

Investigation of the determinants of food security: the role of agricultural inputs for household food security and child nutrition in Ethiopia

Maryia Bakhtsiyarava, Kathryn Grace

Abstract

Malnutrition causes 45% of deaths among children under age five and leads to significant economic losses. This study focuses on Ethiopia, a country with one of the highest rates of chronic malnutrition (38%), where the majority of households rely on agriculture for food production and income. Food security in Ethiopia is threatened by climate variability, growing population, and stalled economic growth. Agricultural inputs such as improved seeds, fertilizers, and irrigation can potentially help households avoid food insecurity undernutrition. We use agricultural and socioeconomic surveys to investigate household food security and child stunting in relation to household's agricultural practices. Preliminary results indicate that food secure households use irrigation, fertilizers, erosion prevention measures, and improved seeds at significantly higher rates than food insecure households. The detailed investigation of the role of agricultural practices on food security will solidify the existing fragmented evidence and provide pathways for policy intervention.

Introduction

Child malnutrition has been a persistent health concern in the developing world, hindering economic and human capital development. Globally, malnutrition causes 45% of deaths among children under age five (IFPRI, 2016). Annual gross domestic product losses from health consequences of malnutrition are 11 % in Africa and Asia, which undermines these regions' developing economies and keeps them off track from improving health indicators (IFPRI, 2016). This study focuses on Ethiopia, a country in sub-Saharan Africa (SSA) where the health burden of undernutrition is accompanied by a growing population, insufficient economic development, and increased climate variability. The confluence of these factors contributes to some of the highest levels of childhood malnutrition on the planet—38% of Ethiopian children under age five are stunted. Moreover and equally compelling, the country has shown stalled progress in reducing undernutrition over the last decades (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). **The goal of this study is to analyze the link between the use of agricultural inputs, household food security and children's nutrition outcomes (stunting) in Ethiopia.**

Agriculture in Ethiopia

Agriculture in Ethiopia represents the main livelihood strategy, or means of obtaining food and income. The majority of Ethiopians lives in rural areas (80% of the population), which limits opportunities for non-agricultural employment for individuals and makes their livelihoods dependent on agricultural production (CIA, 2016). The reliance on agriculture as the main economic activity across the entire country is extremely high with 98% and 64% of rural and urban households, respectively, practicing either farming or livestock rearing (CSA, 2017). In the face of heavy reliance on agriculture, disruptions in agricultural production due to weather,

market, or any other shocks put households at risk of becoming food insecure. In an agriculturally dependent country such as Ethiopia, loss of livelihoods and food insecurity due to crop failure can mean a difference between life and death. Food insecurity is especially dangerous for children and pregnant women as they are most physiologically vulnerable to inadequate diets. Given the high rate of home consumption of cultivated crops (from 60% of wheat harvest to 80% of sorghum) and small plot size (1.38 ha per household on average), household food security and diets are particularly vulnerable to droughts, increases in the price of inputs, and other crop damage (CSA, 2017). More than a quarter of households (26%) surveyed in the Ethiopian Socioeconomic Survey (ESS) responded experiencing food insecurity within the 12 months before the survey (CSA, 2017).

Ethiopia has experienced multiple droughts in the last decades, which severely limited food availability. The 2015-16 drought led to the loss of 50 to 90% (depending on the crop) of crop production (FAO, 2017). Below-average rains in 2017 left 5.6 million people requiring emergency food assistance (FAO, 2017; FEWSNET, 2016). Poor rainfall in the first half of 2017 negatively affected wheat, teff, and maize — staple crops in the Ethiopian diet — with losses of area and yield up to 60% in the most-affected areas. Reported strategies to cope with food shortages include skipping meals, selling assets, and displacement, all of which exacerbate the food security crisis and turn it into a livelihood crisis in Ethiopia (FAO 2017).

Agricultural inputs in the form of fertilizers, machinery, and improved seeds represent ways to improve and protect yields and, consequently, diets from shocks on the markets and in the environment. However, agricultural inputs come at a price and may not be available to all households, which may have implications for their ability to have sufficient food stocks and diets. Interestingly, fertilizers are only applied in 35% of sorghum fields, whereas sorghum has the highest household consumption rate of 80% (CSA, 2017). Households sell from 6 to 21% of high value crops harvest, such as teff, and tend to consume lower value crops such as sorghum (CSA, 2017). This fact illustrates that crops that households are particularly reliant on for food may be the most vulnerable to the shocks because of the low rate of inputs.

