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# Do agriculture extension policies improve nutrition outcomes? panel survey evidence from Uganda[1]


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Abstract

Skepticism on the impact of agriculture interventions on nutrition outcomes exists among academicians and development practitioners. We contribute to this discussion by examining the impact of agriculture extension on anthropometric nutrition outcomes for children below the ages of 5 years. We use nationally representative panel dataset for Uganda and control for endogeneity of receiving extension majorly due to self-selection by a weighted two stage regression procedure that uses propensity score matching in the first stage and weighted fixed effect panel regression in second stage. To understand the channels through which extension is likely to impact on nutrition, we hypothesize that receiving extension increases own food and market food consumption. Preliminary results show positive but insignificant impacts of extension on anthropometric measures of height for age, weight for age, weight for height and body mass index measures irrespective of whether households received extension on agriculture production, markets or received extension training. Receiving extension does have a positive insignificant impact on consumption from the market. On the other hand, receiving extension on production has a negative significant effect while extension training has a positive significant impact on own food consumption.

Key word: Extension, Anthropometry, own food consumption, market consumption

## 1.0 Introduction

Nutrition is essential for child growth including organ formation, immune system, neurological and cognitive development. On the other side of the coin, nutrition is also essential to achieve economic growth and human development. Child malnutrition is one of the causes of poverty as it impedes individuals from living healthy and productive lives. Despite these, malnutrition remains a development challenge for most developing countries with more than 90 percent of the world stunted children living in Africa and Asia as of 2011(UNICEF, WHO, & WorldBank, 2012). In Uganda, there are at least 6 million stunted children (UBOS & WFP, 2013) with children below five years of age constituting at least 19 percent of the Ugandan population(Uganda Bureau of Standards (UBOS), 2016). Walakira et al., (2016) estimated that about 100,000 children below five years of age are at risk of death due to increased prevalence of severe acute malnutrition

Agriculture has the potential of improving nutrition conditions in developing countries where a substantial proportion of the population relies on the sector as a livelihood source. Specifically, investments in extension services have the potential to improve agricultural productivity and increase farmer's incomes(Anderson & Feder, 2004). The dominance of own consumption in consumption for many households in developing countries suggest that constraints to agriculture production such as extension influence human nutrition (Muller, 2009). The linkages between agriculture and nutrition may seem obvious as more food should lead to better nutrition, nevertheless this linkage has not necessarily been obvious and remains debatable (Berti, Krasevec, & FitzGerald, 2003; Slavchevska, 2015). Alston et al., (2007) in reviewing a metastudy of several case studies on the evidence of the impact of and returns to investment in agriculture extension found a wide range of negative to positive rates of return (mostly positively skewed). Such evidence only increases the level of skepticism among policy makers on the effectiveness of agriculture extension on several outcomes (Benin et al., 2015). Studies evaluating the extension agricultural policy of Uganda have not given adequate attention to nutrition as an outcome (Benin et al., 2015; Okoboi, Kuteesa, & Barungi, 2013). Okoboi et al., (2013) for example only focused on the impacts of the policy on consumption expenditure without any focus on nutrition outcomes such as household dietary diversity. Benin et al., (2015) factored in nutrition security in his study from perception of households yet perceptions may not reflect the reality and may therefore not be comprehensive measure for nutrition security. In addition, they use internally collected data by NAADs in 2004 and 2005 which is likely to be positively biased by media and many researchers (Okoboi et al., 2013).

In this study, we focus on evaluating the impact of demand driven agriculture extension policy on nutrition outcomes using nationally representative data set. Unlike Okoboi et al., who use Uganda national panel program of 2009/10 linked to the Uganda national household Survey of 2005/6, we use Uganda national panel survey of 2009/10 linked to the Uganda national household Survey of 2011/12 and 2013/2014. The demand driven nature of NAADS program plus activities related to input distribution and advisory services ended in 2014. Therefore using the dataset which is close to the end date of the demand driven NAADS extension policy (ends in 2014) will provide more comprehensive results of the impact. Our contribution is therefore threefold: first providing a rigorous evaluation of a demand driven extension system that has only been unique to Uganda in Subsaharan Africa as far as we know. Second providing empirical evidence of impact of extension on nutrition outcomes that has hardly been studied in detail which is crucial to the ongoing debate of the effect of agricultural interventions on nutrition. Third using a nationally representative panel dataset that spans a long duration of four years of implementation of the program to evaluate an agriculture policy - a tasks which is often compromised due to data challenges.

In this regard, we propose to:

1. Examine the impacts of the demand driven extension policy on nutrition outcomes particularly anthropometric measures of children below the ages of five.
2. Examine the likely pathways through which the extension policy impacts on nutrition outcomes – own food consumption pathway and market consumption pathway.

We hypothesize that receiving extension has a positive impact on anthropometric measures of height for age, weight for age and weight for height for participating households. To understand the linkages of impact from extension to nutrition outcomes, we specifically hypothesized that the extension policy increases consumption from own food production and market access consumption. In the first scenario, extension increases the production and productivity of some or all crops grown within the household so that households don't have to purchase food and if even if they did, they only do so at a very small extent and rely on subsistence food production. On the other hand, extension increases household's participation in the market to sell food and earn income. Subsequently income earned can be used to purchase nutritious food to be consumed by households. Strauss & Thomas (1995) suggest that as expenditure or income increases, even the poorest households switch into higher-valued foods and foods that are more intensive in proteins improving on their nutrition. Besides in many developing countries given the market imperfections, nutritional status depends on the production of specific agricultural commodities rather than solemnly on income levels (Muller, 2009).

### 1.1 Context of Agriculture and extension policy in Uganda

Like most Sub Saharan African countries, Uganda's economy is highly dependent on agriculture. It is estimated that the sector employs about 72 percent of the total population of which 77 percent are women and youth. In addition, the current contribution of agriculture to the national Gross Domestic Product (GDP) at current prices is 23 percent (Uganda Bureau of Standards (UBOS), 2016). In 2010, agriculture accounted for the highest percentage (38%) of the total land usage in Uganda. Furthermore, the significance of agriculture in Uganda is majorly tailored for the rural population where the majorities are poor smallholder farmers deriving sustenance from small fragmented pieces of family land. According to the Uganda Bureau of Statistics (Uganda Bureau of Standards (UBOS), 2016), 21 percent of the chronically poor were employed in the primary sector (agriculture, forestry, and mining) with the situation more than thrice for the rural residents compared to their urban counterparts. Majority of smallholder households derive livelihood food sources through own-farm production, with most them producing at subsistence levels.

