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Drivers of rural households' food insecurity in Ethiopia: a comprehensive approach of calorie intake and food consumption score

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ABSTRACT
Most food insecurity studies in developing countries, including Ethiopia, use a single food security indicator to determine the food insecurity status, thus overlooking the multidimensional nature of food security. Using cross-sectional data collected from 408 households in three districts of East Hararghe Zone, Ethiopia, this study combined two food security indicators namely calorie intake and Food Consumption Score (FCS) so as to gain more insights on the multidimensional nature of food security and to categorise households into different food insecurity groups. The study further sought to identify factors influencing the households' food insecurity status. The research findings based respectively on the per capita calorie intake and the FCS indicate that 36.03 and 49.02 percent of the sampled households were food insecure. However, the findings reveal that when the two indicators were combined, 22.06 and 40.93 percent of the households were completely food insecure and transitory food insecure respectively. These findings also suggest that the 40.93 percent (26.96 and 13.97 percent) of households categorised as food secure based on single indicators (i.e., per capita calorie intake and FCS respectively) was unrealistic. Furthermore, findings from the bivariate probit model indicate that food insecurity incidences decreased with the adoption of soil and water conservation, access to irrigation, livestock, access to fertilisers, and household income. It increased with the age of the household head, the household size, and the coping strategy index. Therefore, policies and strategies combating food insecurity should consider a combination of food security indicators.

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Food insecurity; per capita calorie intake; food consumption score; bivariate probit model; Ethiopia

1. Introduction

Ethiopia has experienced tremendous economic progress since the early 2000s. Several interlinked factors, including its high economic growth rate and the formation of a social protection programme, namely PSNP, have reduced not only the proportion of people living below the poverty line but also the prevalence of hunger and undernourishment (McGuire, FAO, IFAD and WFP 2015; World Bank 2015). Conversely, Ethiopia is still one of the world's least developed countries

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as it ranked 173 out of 189 in the 2018 UNDP Human Development Index and 97 out of 117 qualifying countries in the 2019 Global Hunger Index (Grebmer et al. 2017; UNDP 2019). Poverty and food insecurity remain serious concerns considering that more than 32 million Ethiopians, particularly those living in rural areas, are still poor and inadequately fed (World Bank 2018; Grebmer et al. 2017).

Like other developing countries, the Ethiopian government has implemented different policies and strategies to tackle this problem of poverty. For instance, in 1996, the emergency relief programme was launched as a food security strategy to help chronically food insecure households reach a level of food security necessary for survival (Abegaz 2017; Hailu, Alemu, and Zaid 2018). Subsequently, the National Program for Food Security (NPFS) launched in 2005 focused on three interdependent components, specifically Productive Safety Nets (PSN), Household Asset Building (HAB), and Voluntary Resettlements (VR). This development programme has exclusively been guided by two fundamental principles. The first is the principle of reliance whereby rural food-insecure farmers are made reliant on food aid to help them use their own resources in order to overcome food insecurity. The second principle is breaking the perpetual food aid dependence so that they become food self-sufficient. Notwithstanding all these efforts by the government and other concerned bodies, the poverty rate is still high and vulnerability to food and nutritional insecurity still persistent, especially in rural Ethiopia (Abafita and Kim 2014; Sileshi et al. 2019a; Jaleta et al. 2018; Bogale 2012).

