Household Landholding, Diversification of Agricultural Activities and Child Nutrition Status in Uganda

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Bringing Rigour and Evidence to Economic Policy Making in Africa

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Abstract

Using household-level data from the Uganda National Panel Survey, a panel probit estimation technique is employed to explain the causal relationship between household landholding, diversification of agricultural activities and children's nutritional status in Uganda. Our results indicate that household landholding and diversification of agricultural activities are significant factors that influence children's nutritional status. The results also indicate that food production among households is vital for household dietary diversity, which affects children's nutritional status. Our findings indicate that access to landholding by households is key to increased food production. In addition, there is a need to diversify farming systems and diversify income sources. Finally, there is a need for promoting access to local markets to enable households to sell their produce more easily, and to purchase the food they require.

Key Words: *Household landholding, Diversification of agricultural activities, Child nutrition, Uganda*

1. Introduction

Virtually every country on this planet is facing a serious public health challenge due to malnutrition, to the extent that one in every three people is affected (IFPRI, 2014). Therefore, malnutrition is not only a concern for the Ugandan community, but a global challenge with huge social and economic costs, and the biggest risk factor for the global burden of diseases (IFPRI, 2016). IFPRI (2016) shows that 159 million children under five years of age are stunted (low weight for age), while 795 million people are hungry. Food insecurity has unprecedented consequences, as noted by the WHO (2006). Micronutrient deficiencies afflict 2 million people worldwide, with iron deficiency alone affecting more than one-and-a-half million people in the world. In Africa and Southeast Asia, two thirds of pre-schoolers and around half of all pregnant women are anaemic. In addition, Vitamin A deficiency affects 250 million pre-school children, causing blindness in up to 500,000, half of whom will die shortly after losing their sight (WHO, 2016). When properly joined up, agricultural landholding, diversification of agricultural activities and nutrition constitute a common galvanizing approach to attaining food and nutrition security, an important goal of the Sustainable Development Goals (SDGs).

The consequences of malnutrition are massive, pervasive and often hidden. The WHO (2016) notes that malnutrition is a cause of 45% of all deaths in children under five years of age, amounting to over 3 million deaths each year. It stunts growth, erodes child development, reduces the amount of schooling children attain, and increases the likelihood of poverty in adulthood. It persists throughout the life cycle and across generations, with underweight mothers more likely to give birth to underweight children. Undernutrition reduces global gross domestic product (GDP) by up to USD2 trillion per year – the size of the total economy of Africa south of the Sahara (The World Bank, 2006).

Increasing food production is considered fundamental to fighting hunger, reducing social inequalities and lifting families out of poverty (WHO, 2015). Thus, agriculture is not only a source of food whereby farmers produce for own consumption, but also a source of income for food and non-food expenditures. Therefore agriculture, as a major direct and indirect source of livelihood for the majority of Ugandans (UBoS, 2018), influences diets and household nutritional status. Evidence shows that diversified agricultural activities and favourable agricultural conditions can boost food production and change the relative prices and affordability of specific foods,

which has an effect on household nutritional status. In addition, women's participation in agricultural activities and influence in household decision making and resource allocation may greatly affect the intra-household allocation of food, health, childcare and feeding. Conversely, women in agricultures' maternal nutrition health status may be compromised by often arduous and hazardous agricultural labour conditions that may, in turn, influence child nutrition outcomes.

The concept of food security centres on the individual and their capability to satisfy basic nutrition and health needs. It has been estimated that 795 million people suffer from undernutrition worldwide (FAO, IFAD and WFP, 2015), with about 780 million of these people living in developing countries (FAO, IFAD and WFP, 2015). Generally, incidences of malnutrition and food insecurity are a national burden created by food insecure households, which has negative consequences as households may remain chronically underfed and unable to fully participate in the economic development of the country (FAO, 2009). Possible illness due to insufficient nutrition could likely put pressure on state health resources. Food security is an issue of importance both at the microeconomic and macroeconomic levels. As a result, the diversification of agricultural activities for households living in developing countries and transition economies has a clear intuitive appeal because it is a form of risk spreading and allows overcoming credit market failures and internal/external shocks, which ultimately allow households to smooth their consumption (Ellis, 2000). The issue of diversification of agricultural activities has become prominent in studies on development (Carney, 1998).

In the case of Uganda, agriculture is the anchor of the country's economy, employing approximately 85% of the labour force and generating about 30% of GDP and 90% of export earnings (of which coffee accounts for 60%, and tea, sugar and cotton for about 20%) (UBoS, 2018). Food security in the country is determined by both supply and demand factors. The main goal of agriculture is to produce food of sufficient quantity (that is, enough calories) and quality (containing the vitamins and minerals that the human body needs) to feed all people on the planet sustainably so that they can lead healthy, productive lives. At a deeper level, the purpose of agriculture is not just to grow crops and livestock for food and raw materials, but to produce healthy, well-nourished people.

The different nutrition indicators include child stunting, wasting and underweight for children under 5, and anaemia. In Uganda, the prevalence of childhood malnutrition is worse in rural than in urban areas, regardless of the region (UBoS, 2018), which is typical in most developing countries (Ruel et al., 2013). In Uganda, 46% of rural pre-schoolers are stunted, compared to 26% in urban areas. Despite its seemingly low prevalence in urban areas, stunting affects approximately 225,000 urban pre-schoolers. In Uganda, stunting affects 29% (2.2 million), underweight 16% and wasting 5% (UDHS, 2016) of children under 5. Considering the well-documented, long-term negative effects of stunting on adult stature, body composition, work capacity and women's reproductive performance (Martorell, 1995),malnutrition is not only a health disaster by has wide socio-economic effects.

