

Aweke, Chanyalew S.; Sassi, Maria; Lahiff, Edward; Wordofa, Muluken G.

Article

Seasonality and food security among smallholder rural households in eastern Ethiopia: Evidence from panel data analysis

Cogent Economics & Finance

Provided in Cooperation with:

Taylor & Francis Group

Suggested Citation: Aweke, Chanyalew S.; Sassi, Maria; Lahiff, Edward; Wordofa, Muluken G. (2022) : Seasonality and food security among smallholder rural households in eastern Ethiopia: Evidence from panel data analysis, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 10, Iss. 1, pp. 1-15,
<https://doi.org/10.1080/23322039.2022.2035492>

This Version is available at:

<https://hdl.handle.net/10419/303584>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Seasonality and food security among smallholder rural households in eastern Ethiopia: Evidence from panel data analysis

Chanyalew S. Aweke, Maria Sassi, Edward Lahiff & Muluken G. Wordofa

To cite this article: Chanyalew S. Aweke, Maria Sassi, Edward Lahiff & Muluken G. Wordofa (2022) Seasonality and food security among smallholder rural households in eastern Ethiopia: Evidence from panel data analysis, Cogent Economics & Finance, 10:1, 2035492, DOI: [10.1080/23322039.2022.2035492](https://doi.org/10.1080/23322039.2022.2035492)

To link to this article: <https://doi.org/10.1080/23322039.2022.2035492>



© 2022 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.



Published online: 12 Feb 2022.



[Submit your article to this journal](#)



Article views: 2292



[View related articles](#)



[View Crossmark data](#)



Citing articles: 3 [View citing articles](#)



Received: 05 March 2020
Accepted: 21 January 2022;

Corresponding author: Chanyalew S. Aweke Director for Research, Extension and Publication, Haramaya University, Ethiopia; Center for International Cooperation and Development (Cicops), University of Pavia, ItalyE-mail: acseyoum@gmail.com

Reviewing editor:
Goodness Aye, Agricultural Economics, University of Agriculture, Makurdi, Benue State, Nigeria

Additional information is available at the end of the article

GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

Seasonality and food security among smallholder rural households in eastern Ethiopia: Evidence from panel data analysis

Chanyalew S. Aweke^{1,2}, Maria Sassi³, Edward Lahiff⁴ and Muluken G. Wordofa⁵

Abstract: Food insecurity remains one of the major challenges in Ethiopia. There is scanty empirical evidence regarding the contribution of seasonality to household food and nutrition security. This study was conducted in eastern Ethiopia with the aim of examining seasonal household food and nutrition security and factors influencing this seasonal variation. Data were gathered from randomly selected households during pre- and post-harvest seasons. A Random Effects Generalized Least Squares (GLS) regression was employed for analysis. The result indicated considerable variation between the two seasons in terms of dietary diversity and food security. Households producing more food groups, cultivating larger size of land, having higher household income, keeping more livestock, owning cell phone, having access to cooperatives, and having access to improved drinking water as well as education were more likely to be more food secure across seasons. However, households keeping livestock in their dwelling units and households who had access to credit were negatively associated with seasonal food insecurity. Future

ABOUT THE AUTHORS

Chanyalew S. Aweke (PhD) is an Assistant Professor and researcher in the School of Rural Development and Agricultural Innovation, Haramaya University, Ethiopia. He obtained his PhD from the Department of Food Business and Development, University College Cork, Ireland. He earned his MSc in Rural Development and Agricultural Extension from Haramaya University, Ethiopia. He is currently Director for Research Extension and Publication. His research areas include food security, agriculture-nutrition linkage, and agricultural systems.

Maria Sassi (PhD) is a Professor of Agricultural Economics at University of Pavia, Italy. She has extensive research experience in the areas of food security and food policy.

Edward Lahiff (PhD) is a senior lecturer at the Department of Food Business and Development, University College Cork, Ireland. His research areas include Agri-nutrition linkage, rural-urban migration and land.

Muluken G. Wordofa (PhD) is an Assistant Professor and senior researcher at Haramaya University with extensive research experience in food systems, impact assessment and climate change.

PUBLIC INTEREST STATEMENT

Food insecurity remains one of the major development challenges in Ethiopia. Its magnitude and effect vary across seasons. This study found a considerable variation in terms of dietary diversity and food security between pre-harvest and post-harvest seasons. Households producing diverse food groups, owning more resources (land, livestock, and income), those with better access to institutions (cooperatives, improved drinking water, and education) as well as owning cell phone were more likely to be more food secure across the seasons. Future interventions aiming at ensuring food security should pay attention to seasonality and mechanisms of improving diversified food production and household income as well as expanding education opportunities and access to cooperatives, infrastructure (mobile telephone), and sanitation.

interventions aiming at ensuring food security should pay attention to seasonality and mechanisms of improving diversified food production and household income as well as expanding education opportunities and access to cooperatives, infrastructure (mobile telephone), and sanitation.

Subjects: Agriculture & Environmental Sciences; Agricultural Development; Development Studies; Rural Development

Keywords: Food security; Seasonality; Smallholder farmers; Panel data; East Hararghe; Ethiopia

1. Introduction

Food insecurity and malnutrition remain serious challenges to the world and a top priority for developing countries. Globally, 821 million people are considered to be food insecure and the absolute number has increased by 17 million from 2016 to 2017 (FAO, IFAD, UNICEF, WFP and WHO, 2018). The authors indicated that 28.9% of these malnourished people were from sub-Saharan African Countries (SSA) which accounts 23.2% of the total population of these countries. The magnitude of under-nourishment in Eastern African region was higher (estimated at 31.4%) compared to other parts of SSA (FAO, IFAD, UNICEF, WFP and WHO, 2018). Malnutrition has been even higher in Ethiopia with approximately half of the population of the country considered to be undernourished (FAO, 2012). Food insecurity is heavily concentrated in rural areas, world-wide, and many of the most vulnerable and malnourished people depend on agriculture for their livelihoods (World Bank, 2008).

Seasonality in food security and household diets is gaining interest in food security literature. Studies on seasonality and household diets in Burkina Faso (Becquey et al., 2012) and Nigeria (Ayenew et al., 2018) found a considerable seasonal variation in terms of dietary diversity. A study in Ethiopia using a nationally representative data has shown that households experienced food shortage and decline in calorie consumption during the lean season (Hirvonen et al., (2015)). The authors also indicated a considerable variation in household dietary diversity between pre-harvest and post-harvest seasons where households had a higher dietary diversity during the pre-harvest season. These studies have shown that agricultural production diversity and seasonality could differentially influence food and nutrition security of smallholder rural households. Variation in food and nutrition security from one season to the next season is an important area of research for redesigning policies and interventions in Ethiopia. This might be due to the fact that most crops are grown using rain-fed agriculture and irrigation is limited to a small minority of households. As a result, households are often selling their assets for meeting their basic requirements such as food due to food shortage during the lean season.