Various studies have analysed food insecurity from different perspectives using different micro-level food security indicators in Ethiopia and elsewhere (Mengistu, Gupta, and Birner 2018; Jaleta et al. 2018; Sileshi et al. 2019a; Aweke, Lahiff, and Hassen 2020; Sani and Kemaw 2019). Some of the most common indicators include the per capita food intake, the Food Consumption Score (FCS), the Household Dietary Diversity Score (HDDS), and the Household Food Insecurity Access Scale (HFIAS). However, no single indicator simultaneously satisfies all the dimensions of food security (availability, accessibility, utilisation, and sustainability) or the complexity of the food security concept (Magrini and Vigani 2014; Carletto, Zezza, and Banerjee 2013; Wiesmann et al. 2006). For instance, the per-capita consumption of calories and food consumption expenditure using daily minimum dietary requirements as thresholds are the most common indicators and measures of mean dietary energy supply as a proxy for food energy consumption in the form of calorie and money, respectively (Babatunde and Qaim 2010; Sileshi et al. 2019a). However, according to WFP (2008), those indicators consider neither dietary diversity nor nutritional composition, which might result in an underestimation of malnutrition. To overcome the limitations of the above indicators, the FCS and HDDS were developed to measure the household food security status in terms of dietary diversity, food frequency, and the relative nutritional importance of different food groups (Tiwari, Skoufias, and Sherpa 2013; WFP 2008). Both indicators provided similar information about the household food security status. They served not only as proxies for the quantity of food (calorie) but also strong predictors of the households' nutrient adequacy (Mekonnen et al. 2020; Ogundari 2017).

Consequently, the combination of more than one indicator provides greater insights into the households' food security status and further classifies households' food security status into different groups. This, in turn, is vital for designing and implementing inclusive food security policies and strategies intended to serve different groups based on the level of inadequacy. However, most of food security studies in Ethiopia have used a single indicator to analyse household food security status and its influencing factors. For example, Aweke, Lahiff, and Hassen (2020), Sani and Kemaw (2019), and Hailu, Alemu, and Zaid (2018), investigated household food insecurity using the FCS as a food security indicator. Others, including Beyene and Muche (2010), Agidew and Singh (2018), Abegaz (2017), and Feyisa (2018) measured household food security using the per capita calorie consumption. These studies used different economic models to identify different demographic, institutional and socio-economic factors that influenced household food insecurity. The emerging findings showed that household food insecurity was significantly influenced by a shortage of cultivated land, land degradation, the dependency ratio, recurrent drought, erratic rainfall patterns, limited access to education, credit, and agricultural technologies like improved seeds, fertilisers, and irrigation.

Further literature, including Reincke et al. (2018) and Sileshi et al. (2022), Wekesa, Ayuya, and Lagat (2018), and Dzanku (2019), attempted to combine three food security indicators as outcome variables for impact studies in Tanzania, Kenya, and Ghana respectively. However, most existing studies have failed to capture simultaneously both the amount of food and its nutritional quality, thus missing an important proxy for accessibility and utilisation dimension of food security (Ogundari 2017; Pangaribowo, Gerber, and Torero 2013; WFP 2008). This study is, therefore, intended to work on a combination of two indicators, namely the per-capita calorie intake and the FCS in order to reflect on food accessibility and food utilisation dimensions of food security. The research question underlying this study is whether these two indices can jointly improve the explanatory power of household food security in Deder, Gorugutu, and Haramaya districts in Ethiopia. To this end, we worked with smallholder farmers from the aforementioned districts in eastern Ethiopia and used both indicators to analyse food insecurity and factors that jointly influenced the level of food insecurity. The study provided insightful implications for effective policy formulation and interventions for different food insecure groups.

The reminder of the paper proceeds as follows: next to this introduction is the methodology of the study, including a description of the study area, the sampling strategy, data collection and the analytical framework. Subsequently, the findings and a discussion of the study are presented followed by the conclusion.

2. Methodology

2.1 Description of the study area

The present study was conducted in the Deder, Gorugutu and Haramaya districts of East Hararghe, Ethiopia in August and September, 2017 to explore households' food insecurity and factors associated with it. East Hararghe is located between latitudes 7° 32′ and 9° 44′ North and longitudes 41° 10′ and 43° 16′ East. The area is characterised by three agroecological zones: semi-arid, semi-temperate, and temperate tropical highlands accounting respectively for 62%, 26.4%, and 11% of the total area. Annual rainfall and temperatures vary across the different agro-ecological zones and range respectively from 400 to 2,000 mm and 10°C to 25°C.