In Uganda, landholding policy (2013) has implications for household agricultural activities, which directly or indirectly affect household food consumption. It affects land size, and type of investments, such as modernization, security for credit and migration. The policy legally recognizes five forms of landholding: customary, mailo, freehold, leasehold and public. Notably, 16% of women own land and only 27% of land is registered with formal land titles (UBoS, 2018).

Increasing food production is considered fundamental to fighting hunger, reducing social inequalities and lifting families out of poverty (WHO, 2016). Thus, agriculture is not only a source of food whereby farmers produce for own consumption, but also is a source of income for food and non-food expenditures. Thus, agriculture is a major direct and indirect source of livelihood for the majority of Ugandans, as it influences diets and household nutritional status. Evidence shows that relevant agricultural policies and favourable agricultural conditions can boost food production and change the relative prices and affordability of specific foods, which has an effect on households' nutritional status. In addition, women's participation in agricultural activities and influence on household decision making and resource allocation may greatly affect the intra-household allocation of food, health, childcare and feeding. Conversely, women in agricultures' maternal nutrition health status may be compromised by often arduous and hazardous agricultural labour conditions, which may, in turn, influence child nutrition outcomes.

Although agricultural advances have been impressive in the past decades, progress in improving the nutrition and health of poor households in developing countries like Uganda has not followed suit (Carletto et al., 2015). As such, understanding the capacity of farming systems to contribute to improved nutrition outcomes is gaining ground as an objective among economists and other development professionals (Carletto et al., 2015). Diversified agricultural production is likely to provide a wide range of different types of food for poor population segments (Pingali and Rosegrant, 2015). Consequently, the impact of agricultural landholding on child nutrition is the subject of empirical analysis in Uganda, where land is not uniformly owned.

2. Methodology

Data

We use Uganda National Panel Survey (UNPS) data (UBoS, 2018), a nationally representative sample spanning 2009/10 to 2016/17, to examine the impact of household landholding and diversification of agricultural activities on child nutrition status in Uganda. The UNPS collected detailed information on agricultural production and marketing, land ownership and cultivated land, livestock, employment, transactions, food and non-food expenditure, children's anthropometric data from women and children under the age of five, education level, household size, and access to markets. It also collected information about food items produced, purchased and consumed by the household, and quantity of different food items that household members consume on a daily or weekly basis.

The UNPS also collected anthropometric data from women and children under the age of five. The children's nutrition status was measured by stunting, wasting and underweight (WHO, 2016). We used three nutritional indicators in our analysis: i) height for age, indicating stunting; ii) weight for height, indicating wasting; and iii) weight for age, indicating underweight. Stunting is the result of long-term insufficiencies in food intake, while wasting and underweight measure medium and short-term nutritional deficiencies. Hence, underweight manifests itself as a combination of stunting and wasting. The empirical analysis focussed on a sample of 18,367 farming households, defined as households that are involved in agricultural or livestock activities. The study used both descriptive analysis and estimation of a panel probit model to help measure the impact of different intensities of landholding and diversification of agricultural activities on child nutritional status in Uganda.

Conceptual framework

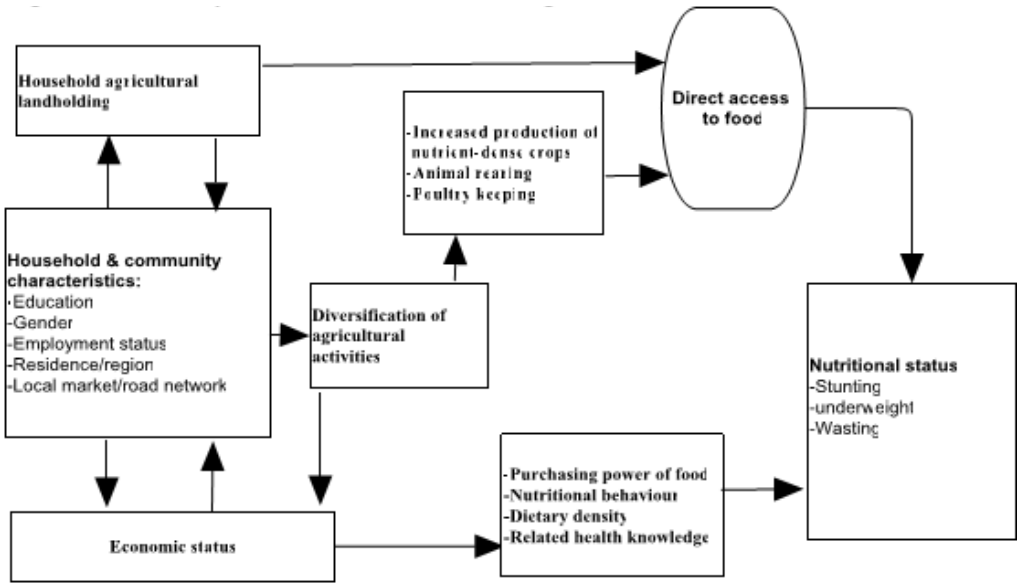
Figure 1 shows multiple proposed pathways through which agriculture may plausibly improve nutrition outcomes via production for own consumption and the income effect (Gillespie and Kadiyala, 2012; Meeker and Haddad, 2013; Ruel and Alderman, 2013; Herforth and Harris, 2014; Webb, 2013; The World Bank, 2014; Jones et al., 2014; Kadiyala et al., 2014). The own-consumption pathway applies to scenarios where