However, the evidence base generated from panel data was scant and focused on national level analysis (Hirvonen et al., (2015); Hunnes, 2015; Matz et al., 2015; Sibhatu et al., 2017). As far as we know, the empirical literature in Ethiopia especially in low-land agro-ecology and detailed evidence on food and nutrition security across agricultural seasons, however, is scant. On the other hand, the literature on food security has mainly focused on cross-sectional data in Ethiopian context (Beyene, 2015; Dam Lam et al., 2017; Habtewold, 2018; Manlosa et al., 2019; Motbainor et al., 2016; Mulugeta et al., 2018). This study will therefore contribute to this research gap by analysing data collected from smallholder rural households during pre-harvest and post-harvest seasons in the low-land agro-ecology in Eastern Ethiopia. Hence, this study was conducted to understand seasonal food security and identify factors contributing to seasonal variation at household level. For this purpose, panel data models were employed as these models describe individual behaviour both across seasons and households.

The rest of this paper is organized into four sections. Section two presents the conceptual framework of the study and the variables selected for analysis. Section three deals with methods employed and details of the approaches used in addressing the objectives of the research. The

fourth section presents substantive findings related to seasonal household dietary diversity and food security as well as factors associated with household food and nutrition security. Finally, the conclusion and policy implications drawn from the study are presented.

2. Food security framework

Household food security refers to the capability of households to produce or purchase the right quantity and quality of food which is enough to meet family food requirements as well as the resources and services required for achieving food security (Ecker & Breisinger, 2012). The concept has evolved over time from availability to access and entitlement on food over the last couple of decades. The concept of food and nutrition security has emerged in the food security literature by combining food access with sanitation, health, and care practices (Benson, 2004).

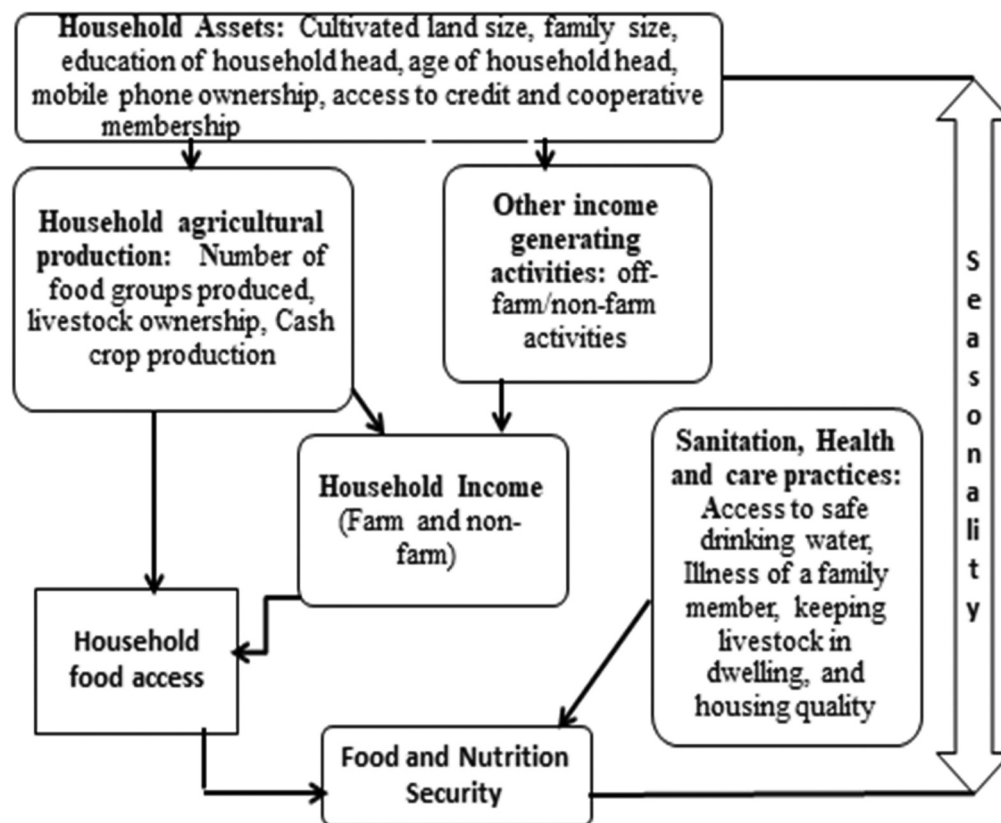
Food security can be influenced by the interplay of several factors such as income, food cost, physical and social environment, government and training policies and food systems at household level (Renzaho & Mellor, 2010). Studies in Ethiopia have shown that agricultural production (Hirvonen & Hoddinott, 2017) and cooperatives (Ayele, 2014) were positively associated with household food security. Agriculture affects food security through household's own consumption, as increase in household agricultural production and diversification of production can be translated into greater availability of, and hence access to, food and households producing market-oriented commodities can generate cash income and this income can be used to purchase more and higher-quality foods (Haddad, 2000; World Bank, 2007). Household food security was also influenced by the age and education of the household head, household labour and size and remittances according to a study in Zimbabwe (Mango et al., 2014). A study in Southern Ethiopia also revealed that agro-climatic zone, younger age, lower education, and access to radio for women were all significantly associated with household food insecurity and hunger (Regassa & Stoecker, 2012). Improving sanitation in food systems can also improve food security of households through its effect on health and food needs (Ecker & Breisinger, 2012; Herforth & Ballard, 2016). This shows that household food and nutrition security can be influenced by a wide range of factors depending on the context such as household assets, household agricultural production, household income (farm and non-farm income sources), and sanitation.

The present study is focused on understanding seasonal food security of smallholder rural households in East Hararghe, Ethiopia using food consumption score as a measure. Figure 1 (below) depicts factors such as household assets, agricultural production, household farm and non-farm income, sanitation and care practices influencing household food security following a conceptual framework by Sassi (2018). These variables were selected based on the literature review and availability in the data set gathered. The arrows below indicate the relationship between explanatory variables and the outcome variable (food and nutrition security). Seasonality is depicted on the right side border as a cross-cutting issue that influence virtually all aspects of agricultural production, household income, assets, and food security. This study focuses on one directional relationship starting from household assets and ends with food and nutrition security.