This study is motivated by the need to identify specific actions households can take to protect their crops, livestock, assets, and avoid undernutrition. Agricultural inputs in the form of improved seeds, fertilizers, machinery, and irrigation present viable strategies to avoid food insecurity and protect children from undernutrition, and research is needed to analyze their efficacy in preventing food shortages and undernutrition.

The goal of this study is to analyze the link between the use of agricultural inputs, household food security and children's nutrition outcomes (stunting) in Ethiopia. This study builds on the already existing frameworks of the determinants of undernutrition and extends them by examining whether inputs and improvements in agriculture translate into health benefits for the agriculturally dependent households. Specifically, this study considers a relationship between the cultivation of specific crops, use of agricultural inputs and household food security and child stunting. Stunting indicates chronic malnutrition and has negative implications for health and well-being later in life; it is observed if a child is too short for their height. The urgency of the proposed work is determined by the already heavy burden of undernutrition on the economic and human capital of Ethiopia, which will only be exacerbated by the growing population and

increasing climate variability. Despite the existing frameworks and numerous studies on the determinants of undernutrition (Carletto et al., 2016; Kennedy et al., 1992), we lack a thorough understanding of how agricultural strategies contribute to undernutrition, which hinders our ability to provide relief. This study has the potential to advance the theoretical knowledge about the determinants of undernutrition by uncovering important aspects of the interplay between agriculture and undernutrition. We rely on the Ethiopian Socioeconomic Survey (ESS), a dataset with detailed information about households' socioeconomic characteristics and agricultural practices, and use logistic and ordinary least squares regressions for the analysis. This study represents an important attempt to comprehensively analyze the nutrition effects of multiple inputs within an agricultural sector of one country and will solidify fragmented evidence about the role of agricultural practices.

Feedback mechanism between agriculture and nutrition

The existing studies linking agricultural activities and nutritional outcomes consider crop choices and agricultural commercialization as the main transmission channels between agriculture, food security, and nutrition (Carletto et al., 2016). Certain crops, such as staple food crops or high value cash crops can provide households with a supply of food and stream of revenue, respectively, which in theory eases access to food and ensures food security. Even though the majority of Ethiopian farmers consume 60-80% of their harvest (CSA 2017), most of the farmers sell some part of the harvest, thus commercializing their agricultural activities to an extent.

Despite a long history of agriculture - nutrition research, evidence about the nutritional benefits of certain agricultural activities has been inconclusive. According to Kennedy et al. (1992), positive nutritional and health effects from cash cropping are observed when the incremental income from selling cash crops is invested into improving health and social services. However, the commercialization of agriculture and increased income do not necessarily translate into improved nutrition and health (Bryceson, 1988; Dewalt, 1993). Incremental income from cash-cropping is often received in lumps and is spent on school fees and consumer goods (Wood et al., 2013). In addition, traditionally, food producers in Africa are women (Gladwin et al., 2001), whereas cash cropping is mostly a man's job. Gender inequality in access to education, land ownership, loans and ready cash can prevent women from entering cash cropping (Ellis, 1998; Gladwin et al., 2001). In cash cropping households, man as the main breadwinner usually controls cash and is guided by his own perceptions of food needs for household members in allocating money for food (Gladwin et al., 2001). Prioritizing men's needs and not allocating an appropriate amount of money for food can leave other members of the household, especially women and young children, at risk for undernutrition. Although recent research has shown that cash cropping does not negatively affect nutritional outcomes but can lead to small positive effects on children's health through increased calorie intake (Carletto et al., 2016; Wood et al., 2013), less is known about the role of agricultural inputs and food security. This study aims to fill this gap and investigates the relationship between the use of various agricultural inputs, food security, and child health.

The research questions proposed in this study are:

1. Do certain agricultural practices (use of fertilizers, irrigation, improved seeds, share of sold harvest, and type of crop grown) lead to improved household food security as demonstrated by the number of experienced food shortages?
2. Do these agricultural practices (use of fertilizers, irrigation, improved seeds, share of sold harvest, and type of crop grown) also translate into improved nutrition outcomes for children as measured by child stunting?