Crop-livestock mixed farming system is the main economic activity in East Hararghe. The wide range of agro-ecological zones allows the area to produce a variety of agricultural products. Based on land coverage and the growing number of households, crops grown in the area include cereals (sorghum, maize, wheat, and teff), vegetables (potatoes, onions, shallots, and cabbage), and perennials [coffee and Khat (Catha adulis)]. The average productivity of the most dominant crops (for example sorghum and maize crops) is very low in Hararghe as compared to other parts of Ethiopia. For instance, in 2016/17, the average yield of sorghum and maize crops was respectively 19.69 and 26.67 qt/ha, which was much lower than the average national yields of 23.31 qt/ha for sorghum and 33.87 qt/ha for maize.

East Hararghie is affected by land degradation in the form of soil erosion and nutrient depletion. It is prone to erratic rainfall and frequent droughts. In addition, the area is broadly characterised by high population density, small and fragmented cultivated land, as well as low agricultural productivity. Because of the aforementioned reasons and other intermingled factors, poverty and chronic food insecurity persist in the area. Accordingly, several food security and productive safety net programmes have been introduced and implemented in the area since the early 2000s.

2.2 Sampling techniques and data collection

In this study, cross-sectional data were gathered from 408 households in three districts (Deder, Gorogutu and Haramaya) of East Hararge, Ethiopia. The districts were purposively selected to capture the existing heterogeneity of human population and socioeconomic, institutional, and agro-ecological zones whose sampling frame was representative of the total population. Three kebeles[1] from each district and a total of 408 sample households were randomly selected (157 from the Deder district, 124 from the Gorogutu district, and 127 from the Haramaya district) using the proportionate probability sampling based on the size of each district and kebele.

The research data were collected from sample households using a structured questionnaire that was prepared and pretested before the actual survey. The survey covered a wide range of subjects (households' demographic, socioeconomic and institutional characteristics, amount and frequencies of different food groups consumed by sample households, food security programmes and related activities) that were intended to determine the food insecurity status of households using the per capita calorie intake and the FCS as indicators of food security.

2.3 Data analysis

2.3.1 Determining food insecurity status

Food security measurement primarily requires methods for identifying food secure from food insecure households. This study employed both the per-capita calorie intake and the FCS to determine the food security status of households. According to the Ministry of Finance and Economic Development (MoFED 2002), the government of Ethiopia set the minimum adequate weighted average food requirement per capita per day at 2200 kcal (MoFED 2002). Thus, if the average per-capita calorie intake of a household was less than the predetermined threshold, the household was classified as food insecure.

Food consumption score is an index developed by the World Food Program (WFP) in 1996. It measures the household food security status in terms of dietary diversity, food frequency, and the relative nutritional importance of different food groups that were consumed by the households over seven days prior to the interview (Maxwell, Coates, and Vaitla 2013; WFP 2008). When calculating the FCS, we first grouped all food items into nine specific food groups (Main staples, Pulses, Dairy, Meat/Fish/Eggs, Vegetables, Fruits, Fats, Sugar, and Condiments). Next, we summed the frequencies with which the households consumed different food items of the same groups, and if a food group frequency exceeded seven, it was recorded as seven. Then, the value obtained for each food group was multiplied by its weight, thus creating a new weighted food group score. Finally, weighted food group scores were summed to form the FCS. Once the food consumption score was calculated, the threshold level which was below 21 was considered as poor food consumption. The threshold level between 21 up to 35 was labelled as borderline food consumption and as acceptable food consumption above 35 (Maxwell, Coates, and Vaitla 2013). However, households under poor food consumption and borderline food consumption were considered as food insecure; that is, households consuming less diversified and less quality food groups (Maxwell, Coates, and Vaitla 2013; WFP 2008, Moller 2015).