3. Research methodology

This study covers the low-land areas in East Hararghe, focusing on rural areas of Babille district. It is based on a field survey of rural households in the district. This district was selected because of its dependence on agriculture and its vulnerability to malnutrition. Nearly half of the children under the age of 5 were found to be stunted following a study by Roba et al. (2016) which indicated nearly half the children were found to be stunted which is higher than the national average (44% of children under the age of five were stunted). Questionnaire was developed and pre-tested for validity following the literature review and in consultation with local experts. Data were collected from randomly selected 400 rural households in the post-harvest, and data were again collected from the same households during pre-harvest season with attrition rate at 2%. The post-harvest season refers to the high season which is immediately after the main harvest (December to February) while pre-harvest season refers to the lean season (from June to September). The total number of observations in this study was 784. Households were twice asked about the food items consumed over the last seven

Figure 1. Conceptual framework of the study (Adapted from Sassi, 2018).



days prior to the survey, once during the post-harvest season (Mid-January to Mid-February, 2014) and again during the pre-harvest season (5 August to 5 September 2014) and were also asked the frequency of consumption of the various food groups over the same period.

Several indicators can be used for measuring food security. In recent years, academic and policy debates have shifted towards more differentiated understandings of food security, emphasizing the need not only for energy, in the form of carbohydrates but also other major food groups such as protein and fats, and a range of micronutrients, including vitamins and minerals, all of which are required for an active, healthy, and productive life (Coates, 2013; Ruel et al., 2013). According to Headey and Ecker (2013), food security measures such as household dietary diversity and food consumption score perform better as a measure of food and nutrition security compared to other various measures, as these measures indicate dietary adequacy. Food consumption score is an indicator of good quality as it measures diversity and frequency of consumption (Mango et al., 2014; World Food Program/WFP, 2008). This measure indicates the number of food groups consumed and the number of times these food groups were consumed seven days prior to the survey period. This recall period was considered to be appropriate as it captures “household’s habitual diet” (Carletto et al., 2013; World Food Program/WFP, 2008) for post-harvest and pre-harvest seasons. After pre-testing and validating the types of foods consumed, food groups such as starches, pulses, vegetables, fruit, meat, dairy, fats and sugar were used following World Food Program/WFP (2008). Following this guideline, standard weights were attached to each food group and food consumption score was computed for each household for post-harvest and pre-harvest seasons. This measure was again used to classify households into food secure and food insecure, as it is one of the key indicators of food security (Carletto et al., 2013; Pérez-Escamilla et al., 2017).

The dependent variable is food consumption score which is continuous. Following the nature of the dependent variable, panel data models were used for examining factors influencing seasonal food security. These models can help us understand the variations over time and across individual households in terms of food security and factors influencing it. These models also have an additional advantage in that it captures the effects that cannot be detected in cross-sectional data (Wooldridge, 2002). Various tests were used for selecting panel data models which fits best to the data set. Hausman test was used for selecting between random effects model and fixed effects model. Moreover, Breusch and Pagan Lagrangian multiplier test (LM test) was used for choosing panel data model between Pooled OLS and Random Effects Model. The model which fits well to the data set was selected based on the results of Hausman test and LM test (See, section 4.3 below). The model specification is outlined as follows:

$$Y_{it} = \beta X_{it} + \alpha_i + u_{it} \quad (1)$$

where

Y_{it} is the dependent variable observed for household i at time t , in this case it is the dependent variable.

X_{it} is a vector of explanatory variables for household i at time t .

θ is a vector of coefficients.

α_i denotes unobserved household specific effects which are assumed to be fixed over time and vary across household i .

u_{it} is the error term.

4. Results

4.1. Descriptive statistics

Following the conceptual framework indicated above and literature review, several explanatory variables were selected for this study. Various categories of explanatory variables such as household assets, own agricultural production, household income, sanitation, and health practices were included in the regression analysis. Specific variables selected under these categories of variables are indicated in Table 1. The descriptive statistics result of each of these variables selected for analysis is presented as follows.

Family size, age of the household head, size of cultivated land, oxen plough and cell phone ownership as well as access to institutional services such as cooperatives, credit, and extension were hypothesized to influence food security. Family is the main source of labour for household agricultural production and the average family size was 6.44. In terms of age of household heads, the average age of the sample households was 38 years. Another important asset is land where households cultivate 1.26 hectare on average. Nearly half of the sample households also owned cell phone. Households had also access to institutions such as credit, cooperatives and extension as shown in Table 1. Access to these institutions was hypothesized to influence food security positively as they provide inputs and other important services to those who had access.

Crop and livestock production are important livelihood activities for rural households in the study area. Crops such as sorghum, maize, groundnuts, faba bean, vegetables, and fruits were grown in the study area. Livestock such as cattle, goats, sheep, donkey, camel, and chicken are among the major livestock types kept in the study area. Livestock ownership was measured in terms of Tropical Livestock Unit (TLU) following Storck et al. (1991). Households on average produce 2.7 food groups out of eight food groups. Cereals and legumes/nuts were grown by majority of

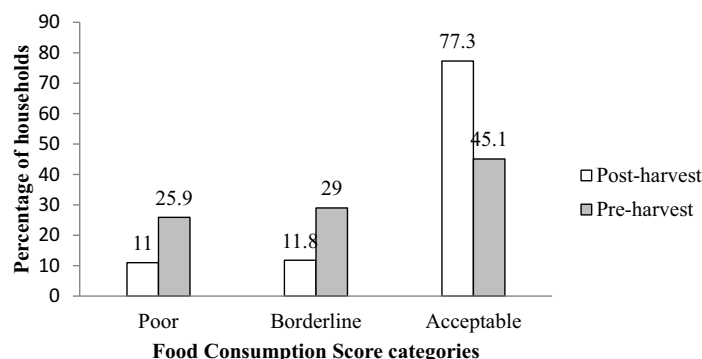
Table 1. Descriptive results of variables used in the econometric analysis (N = 784)

Variable	Measurement and definition	Mean (std. dev.)
Food consumption score	Food Consumption Score (FCS) at household level	45.37(21.82)
Family size*	Number of family members	6.4 (2.34)
Age of the household head*	Age of the household head in years	37.96(12.29)
Literacy of the household head*	1 if the household head is literate or 0 otherwise	0.41 (0.49)
Cell phone ownership*	1 if the household owns cell phone or 0 otherwise	0.50 (0.50)
Credit access	1 if the respondent had access to credit or 0 otherwise	0.25 (0.43)
Extension contact	1 if the respondent have access to extension services or 0 otherwise	0.83 (0.37)
Cooperative membership*	1 if the farmer is a member of a cooperative or 0 otherwise	0.20 (0.40)
Total cultivated land*	Total cultivated land measured in hectare	1.26 (0.74)
Livestock ownership	Livestock ownership measured in Tropical Livestock Unit (TLU)	2.05 (2.89)
Food group production*	Number of food groups produced (count)	2.73 (1.01)
Total Income quintile-1	Refers to household income of 600 ETB and less	100.83 (188.11)
Total Income quintile-2	Refers to household income above 600 ETB and less than or equal to 2,419.5 ETB	1517.27 (515.92)
Total Income quintile-3	Refers to household income above 2419.50 ETB and less than or equal to 4793.4 ETB	3472.88 (703.48)
Total Income quintile-4	Refers to household income above 4793.4 ETB and less than or equal to 9075 ETB	6623.64 (1239.68)
Total Income quintile-5	Refers to household income above 9075 ETB	18319.46 (11,435.47)
Housing quality*	1 if the household has access to improved housing or 0 otherwise	0.60 (0.49)
Illness of household member	1 if the respondent have at least one member is ill or 0 otherwise	0.41 (0.49)
Keeping livestock in the dwelling*	1 if the respondent keeps livestock in the dwelling or 0 otherwise	0.31 (0.47)
Access to safe drinking water (Treated)*	1 if the respondent have access to improved water or 0 otherwise	0.32 (0.47)
Season	Seasonality refers to pre-harvest and post-harvest production periods. It is given the value of 1 if the season is pre-harvest or 0 otherwise	0.49 (0.50)

