# Household nutrition effects of crop commercialization in Uganda

Nicholas Kilimani[a]*

[a] Public and Environmental Economics Research Centre (PEERC), University of Johannesburg, P.O Box 524 Auckland Park 2006, Johannesburg, South Africa.

*Corresponding author: Email: nick.kilimani1@gmail.com; n_kilimani@yahoo.com; nkilimani@cis.mak.ac.ug

## Abstract

Agriculture commercialization is widely seen as a primary pathway towards rural economic transformation since it is not only expected to improve income, but also enhance a wide array of other household welfare indicators such as nutrient intake. This study investigates the impact of crop commercialization on household nutrient intake with a focus on calorie, macro and micronutrient intake. Using the control function approach to address the potential endogeneity issues with respect to the nutrition impacts of commercialization, we examine the channels through which household nutrient intake can be influenced in the process of agricultural commercialization. Using LSMS-ISA survey data for Uganda, the findings show and that while commercialization increases crop income, its impact on overall nutrient intake negative. This is in line with some of the literature on the impact of commercialization where whereas commercialization increases income, possible consumption from the accrued income did not occur in this case.

The overall findings point to three important policy implications. First, the policy interventions geared towards agricultural commercialization are proving beneficial with respect to income generation. However, the rural households who are the primary target and who stand to gain from such interventions are less likely to commercialize. Therefore, interventions to help rural based households to commercialize are critical. Second, since the accrued income from commercialization does not necessarily translate into improvement household nutrient intake overall, there is the need for public sensitization on the importance of a healthy diet. Third, the presence of market infrastructure is crucial for both commercialization and nutrient intake. This reinforces the ongoing government effort to develop and expand market infrastructure in order to not only streamline but also increase the potential gains from agriculture as a market oriented economic activity.

## 1.0 Introduction

The transition from subsistence to commercial agriculture has been proposed as key to the socioeconomic transformation of the low-income countries. The economies of scale associated with agricultural commercialization are expected to enhance production efficiency which in turn improves household income and the prospects for economic growth. Big gains are expected among rural households whose livelihood is directly derived from agricultural activity. Household income, consumption, food security and nutrition are expected to improve as a result. In the anticipation of such benefits, many developing countries have embarked on agricultural commercialization as a growth strategy. In Uganda, objective 3 of the country's National Agricultural Policy seeks to "promote specialization in strategic, profitable and viable enterprises and value addition through agro-zoning". This is informed by the understanding that commodity specialization and agro-zoning strengthen agri-business, enhance profitability and market access, leading to the creation of farm and off-farm employment. The creation of additional employment opportunities necessitates increased commercialization of agriculture and the establishment of industries for value addition to agricultural products (GoU, 2013).

While the drive towards commercialization has been accompanied by policy reforms to create competitive agricultural markets with the aim of improving household welfare, there is literature which emphasizes that agricultural commercialization may not yield the desired welfare effects. This is likely to be the case for the poor households that are positioned at the lowest income strata (Carletto et al., 2017). In Uganda, the debate on the welfare impacts of agricultural commercialization comes at a time when government policies and programmes on commercialization which have seen the expansion of production of commercial crops are being met with mixed reactions. Specifically, the potential outcome of the current commercialization drive with respect to income generation and household nutrition is being put into question. A case in point is the scaling up of sugarcane production which has been met with concerns of increasing food insecurity and rising poverty as the extensive nature of its production requires considerable acreage for a farmer to break-even. The resulting increase in demand for land has inevitably pushed households into allocating their entire landholdings to sugarcane, leaving almost none to food production (see Mwavu et al., 2018).

Mwavu et al. (2018), in their study of the food security implications of expanded sugarcane cultivation among smallholder farmers in Uganda show that households that chose to cultivate sugarcane are food insecure, as they are often short of the physical and economic access to sufficient food to meet their dietary needs (also see Koczberski et al., 2012; Mwavu et al., 2016). They found that home gardens in the sugarcane growing regions were rapidly losing important and nutritious food crops like cowpeas, soya beans, aerial yams, and Bambara groundnuts, with dire implications for household food security. Households were reportedly coping with food insecurity by resorting to offering labor in exchange for food, borrowing food, rationing of food, and at times using unsavory survival strategies such as stealing from their neighbors (Mwavu et al., 2018).

Furthermore, critics of commercial crops contend that the resources used to produce such crops would otherwise be used to produce food for the local economy and improve the nutrition and household food security. Proponents on the other hand insist that production of commercial crops such as sugarcane can increase household incomes which in turn, can help to improve nutrition. Bouis and Haddad (1990), in their study of agricultural commercialization and nutrition of poor households in the Philippines found that smallholder sugarcane land owners made substantially higher profits per hectare than those that had opted for corn, following the establishment of sugar mills in their region. In the case of Uganda, the opposing views are stuck on the proposition that such commercialization has generally been detrimental to household welfare. This study therefore contributes to the nutrition and food security debate by investigating the link between commercialization and nutrient intake using a series of econometric procedures on a nationally-representative household survey dataset from Uganda.

## 1.2 Objectives

The overall objective of the study is to examine the impact of crop commercialization on household nutrient intake. In this regard, the study set out to:

i) Determine the effects of commercialization on nutrient intake among farm households in Uganda.
ii) Analyze whether differences in nutrient intake exist between urban and rural based farm households.
iii) Examine role of socio-economic factors in influencing nutrition among the farming households.

The remainder of this paper is structured as follows. Section 2 presents the literature review which gives the basis for the issues under investigation. Section 3 develops the conceptual framework that summarizes the different mechanisms under which commercialization affects household nutrition. The methodology section discusses the sources and types of data including the how the empirical strategy was conducted. Section 5 presents the results from the analysis, discussion and subsequent robustness checks, while Section 6 provides the conclusion

## 2.0 Literature review

The early works on the nutrition outcomes of agricultural commercialization produced results which were inconclusive and at times contradictory (see e.g., von Braun and Kennedy, 1986). In cross-country studies, results for the same crop were observed to have opposite effects both between and within countries. Such studies focused their comparison of nutrition outcomes between cash crop adopters and non-adopters. The evidence was often anecdotal and based on country case studies, making it impossible to compare results both across and within countries. In most studies, the definition and measurement of commercialization was subjective (based on the adoption or non-adoption of a given list of cash crops). Over time however, the current cropping systems no longer have a strict dichotomy between crops as cash and non-crops. Subsequently, studies especially by the International Food and Policy Research Institute (IFPRI)[1] developed a framework that articulated the complex set of relationships between the process of agricultural commercialization and the nutrition and health status at the household level (see von Braun et al., 1989; von Braun and Kennedy, 1994). Essentially, this cohort of studies[2] examines how agricultural commercialization affects national food production and individual nutrition outcomes (Pinstrup, 1983)[3].

The adoption of a market-oriented production system is expected to influence the degree of food availability at the national, community and household levels. Basically, competition among limited resources (such as land, labor and capital), the amount of food imports and aid, the degree of diversity of available foods and the presence of seasonal and irregular fluctuations may be influenced by a rise in market orientation even among smallholder farmers. In that way, they may impact national or regional food availability which, by affecting food prices, may have important implications for nutrition. However, national food sufficiency can be a poor indicator of household nutrient intake, as ‘‘food may be plentiful but the poor may still be unable to access it” (von Braun and Kennedy, 1986). Thus, at a household level, it is vital to look at the ability of each household and household member to effectively obtain food. This ability varies depending on the effects of the commercialization process on several factors including household income (Carletto et al., 2017).

Increases in real household income have the potential to enhance food consumption which would then positively impact on household nutrition. However, there are challenges for such an outcome to be realized. Intra-household factors may stand in the way in cases where individual household members possess different income elasticities overall, and even within food stuffs. Furthermore, even when additional income

[1] The IFPRI research agenda on agricultural commercialization and nutrition spanned the period, the mid-1980s to the mid-1990s.
[2] See von Braun et al. (1989) for a summary of these cross-country studies.
[3] See Carletto et al. (2017) for an exposé of this research history.

is spent on food, intra-household food consumption could be heterogeneously distributed among family members, with children and women often being relatively penalized compared to the adult males (Carletto et al., 2017). In addition, a high marginal propensity to spend on food does not automatically imply a high marginal propensity to consume nutrient rich diets. Households quite often choose to go for 'variety' thereby pursing higher cost diets rather than simply use the acquired income to increase nutrient intake (von Braun and Kennedy, 1994).