According to Maxwell, Coates, and Vaitla (2013), WFP (2008), and Pérez-Escamilla and Segall-Corrêa (2008), per-capita calorie intake indicators have a very strong exclusion restriction that does not capture the nutrition quality of a diet. Therefore, we combined the per-capita calorie intake with the FCS to obtain more comprehensive results that showed the food accessibility and utilisation as well as further classification of the food security status into four groups: (i) complete food secure based on both indictors, (ii) complete food insecure based on both indictors, (iii) transitory food insecure based on the per capital calorie intake but food secure based on the FCS, and (iv) transitory food insecure based on the FCS but food secure based on the per capital calorie intake.

2.3.2 Econometric modelling strategy

In the current study, we used a bivariate probit regression model to identify factors that influenced the food security status of households using two food security indicators. The dependent variable was the household food security status of each indicator (the per-capita calorie consumption and the FSC). It is a dummy variable. In other words, for each indicator, the food security status took the value 1 if a household is food insecure; otherwise, it had the value zero.

The bivariate probit model is a generalisation of the probit model used to estimate two binary outcomes jointly while allowing for potential correlation between unobserved disturbances as well as the relationship between the two outcomes (households food security status of two indicators) (Yue and Zou 2014; Young, Valdez, and Kohn 2009). According to Chiburis et al. (2011), where correlation exists, both binary probit and logit model results will be biased and inefficient under such circumstances.

In the simple binary probit model, there is only one binary dependent variable, y, and one latent variable, y*. However, in the bivariate probit model, there are two binary dependent variables, y1 and y2, so there are two latent variables, y1* and y2*. It is assumed that each observed variable takes on the value 1 if and only if the continuous latent variable is greater than zero as presented below:

$$\begin{aligned} y_{1i}^* &= X_{1i}\beta_{1i} + v_{1i} \\ y_{2i}^* &= X_{2i}\beta_{2i} + v_{2i} \end{aligned} \tag{1}$$

$$\begin{aligned} y_{1i} &= \begin{cases} 1 & \text{if} \quad y_{1i}^* > 0 \\ 0 & \text{if} \quad y_{1i}^* < 0 \end{cases} \\ y_{2i} &= \begin{cases} 1 & \text{if} \quad y_{2i}^* > 0 \\ 0 & \text{if} \quad y_{2i}^* < 0 \end{cases} \end{aligned} \tag{2}$$

As shown above, y_1 and y_2 are binary dependent variables of the two-food security statuses, x1 and x2 are vectors of different households' demographic, socio-economic, and institution factors determining the respective latent variables, and β's are vectors of parameters to be estimated. The error terms v1i and v2i are correlated disturbances in a seemingly unrelated bivariate probit model with $\sim \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix} \begin{pmatrix} 1 & \rho_{12} \\ \rho_{21} & 1 \end{pmatrix} \right]$, and ρ's are the correlations between the unobserved confounders of equations y_{1i} and y_{2i} (Young, Valdez, and Kohn 2009; Chiburis et al., 2011).

3. Results and discussion

3.1 Descriptive analysis

The summary statistics of different demographic, socio-economic, and institutional variables hypothesised to have influenced the food insecurity status of households and included in the bivariate probit model are presented in Table 1. The specification of these variables is based on a desk review of the relevant literature (Sileshi et al. 2019a; Bogale 2012; Ogundari 2017; Abegaz 2017; Agidew and Singh 2018; Beyene and Muche 2010).

The descriptive statistics are presented for the food insecure and food secure households, as determined by the two indicators (the per capita calorie intake and food consumption score). Apparently, based on the per-capital calorie intake threshold, 36.03 percent of households were regarded as food insecure. Similarly, based on the FCS, 49.02 percent of households were food insecure. The results reveal that food insecure households had relatively older household heads and larger household sizes, expressed as adult equivalents. Although the education levels of the two groups were very low (with an average of 3.65 years of formal education), food secure household heads were relatively better educated. As far as asset ownership was concerned, the food secure households had larger cultivated land areas and livestock holdings than the food insecure households. These assets are key resources for farming households that improve their livelihood and food security status (Schröder-Butterfill and Marianti 2006; Megersa et al. 2014).