*refers to variables that are time invariant

households in the study area. Fruits and vegetables were grown by small proportion of households in the study area. Households in the study area produce cash crops such as groundnuts and khat. Households were also involved in fattening small ruminants and cattle for sale. In terms of livestock ownership, households owned 2.05 TLU on average. Moreover, income generated from farm and non-farm activities along the production year were also important livelihood strategies in

Figure 2. Proportion of households along the three food consumption score categories.



rural areas. On average, households obtained 5,997.6 Ethiopian Birr (ETB) from both farm and non-farm activities. This income was categorized into quintiles so as to see the degree of influence of income to household dietary diversity and food security.

Household sanitation and care practices were hypothesized to influence household food security. These include housing quality, keeping livestock in the dwelling, access to improved drinking water, and illness of a family member. Nearly half of the households owned improved housing quality and at least one member of the household was ill while nearly one-third of the sample households keep their livestock in their dwelling and had improved access to safe drinking water. Another important variable which was included in the regression was season which was categorized into post-harvest and pre-harvest seasons.

4.2. Seasonal household dietary diversity and food security

Food consumption score was used in this study for measuring food security following Maxwell et al. (2014). As indicated above, food consumption score was computed following the standard procedures in the literature (World Food Program/WFP, 2008). The difference in terms of changes in food consumption score was assessed between post-harvest and pre-harvest seasons. A marked difference was obtained between post-harvest and pre-harvest seasons in terms of food consumption score. The food consumption score decreased on average from 52.8 to 37.8 from post-harvest to pre-harvest seasons. The food consumption score declined by nearly 40% from post-harvest to pre-harvest seasons. This shows that dietary diversity had worsened from post-harvest to pre-harvest seasons. This can be attributed to increase in the supply of food in the market and own production during the post-harvest season.

Following World Food Program/WFP (2008), a food consumption score less than or equal to 21 was classified as poor consumption; FCS from 21.5 to 35 was borderline consumption; and a FCS more than 35 was acceptable food consumption. After computing FCS, households were classified into poor, borderline and acceptable consumption categories. The percentage of households across these food consumption categories is shown in figure below for both post-harvest and pre-harvest seasons. Looking into more detail at the sub-categories, 11% of households in our sample were found to have poor food consumption during post-harvest, increasing to 25.9% during pre-harvest; 11.8% fell into borderline consumption during post-harvest, increasing to 29% during pre-harvest; while households with acceptable consumption declined from 77.3% during post-harvest to 45.1% during pre-harvest (see, Figure 2 below). Of the total sample households, two-fifth moved from higher to lower consumption categories from post-harvest to pre-harvest season while three-fifth of the households remain in the same category across the two seasons. This indicates household dietary diversity substantially worsened during pre-harvest season as the proportion of households in the lowest

consumption category was relatively high during this season. This shows a marked seasonal variation in terms of dietary diversity across households and seasons.

Food security status of households was gauged using food consumption score as a measure. Following Maxwell et al. (2014), households with poor consumption score and borderline consumption score were considered food insecure while households with acceptable consumption score were considered as food secure. During the post-harvest season, nearly one-third of the total households were food insecure. This number increased to more than half of the households during the pre-harvest season. This shows marked seasonal variation between post-harvest and pre-harvest seasons in terms of food security status of households and their dietary diversity.

4.3. Drivers of seasonal dietary diversity and food security among rural households

Household food security was explained as a function of various factors. For understanding the magnitude of influence of these factors, panel data models were employed as the data set was generated from post-harvest and pre-harvest seasons. Several categories of explanatory variables such as household assets, own agricultural production, household income, sanitation, health and care practices were used in the regression analysis. A comparison was made between models such as pooled OLS, Fixed Effects, and Random Effects. Hausman test was used in order to choose between fixed effects and random effects models. The chi-square result was insignificant, which means the Random Effects specification better suited the data set (See, Table 2). Moreover, The Breusch and Pagan Lagrangian multiplier test (LM test) was employed to decide between Random Effects Regression and Pooled OLS. The Chi-square test is significant and small, which indicates that we shouldn't use pooled OLS ($P < 0.0005$). This indicates that Random Effects Model is appropriate for this study. These results were obtained immediately after estimating the random effect model following the suggestion by Park (2011). Both Hausman test and LM test have shown that Random Effects Model is better fitted to the data set. As a result, Random Effects GLS regression was employed for understanding the magnitude of influence of factors affecting food security across households and seasons. The model fit was good at 1% probability level. Random-effects GLS regression result is presented in Table 2.

Of the variables included in the regression analysis, education of the household head, ownership of cell phone, cooperative membership, access to credit, size of cultivated land, livestock ownership, number of food groups produced, household income, access to safe drinking water, keeping livestock in the dwelling, and season were significantly associated with household food security. The results related to each of these variables are presented below following the conceptual framework.

(a) Household assets

Literacy of the household head was hypothesized to influence food security positively and significantly. It has a significant and positive effect on household food security at 1% significant level. Those households who are literate are 3.86 times more likely to have better food security compared to households who are illiterate, keeping all other factors constant. It can enhance household access to information which builds capacity for improving their diet which in turn improves food security. Other studies also demonstrated the positive influence of education of household heads on dietary outcomes (Berti et al., 2004; Mango et al., 2014). A review by Bashir and Schilizzi (2013) also identified education as one of the major determinants of food security across Africa. This suggests that educating household head can positively contribute to improving dietary diversity and, ultimately, the food security of households across seasons.

