farmers and resulted in the failure of some government policies toward rural areas. Thus, there is a need to strengthen infrastructure and streamline the flow of market information.

Sustainability of food security is important, as today's security does not guarantee tomorrow's security. This can only be achieved if the natural resources on which food production depends are utilised in a sustainable manner. Application of agricultural inputs in food production by farmers is negligible, land degradation is increasing and this is exacerbated by the rapid population growth. Intuitively, this situation cannot emerge without negative impacts on household food security. This demonstrates a need to promote ecologically and sustainable agricultural intensification.

Concluding Remarks

Notwithstanding the assumptions under which the model was estimated, the results of the analysis provide useful inputs for effective household food security planning and decision-making processes. The paper has empirically demonstrated how food security of the rural households responds to changes in exogenous factors, including the women-specific variables. This is a step forward in the "still fresh" food security research in Uganda. Furthermore, the paper has demonstrated that a complete non-separable agricultural household model could effectively be employed to explain the behaviour of rural households. Non-separability of household consumption and production decisions was evident form the findings when some exogenous factors influenced both decisions.

There is no single policy that can be employed to improve food security of the rural household. Instead a mix of policies were suggested, explicitly addressing the issues that are central to raising the productivity of these women. Rural women should be assisted to improve their productivity on an ecologically sound and sustainable basis. Additionally, to successfully implement the policies/strategies suggested above, participation of women in all aspects is fundamental. This is a key determinant of the government's success in achieving food security for all.

This being the first study of its kind to analytically address food security of the rural households, it could not cover all the issues and putting into considerations some limitations of the data. There is need for further research on food security in Uganda. There is also a need to relax the restrictive assumptions under which the above model was estimated. One would potentially be able to introduce risk in production; estimate a multicrop environment; take into account labour allocation by gender across different farming activities; and incorporate dynamics (time dimension) in the conceptualisation of food security. However, this depends on the government's commitment to data collection at household level on a regular basis.

Appendix 1: Data Collection Methodology[43]

The structured questionnaire used in the actual surveys was pre-tested with a pilot survey that was carried out on 20 households in three villages in Muduma sub-county, Mawokota county in Mpigi district. Random sampling techniques was used in selecting the sample. This exercise assisted in modifying and improving the questionnaire and training the field research assistants.

The field research assistants had the right mix of skills and knowledge of how to deal with respondents in the rural setting. These assistants had been exposed to data collection exercises during their Bachelor of Statistics degree course training and grew up in the rural areas. Uganda as a country has over 30 ethnic groups speaking different languages. This is also true at the district level. Therefore, to overcome the language barrier problem, it was imperative to employ assistants who were also fluent in the local languages. Editing of the questionnaire was carried out on the same day to minimise the incidence of erroneous recording. The actual surveys were carried out from February to July 1996. The data were collected from 300 households from three districts, namely Kiboga, Mbarara and Pallisa. These districts were purposively selected on the basis of their degree of food insecurity based on the previous studies. Kiboga district was selected as one of the districts with the most fertile soils and with high yields but prone to food insecurity, Mbarara as a district less prone to food insecurity and Pallisa as one of the districts with a high risk of food insecurity since 1992.

Over the survey period three visits were made, with the sampled households selected once in main survey. The household as a sampling unit was defined as a person or group of persons who live together under the same compound and have their meals together. A person was considered as a member of a household if s(he) had lived in the unit for at least six months prior to the main survey, else was considered a visitor. Two counties in each district were purposively selected based on the crops grown in the area with the exception of Kiboga district. The multistage random sampling technique was employed in selecting the sub-counties, parishes, and villages. In each county, two sub-counties were selected at random. In the selected sub-counties, two parishes were selected. Furthermore, random sampling was further employed in selecting three villages from each of the selected parishes. From the selected villages, random sampling was further employed in selecting 25 households for each parish. The selection of each sampling unit was based on the list of residents by village provided by the local councils.

The main respondents were women, who were either the head of the household or the spouse to the head of the household. In polygamous households, one woman was selected at random as the main respondent. The husbands were only interviewed for the section marked ëfor men onlyí.

The data on variables that are directly linked to the model are discussed here. Data were collected on the socio-demographic characteristics of all members of the household. More detailed data were collected on the socio-economic characteristics of the woman respondent and spouse, where applicable. The average daily time allocation was collected on both the woman respondent and her spouse, where applicable. Each gave her/his time allocation from the time one wakes up to when one goes to sleep. Data on sources and amount of weekly income were collected on the main respondent and her spouse where applicable. Data were also collected on decision making within the household and health status of the members.

Data on household food were collected on a 30-day recall basis prior to the surveys. The flexible-recall system not only covered the frequently consumed food items but also those infrequently consumed, such as meat. Furthermore, this system was less expensive and less time-consuming on the part of the respondent as compared to the 24 hours recall system commonly used by nutritionists. The women respondents were requested to recall all the food actually eaten by the household as a whole. Memory loss over 30 days was assumed to be negligible given the routine consumption patterns in the rural areas.