Data, Methods, and Measures

Data

This study relies on the 2015-2016 Ethiopian Socioeconomic Survey (ESS) collected in a collaborative effort by the World Bank Living Standards Measurement Study (LSMS) and the Central Statistics Agency of Ethiopia (CSA). The Ethiopian LSMS was conducted by the World Bank within its Integrated Surveys of Agriculture (ISA). The 2015-2016 survey is nationally representative and included 4,954 households. It collects data on demographic characteristics and such domains as health, agriculture, time use and labor, food security and shocks, and banking and credit. Relevant to this study are the sections on health, food security, and shocks. Food security and shocks were assessed by asking respondents about their food spending, consumption, whether their household experienced food shortages and/or environmental shocks, and what implications those shocks had for income, assets, food stocks, and food production. The LSMS-ISA data are distinct in that they take place-specific agricultural context in account by collecting agricultural data twice, before planting and after harvest. As a result, the survey collects detailed data on crop-specific harvests and cultivated area, harvest labor and crop disposition. These data are supplemented by the Enumeration Area (EA) location data provided with displacement: in public files locations of EAs are displaced up to 2 km in urban areas, up to 5 km in rural areas, and a 1% random sample of points is displaced up to 10 km.

Methods and Measures

This study is interested in investigating both food security and stunting. Therefore, the first dependent variable is food security status of a household. A household is considered food insecure if a respondent from that household reported experiencing a food shortage in the last 12 months. We analyze how household food security status relates to agricultural practices (use of fertilizers, irrigation, improved seeds, type of crop grown, and share of harvest sold), adjusted for household wealth and household size. We use logistic regressions to analyze the odds of experiencing a food shortage.

The second dependent variable in this study are height-for-age z-scores estimated for children under five years of age. A child is stunted if his/hers height-for-age is more than two standard deviations below the WHO Child Growth Standards median (WHO, 2017). Stunting is indicative of chronic undernutrition and is caused by mother's poor diet during pregnancy, failure to receive proper nutrition for an extended period of time, and can be aggravated by repeated infections (IFPRI, 2016). Biological factors affecting stunting are mother's age, baby's order and sex, and are controlled for in this study (Grace et al., 2012, 2015). Other variables affecting

stunting outcomes are mother's employment, education and marital status (Grace et al., 2012, 2015). Household ownership of a refrigerator is used to proxy access to resources. Maternal employment, education, marital status and household assets might indicate household wealth and access to resources. Besides being indicative of household resources, ownership of a refrigerator can ensure better food storage and a decreased risk of foodborne illness. We use ordinary least squares regressions to investigate the association between stunting, socioeconomic characteristics, and agricultural practices.

Preliminary results

Food security concerns in Ethiopian households are pervasive. According to preliminary results, in the 7 days before the survey, 20% of households reported being concerned that they may not have enough food for the household. In the last 12 months, as many as 26% of households reported experiencing food shortages. Among the reasons reported for food shortages, dwindled food reserves due to droughts are reported as the most important reason by as many as 40% of the households (Table 1). With regards to stunting, the survey included 2,886 children under the age of five, 41% of whom (1,189 children) were stunted. The observed prevalence of stunting is considered very high according to the WHO classification of malnutrition prevalence ranges (de Onis & Blössner, 1997).

Table 1. Reasons for food shortages reported by households (N=1,123 food insecure households)

Order of importance	Reasons	% households citing the reason
1st most important	Inadequate food stocks due to droughts/poor rains and small land size	40%
2nd most important	Food in the market was very expensive	31%
3rd most important	No food in the market	20%

Table 2 compares the use of inputs for food secure (households that did not report food shortages) and food insecure households (those who reported food shortages). As can be seen, **food secure households use irrigation, urea, erosion prevention measures, and improved seeds at significantly higher rates than food insecure households.** As evident by the role of drought for food shortages, the lack of irrigation inhibits households' ability to protect their crops. Manure, a cheap form of organic fertilizer, is used at a higher rate by food insecure households.