Mobile phones are important for linking farmers with others in the agriculture sector, especially market agents, as well as with health and credit providing institutions. Mobile phone ownership was significantly and positively associated with household food security. Households owning mobile phones were nearly six times more likely to be food secure compared to households who did not own mobile phone. A study in Niger by Aker and Ksoll (2016) found out an increase in production of

Table 2. Factors associated with seasonal household food security (N = 784)

Explanatory variables	RE-rob (std. err.)
Family size	−0.202(0.33)
Age of household head	−0.050(0.06)
Education of household head	3.862(1.50) **
Cell phone ownership	5.786(1.56) ***
Extension contact	1.950(1.70)
Cooperative membership	4.826(1.66) ***
Credit access	−4.521(1.53) ***
Total cultivated land	3.487(1.12) ***
Livestock ownership (TLU)	0.785(0.27)***
Food group production	3.339(0.75) ***
Total Income quintile-2	1.577(1.95)
Total Income quintile-3	3.498(1.89)*
Total Income quintile-4	5.357(1.96)
Total Income quintile-5	3.943(2.33)*
Housing quality	−1.135(1.47)
Illness of household member	1.996(1.35)
Keeping livestock in the dwelling	−4.141(1.55) ***
Access to safe drinking water	5.216(1.52***)
Season	−10.808(1.43) ***
Constant	30.053(3.87) ***
rho	0.20756606 (fraction of variance due to u_i)
Wald chi2 (19)	425.12 (Prob > chi2 = 0.0000)
R-sq: Within	0.3215; Between = 0.3925; Overall = 0.3641
Hausman test chi2 (10)	11.42 (Prob>chi2 = 0.3254)
LM test chi2 (1)	14.05 (Prob > chi2 = 0.0002)

***= Significant at 1%, ** = Significant at 5% * = Significant at 10%

diverse crops as a result of mobile phones ownership. The reason for this might be households can receive exposure regarding the importance of diet diversity and utilize the information for improving their diet and food security.

Membership to cooperatives and access to credit were hypothesized to influence household food security positively. Cooperative membership was significantly and positively associated with food security at 1% significant level. Households who are members of cooperatives have better food security situation compared to other non-member households. A study in Ethiopia by Ayele (2014) indicated that households participating in rural cooperatives improved their food security. This could be attributed to services provided to their member households through provision of agricultural inputs (fertilizer and seed), capacity building and marketing of crops. Households in the study area also took credit for a variety of purposes, including agricultural production, consumption and in response to shocks such as crop loss and livestock death. However, credit was negatively and significantly associated with household food consumption at 1% significant level. This shows that households who did not have access to credit were better off in terms of their food security compared to households who had access to credit. This was against the hypothesized relationship and the finding by Goshu et al. (2013) where household access to credit influenced food security positively in Central and Hararghe

Highlands of Ethiopia. This can be attributed to the reason that households in the study area usually do not take credit unless they are resource poor for cultural reasons. This was also reflected as those households who took credit own on average less than a hectare of land and have an above-average household size (6.5 persons).

Total cultivated land size has been one of the key assets for rural households in the study area and was hypothesized to influence food security positively. As hypothesized, it was found to have positive and significant association with household food security at 1% significant level. A one hectare increase in cultivated land increases the food consumption score by 3.5 while keeping all other factors constant. Seasonal variation across households in terms of food security can then be attributed to size of land cultivated at household level. Households cultivating larger farm size tend to have a more diversified diet on average and better food security as it was also confirmed by other studies (Bashir & Schilizzi, 2013).

(a) Agricultural production and other non-farm activities

Own agricultural production was hypothesized to influence food security positively. Producing additional one food group leads to an increase in household's food consumption score by 3.34, keeping all other factors constant. This shows that as households increase the number of food groups produced, the probability of improving dietary diversity and food security increases. This suggests that an increase in the diversification of food production increases the food security which is consistent with previous studies on the relationship between food security and farm production diversity (Hirvonen & Hoddinott, 2017; Islam et al., 2018; Mulmi et al., 2017; Sibhatu et al., 2015). This suggests that agricultural diversification can be one of the pathways through which agricultural production influences food security for smallholder households in the study area (Haddad, 2000; World Bank, 2007).

Livestock is a means of livelihood on which a large number of households in the study area rely, as well as a potential source of high-quality food. Livestock holding was positively and significantly associated with household dietary diversity and food security at 1% significant level. A one unit increase in TLU increases FCS by 0.79, keeping all other factors constant. Households owning more livestock were more likely to have higher food security. This suggests increasing livestock ownership in the study area for enhancing food security across seasons. This is consistent with the findings of other studies (Hoddinott et al., 2015; Mango et al., 2014; Slavchevska, 2015). A study in Ethiopia also found positive association between food security and livestock ownership using a panel data (Demeke et al., 2011). Another study in Ethiopia also found strong association between cow ownership and child stunting in remote rural areas by improving milk consumption (Hoddinott et al., 2015). The contribution of animal derived foods in terms of supply of protein will continue to grow in low and middle income countries (Enahoro et al., 2018). This shows the growing potential contribution of livestock to household food security in countries like Ethiopia across seasons.

One of the pathways through which agriculture influences food security is through income (World Bank, 2007). In this study, household income was significantly and positively associated with food consumption score, keeping all other factors constant across seasons and households. Household income at the higher quintiles (3rd, 4th, and 5th quintiles) significantly and positively influenced food security. The magnitude of influence of household income was higher at the fourth quintile compared to income at the third and fifth income quintiles (See, Table 2). This shows that household income do not have linear relationship with household food security. Overall, households obtaining higher income increased their food security across seasons. This might be due to the reason that the income they obtained might have been used for purchasing diverse food items. The descriptive result has also shown that households obtaining higher income had higher food security. This is consistent with a review by Bashir and Schilizzi (2013) which revealed income as one of the major determinants of food security in Africa and Asia.

(a) Household sanitation

Several variables related to sanitation practices were included in the regression analysis. Of these variables, access to safe drinking water and keeping livestock in the dwelling were significantly associated with household food security across the two seasons. Access to improved drinking water was hypothesized to positively influence food security of households across the two seasons. Households who had access to improved drinking water were 5.2 times more likely to be food secure than households who did not have access at 1% probability level, keeping all other factors constant. This suggests that improving access to drinking water can improve food security across seasons. Moreover, keeping livestock in dwelling is one of the practices in the study area as livestock is an integral part of farming systems. This was hypothesized to influence food security negatively due to its impact on sanitation and health of the members of households. Households keeping livestock in their dwelling were 4.14 times less likely to be food secure compared to households who keep their livestock outside their dwelling at 1% significant level, keeping all other factors constant. This shows that households keeping livestock in their dwelling were worse off in terms of their food security due to sanitation and health problems. Overall, households who had access to improved drinking water and keeping their livestock outside their dwelling were found to have better food security due to better sanitation.