In an attempt to improve rural farmer's livelihood through improved agriculture productivity and profitability, Uganda has taken on a number of reforms in extension provision since the early 1980s. Until early 2000, the

Government of Uganda implemented the widely known publicly provided and funded traditional unified agricultural extension system. The traditional unified agriculture extension system was supply driven involving government local extension staff reaching out to farmers to provide agricultural advisory services. In 2001, there was a major shift of extension provision from the traditional unified agriculture extension system to National Agricultural Advisory Services (NAADS). NAADS was a move away from top-down approach that was publicly funded with services provided by public agents to a demand driven approach that was still largely publicly funded but with services provided by the private sector(Benin et al., 2015). NAADS was one of the seven pillars of the Plan for the modernization of Agriculture (PMA) established under the NAADS act. The act gave NAADS the mandate to develop a demand driven, farmer led agricultural service delivery advisory services. The demand driven principal would be premised on farmer empowerment and active participation with the overall goal of enhancing rural livelihood through improved agricultural productivity and profitability in a sustainable manner. This approach by NAADS was a deviation from the supply driven approach of the unified traditional extension system. Nevertheless, the NAADs program continued to be implemented parallel to the public extension system.

In 2001 when NAADS started it was piloted in six districts namely Arua, Kabale, Kibaale, Mukono, Soroti and Tororo in a total of 24 sub counties within the districts. By 2006/07, NAADS had extended to cover 83.1 percent of the total sub counties in Uganda at the time. NAADs empowered farmers by allowing them to decide on whether they wanted to be part of a NAADs group or not. NAADS groups were then asked to priotize three enterprises namely crop, livestock, fishery or bee keeping or a mixture and request specific technologies and advisory services associated with their preferred enterprises. These requests are lumped up at sub county level and forwarded to sub county farmer forum that selects three or four specific enterprises to be supported under NAADS at sub county level. It is at the sub county level that private professional firms are secured to provide specialized services like training and demonstration sites. In 2014, the demand driven extension approach provided by NAADS was restructured and a new integrated, coordinated and harmonized public extension system known as the single spine extension system was put in place (Barungi, Guloba, & Adong, 2016).

## 2.0 Theory and Review of literature

### 2.1 Theory

The household production framework (Strauss and Thomas, 1995) as well as the theory of health production function by Grossman 1972 can help us understand the key research question on the impact of agriculture extension on nutritional outcomes.

The underlying framework of the household model is such that households allocate time and goods to produce commodities some of which are sold to the market, some consumed while some virtually have no market. The Grossman model shows that health is a capital good and consumers choose a combination of health goods and other goods that maximize utility (Grossman, 1972)

Overall, households will aim to maximize a utility function consisting of nutritional status $S$, nonfood consumption $G$, food consumption $X$, other health goods $D$ leisure $L$ and taste $T$ (Equation 1) subject to a nutrition production constraint $NP$, time constrant $T$ and income budget constraint $I$. The nutrition production constraint will include household production, purchase and consumption of a nutritious food which will be affected by extension $E$ received by the household and other household characteristics $H$making extension an important input into the household model (Equation 2)

$U = u(NS, G, X, \mathrm{D}, L, T)$ Equation1

$NP = F(E, H)$ Equation 2

The above concept can be extended to understanding child nutrition which can be looked at as biological production function (Strauss & Thomas, 1995). The child production function relates nutritional status of the child to health inputs (Grossman, 1972). Child growth in terms of weight and height can be generated as a production function in which input allocations such as infant feeding or nutrient intakes results from household decisions (Strauss & Thomas, 1995) Households will seek to maximize child nutrition given available information and resources. The corresponding constraints can be modified to include inputs into child health as in equation 3

$N = F(W, H, Z, E)$ Equation 3

Where $N$ is the nutritional status of the child measured by anthropometric measures of height for age, weight for age, weight for height and body mass index. $W$ is a vector of child specific characteristics such as age, gender, belonging to multiple birth or singleton, $H$ is household specific characteristics such as mothers height, parental age and education, structure of the household such as household size and household assets. $Z$ is a measure of community variables such as access to medical facilities while $E$ are measures of extension access by the households such as receipt of training, extension on agriculture product, markets and prices.

### 2.2 Review of literature

Extension systems are intended to improve adoption of new and profitable technologies and practices by small holder farmers increasing production and income earned by farmers. We conceptualize the impact of extension program on nutrition outcomes by Figure 1. In this section we review literature on agricultural interventions particularly extension and how they are likely to affect nutritional outcomes including the channels of effect.

The dominance of own consumption in consumption for many households in developing countries suggest that constraints to agriculture production such as extension influence human nutrition (Muller, 2009). Evidence of the impact of adoption of agriculture technologies on nutrition vary depending on technology. Hallman, Kelly; Lewis (2003) find that non lumpy technologies have more positive effect on nutritional outcomes of children and women empowerment. Further, they find that group fishpond technology is highly beneficial to poor households leading to higher off farm incomes and improved nutritional status. Benson (2015) find a positive but weak and not significant association between irrigation and growth performance of children less than five years from these households who were practicing irrigation. Nevertheless, they find a stronger and significant association between adoption of irrigation farming and the diversity in the foods consumed by the farm households.

Evidence on the effect of farm diversity on nutrition outcomes seem positive (Luckett, DeClerck, Fanzo, Mundorf, & Rose, 2015; Malapit & Quisumbing, 2014; Sraboni, Malapit, Quisumbing, & Ahmed, 2013) Through encouraging farmers to diversify their crops, extension can improve nutrition outcomes. In Nepal, Malapit & Quisumbing, (2014) find that production diversity at household level determines maternal nutrition outcomes, mother's dietary diversity and body mass index. In Bangladesh, Sraboni, Malapit, Quisumbing, & Ahmed (2013) find a significant association between crop diversity and diet diversity but find no significant relationship between crop diversity and caloric availability.

One of the factors that affect nutrition outcomes is the availability of land, price of staple food, household size, characteristics of the household head, asset ownership and consumption of own produce; women's education, health care behavior and healthy environment (Bbaale & Bbaale, 2014; Chung, 2012; Sraboni et al., 2013; UNICEF, 1992). Chung (2012) emphasizes the inseparability of health care behaviors and environment and nutritional status of the individual.