a household is growing food for own consumption and assumes that production practices have the potential to improve the diversity, nutrient quality and quantity of foods available to households all year. The income pathway assumes that agricultural earning via wages or sale of crops/crop products are used to purchase not only more food, but more high quality, nutrient-dense food. It also assumes positive synergies between improved dietary intake and improved health status. Production diversification, which specifically increased production of nutrient-dense crops and small-scale animal husbandry, is key to both these pathways. First, in terms of an immediate and fundamental increase in diet quality and diversity, i.e., pathway 1 and, second, in terms of increased resilience to climate and price shocks, a reduction of seasonal food and income fluctuations, and increased income generation, i.e., pathway 2 (FAO, IFAD and WFP 2015).

Figure 1 shows how household landholding affects nutrition status, both directly and indirectly. This means that it not only affects direct access to food and diversity in food intake, but also the economic and education status. These last two factors strongly influence purchasing power and nutritional behaviour, which further affects nutritional outcomes. Thus, there is a greater probability of undernutrition in the families of landless or small, marginal farmers that are not large enough to fully support food and nutrition security.

Our key argument is that food consumption explicitly enters household consumption and affects the overall welfare of the household members (Strauss and Thomas, 1995).

Figure 1: Pathways of household landholding, diversification and nutrition status



Source: Authors' own construction from reviewed literature (Herforth and Harris, 2014; Webb, 2013; The World Bank, 2014; Jones et al., 2014; Kadiyala et al., 2014)

To examine the effect of landholding and diversification of agricultural activities on children's nutritional outcomes, the household utility maximization model is used. This model specifies a household production function in which households use human capital and other goods to produce health as a final good (Strauss and Thomas, 1995). The model is modified to include other productive capital goods in the form of landholding and agricultural diversification practices that affect households' production potential. Thus, the household utility function is given by:

$$U = u(X, L, N) \tag{1}$$

Equation 1 assumes that a household has preferences that can be characterized by the utility function (U), which depends on the consumption of a vector of commodities (X), amount of leisure time (L), and nutritional health status of a child (N). The nutritional status of children is determined by food availability, morbidity, access to health services and the quality of care at home (Bourne, 2009). Thus, the nutritional outcome of each child at time t is given by the following production function:

$$N_{it} = n(C, K, H, Z, e) \tag{2}$$

In Equation 2, C denotes the consumption of goods and services by the household under consideration, K is a vector of child-specific characteristics such age, sex and size at birth; H is a vector of household-specific characteristics that include wealth, sex of household head, age of household head and geographical location/residence, employment status, decision making, domestic violence, and age at first marriage; Z is a vector of health variables, including child health such as medical care and sickness; and e is the child-specific disturbance term. In Equation 2, N is measured by the standardized anthropometric measures of height-for-age z-score (HAZ), weight-for-age z-score (WAZ) and weight-for-height z-score (WHZ). The z-scores are computed using the World Health Organization's recommended reference population (WHO, 2006).

Thus, the household utility function is maximized subject to several constraints, including a time-specific nutrition production function and income constraints. The budget constraint for the household is given as:

$$\sum_{i=1}^{T} P_i X_i = M \tag{3}$$

From Equation 3, P_i denotes the price of the i^{th} commodity, X_i is the complete set of commodities consumed including C and L, while M is the total money income. The constrained optimization of the utility function subject to the budget, time and nutrition production function constraints gives reduced demand functions for the purchased goods and the nutritional status of the children as follows:

$$H = \beta(P, M, K, Z, H) \tag{4}$$

From Equation 4, the functional form of the function $\beta(.)$ depends on the underlying function characterizing household preferences and the nutrition production function for children. Thus, Equation 4 allows for health demand which, in turn, reflects children's nutritional status expressed as a function of the right-hand side variables, all of which are exogenous independent variables of the model.

Empirical model

To analyze the effect of household landholding and diversification of agricultural activities on child nutrition, a rigorous analysis is undertaken by estimating the following empirical model:

$$Childn_{ijt} = \alpha_i + \beta Achat_{it} + \delta HDC_{ijt} + \theta CC_{ijt} + \pi Z_{it} + \emptyset HDDS_{ijt} + e_{ijt} \quad (5)$$

where $Childn_{ijt}$ denotes a vector of binary dependent variables consisting of the prevalence of stunting, underweight and wasting of children *i* from household j at time t. The three standard anthropometric indicators most used for monitoring malnutrition are stunting (HAZ); underweight (WAZ); and wasting (WHZ). These are used as binary variables for the reduced child nutrition models. The binary dependent variables (stunting, underweight, wasted) are coded "1" if a child is malnourished and "0" if not. Children with z-scores below -2 SD are regarded as stunted, underweight or wasted, while those above -2 SD from the WHO standard (WHO, 2006) are regarded as not malnourished.