Finally, one of the variables which we considered in this research is seasonality which was found to have significant association with household dietary diversity and food security. Households were 10.8 times better off in terms of dietary diversity and food security during the post-harvest season than during the pre-harvest season, keeping all other factors constant. As one moves from post-harvest to pre-harvest season, household dietary diversity and food security declines. This also confirms the worsening of food security during the pre-harvest season and suggests the importance of seasonality in household food security.

5. Discussion and conclusion

Seasonality emerges as an important dimension for understanding diet and food security in the study area. Comparison of results from the two-part household survey highlighted notable seasonal difference in terms of dietary diversity and food security. On average, household food consumption score declined considerably (40%) during the pre-harvest season, with two-fifth of households moving from higher to lower food consumption categories from post-harvest to pre-harvest seasons. The number of food insecure households increased by twofold during the pre-harvest season. This shows that food security and dietary diversity declined considerably during the pre-harvest season. Another study in Ethiopia on the other hand indicated that household dietary diversity increased during the pre-harvest season by 10.5% compared to post-harvest season (Hirvonen et al., (2015).) which contradicts with the results of the current study. The differences between these two studies can be due to difference in the context in which the two studies were based. For example, households in the present study mainly rely on rain-fed agriculture and on market for important food products such as vegetables and fruits. The availability of many of the food products were limited during the pre-harvest season which results in lower food consumption score and food security in the study area. The policy implication from this study is that provision of ware housing services can help in bridging this gap between the two seasons or the availability of some of the agricultural products can be increased through processing and preservation techniques.

Household food production diversity and food security were positively associated in this study. The current study also found out a positive and significant association between livestock ownership and seasonal food security. This confirms a study by Hirvonen and Hoddinott (2017), who indicated a positive association between production diversity and dietary diversity in Ethiopia using a cross-sectional data. A study in Malawi by Jones et al. (2014) also found out strong association between farm production diversity and dietary diversity. This suggests that producing a wide range of food groups and increasing livestock ownership can improve dietary diversity and food security. However, the finding in the current study contradicted with a study conducted in Zambia which found a weaker association between household agricultural production diversity and dietary diversity (Mofya-Mukuka & Hichaambwa,

2018). A study conducted in Ghana by Anderman et al. (2014) also obtained a negative relationship between cash crop production and household food security. The variation in the relationship between agricultural production and food security can emanate from local context (Ickowitz et al., 2019). In the current study households produce various crops and keep livestock as a major livelihood activity. This suggests that increasing agricultural diversification can improve food security across seasons. Households can use their home garden in the production of vegetables, fruits and legumes across seasons. These crops can also be intercropped with major crops grown in the area such as sorghum, maize and groundnut.

Another important finding in the current study is that households in the higher income quintiles (Quintile 3, 4 and 5) were significantly associated with household dietary diversity and food security. This shows that differences in food security across seasons and across households were influenced by household income after the third quintile. This is consistent with a study in Nigeria where dietary diversity of households in the second and third income quintiles was better (Ayenew et al., 2018). A study in Ghana also indicated that farm diversification and income growth were strongly associated with dietary diversity using time-series data (Ecker, 2018). This suggests for policy engaging smallholder farmers into local market through farm and non-farm income generating activities for improving food security of households across seasons.

Apart from household assets and own agricultural production, sanitation and related factors such as access to improved drinking water and keeping livestock in the dwelling were found to have significant association with household food security. Households with improved access to drinking water and household keeping their livestock outside their dwelling had better food security status across seasons. This shows that households with better sanitation can increase their food security. Considering sanitation in the food system is therefore one of the key components for improving food security (Herforth & Ballard, 2016). This suggests that improving access to water by local officials and encouraging households to keep their livestock separately outside their dwelling can enhance food security across seasons.

Overall, seasonal variation in food and nutrition security was positively and significantly associated with own production of food groups, household income, size of cultivated land and livestock ownership. Furthermore, cell phone ownership, cooperative membership, education of the household head and access to improved drinking water positively contribute to household food security. On the other hand, households keeping livestock within their dwelling and credit access were negatively associated with household food security. The implication of the above analysis is that household food security can potentially be improved through increased production of food groups, livestock ownership, household income, and increasing the size of cultivated land. Expanding education of household heads, ownership of cell phones, access to cooperatives and access to safe drinking water can also improve food security. However, it might be difficult to increase land size in the study area given the small size of landholding. Use of modern technologies and increasing the frequency of production and increasing access to irrigation can enhance food security of households across seasons as technology driven intensification can save land and increase the productivity of agricultural products as suggested by Byerlee et al. (2014). The study also indicated that credit access negatively affected household food security for cultural reasons as households who are resource poor are taking credit and was used to purchase cereals. Training should be provided for households who take credit on how they can use it for improving their food security across seasons.

Acknowledgements

We would like to express our deepest appreciations to Irish-Aid through AgriDiet project for its financial support. We also appreciate the Center for International Cooperation and Development of the University of Pavia, Italy and Haramaya University, Ethiopia for all the support during the write-up of the manuscript.

Funding

Irish-Aid through AgriDiet project and Center for International Cooperation and Development (CICOPS) of

the University of Pavia, Italy; Center for International Cooperation & Development (CICOPS) of the University of Pavia, Italy [2019];

Author details

Chanyalew S. Aweke¹²
E-mail: acseyoum@gmail.com
Maria Sassi³
Edward Lahiff⁴
Mulukén G. Wordofa⁵
ORCID ID: <http://orcid.org/0000-0002-5143-180X>

Goodness Aye⁶

¹ Director for Research, Extension and Publication, Haramaya University, Ethiopia.

² Center for International Cooperation and Development (Cicops), University of Pavia, Italy.

³ Department of Economics and Management, University of Pavia, Pavia Italy.

⁴ Department of Food Business and Development, University College Cork, Cork Ireland.

⁵ Institutions, Innovation Systems, and Economic Development Group, Haramaya University, Ethiopia.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Authors' contributions

The first author designed data collection tools, gathered primary data and analysed the data. Other authors were involved in data analysis, interpretation and write-up. All authors read and approved the final manuscript.

Availability of data and materials

The data that support the findings of this research can be obtained from the authors up on request.

Author details

¹ Director for Research, Extension and Publication, Haramaya University, Ethiopia. ²Center for International Cooperation and Development (CICOPS), University of Pavia, Italy. ³Department of Economics and Management, University of Pavia, Italy. ⁴Department of Food Business and Development, University College Cork, Ireland. ⁵Institutions, Innovation Systems, and Economic Development Group, Haramaya University, Ethiopia

Citation information

Cite this article as: Seasonality and food security among smallholder rural households in eastern Ethiopia: Evidence from panel data analysis, Chanyalew S. Aweke, Maria Sassi, Edward Lahiff & Muluken G. Wordofa, *Cogent Economics & Finance* (2022), 10: 2035492.