Food quantities consumed referred to those amounts that entered the cooking pot. Foods consumed away from home were ignored since it was impracticable to expect the respondents to report such information. The impact of the non-edible part and wastage during cooking and leftovers was assumed to be negligible. The respondents were requested to show the interviewers the unit of measure of each particular food just before placing it in the cooking pot. The quantities of food consumed were recorded in units such as tins, baskets, glasses and cans, which were household-specific measures. Kilogram equivalents of the household-specific measures were obtained by actual weighing of the food items for each village. It was not done for each household, as the local units did not vary much across households in the same village. Food items such as matooke, pineapples, chicken and cabbage were graded as average, medium and large. For each village these grades were converted into their kilogram equivalents. For those households that consumed food from the markets units such as bundles, tins, kilograms, glasses and spoons were recorded. For those foods reported in units other than kilograms, their kilogram equivalent was obtained by actual weighing of these food items in the nearest food markets. It was assumed that there was small variation in the amount of food measured in bundles during the 30 days prior to the survey. The quantities of the food consumed with their respective prices were recorded.

Getting information on the prices of the consumed food from the market created no problems. However, prices of the food items consumed from own production were based either on the prevailing village price at the time of the survey or how much the respondents were willing to sell their food items. These prices were checked against prices in the nearest food markets. The prices per local unit measurement were respectively converted into price per kilogram at the data processing stage.

Data on household food production were collected for the season prior to the survey. A subjective method was used to obtain data on their production. The food crops produced were categorised as major, minor and famine crops. Other data collected included the size of the holding[44], years of farming on the same holding, access to productive resource, and availability and accessibility of social infrastructure. Data on agricultural implements used on the farm, and livestock and poultry ownership differentiated by gender were also collected.

Appendix 2

Descriptive Statistics for Selected Variables

	Kiboga			Mbarara			Pallisa		
	Mean	Standard deviation	Valid cases	Mean	Standard deviation	Valid cases	Mean	Standard deviation	Valid cases
I. Group Prices (Ug.Shs)									
a) Consumption side									
Meat	1,262.60	453.00	97	852.50	448.10	93	1,323.30	672.90	65
Cereal	565.90	172.00	93	333.40	154.50	98	267.90	116.50	95
Oils	1,409.10	638.60	90	2,778.90	654.60	87	1,413.10	378.70	37
Roots and tubers	117.00	52.10	95	162.70	79.40	89	117.00	66.50	99
Legumes	456.90	156.40	98	375.80	127.60	99	362.40	92.20	97
Matooke	113.70	20.30	96	73.40	14.60	92	121.30	26.80	27
Miscellaneous	630.70	239.40	98	609.10	263.20	98	817.50	287.40	55
b) Production side[45]									
Cereal	94.49	23.22	90	125.08	40.66	78	65.12	22.34	89
Legumes	347.18	154.21	87	322.79	99.88	95	331.11	164.49	91
Roots and tubers	216.78	123.37	71	180.21	41.58	85	147.85	74.48	92
Matooke	115.22	20.52	90	73.74	12.84	81			
II. Household Dietary Intake									
a) Actual intake									
Calories (kcal)	2,297.1	1,230.2		2,225.6	1,007.1		1,518.7	928.4	
Protein (gm)	66.3	42.5		64.9	34.1		39.8	22.2	
Iron (mg)	19.8	13.6		18.3	9.5		12.3	6.6	
b) Recommended intake									
Calories (kcal)	2,219.9	180.7		2,304.6	202.6		2,292.8	169.7	
Protein (gm)	39.7	3.7		41.6	4.2		41.4	3.4	

	Kiboga			Mbarara			Pallisa		
	Mean	Standard deviation	Valid cases	Mean	Standard deviation	Valid cases	Mean	Standard deviation	Valid cases
Iron (mg)	11.9	1.4		11.7	1.2		12.3	1.3	
c) Actual/Recommend (%)									
Calories	100.96	46.46		96.69	44.36		69.01	34.21	
Protein	160.18	85.80		153.97	73.97		98.94	52.13	
Iron	158.13	92.20		151.77	70.25		107.19	53.10	
III. Age									
Women	35.6	12.9		37.7	14.2		37.0	11.5	
Men	39.8	14.3		43.5	13.6		44.0	13.4	
IV. Time Allocation									
a) Productive activities									
Women	5.0	2.3		5.3	2.2		4.7	1.4	
Men	8.7	3.1		9.0	3.1		6.3	2.7	
VI Household characteristics									
a) Household size	6.4	2.79		7.4	3.34		7.9	4.4	
b) Proportion of children (%)	58.56	15.48	98	57.86	16.26	94	50.86	16.12	95
c) Proportion of female (%)									
d) Number of hoes	3.88	3.14		3.12	1.87		2.07	0.92	
VII Distance to social infrastructure (km)									
a) Safe drinking water	1.69	1.24		0.81	1.04		0.83	0.68	
b) Primary school	1.79	1.20		2.10	1.58		1.95	1.05	
c) Secondary school	4.28	2.00		4.31	2.56		3.91	1.85	
d) Trading centre	2.53	1.85		2.91	2.34		2.10	1.64	
e) Market	3.87	2.24		5.32	2.18		4.40	1.98	