The adoption of improved agricultural technologies, namely improved seeds, fertilisers, irrigation, and soil and water conservation was lower among food insecure households. Nevertheless, these

Table 1. Description of explanatory variables.

Variables	Description	Calorie intake				Food consumption score				Total sample	
		Food secure		Food insecure		Food secure		Food insecure			
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Sex	Dummy of sex of the household head (1 = male)	0.87	0.33	0.85	0.35	0.89	0.30	0.84	0.36	0.86	0.33
Age	Age of the household head in years	38.36[a]	12.33	43.42	12.83	39.81	12.40	40.57	13.09	40.18	12.73
Education	Level of education in numbers of years	4.02[a]	3.70	3.01	3.53	4.25	3.73	3.03	3.50	3.65	3.67
Adult equivalent	Size of household in adult equivalent	4.51	1.56	5.56[a]	1.59	4.85	1.66	4.94	1.65	4.89	1.65
Annual income	Natural log of total household income in Birr	9.54[a]	0.73	9.32	0.79	9.71[b]	0.68	9.21	0.75	9.47	0.76
Off-farm Activity	Dummy for participation in off-farm activities (Yes = 1)	0.42	0.49	0.52b	0.50	0.41	0.49	0.50c	0.50	0.46	0.50
Use of fertilisers	Dummy for use of fertilisers (Yes = 1)	0.56	0.49	0.49	0.50	0.66[a]	0.48	0.42	0.49	0.54	0.50
Use of improved seeds	Dummy for use of improved seeds (Yes = 1)	0.55[b]	0.50	0.44	0.50	0.62[a]	0.49	0.41	0.49	0.51	0.50
Use of irrigation	Dummy for use of irrigation (Yes = 1)	0.38[b]	0.49	0.29	0.45	0.43[a]	0.49	0.26	0.44	0.34	0.47
Cultivated land	Total cultivated land holding (ha)	0.30	0.18	0.28	0.17	0.32[a]	0.16	0.26	0.19	0.29	0.17
Adoption of SWC	Dummy for use of SWC (Yes = 1)	0.54[a]	0.50	0.40	0.49	0.60[a]	0.49	0.38	0.49	0.49	0.50
Livestock TLU	Livestock owned (Tropical Livestock Unit)	1.94[a]	1.94	1.48	1.79	2.37[a]	1.99	1.16	1.57	1.78	1.89
CSI	Coping strategy index	15.58	4.71	18.02[a]	4.94	15.44	4.95	17.52[a]	4.69	16.46	4.93
Received credit	Dummy for receiving credits (Yes = 1)	0.15	0.26	0.11	0.31	0.16[c]	0.37	0.10	0.30	0.13	0.34
Contact with DA	Number of contacts with Development Agent (DA), per month	2.29	2.01	2.27	2.20	2.53	2.09	2.02	2.04	2.28	2.08

[a,b]and [c] significant at the 1, 5 and 10 percent probability levels respectively

Note:"The coping strategies index is a tool that measures what households do when they cannot access adequate food. Food insecure households may change their diet, which means switching food consumption from preferred to cheaper and even less preferred substitutes, as well as others means like purchasing food on credit, consuming wild foods and immature crops or even seed stocks, favouring certain household members over others or going an entire day without eating food, just to mention few" (Maxwell et al., 2003).

technologies enhance the food security status of farm households through increasing productivity and farm income (Sileshi et al. 2019b; Jaleta et al. 2018; Ahmed et al. 2017; Kassie and Holden 2006; Tesfaye et al. 2008; Mengistie and Kidane 2016). With reference to institutional variables, about 13 percent of sample households received credit from formal credit institutions. Food secure households had better access to credit compared to food insecure households. Moreover, the results show that the annual income of food secure households was significantly higher than that of food insecure households. Furthermore, as reported by Maxwell et al. (2003), the descriptive statistics results show that food insecure households use more coping strategies in situations when access to adequate food is difficult.