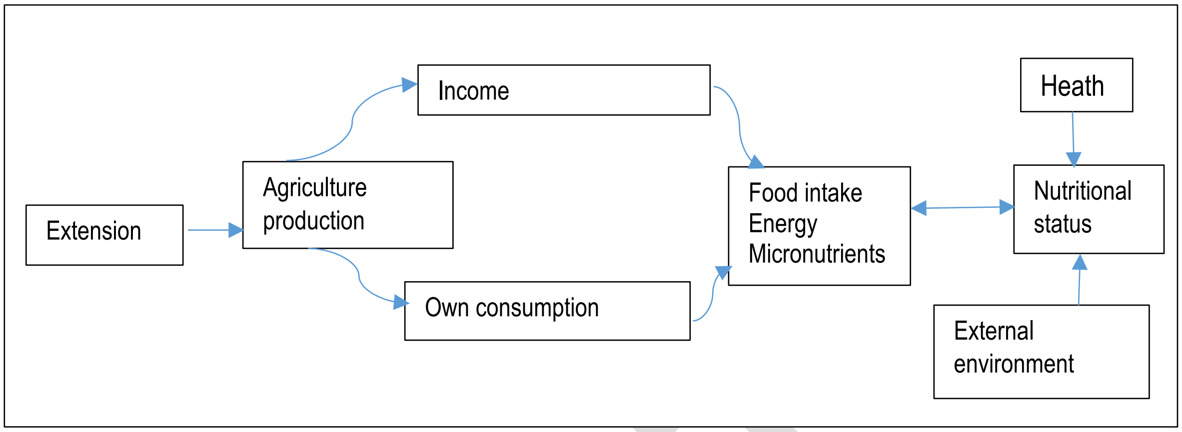
Sraboni et al.,(2013) find that ownership of land is associated with household diet diversity while Muller (2009) find a negative association between land and nutrition and attribute this to the likelihood that with larger land sizes, households have relatively large workloads. Slavchevska & Slavchevska (2015) find that crop values and large livestock ownership have a positive and significant effect on nutrition of children under 10 and they find that these effects vary between boys and girls. Muller (2009) in their study on whether agriculture production of partly autarkic households affects nutrition of these households find that several food outputs like beans and sweet potatoes have a positive effect on nutrition. Pandey, Mahendra Dev, & Jayachandran, (2016) find that the production of targeted nutrient rich crops, home gardens and diversification of agriculture production towards fruits and vegetables and aquaculture can have positive effects on nutrition.

Bbaale & Bbaale (2014) find that maternal education particularly post-secondary education is a crucial factor for child nutrition. Hallman, Kelly; Lewis, (2003) find that technology targeted towards women in households of small land holdings has positive effects on female empowerment and child nutritional status. Sraboni et al., (2013) find that women's score, the number of groups in which women actively participate, women's control of assets, and a narrowing gap in empowerment between men and women within households are positively associated with calorie availability and dietary diversity. On the contrary, Malapit & Quisumbing (2014) find that women empowerment is weakly associated with child nutritional status.

### 2.1 Conceptual framework: Linkages between agriculture extension and nutrition

The immediate causes of nutritional status of an individual are the dietary intake and health status whose underlying causes are centered on household food security, care for children and women, health services and a healthy environment (UNICEF, 1992). The linkages between extension and nutritional status of an individual should be such that extension should affect agriculture production which is expected to improve individual food intake by increasing consumption from own-production or contributing to household income for the purchase of food (Chung, 2012). Subsequently improved intake provides energy and micronutrients needed for growth, maintenance and activity. Therefore, extension may affect household nutrition through directly affecting own food consumption (Benson, 2015; Slavchevska, 2015). Extension has the potential of increasing agriculture production per unit area per year through adoption of improved technologies such as use of improved seeds and fertilizer. Extension can also indirectly affect nutrition though increased production of marketable higher value crops leading to increased incomes. Subsequently, the incomes can be used to meet the health and sanitation needs of household members for better health and nutritional outcomes. Strauss & Thomas (1995) suggest that as expenditure or income increases, even the poorest households switch into higher-valued foods and foods that are more intensive in proteins. So increases in income can be highly associated with improved uptake of nutritious foods within the household and hence high food intake. Given market imperfections in the developing context, the nutritional status of individuals depends also on the production of certain crops rather than on income solemnly (Muller, 2009).

**Figure 1: Conceptual framework of linkages between agriculture extension and nutrition**




Authors modification based on Chung (2012)

## 3.0 Data and Methods

### 3.1 Data used

We use the nationally representative Living Standards Measurement Survey household panel data set collected by Uganda Bureau of Statistics (UBoS) for the World Bank. From May 2005 to April 2006, UBoS carried out the Uganda National Household Survey (UNHS) that covered 7,421 households. In 2009, UBoS reinstated the annual Uganda National Panel Survey (UNPS) as part of the wider efforts to monitor government programs. It made an attempt to follow about 3,123 households out of the 7,421 households that were surveyed in 2005/06. Similarly, in 2011/2012 and 2013/2014, the same households that were followed in 2009 were also followed. The unique feature of the survey is the comprehensive agriculture module and comprehensive socio economic module that captures information on household demographics, health, employment and welfare. The agriculture module also captures aspects related to extension such as whether the household received extension services or not, the providers of the extension and what the extension message captured. In this study, we used the panel dataset from the years 2009/10, 2011/12, and 2013/2014. Given the interest in children ages 0 to 59 months, our panel data was unbalanced with some children occurring in some years and not in other years. In total, our dataset had 4,089 observations, 1,792 individuals in 2009/2010, 1,277 individuals in 2012 and 1,020 in 2014.

### 3.2 Variables and Measurements

Our main variables of interests in the study were nutritional outcomes namely stunting, wasting and underweight for children five years and below derived from anthropometric measurement, access to extension, own production consumption expenditures and market consumption expenditures.

*Participation in extension:* Households were asked if they received extension support from any sources like NAADS, non-governmental organization, cooperative farmer, input supplier, a large farmer or any other sources in the past 12 months. Table 1 shows the proportions of individuals from households that received extension in 2009/10, 2011/12 and 2013/2014. Overall, 19.9 percent of the children were from households who had ever received extension services in atleast one of the years. The highest proportion of households received extension services in 2011/12. The highest proportion of farmers also reported that they had ever received NAADS training particularly by 2013/2014. Households are at liberty to participate or not to participate in extension. Therefore there is some form of self-selection with more experienced farmers and wealthy farmers more likely to join extension groups than their counterparts who are poorer or less experienced in farming. Households were also specifically asked if they received extension on specific aspects of farming such as production, markets, prices, processing and livestock.

**Table 1: Receipt of extension services over the years in percentages**

| | Year | | | |
|---|---|---|---|---|
| | **2009/10** | **2011/12** | **2013/2014** | **All** |
| Received extension | 16.43 | 26.1 | 16.5 | 19.9 |
| Received extension on agriculture production | 13.39 | 25.05 | 15.87 | 18.3 |
| Received extension on markets | 6.03 | 12.16 | 6.24 | 8.25 |
| Received extension on processing | 4.02 | 8.14 | 4.54 | 5.63 |
| Received NAADS training | 18.52 | 18.72 | 21.19 | 19.29 |
| A member of the household is in farmer group | 22.27 | 25.44 | 24.23 | 23.65 |