Notably, stunting[1] as a measure for malnutrition is an indicator of long-term nutritional issues in children who suffer from growth retardation as a result of poor diets or recurrent infections, which puts them at significant risk of illness and death. Stunting is the result of long-term nutritional deprivation and often results in delayed mental development, poor school performance and reduced intellectual capacity. Second, WAZ is a composite measure that incorporates aspects of both stunting and wasting (Chirwa and Ngalawa, 2008). Underweight (low weight for age), is an indicator of malnutrition that increases the risk of child mortality, with severely underweight children at an even greater risk. Note that wasting measures only a short-term malnutrition condition. Wasting (low weight for height) is a symptom of acute undernutrition, usually as a consequence of insufficient food intake. It impairs the functioning of the immune system and can lead to an increase in the severity and duration of and susceptibility to infectious diseases and an increased risk of death. We do not argue that wasting as a measure of child malnutrition is not important, rather, we claim that it does not pose a significant problem if omitted in our study.

In Equation 5, *HDDS* denotes Household Diet Diversity Score (HDDS),[2] calculated by aggregating foods consumed by the child in the surveyed household. Respondents reported their consumption in the seven days prior to the interview, which was recorded in 12 equally weighted groups (A – Cereals; B – Roots and tubers; C – Vegetables; D – Fruits; E – Meat, poultry, offal; F – Eggs; G – Fish and seafood; H –

Pulses, legumes, nuts; I – Milk and milk products; J – Oil/fats; K – Sugar/honey; and L – Miscellaneous). The numbers in these groups were summed to obtain an HDDS (0 to 12) for the household as a whole (Swindale and Bilinsky, 2006; Kennedy et al., 2010). Each food group was assigned a score of 1 (if consumed) or 0 (if not consumed). The household score ranges from 0–12 and equals the total number of food groups consumed by the household, as defined in Equation 6:

$$HDDS_{it} = Sum(A + B + C + D + E + F + G + H + I + J + K + L) \quad (6)$$

Note that, while an HDDS assesses the presence of various food groups in a household's meals, it does not capture differences in the distribution of consumption, as all groups are equally weighted regardless of quantity consumed (Arimond and Ruel, 2004). To better understand the diversification of agricultural activities on child nutrition, we calculate the diversification using the Simpson index (Simpson, 1949) and the Shannon index (Shannon and Weaver, 1948) for the production of the major food groups: starchy foods, legumes/nuts/seeds, starchy vegetables, non-starchy vegetables, starchy fruit, non-starchy fruit, dairy and eggs. The two indices are used to estimate the relative concentration or "distribution" of food group consumption on child nutrition status. Both indices were calculated based on food consumption, which was assessed using expenditure shares from i) purchases, ii) home production, and iii) received as gifts or eaten out. The Simpson index is defined as:

$$Simpson\ index = 1 - \sum_i w_i^2 \quad (7)$$

From Equation 7, w_i denotes the expenditure share of food group i. The Simpson index ranges between "0" and "1". In this case, a value of zero implies only one food group is consumed while a value closer to one reflects a more even distribution of food expenditure by food type.

Another measure of the effect of "distribution" of food group consumption on child nutrition status, the Shannon index, is defined as:

$$Shannon\ index = 1 - \sum_i w_i \log(w_i) \quad (8)$$

From Equation 8, w_i is the expenditure share of food group i. Values for the Shannon index can range from zero to the value of the log of the highest number of the food groups consumed. A value of "0" flags consumption of only one food group to a maximum of log n (when all shares equal 1/n).

Taken together, the Simpson and Shannon indices are more typically used in agricultural analysis and they clarify the distribution or "evenness of consumption" of food consumed. In so doing, they add granularity to the HDDS, which captures only the "crude" diversity of diets.

In addition, *Achat* denotes agriculture characteristics (cultivated land size in acres; agriculture income; livestock as a binary variable, coded as "1" if household has livestock and "0" otherwise; crop diversity dummy coded as "1" if household practices diversification and "0" otherwise). *HDC* is a vector of demographic and socioeconomic characteristics (age of household head in years, sex, highest education of household, residence, house ownership, region and marital status). We also use *CC* as a vector of individual child characteristics (sex of child, Z is institutional factors, distance to market in km, sanitation index and *e* is an error term).

Model estimation

First, descriptive evidence for the study sample is provided using cross-tabulation for the key study variables and mean difference analysis. Second, before the empirical model is estimated, a number of diagnostic tests are carried out to ensure the appropriateness of the empirical model. Also, tests are undertaken for attrition bias in the data; if there are only a few, the fixed effects estimation technique is used, otherwise a random panel model estimation can be used. In order to analyze further how landholding and diversification of agricultural activities may affect child nutritional outcomes, directly through increased food production and more indirectly through changes in household capacity to purchase more food, various estimations for the empirical model (Equation 1) are undertaken in order to ascertain how child nutrition is influenced by household landholding and the diversification of agricultural activities, whether it varies between rural and urban areas, and if it there are any discernible differences in child nutrition between female-headed and male-headed households. Thus, the study results from the disaggregated analysis will shed some light on and provide policy guidance for the measures that can be put in place to overcome child nutrition challenges.

3. Results

Descriptive results

Figure 2 presents the national malnutrition status over the study period. It shows that children mainly suffer from stunting, ranging from as high as 33% in 2009 and reaching 34% in 2012, then falling to 31% in 2013 and 25% in 2015. Child stunting was highest in 2012, and was reduced by 9% in 2015. Child wasting is the least pronounced malnutrition problem affecting the Ugandan population, among children in particular.