Some studies on the impact of agricultural commercialization on the nutrition among rural households have found it to be mostly positive, though rather small in magnitude (Carletto et al., 2017). In other cases, no such evidence has been found (Wood et al., 2013). Where a positive relationship was found, it was primarily achieved through linkages between household income, household caloric intake and child caloric intake (Bellin, 1994). Cash crop adoption generally increased real incomes, which were then used to increase food consumption. This increase was observed to have benefited on average both the household in general and children in particular. Furthermore, the effects of agricultural commercialization on nutrition were found to depend on a number of conditioning complementary factors both at the macro and micro level, making the adoption of commercial crops more or less remunerative and sustainable. However, the positive income effects from the sale of commercial crops can be attenuated if households are unable to smooth their consumption or if there is more risk involved in commercial diversification (Sen, 1981). Furthermore, in the case of seasonal crops, households may not be able to smooth consumption during the growing season of the commercial crop. Besides, increases in lump sum income as is the case with such seasonal crop sales may not be evenly distributed within the household[4].

With respect to the gender related impacts of agriculture commercialization, Duflo and Udry (2004) found that an increase in crops cultivated by women in Cote d'Ivoire increased household food expenditures, while an increase in agricultural output grown by men had mostly no impact. Preliminary evidence from a cross country study on Tanzania Uganda and Malawi indicates that female-headed households participate less but tend to sell larger shares of their production, conditional on participation (Carletto et al., 2017). The complex set of linkages which characterize the commercialization of agriculture and its impact on household nutrition only points to the fact that several scenarios can emerge depending on the factors dominating in each context. As such, policies geared at enhancing beneficial outcomes while minimizing the adverse ones following such transformation must of necessity play a key role. The foregoing review of the link between agricultural commercialization and nutrition reveals that the findings can be as

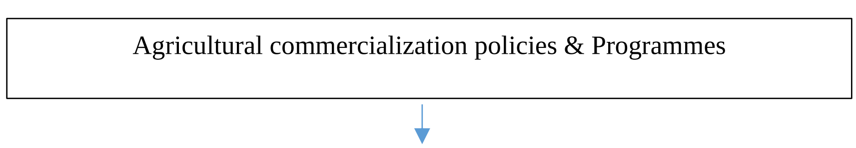
[4] This is the dilemma which smallholder farmers who have switched to sugarcane production in Eastern Uganda quite often face.

inconclusive as they can be mixed. As such, this study will shed light on this issue given the role which agricultural commercialization[5] can play in the socioeconomic transformation of developing economies. The overall focus will be to identify mechanisms through which the positive benefits can be amplified while minimizing any adverse outcomes.

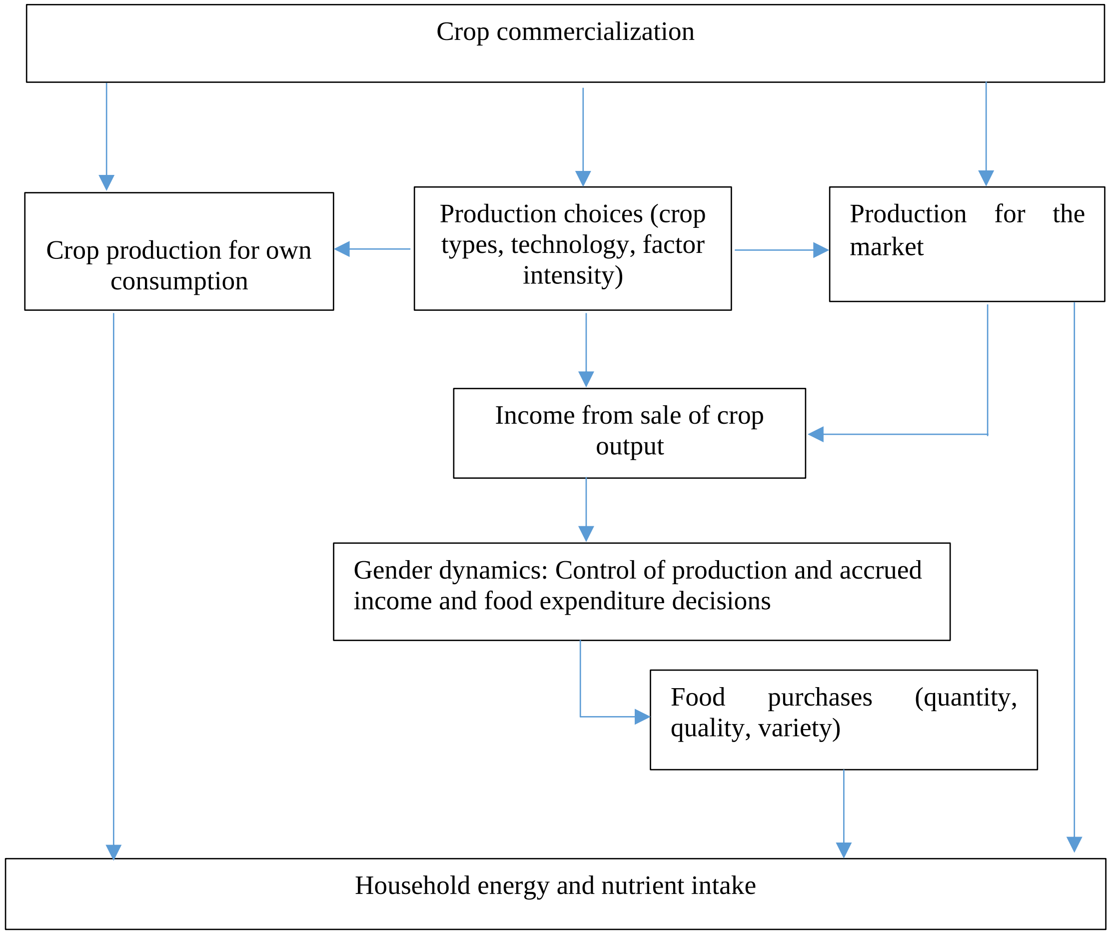
## 3.0 Conceptual framework

The conceptual framework summarized in Figure 1 forms the basis for our empirical analysis. Basically, the introduction of policies and programmes aimed at increasing crop production and providing channels through which the resulting output can be marketed, are expected to lead to crop commercialization. In this study, objective 3 of the National Agricultural Policy that seeks to "promote specialization in strategic, profitable and viable enterprises and value addition forms the basis for the different programmes that have been pursued in order to drive agricultural commercialization. These include: The Poverty Eradication Action Plan (PEAP), the Plan for Modernization of Agriculture (PMA), the National Agricultural Advisory Services (NAADS), the Rural Development Strategy (RDS), and the Prosperity for All programme. The resulting production and market orientation from the afore-mentioned programmes are expected to affect household nutrition through the various channels. For instance, market sales can reduce the availability of own-produced foods and thus limit consumption through the own crop production pathway. However, a fall in food consumption from own production may be prevented through food purchases from the market through income generated from the sold crops. Evidence shows that commercialization is typically associated with income gains through agricultural intensification and use of better technology (von Braun and Kennedy 1994; Muriithi, and Matz 2015; Ogutu et al., 2017). Commercialization may also influence the types of crops grown or the livestock species kept on the farm all of which have implications for nutrition. Closer market integration allows farmers to better harness their comparative advantage, so that higher levels of specialization are generally expected.

**Figure 1:** Crop commercialization and household nutrition




[5] In this study, we focus on agricultural crop commercialization.