3.2 Household food insecurity status

As indicated earlier, the study used both the per capita calorie consumption and the FCS to determine the food security status and categorise sample households into different food security groups. We used 2200 kcal per capita calorie consumption as the threshold to distinguish food secure households from food insecure households. For FCS indicators, households were regarded as food secure if the FSC was greater than 35 (acceptable food consumption); otherwise, they were considered as food insecure (poor food consumption and borderline food consumption). Based on the per capita calorie consumption threshold, the results indicate that 36.03 percent of sampled households were food insecure. The results also show that 49.02 percent of sample households were food insecure according to FCS indicators. By considering the per capita calorie consumption and FCS indicators, we divided our sample into four food security categories as shown in Table 2.

The results indicate that 37.01 percent of the sampled households were completely food secure based on both the per capita calorie consumption and FCS indicators. This means that these households used both adequate quantities and nutritionally diversified food more frequently. On the other hand, 22.06 percent of the households were completely food insecure with respect to both indicators. These households suffered from inadequate access to food in terms of quantity and quality. In other words, they had an average per capita calorie consumption that was below the threshold, and the FCS indicated poor or borderline food consumption.

In addition, about 13.97 percent of the households were below the recommended per capita calorie consumption and used nutritionally diversified food more frequently. Hence, they were classified as transitory food insecure based on the per capita calorie consumption and food secure based on the FCS. Lastly, about 26.96 percent of the households were food secure, based on the per capita calorie intake indicators, and food insecure, based on the FCS indicators. This implies that households had the ability to access adequate and sufficient quantity of calories but not nutritionally diversified food. Thus, we categorised these households as transitory food insecure based on the FCS and food secure based on the calorie intake.

Overall, these findings imply that 40.93 percent (13.97 plus 26.96) of the sampled households were transitory food insecure. If only one indicator (either the FCS or per capita calorie intake) had been considered, these households would have been classified as food secure. The results indicate that a single indicator cannot provide enough insight to get a more informative picture of a

Table 2. Food security status of households, using food consumption score and per capita calorie intake.

		Food security status (calorie intake)						
		Secure		Insecure			Total	
		No.	Percent	No.	Percent	χ^2-value	No.	Percent
Food security status (FCS)	Secure	151	37.01	57	13.97		208	50.98
	Insecure	110	26.96	90	22.06	13.70[a]	200	49.02
Total		261	63.97	147	36.03		408	100.00

[a]significant at the 1 percent probability levels.

household's food insecurity status. Thus, it is vital for policymakers to account for all food insecure groups, including completely food insecure and transitory food insecure, when designing food security policies and strategies to address the challenges of food insecurity. In resource constrained countries like Ethiopia, this consideration will help policymakers not only to develop specific interventions for each food insecure group but also to identify households needing urgent care.

3.3 Drivers of households' food insecurity

In this section, we present and discuss the results of factors that influence food insecurity status of household. Table 3 presents results from the bivariate probit model. The model fits the data reasonably well with the Wald χ2 test statistic (202.91). This implies that all explanatory variables in each equation jointly equal to zero are rejected ($P < 0.001$). The results of the bivariate probit model reveal that out of the 15 hypothesised demographic, socioeconomic, and institutional variables inserted into the model, 4 and 6 variables significantly influenced household food insecurity, based on per capital calorie intake and FCS, respectively.

Based on per capita calorie intake, the food insecurity status of households increased with the age of the household head (P0.01). This implies that older households may be less educated than younger households. Furthermore, according to Haile (2019), the young farm household heads were stronger, more energetic, and more likely to adopt new technologies, resulting in high-yielding crops and food security. Similarly, Abafita and Kim (2014), Babatunde, Omotesho, and Sholotan (2007), and Bukenya (2017) discovered an inverse relationship between household head age and food security.