**Nutrition outcomes**. We used anthropometric measures for children ages 0-59 months to proxy for nutritional status of the children. Anthropometric indicators length/height-for-age3 (HAZ), weight-for-age (WAZ) and weight-for-height4 (WHZ) are expressed using z-scores – the difference between a child's length/height/weight and the median length/height/weight of the WHO reference population for the same age and gender, divided by the standard deviation of the reference population (World Health Organisation, 1995). Acute malnutrition is weight for height measure and a low measure is an indicator of wasting, chronic malnutrition measured as height for age (HAZ below -2 standard deviations) is an indicator of stunting. Underweight or weight for age is an indicator of general malnutrition; it reflects the body mass relative to age. Using a reference population of well-nourished children, we calculated anthropometric indices expressed in the form of z scores. Z scores for a child's height or weight is obtained by subtracting the median height or weight from the reference population and dividing by the standard deviation of the reference population. Table 2 shows basic summary characteristics based on whether individuals were from households that received or did not receive extension services in any of the years. The mean HAZ of those who received extension services was -1.49 standard deviations while those from households that did not receive any extension services was -1.47 SD, Overall the mean HAZ for all individuals irrespective of whether one received extension or not was -1.47 SD. The proportion of those stunted seemed almost the same for those receiving and not receiving extension at 33.6 percent and 33.3 percent respectively. The mean WAZ is almost the same for both populations but those individuals from households that received extension services show a higher value for WHZ and BMIZ although the t values show no statistical difference. The child is nutritionally deprived if they were stunted, wasted or underweight and there is no significant difference between those whose households received extension services and those that did not. On average about 35.6 percent of the children in our data were nutritionally deprived.

**Household own production consumption and market consumption**: Household's own production consumption was computed from the household's recollection of own food consumed from its household production in the past seven days. The total own food consumption expenditure for the past twelve months was then derived by multiplying it with number of days in 12 months expressed in USD dollars.

Market consumption expenditure was computed from the household's recollection of food consumed in the past 7 days that was purchased. This excludes food that was undertaken outside the household such as in restaurants etc. The total market food expenditure for the past twelve months was then derived by multiplying it with number of days in 12 months expressed in USD dollars. The average own food consumption is higher for individuals from households that received extension than for those that did not receive extension and the difference is statistically significant. On the other hand, the market consumption for those individuals from households that did not receive extension is higher than for those individuals in households that received extension services.

**Independent variables**: Besides the dummy variable of participation or non-participation in extension, other independent variables whose inclusion in the models was guided by literature included: household factors that are likely to affect nutrition such as land size, education level of the mother, household size, presence of handwashing facility at the household; individual variables such as gender of the child, age of the child, whether the individual had received vaccinations or not and community variables such as distance to the market, distance to the extension agent. In Table 2, children from households that received extension services have on average similar ages with a slightly higher proportion of males in households that did not receive extension services although the difference is not statistically significant. Mothers of children from households that received extension services are statistically older and on average have higher years of education than their counterparts from households that did not receive extension.

**Table 2: Basic summary statistics by receipt of extension services**

| | Extension | No Extension | All | t statistic |
|---|---|---|---|---|
| Mean values | | | | |
| HAZ | -1.488(1.445) | -1.465(1.367) | -1.47(1.384) | 0.437 |
| WAZ | -0.734(1.045) | -0.748( 1.01) | -0.745(1.023) | -0.355 |
| WHZ | 0.175(0 .955) | 0.125(1.00) | 0.136(0.991) | 1.323 |
| BMIZ | 0.342(0.995) | 0.289(1.038) | 0.301(1.02) | 1.349 |
| Stunting+ | 0.336(0.472) | 0.333(0.471) | 0.334(0.471) | -0.172 |
| Wasting+ | 0.011(0.106) | 0.015(0.125) | 0.014(0.121) | 0.977 |
| Underweight+ | 0.112(0.316) | 0.114(0.319) | 0.114(0.318) | 0.191 |
| Nutrition deprived++ | 0.356(0.479) | 0.352(0.477) | 0.352(0.477) | -0.223 |
| Logarithm market consumption | 6.987(6.664) | 7.503(6.571) | 7.392(6.594) | 2.055 |
| Logarithm own production consumption | 12.266(4.474) | 11.283(5.228) | 11.494(5.091) | -5.086 |
| Age (months) | 39.19(11.12) | 39.36(11.09) | 39.33(11.09) | 0.403 |
| Child is Male+ | 0.4903(0.500) | 0.501(0.500) | 0.498(0.500) | 0.573 |
| Age of the mother | 32.967(12.665) | 30.738(11.93) | 31.21(12.121) | -4.725 |
| Years of education of the mother | 5.080(3.701) | 4.875(3.709) | 4.921(3.708) | -1.317 |
| Number of Observations | 879 | 3210 | 4089 | |
| Number of households | 357 | 1340 | 1697 | |

Figures in parenthesis refer to standard deviations, + shows dummy variables, while ++ is dummy variable and a a child is nutritionally deprives, if they are stunted, wasted and underweight.

### 3.3 Empirical strategy

First, we find the impact of extension on different anthropometric indicators namely height for age, weight for age and weight for height. Secondly, we find the effect of specific extension received such as extension on production practices, extension on market access and whether a household received training or not with NAADS. Following literature that food insecurity has effects on nutrition outcomes (UNICEF, 1992) and hence anthropometric measures, we test separately if extension increases own food consumption expenditures and increases market consumption pathways.

The impact of receiving extension on nutrition and can be measured as the difference between the expected value of $Y$ earned by each farm household $i$ participating in extension and the expected value of $Y$ the farm household would have received if the farm household had not received any extension services. The difference which is referred to as the Average Treatment Effect on the Treated ( $ATT_i$ ) is the impact of receipt of extension (Equation 1)

$$ATT_i = E(Y_{1i} / EXTENSION_i = 1) - E(Y_{0i} / EXTENSION_i = 1) \text{ --------------------------------1}$$

where $Y_{Ii}$ is the value of the outcome of individual $i$ in a household after receiving extension and $Y_{0i}$ is the value of the outcome of the same individual $i$ in a household that had not received extension. Nevertheless, we are unable to observe the same household when it has received and not received extension. Households also get to choose on whether to receive extension or not implying that those who benefit are more likely to be different than those who don't hence self-selection. The model specification for determining impact can be specified as equation 2 below

$$Y_{iht} = \beta_0 + \beta_1 EXTENSION_{iht} + \beta_2 HH_{iht} + \beta_3 FL_{iht} + \beta_4 COM_{iht} + \alpha T_t + \mu_i + \varepsilon_{it} \text{ ----------------------2}$$

Where $Y_{it}$ is the anthropometric measure of individual $i$ in household h in year $t$

$\beta_0$ is the constant, $\beta_1$ is the impact of receiving extension and is a dummy variable of participation or non-participation in extension. $HH_{it}$ are a set of household factors that are likely to affect nutrition such as land size, education level of the mother, age of the mother and many others while $COM_{it}$ are a set of community factors that are likely to affect nutrition such as distance to the market, distance to the hospital etc. $\alpha$ is a time fixed effects (FE) parameter where we specify fixed effects for the panel model, $\mu_i$ are unobserved household fixed effects and $\varepsilon_{it}$ is the normally distributed error term.