Figure 2: Child malnutrition prevalence in Uganda (%)

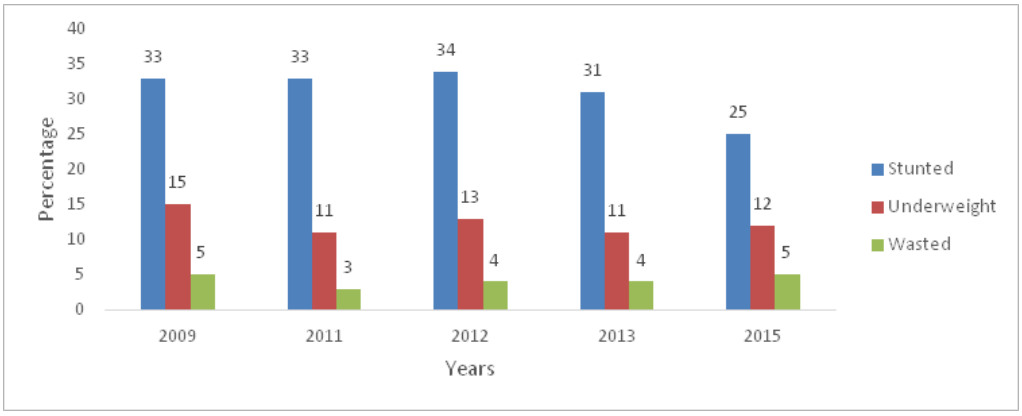
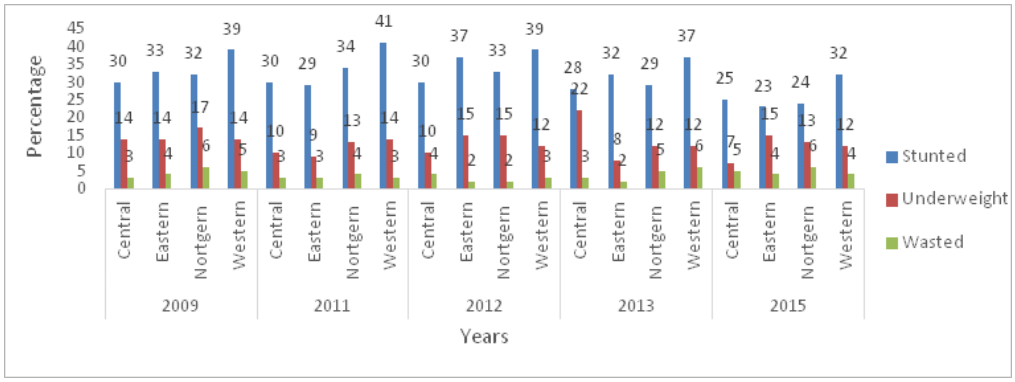


Figure 3 reveals that the Western region had the biggest number of stunted children (41%) in 2011, followed by the Eastern region (37%), and the Northern (32%) and Central (30%) regions. In terms of underweight, the Northern region had the biggest number of underweight children (17%) in 2009, followed by the Eastern region (15%) in 2012 and 2015, while the Central region had the lowest prevalence of underweight children (7%) in 2015. The data show that child wasting is a lesser malnutrition problem, ranging between 2% and 6% over the study period in the different regions.

Figure 3: Child malnutrition prevalence by region in Uganda (%)



Our findings reveal that child stunting is a critical health problem among rural children, with about 37% of children in rural areas suffering from stunting in 2009, compared to 22% of children in urban areas in 2012 and 2013 (Figure 4). The underweight malnutrition problem stood at 16% among rural children in 2009, while 10% of children in urban areas were underweight in 2011. As with child wasting, the problem is more prevalent among children in urban areas (7%) in 2015 compared to children in rural areas (5%) in 2009.

Figure 4: Child malnutrition prevalence by residence in Uganda (%)

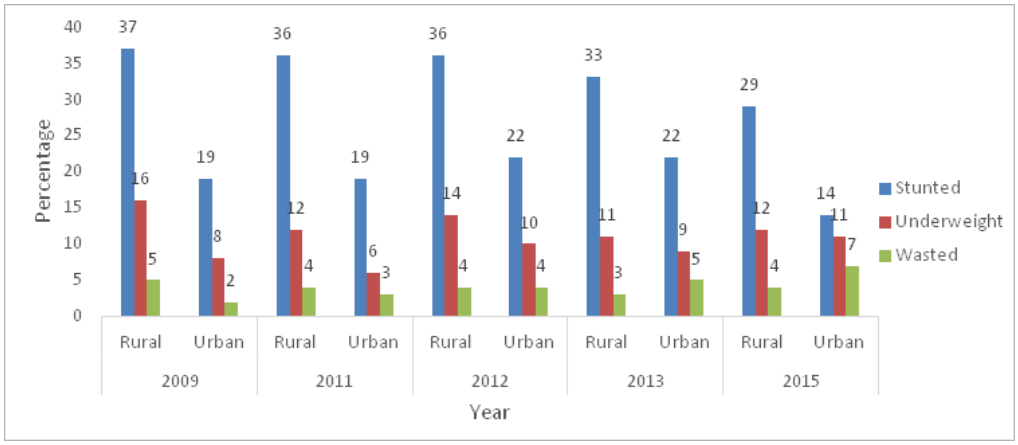


Figure 5 shows that the problem of child stunting is low among children in female-headed households compared to children in male-headed households across all the years. In addition, the problem of children being underweight and wasting were lowest among female-headed households at 9% and 4%, respectively. These findings imply that women place more importance on child nutrition than their male counterparts by providing more food varieties in their households.