**Source:** Adopted from von Brown et al. (1990); Ogutu et al. (2017)

A focus on the production of non-food cash crops could further reduce the availability of own-produced foods for consumption. Yet, in specific situations, it is also possible that farmers further diversify production, especially when markets for certain niche products that are not traditionally grown for own consumption emerge (Tipraqsa and Schreinemachers, 2009). In an African context, the levels of commercialization, types of crops grown, and technologies used can also have important effects on gender roles within the farm household. Subsistence food crops are often produced and controlled by women, while crops that are primarily produced to generate cash are typically controlled by men (von Braun et al., 1994; Fischer and Qaim, 2012). Studies show that female-controlled income is often beneficial for household nutrition, as women tend to spend more on food, dietary quality, and healthcare than men (Hoddinott and Haddad 1995; Chege et al., 2015). Thus, commercialization may potentially have a negative partial effect on household nutrition through the gender pathway.

## 4.0 Methodology

## 4.1 Data

The study uses data from the 2013/14 wave of the Uganda National Panel Survey (UNPS). The survey captures data on agricultural production, household food consumption and a range of other socioeconomic, community characteristics. The UNPS is a nationally representative dataset with information on the key variables contained in the household, agriculture and community modules. The study focuses only on farming households (both rural and urban), defined as households that reported involvement in agricultural activities through ownership and/or cultivation of land and have non-zero crop production data.

## 4.2 Empirical estimation Strategy

The analysis starts by estimating the overall effect of commercialization on calorie and micronutrient intake with equation (1). Formally:

$$N_i = \alpha_0 + \alpha_1 CC_i + \alpha_2 X_i + \epsilon_i \qquad (1)$$

where $N_i$ is the nutrition indicator for household $i$, $CC_i$ is the level of commercialization, $X_i$ is a vector of control variables, and $\epsilon_i$ is a random error term. We use different nutrition indicators ($N_i$) namely: vitamin A, iron, zinc, and calcium which were computed using Adult Male Equivalence. The choice of nutrients for analysis was informed by evidence that deficiencies in vitamin A, zinc, and iron pose serious health challenges in many developing countries. Thus, the consumption level of these three micronutrients is considered to be an important proxy for a healthy diet (Chege et al., 2015; Ogutu et al., 2017). The level of commercialization ($CC_i$) is a continuous variable ranging between zero (complete subsistence) and 1 (fully commercialized). Building on Strasberg et al. (1999) and Govereth et al. (1999), we construct a household crop commercialization index (CCI) as follows:

$$CCI_i = \frac{Gross\ value\ of\ crop\ sales_{hh_{i,}}}{Gross\ value\ of\ all\ crop\ production_{hh_i}}$$

Control variables ($X_i$) include age, gender, and education of the household head, as well as other farm, household, community and environmental variables that may affect nutrition. In this model, we are particularly interested in the effect of $\alpha_1$. Positive and significant estimates of $\alpha_1$ would imply that commercialization contributes to improved nutrition, and vice versa. It is possible that the sign of $\alpha_1$ differs between the nutrient indicators. For instance, if households substitute energy-dense purchased foods for more nutritious own-produced foods, we would expect a positive coefficient $\alpha_1$ in the calorie intake model and possibly negative coefficients in the micronutrient consumption models.

#### 4.2.1 Addressing potential endogeneity in the model

If $X_i$ in equation (1) includes all the factors that influence commercialization and there is no correlation between $CCI_i$ and $\epsilon_i$, then ordinary least squares (OLS) would produce unbiased estimates of $\alpha_1$. However, it is possible that there are unobserved factors that jointly influence $CCI_i$ and $N_i$, which would lead to endogeneity bias. For instance, unobserved heterogeneity could occur through differences in farmers' ability or entrepreneurial skills, which are difficult to measure in the data. Potential for endogeneity of the commercialization variable $(CCI_i)$ was tested through a control function (see Wooldridge, 2015; Smith and Blundell, 1986; Rivers and Voung, 1988). This approach entails predicting residuals from a first-stage model of the determinants of commercialization, and using the predicted residual term as an additional regressor in the nutrition outcome model in equation (2). Formally:

$$CC_i = \alpha_0 + \alpha_1 ncycle_i + \alpha_2 X_i + \epsilon_i \qquad (2)$$

This control function approach requires at least one valid instrument in the first-stage regression. In this case, we use the variable $ncycle$ which is the number of motorcycles in a parish. A statistically significant coefficient of the predicted residual term obtained from equation (2) and used in equation (1) would imply that commercialization is endogenous and would also correct for the resulting bias. An insignificant residual term would fail to reject the null hypothesis of exogeneity of $CCI_i$. In that case, OLS would be preferred. Since $CCI_i$ is bounded between 0 and 1, we estimated the first-stage regression (Equation 2) using a generalized linear model (GLM) with a binomial family and a probit link in order to obtain consistent residual predictions for use in equation 1 (see Wooldridge, 2015; Papke and Wooldridge, 1996). Both stages of the process were based on bootstrapped standard errors of the observed coefficients.

#### 4.2.2 Choice of Instrument

As earlier on noted, the control function requires at least one instrument for inclusion in the first-stage regression. A valid instrument must be strongly correlated with commercialization (instrument relevance), but uncorrelated with omitted variables that may affect nutrition (instrument exogeneity), except indirectly through commercialization (Imbens and Wooldridge, 2009). The instrument of choice was the average number of motorcycles in a parish. The strength and validity of the chosen instrument for commercialization is based on the view that farmers without motorcycles can easily hire and take their produce to the markets (see e.g., Ogutu et al., 2017). Similarly, traders who buy at farm gate prices can sell in the market place. Hence, the more are the motorcycles in a parish, the better is the market access situation.

### 4.3 Analyzing the transmission channels for the commercialization-nutrition nexus

The critical questions to better understand the transmission channels from commercialization to nutrition are the extent to which purchased foods are substituted for own-produced foods and how this affects dietary quality. To analyze this in more detail, we estimated the different models in equation (2). This entailed a differentiation between calories and micronutrients from purchased and own-produced foods. If households primarily purchase energy-dense foods in the market, we would expect a positive effect of commercialization on calorie consumption, but not necessarily micronutrient consumption from purchased foods. On the other hand, the effects of commercialization on calorie and micronutrient consumption from own-produced foods will depend on possible changes in farm productivity and production diversity. Furthermore, we are also interested in better understanding the role of the income and gender pathways that were discussed in the foregoing.

### 4.4 Nutrition data and measurement

The literature on nutrition presents various ways of assessing nutrient intake at a household level, including clinical measures, anthropometric measures, food consumption-based measures, among others (de Haen et al., 2011). Clinical and anthropometric measures are the most precise indicators of individual nutrition status, but they are less suitable for the assessing the details of people's food sources and dietary quality (Ogutu et al., 2017). In this study, the data used includes a food consumption recall, capturing the quantities of different food items consumed by all household members over a 7 days period. Survey respondents were also asked to specify the source of each food item consumed, including market purchases, own production, gifts, and other sources. Based on the food quantities consumed by the household, edible portions were calculated which were then converted into calorie and micronutrient levels using food composition tables for Uganda (Hotz et al., 2012). In terms of micronutrients, we focus on vitamin A, zinc, iron and calcium.

We computed the calorie and micronutrient consumption at household level by adult male equivalence (see e.g., Karageorgou et al., 2018; Chiputwa and Qaim, 2016). Bromage et al. (2018) note that estimating diet from household survey data using direct inference from percapita household consumption is inferior to the disaggregated approach that uses the "adult male equivalent" method, as percapita household consumption overestimates dietary energy in single and multi-person households. We use minimum consumption thresholds to characterize undersupplied households (FAO, WHO and UNU, 2001; IOM 2006). A household's nutrient intake is considered to be inadequate when it consumes less than 2750 kcal per AE and day and 50g per AE per day for proteins. This would also be the case if its intake of vitamin A is less than 1000μg of retinol equivalents (RE). For zinc and iron, the thresholds are 14mg and 27mg respectively while calcium is 1000mg. Section 5 follows with the empirical results and analysis.

## 4.5 Summary statistics

From the summary statistics in Table 1, the average household both rural and urban sells approximately 71% of its total farm output.