Receiving extension can be described by equation 3 below:

$$EXTENSION_i^* = \gamma_0' + \gamma_1 HH_{it} + \gamma_2 FL_{it} + \gamma_3 COM_{it} + \alpha T_t + u_i \text{ -----------------------3}$$

$$EXTENSION_i = \begin{pmatrix} 1 if EXTENSION_i^* > 0 \\ 0 otherwise \end{pmatrix}$$

Where $EXTENSION_i^*$ is a latent unobserved variable whose counterpart $EXTENSION_i$ is observed

Equation 2 is a reduced form model specification of the impact of receiving extension on anthropometric measures height for age, weight for age and weight for height. To understand the mechanism through which extension is likely to affect nutrition, we hypothesize that extension increases own food production consumption pathway and market consumption pathways with the reduced equations shown in equation 4 and 5 respectively.

$$OWNFOOD_{h,t} = \beta_0 + \beta_1 EXTENSION_{it} + \beta_2 HH_{it} + \beta_3 FL_{it} + \beta_4 COM_{it} + \alpha T_t + \mu_i + \varepsilon_{it} \text{ --------------4}$$

$$MARKETFOOD_{ht} = \beta_0 + \beta_1 EXTENSION_{it} + \beta_2 HH_{it} + \beta_3 FL_{it} + \beta_4 COM_{it} + \alpha T_t + \mu_i + \varepsilon_{it} \text{ ---5}$$

Where $OWNFOOD_{iht}$ is the value of own food consumed by household $i$ at time $t$ and $\beta_1$ is the impact of receiving extension on own food consumption and market consumption for household $i$ at time $t$ and $MARKETFOOD_{ht}$ is the consumption expenditure from market purchase of household $i$ at time $t$.

### 3.4 Endogeneity and identification

In this paper, the challenge is to attribute change in anthropometric measures and own production and market consumption expenditure to extension. It is even more complex when it is an extension policy given the so many confounding factors that may influence outcomes (Benin et al., 2011). Alston et al., (2000) in reviewing a metastudy of several case studies on the evidence of the impact of and returns to investment in agriculture extension found a wide range of negative to positive rates of return (mostly positively skewed). Such evidence only increased the level of skepticism among policy makers on the effectiveness of agriculture extension on several outcomes (Benin et al., 2011). Given self-selection into receiving extension, estimating equation 2, 4 and 5 by ordinary least squares yields biased results mainly due to overestimation given that those who receive extension may also have other characteristics that lead to better nutrition outcomes. Various methods have been employed to tackle this challenge namely instrumental variable method, fixed effect method from panel data analysis, propensity score matching, and experimental methods through randomized control trials. In this study, we employed a two stage weighted procedure in which we do a propensity score matching in the first stage and then a panel regression in the second stage. .

In propensity score matching, we matched recipients of extension to non-recipients of extension in the three years to ensure that they are as similar as possible in terms of pretreatment observable characteristics that could have affected the decision to receive extension as well as on the outcomes nutrition, own production consumption and market consumption. Propensity score matching uses the propensity score – the conditional probability of participation in the program to match recipients of extension with comparable group of non- recipients. Those for which a close match are not found are dropped off before estimation. The difference in the outcome between the two matched groups is the impact of receiving extension on our anthropometric measures and on consumption expenditures.

Similar to Benin et al., (2015), we used a combined matching and panel regression approach in a two-stage weighted procedure. In the first stage, we derived propensity scores by estimating the probit model for extension participation. In the second stage, we employ the propensity scores as weights in panel regressions. This approach allows for an overlap in the covariate distributions or common support between the treatment and control observations (avoid incidences of comparing apples and oranges). To assess the sensitivity of the results, we used a number of model specifications and different matching techniques. In determining the impact of extension on anthropometric measures, we used the fixed effect model given the heterogeneity within households that is likely to affect anthropometric levels. To find the impact of extension on own food consumption and market consumption, we employed the fixed effect poisson regression given that a number of observations for own food consumption and market consumption are likely to be zeros.

## 4.0 Results

### 4.1 Non parametric estimates of the impact of extension on height for age, weight for age, weight for height and body mass index.

### 4.2 Regression results for the impact of extension on anthropometric outcomes and own consumption and market consumption by households

Estimates for impact of extension on height for age measures (HAZ)

Table 3 shows the impact of extension by households on height for age for children below the age of five. Table with all the regressors is in Appendix 1. Columns HAZ1 and HAZ2 show the impact of overall extension received on HAZ irrespective of whether it was extension on production , marketing or prices. The effect on HAZ is insignificant for extension received by households. Column HAZ3 and HAZ4 shows the effect of total extension visits on height for age, the results are also insignificant showing no effect. The last column shows the effect of receiving NAADS training as form of extension on height for age and like the other forms of extension, the result is positive but insignificant. The NAADS program was a demand driven extension that was undertaken between 2001 and 2014, it incorporated an element of training in which households where encouraged to join groups and were trained in these groups. In conclusion we see a positive but insignificant impact of extension on HAZ.

**Table 3: Regression of effect of extension on Height for Age (HAZ)**

| | HAZ1 | HAZ2 | HAZ3 | HAZ4 | HAZ5 |
|---|---|---|---|---|---|
| Received extension+ | 0.011 | -0.033 | | | |
| | (0.09) | (0.11) | | | |
| Total number of extension visits | | | 0.014 | 0.012 | |
| | | | (0.05) | (0.05) | |
| Received NAADS training+ | | | | | 0.05 |
| | | | | | (0.20) |
| Gender of the household head+(cf: Male) | | 0.007 | | 0.004 | -0.106 |
| | | (0.11) | | (0.11) | (0.12) |
| Age of the mother | | 0.007 | | 0.007 | -0.013 |
| | | (0.02) | | (0.02) | (0.02) |
| Age of the child (months) | | 0.007* | | 0.007* | -0.232 |
| | | (0.00) | | (0.00) | (0.13) |
| Gender of the child+(cf; Male) | | 0.297*** | | 0.296*** | 0.265*** |
| | | (0.05) | | (0.05) | (0.05) |
| Constant | -1.459*** | -2.291*** | -1.459*** | -2.299*** | -1.541* |
| | (0.02) | (0.59) | (0.01) | (0.60) | (0.78) |
| Sigma_u | 1.233 | 1.501 | 1.235 | 1.501 | 1.361 |
| Sigma_e | 1.032 | 0.968 | 1.032 | 0.968 | 0.96 |
| rho | 0.588 | 0.706 | 0.589 | 0.706 | 0.667 |
| No. of Observations | 3,372 | 2,954 | 3,372 | 2,954 | 2,602 |

All models control for household size, wealth quintiles constructed from principal component analysis of majors assets within a household, a dummy for presence of a hand washing facility, year, a dummy for urban or rural. Figures in parenthesis are standard errors and ***p < 0.01, **p < 0.05, *p < 0.1. + represents a dummy variable.