Figure 5: Child malnutrition prevalence by sex of household head (%)

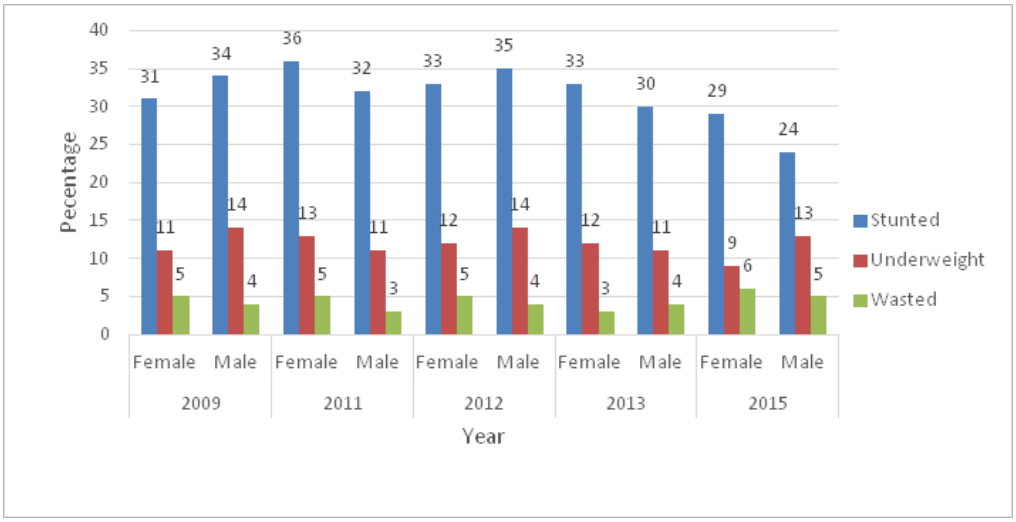


Table 1 shows that female and male-headed households' HDDS approximately constituted 6.7 and 6.9 food items, respectively. The data show that, on average, female-headed households were relatively older at 44 years old compared to the 43 years of their male counterparts. Female-headed households, on average, consisted of 6 members compared to 7 for their male counterparts. Table 1 shows that 57% of female-headed households were non-poor compared to the 60% of their male counterparts.

Table 1: Comparison of variables means between female and male-headed households

Variables	(Female)	Mean	(Male)	Mean	Mean Diff
Stunted	3534	0.330	12975	0.340	-0.010
Wasted	3526	0.0500	12869	0.0400	0.01***
Underweight	3565	0.120	13001	0.130	-0.01**
Land size	3595	0.930	13182	2.340	-1.61***
HDDS-12 crops	3569	6.720	13067	6.920	-0.19***
Simpson index	3569	7.603	2587	7.587	0.016
Shannon index	3569	7.634	2587	7.618	0.016
Age of household head	3292	44.47	12068	41.02	3.45***
Land access	3595	0.930	13182	0.940	-0.01***
Household size	884	6.110	2917	6.850	-0.75***
Poor	3595	0.570	13175	0.600	-0.03***
No education	3566	0.340	13116	0.110	0.23***
Primary	3566	0.540	13116	0.600	-0.06***
Secondary	3566	0.100	13116	0.230	-0.13***

continued next page

Table 1 Continued

Variables	(Female)	Mean	(Male)	Mean	Mean Diff
Postsecondary	3566	0.0200	13116	0.0600	-0.04***
Rural	3595	0.850	13182	0.880	-0.03***
Urban	3595	0.150	13182	0.120	0.03***
Central	3595	0.290	13182	0.240	0.05***
Eastern	3595	0.170	13182	0.250	-0.08***
Northern	3595	0.380	13182	0.340	0.04***
Western	3595	0.160	13182	0.170	-0.010
Access to roads	3317	0.800	12297	0.820	0.020
Local market	3317	0.540	12297	0.820	0.280
Agriculture	242	0.930	1978	0.700	0.23***
Wage employment	242	0.0700	1978	0.300	-0.23***
Married monogamously	3595	0.200	13179	0.760	-0.56***
Married polygamous	3595	0.290	13179	0.220	0.07***
Divorced/separated	3595	0.160	13179	0.0100	0.16***
Widow/widower	3595	0.350	13179	0.0100	0.34***
Has livestock	252	0.790	985	0.850	-0.06**
Consumption expenditure	3595	230000	13175	220000	5348
Non-consumption expenditure	285	160000	1028	190000	-24000

*** Indicates that the difference between the means is greater than zero at a significance level of 1%.
Source: Authors' calculation based on UNPS (2009, 2010, 2011, 2013, 2016).

In addition, 7% of female-headed households reported having wage employment compared to 30% of their male counterparts. Also, female-headed households spent more money on food consumption than their male counterparts, while male-headed households spent more money on non-food consumption. Women spending more on food is consistent with the findings of Farid and Wadood (2010) who show that expenditure on food is an important indicator of food security because it captures the concept of vulnerability to food insecurity. Interestingly, 82% of households reported access to roads, but only 54% of female-headed households reported living in villages with access to local markets compared to 85% of their male counterparts.