Table 2. Household use of agricultural inputs by food security status

Measure of food security: Have you experienced a situation when you did not have enough food for your household in the last 12 months?							
Variables		Food insecure Total N	Food Secure Total N	Food insecure %	Food Secure %	χ^2	<i>p</i> -value
Extension Program							
	Yes	282	832	26%	29%	3.535	0.060
	No	810	2048	74%	71%		
Irrigation							
	Yes	73	261	8%	11%	5.853	0.016
	No	842	2137	92%	89%		
Fertilizer							
	Yes	619	1605	49%	48%	0.152	0.697
	No	650	1733	51%	52%		
Urea (nitrogen fertilizer)							
	Yes	278	900	34%	40%	9.898	0.002
	No	539	1329	66%	60%		
DAP (Diammonium phosphate fertilizer)							
	Yes	295	815	36%	38%	1.058	0.304
	No	520	1311	64%	62%		
NPS (nitrogen-phosphorus-sulfur fertilizer)							
	Yes	80	248	12%	14%	1.707	0.191
	No	602	1546	88%	86%		
Manure							
	Yes	511	1269	58%	54%	4.332	0.037
	No	366	1077	42%	46%		
Erosion prevention							
	Yes	580	1637	48%	51%	3.819	0.051
	No	636	1570	52%	49%		
Seeds							
	Traditional	848	2144	86%	83%	5.411	0.020
	Improved	139	451	14%	17%		

Chi-square test was used to compare the rates of use of agricultural inputs between food secure and food insecure households. Variables for which significant differences were observed are in bold.

Further analysis will employ logistic and OLS regressions to investigate the relationship between household-level food security and child stunting and agricultural practices. Preliminary results have already demonstrated significant differences in the rates of use of agricultural inputs between food secure and insecure households, but further detailed analysis will provide

important evidence about the role of various inputs for food security and child nutrition outcomes. Our findings will solidify the fragmented evidence that currently exists about agricultural practices and food security and thus will uncover areas for policy intervention.

References

- Bryceson, D. (1988). Peasant cash cropping versus self-sufficiency in Tanzania: A historical perspective (Vol. 19). Institute of Development Studies, Sussex: IDS Bulletin.
- Carletto, C., Corral, P., & Guelfi, A. (2016). Agricultural commercialization and nutrition revisited: Empirical evidence from three African countries *Food Policy*.
- Central Statistical Agency - CSA/Ethiopia, & ICF. (2017). *Ethiopia Demographic and Health Survey 2016*. Addis Ababa, Ethiopia: CSA and ICF.
- CIA. (2016). The World Factbook. Washington, DC: Central Intelligence Agency.
- CSA. (2017). LSMS—Integrated Surveys on Agriculture Ethiopia Socioeconomic Survey (ESS) Central Statistical Agency and Living Standards Measurement Study (LSMS), World Bank
- de Onis, M., & Blössner, M. (1997). WHO Global Database on Child Growth and Malnutrition. Geneva, Switzerland: World Health Organization.
- Dewalt, K. M. (1993). Nutrition and the commercialization of agriculture - 10 years later. *Social Science & Medicine*, 36(11), 1407-1416.
- Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development Studies*, 35(1), 1-38.
- FAO. (2017). Ethiopia: Drought response plan and priorities in 2017 (pp. 1-7): Food and Agriculture Organization of the United Nations.
- FEWSNET. (2016). Famine Early Warning Systems Network.
- Gladwin, C. H., Thomson, A. M., Peterson, J. S., & Anderson, A. S. (2001). Addressing food security in Africa via multiple livelihood strategies of women farmers. *Food Policy*, 26(2), 177-207.
- Grace, K., Davenport, F., Funk, C., & Lerner, A. M. (2012). Child malnutrition and climate in Sub-Saharan Africa: An analysis of recent trends in Kenya. *Applied Geography*, 35(1-2), 405-413.
- Grace, K., Davenport, F., Hanson, H., Funk, C., & Shukla, S. (2015). Linking climate change and health outcomes: Examining the relationship between temperature, precipitation and birth weight in Africa. *Global Environmental Change-Human and Policy Dimensions*, 35, 125-137.
- IFPRI. (2016). Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030. Washington, DC.: International Food Policy Research Institute
- Kennedy, E., Bouis, H., & von Braun, J. (1992). Health and nutrition effects of cash crop production in developing counties: a comparative analysis. *Social Science and Medicine*, 35(5), 689-697.
- WHO. (2017). WHO Child Growth Standards. World Health Organization. Available at <http://www.who.int/childgrowth/standards/en/>.
- Wood, B., Nelson, C., Kilic, T., & Murray, S. (2013). Up in the smoke? Agricultural commercialization, rising food prices and stunting in Malawi. The World Bank Development Research Group: Policy Research Working Paper 6650.