**Table 1:** Summary statistics of the key variables

| Variable | Location | Observation | Mean | Standard Dev | Min | Max |
|---|---|---|---|---|---|---|
| *Socioeconomic characteristics* | | | | | | |
| Education of house head (years) | Urban | 1369 | 9.04 | 3.71 | 0.00 | 17.00 |
| | Rural | 2627 | 5.69 | 2.73 | 0.00 | 17.00 |
| Age of household head (years) | Urban | 2399 | 41.83 | 17.13 | 18.00 | 102.00 |
| | Rural | 6601 | 48.66 | 17.71 | 16.00 | 96.00 |
| Male household head (dummy) | Urban | 2399 | 0. 65 | 0.48 | 0.00 | 1.00 |
| | Rural | 6601 | 0.63 | 0.48 | 0.00 | 1.00 |
| Household size | Urban | 8668 | 4.71 | 2.85 | 1.00 | 23.00 |
| | Rural | 25188 | 5.33 | 2.85 | 1.00 | 24.00 |
| Number of motorcycles (Parish) | Urban | 8668 | 0.77 | 1.03 | 0.00 | 4.00 |
| | Rural | 25188 | 0.81 | 1.04 | 0.00 | 4.00 |
| Value of farm assets (UGX' 000) | Urban | 266 | 131 | 188 | 5.05 | 863 |
| | Rural | 5137 | 57.60 | 70.05 | 2.00 | 438 |
| Customary land tenure system | Urban | 266 | 0.32 | 0.47 | 0.00 | 1.00 |
| | Rural | 5137 | 0.36 | 0.48 | 0.00 | 1.00 |
| Presence of produce market | Urban | 8668 | 0.032 | 0.179 | 0.00 | 1.00 |
| | Rural | 25,188 | 0.242 | 0.154 | 0.00 | 1.00 |
| *Farm production characteristics* | | | | | | |
| Crop commercialization index | Urban | 266 | 0.71 | 0.20 | 0.27 | 1.00 |
| | Rural | 5137 | 0.71 | 0.22 | 0.13 | 1.00 |
| Total land ownership (acres) | Urban | 266 | 4.61 | 9.00 | 0.16 | 42.00 |
| | Rural | 5137 | 2.37 | 2.65 | 0.04 | 28.2 |
| Planted area (acres) | Urban | 266 | 3.59 | 2.16 | 1.1 | 10.5 |
| | Rural | 5137 | 4.1 | 3.23 | 0.12 | 22 |
| Crop income (UGX '000) | Urban | 266 | 262 | 417 | 103 | 1,809 |
| | Rural | 5137 | 195 | 267 | 10.02 | 2,703 |
| Number of family workers | Urban | 266 | 6.79 | 3.18 | 2.00 | 17.00 |
| | Rural | 5137 | 5.34 | 2.87 | 1.00 | 16.00 |

**Notes:** UGX= Uganda Shilling

**Source:** Author's computations from LSMS-ISA 2014 data

This highlights the fact that changes in market orientation have resulted in the disappearance of a strict dichotomy between “cash crop” and “food crop” agriculture as the ability to be sold has increased. The policies geared towards production for the market appear to be yielding fruit. In the analysis, we seek to establish whether or not, the commercialization has translated into improved household welfare from a nutrient intake point of view. It is interesting to note that while the urban based households own more land with an acreage that doubles that of their rural counterpart. The bigger size of total planted area compared to land ownership is attributed to the fact that a number of rural households seeking to expand their production typically rent land from the large land owners. In fact, the larger land owners are the urban based many of whom have their land under fallow. It is these that usually rent out to those that wish to actively engage in agriculture.

Table 2 presents summary statistics for the nutrition indicators. All sampled households perform well with respect calorie, calcium and protein intake. Essentially, Ugandan households, rural and urban alike consume food stuff that is rich in proteins and calories, and this is quite clearly demonstrated in the data.

**Table 2:** Summary statistics for total nutrient intake based on Adult Male Equivalent

| Variable | National | Urban | Rural | Median | **Recommended** | National | Urban | Rural |
|---|---|---|---|---|---|---|---|---|
| | Mean | | | | | Mean Adequacy (%) | | |
| Total caloric intake (kcal/day/AE | 2974.58 | 2274.76 | 3002.782 | 2420.70 | 2750.00 | 8.1* | 82.72 | 9.1* |
| | (2277.5) | (1050.75) | (2308.95) | | | | | |
| Total calcium intake (mg/day/AE) | 396.46 | 393.75 | 396.57 | 342.03 | 1000.00 | 39.65 | 39.38 | 39.66 |
| | (275.67) | (277.67) | (275.6) | | | | | |
| Total protein intake (g/day/AE) | 78.84 | 56.611 | 79.76 | 61.72 | 50.00 | 57.68* | 13.22* | 59.52* |
| | (71.18) | (39.05) | (72.05) | | | | | |
| Total iron intake (mg/day/AE) | 9.63 | 8.56 | 9.28 | 9.06 | 27.40 | 35.15 | 35.15 | 33.87 |
| | (5.32) | (4.59) | (4.87) | | | | | |
| Total zinc intake (mg/day/AE) | 7.35 | 6.54 | 7.14 | 6.95 | 14.00 | 52.5 | 46.71 | 51 |
| | (4.06) | (4.29) | (3.97) | | | | | |
| Total vitamin A intake (μg RE/day/AE) | 833.89 | 676.69 | 840.44 | 603.18 | 1000.00 | 83.39 | 67.67 | 84.04 |
| | (697.3) | (577.16) | (701.14) | | | | | |
| Observations | 5403 | 266 | 5137 | | | | | |

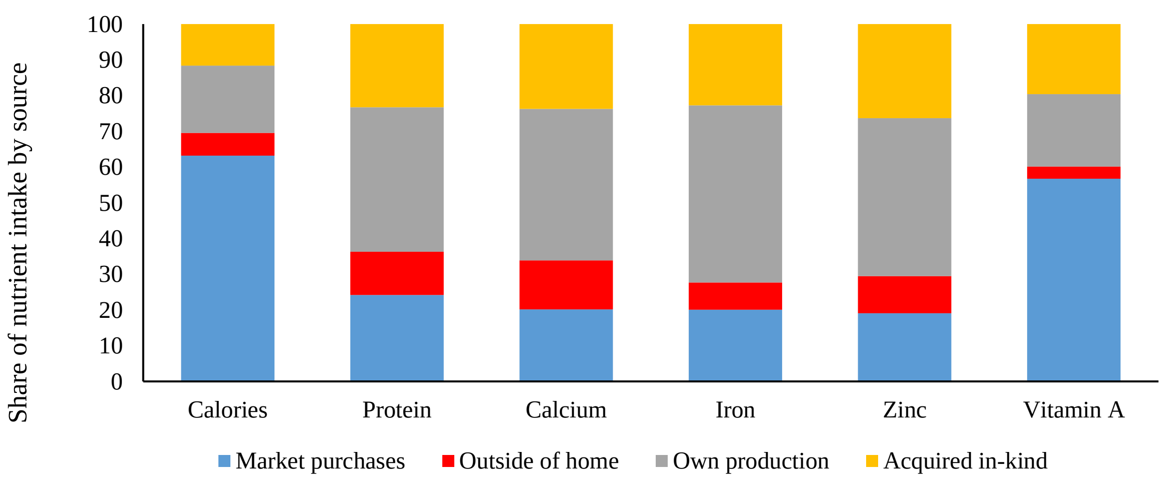
**Notes:** The variables were analytic weighted before the summary statistics were computed. Energy and macro and micronutrients were measured as follows: caloric intake (kcal/day/AE), calcium intake (mg/day/AE), protein intake (g/day/AE), iron intake (mg/day/AE), zinc intake (mg/day/AE), vitamin A intake (μg RE/day/AE). AE, adult male equivalents; RE, retinol equivalent Values for mean intake adequacy are computed as the percentage of recommended intake that is met. Asterisks indicate the percentage for which nutrient intake is above the recommended based on the FAO/WHO recommended daily nutrient intake. The computations are based on food intake from a 7-day recall. Standard deviations in parentheses.