Similarly, food insecurity status of households increased with adult equivalents for both indicators ($P < 0.01$). The possible explanation is that the larger household sizes that operated on a small-scale and subsistence farming system tended to exert more pressure on household consumption than their contribution to production (Haile 2019). This implies that large households faced increased food demand but limited resources. According to Frimpong and Asuming-Brempong (2013),

Table 3. Results of bivariate probit model for determinant of food insecurity.

Seemingly unrelated bivariate probit				Number of obs = 408		
				Wald chi2(34) = 202.91		
Log pseudolikelihood = −449.51169				Prob > chi2 = 0		
	Calorie intake			FCS		
Variables	Coef.	B.Std. Err.	Z	Coef.	B.Std. Err.	Z
Sex	0.1889	0.2090	0.90	0.0234	0.2295	0.1
Age	0.0182[a]	0.0063	2.87	0.0065	0.0062	1.05
Education	0.0170	0.0239	0.71	0.0050	0.0231	0.22
Adult equivalents	0.2916[a]	0.0477	6.12	0.1051[a]	0.0441	2.38
Annual income	−0.2069	0.1284	−1.61	−0.2435[c]	0.1293	−1.88
Off-farm Activities	0.2282	0.1574	1.45	0.0624	0.1621	0.38
Use of fertilisers	0.0549	0.1757	0.31	−0.3517[b]	0.1757	−2.00
Use of improved seeds	−0.2411	0.1734	−1.39	−0.1553	0.1728	−0.90
Use of irrigation	−0.3032[c]	0.1617	−1.87	−0.4443[a]	0.1483	−3.00
Cultivated land	−0.3562	0.4963	−0.72	−0.2321	0.5044	−0.46
Adoption of SWC	−0.2393	0.1581	−1.51	−0.3540[a]	0.1486	−2.38
Livestock TLU	−0.0552	0.0454	−1.22	−0.2123[a]	0.0574	−3.70
Coping strategy index	0.0380[b]	0.0166	2.29	0.0013	0.0161	0.08
Received credit	−0.2399	0.2097	−1.14	−0.2525	0.2041	−1.24
Contact with DA	0.0098	0.0376	0.26	−0.0272	0.0349	−0.78
_cons	−1.0699	1.1471	−0.93	2.5385[b]	1.1479	2.21
/athrho	0.0956	0.0904	1.06			
Rho	0.0953	0.0896				

Wald test of rho = 0: chi2(1) = 1.11807 Prob > chi2 = 0.2903.
[a,b]and [c] significant at the 1, 5 and 10 percent probability levels, respectively.

Muche, Endalew, and Koricho (2014), and Amare and Simane (2017), Haile (2019), this scenario leads to a discrepancy between food demand and food production, resulting in financial stress to buy food and, ultimately, in the household becoming food insecure.

The results also show that annual income (the combination of farm and off/non-farm income) was another explanatory variable that was negatively and significantly associated with household food insecurity ($P < 0.1$). The significance of this variable is registered on the FCS indicator. This means that households with high income from farm and off/non-farm activities were less likely to be food insecure than other households. The possible explanation is that households allocated more of their labour time to on-farm and off/non-farm activities to earn higher income so were able to purchase food items that could improve the food security status of their households. A similar relationship is also reported by Beyene and Muche (2010) and Abafita and Kim (2014).

Fertiliser use is another important factor that is negatively and significantly related to the dependent variable ($P < 0.05$). This suggests that the use of yield-enhancing technologies such as fertilisers and other complementary inputs guaranteed food security. In fact, fertilisers contributed to an increase in agricultural productivity that resulted in higher household income, which enabled farmers to purchase nutritious food items to satisfy their family food demands. Our research findings also indicate that intensification of agriculture helps to produced more food that met the increasing food demand in the study area.