	Kiboga			Mbarara			Pallisa		
	Mean	Standard deviation	Valid cases	Mean	Standard deviation	Valid cases	Mean	Standard deviation	Valid cases
f) Health centre/hospital	3.35	1.77		3.89	2.67		4.28	2.01	
g) Bus/taxi/motorable road	2.98	2.10		3.70	2.54		1.39	1.21	
VIII Others									
a) Savings ñ Women	10,125.00	9,252.79	24	16,293.44	22,278.20	32	3,650.00	1,915.58	10
b) Income ñ Women	6,414.04	8,610.09	54	15,250.97	33,767.83	73	5,353.51	13,959.84	76
- Men	12,889.74	14,805.61	39	25,885.03	45,685.36	72	9,696.57	14,680.27	77

Notes:

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[2] Based on food balance sheets.

[3] See, example, Simon Maxwell and Marisol Smith, 'Household Food Security: A Conceptual Review', Household Food Security: Concepts, Indicators, Measurements: A Technical Review, ed. Simon Maxwell and Timothy R. Frankenberger (Jointly sponsored by UNICEF and IFAD, 1992): 1-72; Simon Maxwell, ìFood Security: a Post-Modern Perspective', Food Policy, 41, no. 2 (1996): 385-399.

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[5] According to The New Vision, the local newspaper. Feeding on wild foods has never been a common practice among households.

[6] For example, Agnes R. Quisumbing, Lynn R. Brown, Hilary Sims Feldstein, Lawrence Haddad and Christine Pena, Women: The Key to Food Security, (Washington, D.C.: International Food Policy Research Institute, 1995).

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[23] See Republic of Uganda.

[24] See Appendix 1 for details.

[25] A 30-day recall system was employed as opposed to the 24-hour recall system. This enabled inclusion of the infrequently eaten foods.

[26] Some food items such as fish, maize on cob, eggplant, etc were excluded as it was difficult to quantify them.

[27] G. G. Judge, W. E. Griffiths, R. C. Hill, H. Lutkepohl and T. C. Lee, The Theory and Practice of Econometrics, 2nd ed. (New York and Brisbane: John Wiley and Sons, 1985); W. E. Griffiths, R. C. Hilland G. G. Judge, Learning and Practicing Econometrics, (New York and Toronto: John Wiley and Sons, Inc., 1993).

[28] See, for example, R. Ramanathan, Introductory Econometrics with Applications, 3rd ed., (London and Sydney: The Dryden Press, 1995), esp p. 426.

[29] See, for example, T. B. Fomby, R. C. Hill and S. R. Johnson, Advanced Econometric Methods, (New York: Springer-Verlag, 1985), esp. p. 284; W. H. Green, Econometric Analysis, 3rd ed., (New Jersey: Prentice Hall, 1997), esp. p.279.

[30] See, Fomby, p. 294.

[31] See, for example, David E. Sahn, ‘Nutritional Effects of Structural Adjustment in sub-Saharan Africa’ in Nutrition in the Nineties: Policy Issues, M. R. Biswas and M. Gabr, ed., (Dehli: Oxford University, 1994); Dale Heien and Cathy R. Wessells, ‘Demand Systems Estimation with Microdata: A Censored Regression Approach’, Journal of Business and Economic Statistics, 8, no.3, (1990):365-371; H. G. Jacoby, (1991 1993); C. A. Ramezani, D. Rose, and S. Murphy, ‘Aggregation, Flexible Forms and Estimation of Food Consumption

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[36] B. L. Rogers, 'The Implications of Female Household Headship for Food Consumption and Nutritional Status in the Dominican Republic', World Development, 24, no.1, (1996): 113-128.

[37] Lack of data on these variables led to their omission.

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[42] David E. Sahn; S. Okuonzi and J. MacRae, 'Whose Policy is it Anyway? International and National Influences on Health Policy Development in Uganda', Health Policy and Planning, 10, no. 2, (1995): 122-132; D. O. Okello, R. Lubanga, D. Guwatudde, and Abby Sebina-Ziwa, 'The Challenge to Restoring Basic Health Care in Uganda', Social Science and Medicine, 46, no. 1, (1998): 13-21.

[43] The senior author of this paper engaged in the data collection exercise with the assistance of field research assistants.

[44]Size of the holding did not necessarily refer to area planted.

[45] The food items included in the food groups differ slightly from those on the consumption side.