**Source:** Author's computations from LSMS-ISA 2014 data based on the recommended thresholds

The nutrition challenge is with respect to micronutrient intake where the levels are not as high with compared to calories and protein, where intake is above three quarters of the recommended intake. Micronutrient intake is still low, save for vitamin A at the national level. However, there are challenges in the intake of vitamin A for the urban population. The national average micronutrient intake stands at only 52% for zinc, 35% for iron, while calcium stands at 40%. This finding is strikingly similar to that of Ogutu et al. (2017) in their study of the impact of commercialization on nutrition in Kenya where similar trends in micro nutrient deficiency were found. What is fundamental to note is the fact that as expected, rural households perform better on all nutrition indicators compared to their urban counterparts. This finding is contrary to the expectation given that commercialization results in food items being available in the market. As such, conditional on income, nutrition knowledge and market access, urban households should purchase the right food stuff.

Figure 2 shows a breakdown of the sources of household calorie and micronutrient intake. Much of the intake of protein, zinc, calcium and iron is derived from own production while market purchases are an important source of calories and vitamin A. For protein, calcium, iron and zinc, market purchases and consumption in-kind also pray a role in their intake. These findings serve to reinforce the role of commercialization in improving nutrient intake given the fact that it provides an opportunity for households to improve their diets either from their own production or through market purchases. Market oriented production gives the opportunity to access a variety of food stuff beyond what is produced with households. Given this finding, controlling for everything else, both household income and own production are critical for improving household nutrition.

**Figure 2:** Share of nutrient intake by food acquisition source




**Source:** Author's computations from LSMS-ISA data

## 5.0 Empirical results and discussion

### 5.1 Basic model results and tests for endogeneity

The discussion of the estimated results starts by looking at the tests for the endogeneity of crop commercialization.

**Table 4:** Estimates of commercialization effects on calorie and micronutrients intake

| | CCI | Calories | Protein | Calcium | Iron | Zinc | Vitamin A |
|---|---|---|---|---|---|---|---|
| Number of motorcycles | 0.042*** | | | | | | |
| | (0.010) | | | | | | |
| Commercialization index | | -0.872*** | -1.020*** | -0.836*** | -0.335* | -0.517** | -0442 |
| | | (0.289) | (0.283) | (0.272) | (0.180) | (0.203) | (0.381) |
| Rural households dummy | -0.121** | -0.195 | 0.141 | 0.534** | 0.602*** | 0.655*** | -0754* |
| | (0.050) | (0.221) | (0.217) | (0.232) | (0.124) | (0.141) | (0.386) |
| Crop income | 0.096*** | | | | | | |
| | (0.010) | | | | | | |
| Number of family workers | 0.067** | | | | | | |
| | (0.027) | (0.159) | (0.167) | (0.132) | (0.093) | (0.095) | (0.223) |
| Planted area (acres) | 0.052*** | -0.073 | -0.138 | -0.346**** | -0.119** | -0.171*** | -0.130 |
| | (0.014) | (0.097) | (0.098) | (0.085) | (0.053) | (0.053) | (0.119) |
| Total land ownership (acres) | 0.023* | 0.005 | -0.086 | -0.081 | 0.096** | 0.036 | -0.137 |
| | (0.012) | (0.069) | (0.057) | (0.059) | (0.048) | (0.045) | (0.085) |
| Farm assets (UGX' 000) | 0.035*** | 0.254*** | 0.090*** | 0.392*** | 0.126*** | 0.098** | 0.342*** |
| | (0.012) | (0.075) | (0.079) | (0.070) | (0.044) | (0.048) | (0.096) |
| Education of house head (yrs) | -0.078*** | 0.048 | 0.018 | -0.111 | 0.102 | 0.003 | 0.459*** |
| | (0.021) | (0.120) | (0.110) | (0.095) | (0.069) | (0.073) | (0.153) |
| Household size | | -0.013 | 0.362*** | 0.358*** | 0.286*** | 0.385*** | -0.249 |
| | | (0.114) | (0.117) | (0.094) | (0.069) | (0.073) | (0.167) |
| Age of house head (yrs) | 0.511 | -1.473 | 1.409 | 2.583 | 1.234 | 1.252* | -7.876*** |
| | (0.474) | (2.467) | (2.209) | (2.321) | (1.527) | (1.687) | (2.801) |
| Age of house head (yrs sq) | -0.075 | 0.194 | -0.223 | -0.384 | -0.204 | -0.182 | 1.076*** |
| | (0.065) | (0.341) | (0.306) | (0.320) | (1.208) | (0.230) | (0.391) |
| Male house head (dummy) | 0.054** | 0.102 | -0.175 | -0.807*** | -0.442*** | -0.411*** | 0.307** |
| | (0.023) | (1.131) | (0.126) | (0.108) | (0.083) | (0.086) | (0157) |
| Freehold land tenure system | -0.061*** | -0.856*** | -0.665*** | -0.426*** | -0.323*** | -0.330*** | -1.073*** |
| | (0.021) | (0.137) | (0.126) | (0.110) | (0.074) | (0.076) | (0.157) |
| Presence of produce market | 0.173** | 0.389 | 0.912*** | 0.582 | 0.4567* | 0.003 | 0.699** |
| | (0.847) | (0.918) | (0.205) | (0.360) | (0.233) | (0.121) | (0.284) |
| Constant | -0.287*** | 5.199 | -0.029 | -4.836 | -2.762 | -4.271 | -12.448*** |
| | (0.842) | (4.193) | (0.126) | (3.959) | (2.765) | (2.999) | (4.548) |
| Log likelihood | 142.817 | | | | | | |
| Adj-$R^2$ | - | 0.387 | 0.514 | 0.495 | 0.459 | 0.579 | 0.419 |
| Observations | | 5403 | 5403 | 5403 | 5403 | 5403 | 5403 |

**Notes:** Model results are based on observed coefficients and bootstrapped standard errors in parentheses. The crop commercialization model was estimated using GLM, while OLS was applied to the rest. All results are based on observed coefficients and bootstrapped standard errors. *, **, and *** denote significance at 10%, 5%, and 1% level, respectively.

**Source:** Author's computations

As explained in section 5, a control function was used, with the average number of motorcycles owned by households in the parish as the instrument. The first-stage results with commercialization as the dependent variable are shown in the first column of Table 4. The coefficient estimates for the residual terms included in the second-stage equations are shown in Table 5, for all the relevant nutrient intake models. Both stages of estimation were bootstrapped. In all models, the residual-terms from the first stage GLM estimation are statistically significant, hence, rejecting the null hypothesis for endogeneity of commercialization in the second stage (see Table 5).

In Table 4, the results in column 1 show that rural based households are less likely to engage in production for sale. This could be attributed to the perverse nature of subsistence agriculture in the country and the fact that rural based households are most likely to be smallholder farmers. Male headed households are more likely to be commercialized than their female counterparts. The role of the primary factors of production is brought into the picture with both farm capital, land and family labour, exhibiting a very significant and positive relationship with the likelihood that a household produces for sale. Furthermore, we find that larger households have more nutrient intake on average than smaller households. This could possibly be due to the fact that larger households are in a position to farm more, and therefore gain from having both crop income and consumption from own production. However, the impact of commercialization on nutrient intake is found to be negative for all the nutrition indicators. However, rural households were found to have better intake of some of micronutrients such as calcium, iron and zinc, but perform less than the urban households in Vitamin A and calorie intake. This could be attributed to the fact the bulk of vitamin A nutrients and calories are derived from market purchases (see Figure 2). From Table 4, commercialization has a negative and significant effect on micronutrient intake. These findings suggest that commercialization may not primarily result in improved household micronutrient intake. This is consistent with some of the evidence on the agricultural commercialization-nutrition nexus (see Carletto et al., 2017).

**Table 5:** Endogeneity test results for the crop commercialization model based on the control function

| **Variable** | Coefficient | Std. error. | Z |
|---|---|---|---|
| Total calorie intake (kcal/day/AE) | -2.695 | 1.120 | -2.410 |
| Total calcium intake (mg/day/AE) | -2.004 | 0.901 | -2.220 |
| Total protein intake (g/day/AE) | -2.851 | 1.111 | -2.570 |
| Total iron intake (mg/day/AE) | - 17.998 | 10.880 | -1.650 |
| Total zinc intake (mg/day/AE) | -4.495 | 2.470 | -1.820 |
| Total vitamin A intake (µg RE/day/AE) | -5.426 | 1.393 | -3.900 |

**Note:** Coefficients of the residual terms for the relevant models are shown with bootstrapped standard errors.
**Source:** Author's computations from LSMS-ISA 2014 data

Table 6 presents results for the impact of crop commercialization on household crop income and how that can in turn impact on nutrient intake. The findings show positive effects of commercialization on the crop income as well as the different factors that positively impact on crop income such as land ownership, land tenure, and the age of the household head. Crop income is positive for the rural households as expected. Rural households also have better nutrient intake compared to their urban counterparts.