## Estimates for effect of extension on weight for age measures (WAZ)

Table 4 shows the impact of receiving extension by households on weight for age for children below the ages of five. The full table with all the regressors is in Appendix 2. Columns WAZ1 and WAZ2 show the impact of overall extension received on WAZ irrespective of whether it was extension on production, marketing or prices of commodities received. The effect on WAZ is insignificant for extension received by households. Column WAZ3 and WAZ4 shows the effect of total extension visits on weight for age, the results show positive but insignificant effect of total extension visits on WAZ. The last column shows the effect of receiving NAADS training as form of extension on weight for age. Like the other forms of extension, the result is positive but insignificant. In conclusion we see a positive but insignificant impact of all forms of extension received on WAZ.

**Table 4: Regression of impact of extension on weight for age (WAZ)**

| | WAZ1 | WAZ2 | WAZ3 | WAZ4 | WAZ5 |
|---|---|---|---|---|---|
| Extension+ | -0.024 | 0.343 | | | |
| | (0.08) | (0.58) | | | |
| Total extension visits | | | 0.014 | 0.118 | |
| | | | (0.04) | (0.09) | |
| NAADS training+ | | | | | 0.03 |
| | | | | | (0.23) |
| Gender of the household head+ | | -0.823* | | -0.846 | -0.021 |
| | | (0.39) | | (0.43) | (0.10) |
| Age of the mother | | 0.073 | | 0.043 | 0.014 |
| | | (0.06) | | (0.05) | (0.02) |
| Age of the child | | -0.01 | | -0.011 | -0.004 |
| | | (0.01) | | (0.01) | 0.00 |
| Gender of the child+ | | 0.309*** | | 0.319*** | 0.271*** |
| | | (0.05) | | (0.05) | (0.04) |
| Constant | -0.726*** | -0.663 | -0.735*** | -0.359 | -1.246 |
| | -0.02 | -2.2 | -0.01 | -2.04 | -0.73 |
| Sigma_u | 0.907 | 0.922 | 0.909 | 0.938 | 0.953 |
| Sigma_e | 0.782 | 0.73 | 0.782 | 0.764 | 0 .713 |
| rho | 0.573 | 0.612 | 0.575 | 0.601 | 0.641 |
| Number of Observations | 3,372 | 3,039 | 3,372 | 3,012 | 2,602 |

All models control for household size, wealth quintiles constructed from principal component analysis of majors assets within a household, a dummy for presence of a hand washing facility, year, a dummy for urban or rural. Figures in parenthesis are standard errors and ***p < 0.01, **p < 0.05, *p < 0.1. + represents a dummy variable



## Estimates for effect of extension on weight for height (WHZ)

Table 5 shows the impact of receiving extension by households on weight for height for children below the ages of five. The full table with all the regressors is in Appendix 3. Columns WHZ1 and WHZ2 show the impact of overall extension received on WHZ irrespective of whether it was extension on production, marketing or prices of commodities received. The effect on WHZ is insignificant for extension received by households. Column WHZ3 and WHZ4 shows the effect of total extension visits on weight for height, the results show positive but insignificant effect of total extension visits on WHZ. The last column shows the effect of receiving NAADS training as form of extension on weight for height. Like the other forms of extension, the result is positive but insignificant. In conclusion we see a positive but insignificant impact of all forms of extension received on WHZ. Agriculture may affect short-term measures of nutrition such as weight, but it is expected to have no effect on long-term measures (height) (Slavchevska, 2015).

**Table 5: Regression of effect of extension on weight for height**

| | WHZ1 | WHZ2 | WHZ3 | WHZ4 | WHZ5 | WHZ6 |
|---|---|---|---|---|---|---|
| Received Extension+ | -0.037 | -0.03 | | | | |
| | (0.08) | (0.09) | | | | |
| Total extension visits | | | 0.015 | -0.017 | | |
| | | | (0.04) | (0.03) | | |
| NAADS training+ | | | | | 0.154 | 0.08 |
| | | | | | (0.22) | (0.24) |
| Gender of the household head+ | | 0.075 | | 0.075 | | 0.055 |
| | | (0.09) | | (0.09) | | (0.10) |
| Age of the mother | | 0.015 | | 0.016 | | 0.031 |
| | | (0.01) | | (0.01) | | (0.02) |
| Mother has a wage job | | 0.091 | | 0.091 | | 0.146 |
| | | (0.10) | | (0.10) | | (0.11) |
| Age of the child | | -0.003 | | -0.003 | | -0.004 |
| | | (0.00) | | (0.00) | | (0.000) |
| Gender of the child+ | | 0.216*** | | 0.216*** | | 0.187*** |
| | | (0.03) | | (0.03) | | (0.04) |
| Constant | 0.153*** | -0.56 | 0.140*** | -0.585 | 0.123** | -0.779 |
| | (0.02) | (0.53) | (0.01) | (0.52) | (0.05) | (0.70) |
| Sigma_u | 0.859 | 0.888 | 0.859 | 0.894 | 0.884 | 0.975 |
| Sigma_e | 0.77 | 0.729 | 0.77 | 0.733 | 0.76 | 0.72 |
| rho | 0.554 | 0.597 | 0.554 | 0.597 | 0.574 | 0.646 |
| No. of observations | 3,372 | 3,039 | 3,372 | 3,039 | 3,012 | 2,608 |

All models control for household size, wealth quintiles constructed from principal component analysis of majors assets within a household, a dummy for presence of a hand washing facility, year, a dummy for urban or rural. Figures in parenthesis are standard errors and ***p < 0.01, **p < 0.05, *p < 0.1. + represents a dummy variable



### Estimates for effect of extension body mass index BMIZ

Table 6 shows the impact of receiving extension by households on body mass index for children below the ages of five. The full table with all the regressors is in Appendix 4. Columns BMIZ1 and BMIZ2 show the impact of overall extension received on BMIZ irrespective of whether it was extension on production, marketing or prices of commodities received. The first column shows the results for regression in which only extension is controlled for. The effect of extension on body mass index is negative but insignificant for. Column BMIZ3 and BMIZ4 show the effect of total extension visits on body mass index height, the results show negative but insignificant effect of total extension visits on BMIZ. The last column shows the effect of receiving NAADS training as form of extension on weight for height. Contrary to other extension indicators, receiving NAADS training has a positive non-significant effect.