References

- Aker, J. C., & Ksoll, C. (2016). Can mobile phones improve agricultural outcomes? Evidence from a randomized experiment in Niger. *Food Policy*, 60 (2016) , 44–51. <https://doi.org/10.1016/j.foodpol.2015.03.006>
- Anderman, T. L., Remans, R., Wood, S. A., DeRosa, K., & DeFries, R. S. (2014). Synergies and tradeoffs between cash crop production and food security: A case study in rural Ghana. *Food Security*, 6(4), 541–554. <https://doi.org/10.1007/s12571-014-0360-6>
- Ayele, Z. A. (2014). The impact of saving and credit cooperatives on food security in the West Amhara Region of Ethiopia. PhD Thesis, University College Cork.
- Ayenew, H. Y., Biadgilign, S., Schickramm, L., Abate-Kassa, G., & Sauer, J. (2018). Production diversification, dietary diversity and consumption seasonality: Panel data evidence from Nigeria. *BMC Public Health*, 18(1), 988. <https://doi.org/10.1186/s12889-018-5887-6>
- Bashir, M. K., & Schilizzi, S. (2013). Determinants of rural household food security: A comparative analysis of African and Asian studies. *Journal of the Science of Food and Agriculture*, 93(6), 1251–1258. <https://doi.org/10.1002/jsfa.6038>
- Becquey, E., Delpeuch, F., Konaté, A. M., Delsol, H., Lange, M., Zoungrana, M., & Martin-Prevel, Y. (2012). Seasonality of the dietary dimension of household food security in urban Burkina Faso. *British Journal of Nutrition*, 107(12), 1860–1870. <https://doi.org/10.1017/S0007114511005071>
- Benson, T. (2004). Africa's food and nutrition security situation. International Food Policy Research Institute 2020 discussion Paper 37, Washington DC.
- Berti, P. R., Krasevec, J., & FitzGerald, S. (2004). A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutrition*, 7(5), 599–609. Ottawa, Canada. <https://doi.org/10.1079/PHN2003595>
- Beyene, F. (2015). Determinants of food security under changing land-use systems among pastoral and agro-pastoral households in eastern Ethiopia. *Environment, Development and Sustainability*, 17(5), 1163–1182. <https://doi.org/10.1007/s10668-014-9596-8>
- Byerlee, D., Stevenson, J., & Villoria, N. (2014). Does intensification slow crop land expansion or encourage deforestation? *Global Food Security*, 3(2), 92–98. <https://doi.org/10.1016/j.gfs.2014.04.001>
- Carletto, C., Zezza, A., & Banerjee, R. (2013). Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Global Food Security*, 2(1), 30–40. <https://doi.org/10.1016/j.gfs.2012.11.006>
- Coates, J. (2013). Build it back better: Deconstructing food security for improved measurement and action. *Global Food Security*, 2(3), 188–194. <https://doi.org/10.1016/j.gfs.2013.05.002>
- Dam Lam, R., Bofo, Y. A., Degefa, S., Gasparatos, A., & Saito, O. (2017). Assessing the food security outcomes of industrial crop expansion in smallholder settings: Insights from cotton production in Northern Ghana and sugarcane production in Central Ethiopia. *Sustainability Science*, 12(5), 677–693. <https://doi.org/10.1007/s11625-017-0449-x>
- Demeke, A. B., Keil, A., & Zeller, M. (2011). Using panel data to estimate the effect of rainfall shocks on smallholders food security and vulnerability in rural Ethiopia. *Climatic Change*, 108(1), 185–206. <https://doi.org/10.1007/s10584-010-9994-3>
- Ecker, O. (2018). Agricultural transformation and food and nutrition security in Ghana: Does farm production diversity (still) matter for household dietary diversity? *Food Policy*, 79, 271–282. <https://doi.org/10.1016/j.foodpol.2018.08.002>
- Ecker, O., & Breisinger, C. (2012). *The food security system: A new conceptual framework* (No. 1166). International Food Policy Research Institute (IFPRI).
- Enahoro, D., Lannerstad, M., Pfeifer, C., & Dominguez-Salas, P. (2018). Contributions of livestock-derived foods to nutrient supply under changing demand in low- and middle-income countries. *Global Food Security*, 19, 1–10. <https://doi.org/10.1016/j.gfs.2018.08.002>
- FAO. (2012). *Nutrition country profiles. Nutrition and consumer protection*. <http://www.fao.org/ag/agn/nutrition/ethen.stm>
- FAO, IFAD, UNICEF, WFP and WHO. (2018). *The state of food security and nutrition in the World 2018: Building climate resilience for food security and nutrition* (Rome: FAO).
- Goshu, D., Kassa, B., & Ketema, M. (2013). Measuring diet quantity and quality dimensions of food security in rural Ethiopia. *Journal of Development and Agricultural Economics*, 5(5), 174–185. <https://doi.org/10.5897/JDAE12.141>
- Habtewold, T. M. (2018). Determinants of food security in the oromiya region of Ethiopia. In A. Heshmati, and H. Yoon (Eds.), *Economic growth and development in Ethiopia* (Singapore: Springer Singapore) 39–65.