**Table 6:** Estimates of commercialization effects on crop income, calorie and micronutrient intake

| Variables | Crop income | Calories | Protein | Calcium | Iron | Zinc | Vitamin A |
|---|---|---|---|---|---|---|---|
| Commercialization index | 2.088*** | | | | | | |
| | (0.268) | | | | | | |
| Crop income | | 0.087* | 0.167*** | 0.148*** | 0.066** | 0.144*** | 0.210*** |
| | | (0.048) | (0.042) | (0.042) | (0.031) | (0.031) | (0.063) |
| Rural households dummy | 0.380* | 0.376** | 0.620*** | 0.837*** | 0.646*** | 0.736*** | 0.217 |
| | (0.225) | (0.165) | (0.171) | (0.212) | (0.109) | (0.127) | (0.342) |
| Number of family workers | 0.041 | | | | | | |
| | (0.155) | (0.112) | (0.125) | (0.118) | (0.072) | (0.080) | (0.169) |
| Planted area (acres) | 0.091 | 0.195** | 0.089 | -0.202*** | -0.097*** | -0.132*** | 0.323*** |
| | (0.078) | (0.076) | (0.078) | (0.055) | (0.037) | (0.037) | (0.066) |
| Total land ownership (acres) | 0.402*** | 0.087 | -0.007 | -0.030 | 0.102** | 0.049 | 0.022 |
| | (0.067) | (0.056) | (0.050) | (0.062) | (0.045) | (0.042) | (0.080) |
| Farm assets (UGX' 000) | 0.102 | 0.106 | -0.037 | 0.310*** | 0.114*** | 00.076* | 0.091 |
| | (0.083) | (0.067) | (0.073) | (0.062) | (0.039) | (0.046) | (0.078) |
| Education of house head (yrs) | 0.065 | 0.281*** | 0.220** | 0.019 | 0.120* | 0.036 | 0.856*** |
| | (0.116) | (0.097) | (0.091) | (0.083) | (0.063) | (0.065) | (0.140) |
| Household size | | 0.227** | 0.566*** | 0.488*** | 0.305*** | 0.421*** | 0.156 |
| | | (0.089) | (0.089) | (0.084) | (0.056) | (0.062) | (0.128) |
| Age of house head (yrs) | 11.288*** | 0.025** | 2.689 | 3.401 | 1.369 | 1.482* | -5.398* |
| | (2.339) | (2.506) | (2.246) | (2.358) | (1.574) | (1.721) | (2.844) |
| Age of house head (yrs sq) | -1.542*** | -0.039 | -0.422 | -0.511 | -0.225 | -0.218 | 0.689* |
| | (0.326) | (0.346) | (0.310) | (0.325) | (0.214) | (0.234) | (0.393) |
| Male house head (dummy) | -0.409*** | -0.195 | -0.418*** | -0.959*** | -0.466*** | -0.455*** | -0.192 |
| | (0.118) | (0.120) | (0.102) | (0.099) | (0.075) | (0.081) | (0.132) |
| Freehold land tenure system | 0.269*** | -0.630*** | -0.475*** | -0.305*** | -0.305*** | -0.298*** | -0.690*** |
| | (0.097) | (0.116) | (0.112) | (0.107) | (0.066) | (0.068) | (0.140) |
| Presence of produce market | -0.131 | 0.255 | 0.346 | 0.254 | -0.189 | 0.027 | 1.064* |
| | (0.524) | (0.697) | (0.555) | (0.549) | (0.260) | (0.299) | (0.596) |
| Constant | -11.011*** | 4.903 | -3.246 | -5.016 | -2.812 | -4.337 | 12.048** |
| | (4.107) | (4.314) | (3.894) | (4.100) | (2.853) | (3.055) | (4.734) |
| Adj-$R^2$ | 0.365 | 0.345 | 0.469 | 0.487 | 0.506 | 0.575 | 0.363 |
| Observations | 5403 | 5403 | 5403 | 5403 | 5403 | 5403 | 5403 |

**Notes:** Model results are based on observed coefficients and bootstrapped standard errors in parentheses. The crop commercialization model was estimated using GLM, while OLS was applied to the rest. All results are based on observed coefficients and bootstrapped standard errors. *, **, and *** denote significance at 10%, 5%, and 1% level, respectively.

**Source:** Author's computations

Crop income has a positive impact on calories as well as other measures of micronutrient intake. This finding is in line with that of Bellin (1994) where a positive relationship between commercialisation, income and nutrient intake was found. Households under the freehold land tenure system are in a position to maximise all their gains from crop production since they face no costs of using their land compared to other land tenure systems. The results also show that the younger household heads generate higher incomes from agriculture compared to their older counterparts. In addition, their intake of micronutrient rich food is also higher for households with educated household heads as well those that female headed.

Male headed households perform poorly on nutrient intake and generation of crop income. Fischer and Qaim (2012) find that male-controlled income is often spend less on dietary quality and nutrition than female-controlled income. This result reinforces a common finding in the literature on the effects of commercialization on income and gender which shows that female-controlled income is often particularly beneficial for household nutrition, as women tend to spend more on food, dietary quality, and healthcare than men (Hoddinott and Haddad 1995; Chege et al., 2015). Thus, commercialization may potentially have different effects on household nutrition depending on the decision maker.

### 5.1.1 Effects of commercialization on nutrient intake by food source

In this section, we present results of the effects of commercialization on household nutrient intake by food source. Table 7 presents results of the effects of commercialization on nutrient intake from purchased foods.

**Table 7:** Estimates of commercialization effects on purchased calorie and micronutrient intake

| | Calories | Protein | Calcium | Iron | Zinc | Vitamin A |
|---|---|---|---|---|---|---|
| Commercialization index | 0.578* | 0.041 | 0.633 | 0.039 | -0.003 | 0.043 |
| | (0.336) | (0.409) | (0.392) | (0.445) | (0.397) | (0.627) |
| Rural households dummy | -0.089 | 0.331 | 0.110 | 0.375 | 0.559 | -1.164 |
| | (0.256) | (0.496) | (0.429) | (0.536) | (0.511) | (0.437) |
| Crop income | | | | | | |
| Number of family workers | | | | | | |
| Planted area (acres) | 0.043 | -0.427*** | -0.123 | -0.474*** | -0.404*** | 0.204 |
| | (0.133) | (0.160) | (0.158) | (0.160) | (0.151) | (0.229) |
| Total land ownership (acres) | -0.243** | -0.371*** | -0.214** | -0.428*** | -0.342*** | -0.131 |
| | (0.097) | (0.100) | (0.100) | (0.110) | (0.098) | (0.143) |
| Farm assets (UGX' 000) | 0.321*** | 0.115 | 0.228** | 0.183* | 0.127 | 0.120 |
| | (0.073) | (0.094) | (0.091) | (0.102) | (0.095) | (0.127) |
| Education of house head (yrs) | 0.026 | -0.462** | -0.746*** | -0.526** | -0.593*** | -0.350 |
| | (0.189) | (0.216) | (0.229) | (0.218) | (0.214) | (0.281) |
| Household size | 0.531* | 0.048 | 0.286 | 0.270 | 0.223 | -0.028 |
| | (0.277) | (0.340) | (0.359) | (0.371) | (0.369) | (0.437) |
| Age of house head (yrs) | -3.380 | -8.017* | 1.230 | -10.211** | -10.448** | -2.973 |
| | (3.071) | (4.390) | (4.358) | (4.582) | (4.127) | (4.882) |
| Age of house head (yrs sq) | 0.526 | 1.215** | -0.089 | 1.508** | 1.568*** | 0.391 |
| | (0.421) | (0.608) | (0.609) | (0.636) | (0.573) | (0.672) |
| Male house head (dummy) | 0.623*** | 1.145*** | 0.573** | 1.338*** | 1.111*** | 0.896*** |
| | (0.190) | (0.252) | (0.252) | (0.247) | (0.248) | (0.286) |
| Freehold land tenure system | -1.503*** | -1.779*** | -1.463*** | -1.646*** | -1.460*** | -2.238*** |
| | (0.151) | (0.186) | (0.211) | (0.207) | (0.193) | (0.249) |
| Agricultural market (dummy) | 0.991 | 0.395 | 0.397 | 0.297 | 0.397 | 1.498 |
| | (0.935) | (0.801) | (0.891) | (0.792) | (0.786) | (1.456) |
| Constant | 7.764 | 25.585*** | -0.770 | 25.376*** | 15.388** | 7.230 |
| | (5.083) | (7.579) | (7.196) | (7.742) | (6.909) | (8.787) |
| Adj-$R^2$ | 0.341 | 0.387 | 0.264 | 0.321 | 0.271 | 0.382 |
| Observations | 5403 | 5403 | 5403 | 5403 | 5403 | 5403 |