Empirical findings

We use a panel data sample for Uganda, which allows us to control for unobserved heterogeneity at the household level. For convenience, we assume that agriculture diversification indicators are exogenous. As the agricultural diversification indicators are complex and multidimensional, we choose to use a combination of them to explore their effect on child nutritional outcomes in order to gain insights into the relationship between agricultural diversification indicators and child nutrition status in Uganda.

Table 2 presents the estimated marginal effects for the effects of household landholding and diversification of agricultural activities on child nutritional status. Different specifications are estimated for the panel probit models to consider the effect of household landholding and diversification of agricultural activities on child nutritional status. First, the regression results for the estimated model reveal that household landholding is very important in influencing child nutrition status in Uganda. The findings show that household land ownership significantly reduces child stunting by between 5% and 3%, wasting by 3% and underweight by between 1% and 3%, compared to children living in households with no land. These results suggest that land is a critical resource that affects food security and the nutritional status of children at a household level, especially among vulnerable populations in a country like Uganda where 80% of people derive their livelihood from agriculture (Carletto et al., 2015; UBoS, 2016).

Also, the diversification of agricultural activities significantly reduces children's stunting by between 6% and 1%, and underweight between 2% and 1% compared to children living in households who do not practice diversifying agricultural activities. The results imply that the diversification of agricultural activities provide households with a variety of food, which implicitly reduces child stunting, wasting and underweight in households practicing diversification compared to children in non-diversifying households. This finding is in line with the findings by some authors (Carletto et al., 2015; Pingali and Rosegrant, 1995; Joshi et al., 2004) who concluded that the diversification of agricultural activities is vital for households' foods security and the nutrition requirements for children's growth. Besides, agricultural diversification is used as a tool to increase farm income, generate employment, alleviate poverty, and conserve soil and water resources.

The findings indicate that the HDDS index serves as a next-best option for assessing diet quality, reflecting what households are eating as a unit and thus providing important clues about the nutrient adequacy of the options available at the individual level. The findings show that in households with high food diversity, children are likely to be less stunted and underweight. This may provide a possible explanation for better food variety and food security that both have a direct and indirect effect on the nutrition of young children. This finding confirms the findings of Onyango et al. (1998) who note that improved consumption of nutritious foods, i.e., high HDDS, improves children stunting, wasting and underweight.

Also, the gender of the household head is an important factor that influences child nutrition status in Uganda. The findings show that the problem of child stunting reduces by 3% and wasting by 1% among children living in female-headed households compared to children living in male-headed households. This finding illustrates the strong relationship between child nutritional status and the gender of the household head, as noted by Farid and Wadood (2010), who indicate that the nutritional sensitivity of mothers compared to fathers is stronger with mothers, who take more care of their children than fathers. Our results also support the findings by Smale et al. (2015) who note that there is a close relationship between a woman's diet and the diet of their children, and that this is likely to affect their agriculture decisions.

In addition, the age of the mother has an important influence on their children's nutrition status outcomes. Our findings for young mothers (linear effect) reveal that

one additional year in the age of the mother increases the problem of child wasting by 2% and underweight also by 2%. Conversely, after a certain age the findings for an older mother (nonlinear effect of age) show that one additional year in the age of the mother reduces the problem of child stunting, wasting and underweight by 3%, 4% and 1%, respectively. This finding means that older mothers know more about how to take care of feeding their children than young mothers and, therefore, there is a need to promote advocacy for delayed motherhood..

Table 2: Effects of landholding and agriculture diversification on child nutrition in Uganda

Variables	Stunted		Underweight		Wasted	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	ME	ME	ME	ME	ME	ME
Own land	-0.054***	-0.025*	-0.031**	-0.032***	0.057	-0.011*
	(0.001)	(0.063)	(0.044)	(0.001)	(0.567)	(0.094)
Simpson index	-0.033***		-0.023***		-0.004	
	(0.002)		(0.009)		(0.462)	
HDDS		-0.010*		-0.008*		-0.001
		(0.068)		(0.068)		(0.736)
Household size	0.068**	0.033***	0.001	0.007	0.001	0.001
	(0.041)	(0.000)	(0.730)	(0.976)	(0.493)	(0.451)
Male household head	0.057**	0.065***	0.006	0.005	-0.000	-0.001
	(0.020)	(0.009)	(0.775)	(0.837)	(0.971)	(0.949)
Mother's age	-0.009**	-0.021*	0.007**	-0.019***	-0.006*	0.012**
	(0.029)	(0.069)	(0.042)	(0.009)	(0.069)	(0.033)
Mother's age squared	0.007*	0.037***	0.006*	0.035*	0.027***	0.013*
	(0.088)	(0.000)	(0.062)	(0.057)	(0.000)	(0.042)
Education (RC: No education)						
Primary	0.033*	0.007***	-0.031	0.018	0.016**	-0.011
	(0.087)	(0.000)	(0.107)	(0.335)	(0.014)	(0.168)
Secondary	-0.017	-0.018	-0.010	-0.012	-0.009	-0.011
	(0.381)	(0.384)	(0.553)	(0.467)	(0.324)	(0.225)
Postsecondary	-0.091***	-0.095***	-0.075***	-0.072***	-0.029***	-0.029***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Male child	0.059***	0.064***	0.005	0.008	0.002	0.002
	(0.000)	(0.000)	(0.680)	(0.523)	(0.766)	(0.836)
Urban residence	-0.123***	-0.123***	-0.030*	-0.031*	-0.002	-0.000
	(0.000)	(0.000)	(0.081)	(0.086)	(0.858)	(0.995)
Local markets	-0.061***	-0.031	-0.020**	-0.041	-0.072	-0.020
	(0.000)	(0.151)	(0.014)	(0.554)	(0.432)	(0.743)