- Haddad, L. (2000). A conceptual framework for assessing agriculture-nutrition linkages. *Food and Nutrition Bulletin*, 21(4), 367–373. <https://doi.org/10.1177/156482650002100405>
- Headey, D., & Ecker, O. (2013). Rethinking the measurement of food security: From first principles to best practice. *Food Security*, 5(3), 327–343. <https://doi.org/10.1007/s12571-013-0253-0>
- Herforth, A., & Ballard, T. J. (2016). Nutrition indicators in agriculture projects: Current measurement, priorities, and gaps. *Global Food Security*, 10, 1–10. <https://doi.org/10.1016/j.gfs.2016.07.004>
- Hirvonen, K., & Hoddinott, J. (2017). Agricultural production and children's diets: Evidence from rural Ethiopia. *Agricultural Economics*, 48(4), 469–480. <https://doi.org/10.1111/agec.12348>
- Hirvonen, K., Taffesse, A. S., & Worku, I. (2015). Seasonality and household diets in Ethiopia. The ESSP Working Papers 74, International Food Policy Research Institute.
- Hoddinott, J., Headey, D., & Dereje, M. (2015). Cows, missing milk markets, and nutrition in rural Ethiopia. *The Journal of Development Studies*, 51(8), 958–975. <https://doi.org/10.1080/00220388.2015.1018903>
- Hunnes, D. E. (2015). The effects of weather, household assets, and safety-net programs on household food security in Ethiopia using rural household panel data. *Regional Environmental Change*, 15(6), 1095–1104. <https://doi.org/10.1007/s10113-014-0680-2>
- Ickowitz, A., Powell, B., Rowland, D., Jones, A., & Sunderland, T. (2019). Agricultural intensification, dietary diversity, and markets in the global food security narrative. *Global Food Security*, 20, 9–16. <https://doi.org/10.1016/j.gfs.2018.11.002>
- Islam, A. H. M. S., von Braun, J., Thorne-Lyman, A. L., & Ahmed, A. U. (2018). FarmDiversification and food and nutrition security in Bangladesh: Empirical evidence from Nationally representative household panel data. *Food Security*, 10(3), 701–720. <https://doi.org/10.1007/s12571-018-0806-3>
- Jones, A. D., Shrinivas, A., & Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in Malawi: Findings from nationally representative data. *Food Policy*, 46, 1–12. <https://doi.org/10.1016/j.foodpol.2014.02.001>
- Mango, N., Zamasiya, B., Makate, C., Nyikahadzoi, K., & Siziba, S. (2014). Factors influencing household food security among smallholder farmers in the Mudzi district of Zimbabwe. *Development Southern Africa*, 31(4), 625–640. <https://doi.org/10.1080/0376835X.2014.911694>
- Manlosa, A. O., Hanspach, J., Schultner, J., Dorresteyn, I., & Fischer, J. (2019). Livelihood strategies, capital assets, and food security in rural Southwest Ethiopia. *Food Security*, 11(1), 167–181. <https://doi.org/10.1007/s12571-018-00883-x>
- Matz, J. A., Kalkuhl, M., & Abegaz, G. A. (2015). The short-term impact of price shocks on food security-Evidence from urban and rural Ethiopia. *Food Security*, 7(3), 657–679. <https://doi.org/10.1007/s12571-015-0467-4>
- Maxwell, D., Vaitla, B., & Coates, J. (2014). How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia. *Food Policy*, 47, 107–116. <https://doi.org/10.1016/j.foodpol.2014.04.003>
- Mofya-Mukuka, R., & Hichaambwa, M. (2018). Livelihood effects of crop diversification: A panel data analysis of rural farm households in Zambia. *Food Security*, 10(6), 1449–1462. <https://doi.org/10.1007/s12571-018-0872-6>
- Motbainor, A., Worku, A., & Kumie, A. (2016). Level and determinants of food insecurity in East and West Gojjam zones of Amhara region, Ethiopia: A community based comparative cross-sectional study. *BMC Public Health*, 16(1), 503. <https://doi.org/10.1186/s12889-016-3186-7>
- Mulmi, P., Masters, W. A., Ghosh, S., Namirembe, G., Rajbhandary, R., Manohar, S., Shrestha, B., Keith, P. W., Webb, P., & Cardoso, M. A. (2017). Household food production is positively associated with dietary diversity and intake of nutrient-dense foods for older preschool children in poorer families: Results from a nationally-representative survey in Nepal. *PLoS one*, 12(11), e0186765. <https://doi.org/10.1371/journal.pone.0186765>
- Mulugeta, M., Tiruneh, G., & Alemu, Z. A. (2018). Magnitude and associated factors of household food insecurity in Fedis Woreda East Hararghe zone, Oromia region, Ethiopia. *Agriculture & Food Security*, 7(1), 3. <https://doi.org/10.1186/s40066-017-0140-6>
- Park, H. M. (2011). Practical guides to panel data modeling: A step-by-step analysis using stata. Tutorial Working Paper. Graduate School of International Relations, International University of Japan.
- Pérez-Escamilla, R., Gubert, M. B., Rogers, B., & Hromi-Fiedler, A. (2017). Food security measurement and governance: Assessment of the usefulness of diverse food insecurity indicators for policy makers. *Global Food Security*, 14, 96–104. <https://doi.org/10.1016/j.gfs.2017.06.003>
- Regassa, N., & Stoecker, B. J. (2012). Household food insecurity and hunger among households in Sidama district, southern Ethiopia. *Public Health Nutrition*, 15(7), 1276–1283. <https://doi.org/10.1017/S1368980011003119>
- Renzaho, A. M., & Mellor, D. (2010). Food security measurement in cultural pluralism: Missing the point or conceptual misunderstanding? *Nutrition*, 26(1), 1–9. <https://doi.org/10.1016/j.nut.2009.05.001>
- Roba, K. T., O'Connor, T. P., Belachew, T., & O'Brien, N. M. (2016). Infant and young child feeding (IYCF) practices among mothers of children aged 6–23 months in two agro-ecological zones of rural Ethiopia. *Int J Nutr Food Sci*, 5(3), 185–94. doi: 10.11648/j.ijnfs.20160503.16
- Ruel, M. T., & Alderman, H., & Maternal and Child Nutrition Study Group. (2013). Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition? *The Lancet*, 382(9891), 536–551. [https://doi.org/10.1016/S0140-6736\(13\)60843-0](https://doi.org/10.1016/S0140-6736(13)60843-0)
- Sassi, M. (2018). Conceptual Frameworks for the Analysis of Food Security: Understanding Food Insecurity. Springer, Cham <https://doi.org/10.1007/978-3-319-70362-6>
- Sibhatu, K. T., Krishna, V. V., & Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences*, 112(34), 10657–10662. PMID: 26261342. <https://doi.org/10.1073/pnas.1510982112>
- Sibhatu, K. T., Qaim, M., & Shankar, B. (2017). Rural food security, subsistence agriculture, and seasonality. *PLoS ONE*, 12(10), e0186406. <https://doi.org/10.1371/journal.pone.0186406>
- Slavchevska, V. (2015). Agricultural Production and the Nutritional Status of Family Members in Tanzania. *The Journal of Development Studies*, 51(8), 1016–1033. <https://doi.org/10.1080/00220388.2015.1018906>

- Storck, H., Bezabih, E., Birhanu, A., and Borowiecki, A., & Shimeles, W/Hawariate. (1991). Farming systems and farm management practices of smallholders in the hararghe highlands. *Farming Systems and Resource Economics in the Tropics*. Wissenschaftsverlag Vauk Kiel, Germany, 11: 41–48.
- Wooldridge, J. F. (2002). *Econometric analysis of cross section and panel data*. The MIT Press.
- World Bank. (2007). *From agriculture to nutrition: Pathways, Synergies and Outcomes*.
- World Bank. (2008). *Agriculture for development: World development report*. The International Bank for Reconstruction and Development New York. http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf.
- World Food Program/WFP. (2008). *Food consumption analysis: Calculation and use of the food consumption score in food security analysis*. World Food Program, Rome, Italy. https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf.



© 2022 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.



You are free to:

Share — copy and redistribute the material in any medium or format.

Adapt — remix, transform, and build upon the material for any purpose, even commercially.

The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.

You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

No additional restrictions

You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

***Cogent Economics & Finance* (ISSN: 2332-2039) is published by Cogent OA, part of Taylor & Francis Group.**

Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com