*Table 6: Fixed effect regression of the effect of different forms of extension on BMIZ*

| | BMIZ1 | BMIZ2 | BMIZ3 | BMIZ4 | BMIZ5 | BMIZ6 |
|---|---|---|---|---|---|---|
| Received extension | -0.04 | -0.016 | | | | |
| | (0.08) | (0.09) | | | | |
| Total extension visits | | | 0.02 | -0.012 | | |
| | | | (0.04) | (0.02) | | |
| Received NAADS training | | | | | 0.108 | 0.075 |
| | | | | | (0.22) | (0.24) |
| Gender of the household head | | 0.068 | | 0.068 | | 0.058 |
| | | (0.09) | | (0.09) | | (0.10) |
| Age of the mother | | 0.017 | | 0.017 | | 0.034* |
| | | (0.01) | | (0.01) | | (0.02) |
| Mother has a waged job | | 0.095 | | 0.095 | | 0.158 |
| | | (0.10) | | (0.10) | | (0.12) |
| Age of the child | | -0.008** | | -0.008** | | -0.009*** |
| | | (0.00 ) | | (0.00) | | (0.00) |
| Gender of the child | | 0.124*** | | 0.124*** | | 0.095* |
| | | (0.04) | | (0.04) | | (0.04) |
| Household size | | -0.008 | | -0.007 | | -0.037 |
| | | (0.03) | | (0.03) | | (0.03) |
| Constant | 0.316*** | -0.086 | 0.303*** | -0.101 | 0.300*** | -0.348 |
| | (0.02) | (0.52) | (0.01) | (0.51) | (0.05) | (0.68) |
| sigma_u | 0.894 | 0.966 | 0.909 | 0.966 | 0.915 | 1.030 |
| sigma_e | 0.791 | 0.738 | 0.799 | 0.74 | 0.786 | 0.74 |
| rho | 1 | 0.631 | 0.564 | 0.631 | 0.575 | 0.658 |
| Number of Observations | 3,372 | 2,954 | 3,372 | 2,954 | 3,012 | 2,602 |

All models control for household size, wealth quintiles constructed from principal component analysis of majors assets within a household, a dummy for presence of a hand washing facility, year, a dummy for urban or rural. Figures in parenthesis are standard errors and ***p < 0.01, **p < 0.05, *p < 0.1. + represents a dummy variable



### 3.2 Mechanism through which extension links with nutrition outcomes

#### Linkages between market consumption and extension

We estimate the effect of extension on market consumption by individuals by the two stage weighted procedure in which we conduct propensity score marching to control for observed differences between individuals who received extension or not, received extension on production, received extension in agriculture markets, total extension number of visits received and those who received training with NAADS. We also control for other observable characteristics such as gender of the household head, age of the household head, land size, household size, year dummies and many others. The second stage is a fixed effect estimation using the propensity scores from the first estimation as weights I the fixed effects estimation. Table 7 shows fixed effects estimates of the effect of receiving extension on logarithm of value of market consumption. Columns MKT1 and MKT2 show the results of the effect of receiving extension irrespective of whether it was advice on production, markets or training on market consumption expenditures by households. Columns MKT3 and MKT4 show fixed effect regression of the effect of extension on agriculture production on market consumption by individuals. Columns MKT5 and MKT6 show fixed effect regression of the effect of receiving extension on markets on market consumption while columns MKT7 and MKT8 show the fixed effect regression of the effect of total extension visits on market access consumption. Lastly columns MKT9 and MKT10 show the effect of receiving NAADS training on market consumption by households. Overall, the results show a positive non-significant effect of extension on market consumption by households although receiving training by NAADS does indeed increase market consumption by individuals by and is significant at 10 percent.

**Table 7: Fixed effects estimates of the effect of receiving extension on logarithm of value of market consumption**

| | MKT1 | MKT2 | MKT3 | MKT4 | MKT5 | MKT6 | MKT7 | MKT8 | MKT9 | MKT10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Received extension | -1.108 | 0.121 | | | | | | | | |
| | (0.75) | (0.42) | | | | | | | | |
| Received Extension on production | | | -1.989** | -0.001 | | | | | | |
| | | | (0.77) | (0.45) | | | | | | |
| Received Extension on markets | | | | | 0.686 | 0.58 | | | | |
| | | | | | (1.09) | (0.58) | | | | |
| Total extension visits | | | | | | | -1.303*** | 0.061 | | |
| | | | | | | | (0.31) | (0.14) | | |
| Received NAADS training | | | | | | | | | -0.194 | 0.262 |
| | | | | | | | | | (1.49) | (0.45) |
| Gender of the household head | | 1.025 | | 1.033 | | 0.997 | | 1.027 | | 1.210*** |
| | | (0.56) | | (0.55) | | (0.56) | | (0.56) | | -0.27 |
| Age of the household head | | -0.002 | | -0.002 | | -0.001 | | -0.002 | | -0.006 |
| | | (0.01) | | (0.01) | | (0.01) | | (0.01) | | (0.01) |
| Years of education of the household head | | 0.019 | | 0.022 | | 0.022 | | 0.023 | | 0.11 |
| | | (0.37) | | (0.37) | | (0.37) | | (0.37) | | (0.23) |
| Household size | | -0.06 | | -0.061 | | -0.065 | | -0.061 | | 0.034 |
| | | (0.13) | | (0.13) | | (0.13) | | (0.13) | | (0.08) |
| Landsize | | -0.036 | | -0.037 | | -0.039 | | -0.037 | | -0.066* |
| | | (0.04) | | (0.04) | | (0.04) | | (0.04) | | (0.03) |
| Ownership of bicycle | | 0.066 | | 0.074 | | 0.059 | | 0.073 | | 0.249 |
| | | (0.49) | | (0.49) | | (0.49) | | (0.49) | | (0.29) |
| Ownership of mobile phone | | 1.110* | | 1.111* | | 1.114* | | 1.112* | | 1.265*** |
| | | (0.55) | | (0.55) | | (0.55) | | (0.55) | | -0.29 |
| 2012 | | -11.534*** | | -11.525*** | | -11.509*** | | -11.546*** | | -11.565*** |
| | | (0.37) | | (0.37) | | (0.37) | | (0.38) | | (0.21) |
| 2014 | | -10.216*** | | -10.222*** | | -10.200*** | | -10.239*** | | -10.404*** |
| | | (0.45) | | (0.44) | | (0.45) | | (0.44) | | (0.27) |
| Constant | 7.688*** | 12.467*** | 7.853*** | 12.490*** | 7.360*** | 12.482*** | 7.692*** | 12.500*** | 7.680*** | 11.420*** |
| | (0.18) | (1.87) | (0.17) | (1.87) | (0.10) | (1.87) | (0.07) | (1.86) | (0.31) | (1.05) |
| Sigma_u | 5.537 | 3.277 | 5.555 | 3.28 | 5.523 | 3.278 | 6.071 | 3.285 | 3.728 | 3.226 |
| Sigma_e | 5.933 | 2.672 | 5.912 | 2.672 | 5.942 | 2.668 | 5.869 | 2.671 | 2.088 | 2.557 |
| rho | 0.465 | 0.6 | 0.468 | 0.601 | 0.463 | 0.601 | 0.516 | 0.601 | 0.761 | 0.614 |
| Number of Observations | 3,656 | 2,749 | 3,656 | 2,749 | 3,656 | 2,749 | 3,656 | 2,749 | 3,072 | 2,518 |