continued next page

Table 2 Continued

Variables	Stunted		Underweight		Wasted	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	ME	ME	ME	ME	ME	ME
Regions (RC: Central)						
Eastern	-0.013	-0.012	-0.024	-0.019	-0.012	-0.013
	(0.589)	(0.597)	(0.183)	(0.300)	(0.260)	(0.226)
North	-0.049**	-0.050**	-0.014	-0.011	0.008	0.006
	(0.031)	(0.027)	(0.456)	(0.577)	(0.533)	(0.644)
West	0.081***	0.085***	-0.012	-0.009	0.012	0.009
	(0.003)	(0.002)	(0.532)	(0.656)	(0.391)	(0.512)
Marital status (RC: Single)						
Monogamous	0.079	0.061	-0.022	-0.041	-0.009	-0.011
	(0.230)	(0.379)	(0.744)	(0.560)	(0.832)	(0.805)
Polygamous	0.195*	0.179	-0.029	-0.042	-0.023	-0.024
	(0.077)	(0.103)	(0.608)	(0.424)	(0.328)	(0.287)
Divorced/separated	0.155	0.151	-0.023	-0.039	-0.013	-0.014
	(0.139)	(0.151)	(0.690)	(0.459)	(0.689)	(0.662)
Household expenditure	0.100***	0.083***	0.038**	0.021	0.010	0.009
	(0.000)	(0.000)	(0.027)	(0.257)	(0.350)	(0.425)
Employment sector (RC:)						
Agriculture	0.027	0.027	0.022	0.022	0.011	0.012
	(0.400)	(0.394)	(0.403)	(0.412)	(0.540)	(0.488)
Industry	-0.048	-0.050	0.026	0.029	0.020	0.016
	(0.224)	(0.209)	(0.510)	(0.482)	(0.492)	(0.582)
Services	-0.032	-0.028	0.006	0.009	0.021	0.023
	(0.338)	(0.407)	(0.831)	(0.753)	(0.345)	(0.306)
Observations	2,459	2,424	2,470	2,433	2,448	2,412
Log likelihood	101.5	12.78	41.21	97.13	14.12	32.27
Wald $\chi 2$	209.3	208.7	42.50	30.13	16.92	16.46
Prob > F/ $\chi 2$	(0.000)	(0.000)	(0.002)	(0.068)	(0.003)	(0.088)

p-val in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Furthermore, the findings of this study articulate that overly large households imply competition for food among household members, which might deny young children sufficient food consumption, which may subsequently cause poor child nutrition outcomes. This study indicates that one additional member added to the household is likely to increase the problem of child stunting at a rate of between 7% and 3%, while the problem of wasting is likely to increase by 3% if all other factors remain constant. Thus, a big household means oversharing of available food, which may lead to food insecurity and, subsequently, the malnutrition of children.

4. Conclusion

Household landholding and diversification of agricultural activities remain critical for improving the nutrition status of children in Uganda. The study reveals evidence of huge inequalities in agricultural landholding between male and female household heads, and low practice of diversification of agricultural activities in the country. Therefore, household landholding and diversification of agricultural activities remain critical for improving the nutrition status of children in Uganda. The findings of our study have important implications for public health policy makers, planners and organizations seeking to meet national targets. Policies need to consider the current diversification of agricultural activities of households and the consequences on wasting and stunting when implementing diversification strategies. The findings indicate that elevated levels of diversification could improve the wasting and underweight status of children by delivering a high amount of nutrients, but this may come at the cost of reducing the production efficiency of households and thus increase the possibility of longer-term stunting. Interventions focussed on improving the diversification of agriculture may enhance adequate and diverse food sources, while at the same time households would have excess produce for the market to meet their income demands. Therefore, there is a need to promote diversification of agricultural activities at the household level for further improvements in the nutritional status of children in Uganda.

The findings also offer evidence that the proportion of stunted, underweight and wasted children decreased with an increase in the size of planted crop area. The findings offer evidence that the proportion of children stunted, underweight and wasted decreased with an increase in the size of households' agricultural landholding. Therefore, it implies that households' access to usable agricultural land is one of the critical entitlements that is likely to pave the way for children's access to food, food diversity, and socioeconomic and nutritional security. Finally, there is a need for deliberate efforts to promote measures aimed at strengthening a gender-sensitive approach to agricultural production that does not set men and women in opposition to one another or assume that they have exact symmetry in roles, assets and responsibilities, because increasing women's control over land, physical assets and financial assets can improve children's health and nutrition.

Notes

1. Reflected by low HAZ.

2. The food included in the HDDS constitutes food purchased outside the home and consumed in or outside the home, home-produced food for own consumption, and food received as gifts for consumption. Thus, HDDS is used as a continuous variable.

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