**Notes:** Model results are based on observed coefficients and bootstrapped standard errors in parentheses. The crop commercialization model was estimated using GLM, while OLS was applied to the rest. All results are based on observed coefficients and bootstrapped standard errors. *, **, and *** denote significance at 10%, 5%, and 1% level, respectively.
**Source:** Author's computations

The results in Table 7 suggest that commercialization has positive but weakly significant effects only on the consumption of calories.

**Table 8:** Estimates of commercialization effects on own produced calorie and micronutrient intake

| | Calories | Protein | Calcium | Iron | Zinc | Vitamin A |
|---|---|---|---|---|---|---|
| Commercialization index | -0.995*** | -0.770** | -1.614*** | -0.931*** | -0.604* | -0.042 |
| | (0.305) | (0.345) | (0.389) | (0.329) | (0.330) | (0.511) |
| Rural households dummy | 0.441 | 0.172 | 0.685* | 0.390 | 0.407 | 3.768*** |
| | (0.279) | (0.340) | (0.380) | (0.288) | (0.293) | (0.581) |
| Crop income | | | | | | |
| Number of family workers | | | | | | |
| Planted area (acres) | -0.006 | 0.039 | -0.209 | 0.126 | 0.052 | 0.502** |
| | (0.108) | (0.137) | (0.157) | (0.131) | (0.090) | (0.219) |
| Total land ownership (acres) | 0.237** | 0.040 | -0.060 | 0.095 | 0.052 | 0.003 |
| | (0.093) | (0.090) | (0.103) | (0.086) | (0.090) | (0.144) |
| Farm assets (UGX' 000) | 0.304*** | 0.366*** | 0.491*** | 0.268*** | 0.360*** | 0.425** |
| | (0.066) | (0.080) | (0.110) | (0.082) | (0.077) | (0.176) |
| Education of house head (yrs) | -0.061 | -0.147 | -0.232 | -0.091 | -0.256* | 0.642*** |
| | (0.126) | (0.146) | (0.166) | (0.139) | (0.138) | (0.240) |
| Household size | 0.417** | 0.272 | 0.342 | 0.219 | 0.350 | 0.769 |
| | (0.204) | (0.266) | (0.355) | (0.234) | (0.249) | (0.490) |
| Age of house head (yrs) | -2.461 | -1.827 | -7.256** | -1.655 | -2.629 | -21.927*** |
| | (2.751) | (3.158) | (3.237) | (3.251) | (2.974) | (4.961) |
| Age of house head (yrs sq) | 0.313 | 0.229 | 0.989** | 0.171 | 0.342 | 2.888*** |
| | (0.379) | (0.435) | (0.445) | (0.447) | (0.408) | (0.685) |
| Male house head (dummy) | -1.073*** | -1.239*** | -1.222*** | -1.152*** | -1.184*** | -1.331*** |
| | (0.171) | (0.191) | (0.191) | (0.181) | (0.183) | (0.255) |
| Freehold land tenure system | 0.270* | 0.421** | 0.161 | 0.334** | 0.313* | 1.203*** |
| | (0.161) | (0.181) | (0.185) | (0.168) | (0.169) | (0.282) |
| Agricultural market (dummy) | 0.001 | -0.145 | 0.026 | -0.522 | -0.178 | 1.055 |
| | (0.380) | (0.328) | (0.400) | (0.544) | (0.340) | (0.690) |
| Constant | 8.927 | 2.665 | 10.679* | 2.458 | 1.367 | 32.009*** |
| | (8.802) | (5.400) | (5.580) | (5. 460) | (5.076) | (8.295) |
| Adj-$R^2$ | 0.417 | 0.466 | 0.489 | 0.378 | 0.440 | 0449 |
| Observations | 5403 | 5403 | 5403 | 5403 | 5403 | 5403 |

**Notes:** Model results are based on observed coefficients and bootstrapped standard errors in parentheses. The crop commercialization model was estimated using GLM, while OLS was applied to the rest. All results are based on observed coefficients and bootstrapped standard errors. *, **, and *** denote significance at 10%, 5%, and 1% level, respectively.

**Source:** Author's computations

A unit percentage point increase in the level of commercialization increases calorie consumption from purchased foods by 0.58 units/AE/day. Ogutu et al. (2017) in his study on Kenya found that the benefits of commercialization resulted in increased consumption of both calorie and micronutrients from purchases. In Uganda's case, we see that the impact is only on calorie intake. This finding is in line with the postulation in our conceptual framework where in cases where households primarily purchase energy-dense foods in the market, a positive impact of commercialization on caloric intake only is expected. This might be the case with Uganda, given that the bulk of the staple foods are rich in calories (see Table 3). In addition, food consumption data shows that the bulk of calories are derived from purchased food stuff.

Table 8 shows that commercialization has negative and significant effects on the consumption of calories and micronutrients from own produced food. This is an insightful finding and could be attributed to the fact that the increase in market oriented agriculture results in households selling their output. However, the resulting income is not necessarily spent on nutrient rich foods as the results in Table 7 show. Duflo and Udry (2004) indicate that income from different crops may serve distinct purposes within the household and thus have different impacts on nutrient intake. Carletto et al. (2017) notes that while income is crucial for improving nutrient intake, its rise may not necessarily result in improvements household nutrient intake. If it is to happen, households must be deliberate about obtaining nutrient rich food. This condition they note, is not easily satisfiable due to differences in income elasticities of household members. In addition, a high marginal propensity to spend on food does not necessarily imply a high marginal propensity to consume nutrient rich food. Households may often choose to obtain a "diversified" higher cost diet following a rise in income rather than directing the accrued income to pursue nutrient rich diets.[6] In line with the previous findings on the role of own production in contributing to micronutrient intake, we see that vitamin A intake from own production is higher for rural households, due to the fact that this micronutrient is sourced largely from own production.

## 6.0 Conclusion

While studies on agricultural commercialization show that the policy can improve productivity and income for farmers, evidence of its effects on household nutrition are less understood. This study adds to the literature by not only analyzing household nutrient intake under commercialization but also identifies the transmission channels through which the observed effects are realized. The findings show that the nutrient intake following commercialization depends on several pathways as established in the literature. However, the effects of commercialization are rooted in the socioeconomic and cultural setting of a given target population. We find that commercialization generally presented negative effects on nutrient and caloric intake. This could be related to the fact that while male headed households were more commercialized, its

[6] von Braun et al. (1989) observe that there are cases of malnutrition where households are not even aware of the problem based on their comparisons with the rest of other members in the community.

effect on nutrient intake was negative for all indicators. Further disaggregation of intake by food source remained consistent with the earlier finding. This is in line with a large body of the literature that male headed households perform less than female headed ones on nutrient intake under commercialization. It was found that while commercialization resulted in income generation, the accrued income was not channeled towards purchase of nutrient rich food stuff.