**Linkages between own food production consumption and extension**

We estimate the effect of extension on own food consumption by individuals by the two stage weighted procedure in which we conduct propensity score marching to control for observed differences between individuals who received extension or not, received extension on production, received extension in agriculture markets, total extension number of extension visits received and those who received training with NAADS. We also control for other observable characteristics such as gender of the household head, age of the household head, land size, household size, year dummies and many others. The second stage is a fixed effect estimation using the propensity scores from the first estimation as weights in this second regression of the fixed effects estimation. Table 8 shows fixed effects estimates of receiving extension on logarithm of value of own food production consumption. Columns OWN1 and OWN2 show the results of the effect of receiving extension irrespective of whether it was advice on production, markets or training on own production consumption by individuals. Columns OWN3 and OWN4 show fixed effect regression of the effect of extension on agriculture production on own production consumption by individuals. Columns OWN5 and OWN6 show fixed effect regression of the effect of receiving extension on markets on own food consumption while columns OWN7 and OWN8 show the fixed effect regression of the effect of total extension visits on own food consumption. Lastly columns OWN9 and OWN10 show the effect of receiving NAADS training on own food consumption. Overall, the results show a negative non-significant effect of extension on own food consumption by households although receiving extension on production does reduce own food consumption by 9.5 percentage points and is significant at 10 percentage points. On the other hand receiving training by NAADS does indeed increase own food consumption by 51.4 percentage points and is significant at 10 percent.

| | OWN1 | OWN2 | OWN3 | OWN4 | OWN5 | OWN6 | OWN7 | OWN8 | OWN9 | OWN10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Received extension | -0.164 | -0.417 | | | | | | | | |
| | (0.22) | (0.22) | | | | | | | | |
| Received Extension on production | | | -0.095 | -0.445* | | | | | | |
| | | | (0.23) | (0.21) | | | | | | |
| Received Extension on markets | | | | | 0.253 | -0.055 | | | | |
| | | | | | (0.28) | (0.17) | | | | |
| Total extension visits | | | | | | | -0.074 | -0.173 | | |
| | | | | | | | (0.08) | (0.09) | | |
| Received NAADS training | | | | | | | | | 0.212 | 0.514* |
| | | | | | | | | | (0.29) | (0.23) |
| Gender of the household head | | -0.116 | | -0.13 | | -0.138 | | -0.127 | | -0.275 |
| | | (0.28) | | (0.28) | | (0.28) | | (0.28) | | (0.31) |
| Age of the household head | | -0.002 | | -0.002 | | -0.002 | | -0.001 | | 0.002 |
| | | (0.01) | | (0.01) | | (0.01) | | (0.01) | | (0.01) |
| Years of education of the household head | | -0.359* | | -0.354* | | -0.369* | | -0.373* | | -0.316 |
| | | (0.17) | | (0.17) | | (0.17) | | (0.17) | | (0.17) |
| Household size | | 0.002 | | 0.005 | | 0.006 | | 0.007 | | -0.04 |
| | | (0.05) | | (0.05) | | (0.05) | | (0.05) | | (0.06) |
| Landsize | | 0.033** | | 0.034** | | 0.034** | | 0.035** | | 0.031** |
| | | (0.01) | | (0.01) | | (0.01) | | (0.01) | | (0.01) |
| Ownership of bicycle | | 0.24 | | 0.216 | | 0.214 | | 0.215 | | 0.406 |
| | | (0.31) | | (0.31) | | (0.31) | | (0.31) | | (0.33) |
| Ownership of mobile phone | | 0.209 | | 0.221 | | 0.205 | | 0.201 | | 0.185 |
| | | (0.31) | | (0.31) | | (0.31) | | (0.30) | | (0.34) |
| 2012 | | 0.196 | | 0.204 | | 0.163 | | 0.224 | | 0.276 |
| | | (0.24) | | (0.24) | | (0.24) | | (0.24) | | (0.26) |
| 2014 | | 0.387 | | 0.394 | | 0.405 | | 0.455 | | 0.574* |
| | | (0.24) | | (0.24) | | (0.23) | | (0.24) | | (0.29) |
| Constant | 12.221*** | 13.749*** | 12.202*** | 13.714*** | 12.159*** | 13.671*** | 12.197*** | 13.641*** | 12.751*** | 13.719*** |
| | (0.05) | (0.91) | (0.05) | (0.91) | (0.02) | (0.92) | (0.02) | (0.91) | (0.06) | (1.05) |
| Sigma_u | 5.013 | 3.44 | 5.011 | 3.44 | 5.005 | 3.437 | 5.016 | 3.461 | 3.728 | 3.376 |
| Sigma_e | 2.217 | 1.773 | 2.217 | 1.772 | 2.217 | 1.778 | 2.21 | 1.772 | 2.088 | 1.734 |
| rho | 0.836 | 0.79 | 0.836 | 0.79 | 0.835 | 0.788 | 0.836 | 0.792 | 0 .761 | 0.791 |
| Number of Observations | 3,656 | 2,749 | 3,656 | 2,749 | 3,656 | 2,749 | 3,656 | 2,749 | 3,656 | 2,749 |

## 5.0 Conclusion

In this study, we have explored the impact of extension on nutrition outcomes using anthropometric measures of height for age, weight for age, weight for height and body mass index. Using the assumption that nutrition is achieved through achieving food security, we hypothesized that extension increases market consumption and own food consumption of households. Conceptually, if extension is successfully done, households should be able to increase the production and productivity of number of crops, diversify in household production, have sufficient information on the production of nutritious foods, and have information on prices and the markets and many others. This should ultimately increase their income and hence purchase from the market various nutritious food or increase consumption of own production of various nutritious foods resulting into improved child nutritional outcomes. This is the underlying conceptual framework for this paper.

Using a two stage weighted fixed effect regression, we estimate the impact on extension on HAZ, WAZ WHZ and BMIZ measures. We also estimate the effect of extension on own food consumption and market consumption. The results show positive but insignificant effect of extension on all anthropometric measures. We also find positive and insignificant effect of overall extension on market food consumption and a negative and insignificant effect on own food production although receiving extension on production shows a negative significant effect ($p<0.10$) while receiving NAADS training shows a positive significant effect ($p<0.10$) on own food production.  These results show that the positive increase in market food consumption by receiving extension is not sufficient to impact on the nutrition outcomes for children. The non-significant effect of extension policy on anthropometric measures is not only unique to our study. Agriculture interventions may improve agriculture production but not necessarily on nutrition and there is need to intergrate these interventions with other forms of capital such as nutrition education (Berti et al., 2003). Extension messages besides focusing on production, markets and prices should widen the scope and also incorporate nutritional messages.

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