Access to irrigation was another important factor influencing household food insecurity, based on the per capital calorie intake and the FCS at 10 and 5 percent probability levels respectively. Farmers with access to irrigation could produce crops more than once a year, which enabled them to withstand seasonal fluctuations in food consumption patterns. Consequently, farmers with access to irrigation were less likely to be food insecure than other farmers. Several studies also indicate that irrigation technologies play an important role in improving food and nutrition security (Rosegrant, Ringler, and Zhu 2009; Smith, Alderman, and Aduayom 2006).

Household asset holdings were assessed using ownership of livestock and cultivated land. Livestock holdings, expressed as TLU, were negatively associated with food insecurity, based on the FCS ($P < 0.01$). In this regard, they contributed to reducing food insecurity by providing food for subsistence needs and nutritional requirements. In addition, the contribution could be through the supply of farm inputs, like oxen and organic manure, into food production and assured accumulation of wealth reserves for use in case household food stocks deteriorated.

The adoption of Soil and Water Conservation (SWC) is another factor hypothesised to have affected household food insecurity. It was found to negatively affect household food insecurity ($P < 0.01$). Farmers adopting soil and water conservation were less likely to be food insecure than non-adopters. The possible implication of this result is that farmers who adopted the SWC were able to avoid soil degradation, keep soil fertile, and maintain the moisture content of the farm plot, thus increasing farm production and productivity. According to Sileshi et al. (2019b), such agricultural practices can improve food accessibility and utilisation either through own production or through increased purchasing capacity.

The results of the bivariate probit model indicate that coping strategy index was another factor observed to be positively associated with food insecurity based on the per capital calorie intake ($P < 0.05$). Indeed, when households faced difficulty, such as food insecurity, they used various coping strategies, such as changing their diet. According to Maxwell et al. (2003), this entailed substituting less expensive or less preferred alternatives for food consumption, as well as other coping strategies. Obviously, households using many coping strategies were more likely to be food insecure than those using fewer coping strategies.

4. Conclusion

Due to the very broad and multidimensional nature of food security, a single indicator cannot provide a full picture and complete story of household food insecurity. Using more than one indicator is of paramount importance because it unearths more insights on the broad concept of food security and food insecurity. This is significant for policymakers who are developing interventions to identify not only food insecure households but also households with urgent needs. In this research, we used the per capita calorie intake and the FCS as indicators to determine the food insecurity status of farming households in East Hararghe, Ethiopia. The results indicate that 36.03 percent of surveyed households were food insecure, based on the per capita calorie intake standards, whereas 49.02 percent were food insecure, based on the FCS. When the per capita calorie intake and the FCS were combined, the findings revealed that 22.06 percent of the households suffered from complete food insecurity. Besides, 26.96 percent suffered from transitory food insecurity, based on the FCS, and 13.97 percent suffered from transitory food insecurity, based on the per capital calorie intake. With these findings, it is clear that the combination of two indicators is of paramount importance because it increases the explanatory power of the dimensions of food quality (nutrition) and quantity.

Moreover, results from the bivariate probit model indicate that the age of the household head, the household size (adult equivalent), the livestock owned, the annual income, adoption of soil and water conservation, use of fertilisers, use of irrigation, and the coping strategy index are important factors influencing the food insecurity status of households. Based on these findings, we propose that a multi-perspective, pre-discussion of policy interventions be held. Equally vital, the government and development partners should support agriculture input providers to facilitate the supply of agricultural inputs that are both easy to use and affordable for smallholder farmers. In addition, it is important to support the introduction and implementation of soil and water conservation along with small scale irrigation practices for farming households in order to boost productivity through sustainable use of land water resource. Further research on food security is needed to understand the seasonal fluctuation in food and nutritional security status of farming households by using panel data and combining different indicators.

Note

1. The term Kebele normally refers to a named peasant association and is considered to be the lowest administrative unit in Ethiopia.

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