Overall, three important policy implications emerge from this study. First, agricultural commercialization is beneficial with respect to income generation. However, the rural based households are less likely to practice commercialization. This could be attributed to the fact that increasing production for sale comes with additional investment which rural households are less capable to undertake. In the absence of strategic support therefore, rural households potentially miss out on the benefits of commercialization. Consequently, they can be trapped in a vicious cycle of subsistence agriculture with all its attendant ramifications. Therefore, the current government policy on credit and agricultural inputs provision through the programme code-named "Operation Wealth Creation" is a step in the right direction. Second, the role of market infrastructure is highlighted in the study where the presence of a market for agricultural produce is a strong driver for both commercialization and nutrient intake. Third, while commercialization results in crop income generation, nutrient intake is adversely affected. This may call for implementation of interventions such as public sensitization to ensure that the generated income translates into improved nutrient intake.

## 7.0 References

AGRA (2016). Africa agriculture status Report: Progress towards agricultural transformation in Africa. Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA).

Bellin, F. (1994). Smallholder tree crops in Sierra Leone: Impacts on food consumption and nutrition. In: von Braun, J., Kennedy, E. (Eds.), Agriculture Commercialization, Economic development, and Nutrition. The John Hopkins University Press, Baltimore and London.

Bouis, H. E., and Haddad, L. (1990). Agricultural commercialization, nutrition, and the rural poor: A study of Philippine farm households. Lynne Rienner Press, Colorado and London.

Bromage, S., Rosner, B., Rich-Edwards, J.W., Ganmaa, D., Tsolmon, S., Tserendejid, Z., Odbayar, T-O., Traeger, M., and Fawzi, W.W. (2018). Comparison of Methods for Estimating Dietary Food and Nutrient Intakes and Intake Densities from Household Consumption and Expenditure Data in Mongolia. Nutrients, 10, 703; doi:10.3390/nu10060703.

Carletto, C., Corral, P., and Guelfi, A. (2017). Agricultural commercialization and nutrition revisited: Empirical evidence from three African countries. Food Policy, 67:106-118.

Chege, C.G.K., Andersson, C.I.M., and Qaim, M. (2015). Impacts of supermarkets on farm household nutrition in Kenya. World Development, 72 (1): 394-407.

Chiputwa, B., and Qaim, M. (2016). Sustainability standards, gender, and nutrition among smallholder farmers in Uganda. Journal of Development Studies, 52 (9): 1241-1257.

de Haen, H., Klasen, S., and Qaim, M. (2011). What do we really know? Metrics for food insecurity and undernutrition. Food Policy, 36 (6): 760-769.

Duflo, E., and Udry, C. (2004). Intra-household resource allocation in Cote d'Ivoire: Social norms, separate accounts and consumption choices. Technical report, National Bureau of Economic Research.

FAO, WHO, and UNU (2001). Human energy requirements: Report of a Joint Expert Consultation. Food and Nutrition Technical Report, Food and Agriculture Organization of the United Nations. Rome.

Fischer, E., and Qaim, M. (2012). Gender, agricultural commercialization, and collective action in Kenya. Food Security, 4 (3): 441-453.

GoU (2013). National Agriculture Policy, Ministry of Agriculture Animal Industry and Fisheries, Entebbe-Uganda.

Govereth, J., Jayne, T. S., and Nyoro, J. (1999). Smallholder commercialization, interlinked markets and food crop productivity: cross-country evidence in eastern and Southern Africa, Mimeo, MSU, June.

Hoddinott, J., and Haddad. L. (1995). Does female income share influence household expenditures? Evidence from Cote d'Ivoire. Oxford Bulletin of Economics and Statistics, 57: 77–96.

Hotz, C., Lubowa, A., Sison, C., Moursi, M., Loechl, C.A. (2012). Food composition table for Central and Eastern Uganda. Harvest Plus Technical Monograph 9. HarvestPlus/International Food Policy Research Institute/International Center for Tropical Agriculture, 2012.

Imbens, G.W., and Wooldridge, J.M. (2009). Recent developments in the econometrics of programme evaluation. Journal of Economic Literature, 47: 5–86.

IOM (2006). Dietary reference intakes: Applications in dietary assessment. Institute of Medicine, National Academy Press, Washington, D.C.

Karageorgou, D., Imamura, F., Zhang, J., Shi, P., Mozaffarian, D., and Micha, R. (2018). Assessing dietary intakes from household budget surveys: A national analysis in Bangladesh. PLoS ONE 13(8): e0202831. https://doi.org/10.1371/journal.pone.0202831.

Koczberski, G., Curry, G. N., and Bue, V. (2012). Oil palm, food security and adaptation among smallholder households in Papua New Guinea. Asia Pacific Viewpoint, 53(3): 288–299. doi:10.1111/j.1467-8373.2012.01491.x.

Muriithi, B.W., and Matz, J.A. (2015). Welfare effects of vegetable commercialization: Evidence from smallholder producers in Kenya. Food Policy, 50: 80-91.

Mwavu, E.N., Kalema, V.K., Bateganya, F., Byakagaba, P., Waiswa, D., Enuru, T., and Mbogga, M.S. (2018). Expansion of commercial sugarcane cultivation among smallholder farmers in Uganda: Implications for household food security. Land, 7(2), 73. doi:10.3390/land7020073.

Mwavu, E.N., Ariango, E., Ssegawa, P., Kalema, V.N., Bateganya, F., Waiswa, D., Byakagaba, P. (2016). Agrobiodiversity of home gardens in a commercial sugarcane cultivation land matrix in Uganda. International Journal of Biodiversity Science, Ecosystem Services & Management, 12 (3): 191–201.

Ogutu, S., Gödecke, T., and Qaim, M. (2017). Agricultural commercialization and nutrition in smallholder farm households. Global Food Discussion Papers 97, Universität Göttingen. http://hdl.handle.net/10419/161624.

Papke, L.E., and Wooldridge, J.M. (1996). Econometric methods for fractional response variables with an application to 401 (k) plan participation rates. Journal of Applied Econometrics, 11:619-632.

Pinstrup-Andersen, P. (1983). Export crop production and malnutrition, Occasional Paper Series, vol. 2, no. 10, Chapel Hill, University of North Carolina, reprinted by IFPRI.

Rivers, D., and Vuong, Q.H. (1988). Limited information estimators and exogeneity tests for simultaneous probit models. Journal of Econometrics, 39 (3): 347-366.

Smith, R.J., and Blundell, R.W. (1986). An exogeneity test for a simultaneous equation Tobit model with an application to labor supply. Econometrica, 54 (3): 679-685.

Sen, A. (1981). Poverty and famines: An essay on entitlement and deprivation, Oxford, Clarendon Press.

Strasberg, P.J., Jayne, T. S., Yamano, T., Nyoro, J., Karanja, D., and Strauss, J. (1999). Effects of agriculture commercialization on food crop input use and productivity in Kenya, MSU International Development Working Papers No. 71.

Tipraqsa, P., and Schreinemachers, P. (2009). Agricultural commercialization of Karen Hill tribes in northern Thailand. Agricultural Economics, 40(1): 43–53. doi:10.1111/j.1574-0862.2008.00343.x.

von Braun, J., Kennedy, E., and Bouis, H. (1989). Comparative analyses of the effects of increased commercialization of subsistence agriculture on production, consumption, and nutrition, Final Report. International Food Policy Research Institute.

von Braun, J., and Kennedy, E. (1994). Agricultural commercialization, economic development, and nutrition. Johns Hopkins University Press.

von Braun, J., and Kennedy, E. (1986). Commercialization of Subsistence Agriculture: Income and Nutrition Effects in Developing Countries. IFPRI Working Papers on Commercialization of Agriculture and Nutrition, n.1.

Von Braun, J., Kennedy, E., and Bouis, H. (1990). Commercialization of smallholder agriculture: Policy requirements for the malnourished poor. Food Policy, 15(1), 82–85. doi:10.1016/0306-9192(90)90027-w.

Wood, B., Nelson, C., Kilic, T., & Murrey, S. (2013). Up in smoke? Agricultural commercialization, rising food prices and stunting in Malawi. World Bank Policy Research Working Paper 6650.

Wooldridge, J.M. (2015). Control function methods in applied econometrics. Journal of Human Resources, 50:420-445.