Abegaz *Agric & Food Secur (2017) 6:70*
https://doi.org/10.1186/s40066-017-0153-1

Agriculture & Food Security

RESEARCH Open Access

Determinants of food security: evidence from Ethiopian Rural Household Survey (ERHS) using pooled cross-sectional study

Kedir Hussein Abegaz*

Abstract

Background: Though agriculture is obstructed by a number of both endogenous and exogenous problems, it is the dominant generator of means of livelihoods for the majority of people in the least developing countries like Ethiopia. The aim of this study is to look at the status of food security and to identify its determinants in the rural Ethiopia.

Methodology: The pooled data for this study were obtained from the sixth and seventh round of the Ethiopia Rural Household Survey (ERHS). Bar chart and frequency distribution tables were used to illustrate the given data. Binary multivariable logistic regression was employed to identify the determinants of food security.

Results and conclusion: Majority of the households were found to be food insecure, though the figure of food insecurity decreased in 2009 when it is compared with 2004. Food security was significantly determined by rain shock, lack of off-farm income, and region of the households. To assure food security, the farmers should have to consider every rain seasons in the farming activity and the availability of off-farm income-generating activities should have to be enhanced. Finally, there is a need for an international policy regarding the adoption of mitigation strategies to control climate change, the main cause of agriculture and rainfall shock.

Keywords: Agriculture, ERHS, Ethiopia, Food security, Pooled cross section

Background

For several decades in the globe, agriculture has been the main source of livelihoods for the developing world subsisting for a significant portion of their nations. It has been the key sector providing employment opportunities for nearly seventy percent of the rural population and contributing the largest share to their national gross domestic product (GDP). However, its productivity has been challenged by a massive amount of exogenous and endogenous shocks. These shocks arise from climate changes as well as man-made calamities of civil strife and prolonged war [1, 2]. In consequence, it has resulted in lower agricultural outputs putting rural people at greater risks of food insecurities.

In the developing world, the agricultural sector is characterized by miserable performance often carried out by traditional means and farming technologies. Poor infrastructural developments ensure a poor level of productivity. Productivity can be affected at different stages of the agricultural activities starting from preparations of farming land, through growing, harvesting, storing, and distributions of the final outputs. This unique nature has made the sector to be more vulnerable and susceptible to wide ranges of risks, natural and artificial, which in turn increases the risks of food insecurity and malnutrition.

Conversely, population growth has been increasing since long times widening the gap between food supply and food demand. In the twenty-first century, this gap has reached intolerable levels, where securing food supply to the most rural destitute is the most challenging part of social welfare objectives and global development endeavors. Food and Agriculture Organization of the United Nations (FAO)'s successive World Food Summits since 1996 to date and the global development objectives of the millennium attest the above fact with their long

*Correspondence: kedir6300@gmail.com
Biostatistics and Health Informatics, Public Health Department, Goba Referral Hospital, Madda Walabu University, Bale Goba, Ethiopia

and grip vision of "the world free from hunger and malnutrition" [3].

The agricultural shock impacts on food security have been identified as a major area of concern owing to climatic variations in many parts of the world. The predominance of rain-fed agriculture in much of the developing world especially in sub-Saharan African (SSA) has resulted in food systems that are highly reliant and sensitive to rainfall variability. Agricultural shocks, driven by climate changes, affect agricultural production and hence food security in a multitude of ways.

Food insecurity status is increasing from time to time. According to recent estimates of FAO [4], over 870 million people are chronically malnourished and food insecure around the world. Even though considerable efforts were made to reduce food insecurity, the number of people suffering from malnutrition and hunger remains unacceptably high. In the developing countries, the vast majority, over 850 million people, are estimated to be undernourished. Similarity, Tobin et al. [5] have pointed out that the number of food-insecure people in SSA is showing unabated signs, increasing from 170 million in 1990 to over 200 million in 2004.

The developing regions of the world are the most vulnerable groups to food insecurity in the world, as it has been well documented in the literature. Of the developing world, SSA appears to be the hardest area to food security risks. Several factors contributing to this insecurity in the region were identified, and Tobin et al. [5] listed poor agricultural productivity as the major factor. Agricultural productivity is constrained by poor technology, poor infrastructure, natural and man-made shocks, poor marketing, etc. The region is also lagging behind others in terms of using agricultural inputs. As a result, productivity has stagnated for several decades.

In spite of the rapid and impressive progress in tackling poverty in recent years, it has been reported in subsequent food security assessment studies that on average nearly 35% of Ethiopians have been suffering from chronic food insecurity and undernourishment every year mainly caused by agricultural shocks and climate changes [6, 7].

In response to how agricultural shocks affect the level of food security at household level, the sound policy formulation with a view to reducing the level of food insecurity risks and increasing resilience in an economy requires a detailed understanding. This study is important in the sense that it gives helpful insight to the true nature of agricultural shock in the country and its determinants on the level of food insecurity along with the channels through which agricultural shocks affect food security. Food security was one of the MDGs that was expected to be achieved through "Eradication of extreme poverty and hunger." Therefore, the result of this study and its resultant recommendation is very important for policymakers at all levels.

The objective of the study is to look at the status of food security and to identify determinants of food security in the rural Ethiopia.

Food security concepts and definitions

Food security concept is believed to have originated three decades ago in the mid-1970s in the first world food conference and was narrow in its coverage and definition. This concept initially paid attention to the national and international level and was defined from the perspective of the food supply with special attention to stable food price and food availability [8].

A situation where all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life is known as food security [9]. With boosting awareness and dynamism of vulnerability to risks of food shortages, a more comprehensive and multidimensional approach to the concept of food security became emergent. Accordingly, the food security concept encompasses the following four components: food access, food availability, food utilization, and sustainability [10, 11].

Food access is ensured when households and all individuals within them have adequate resources to obtain appropriate foods for a nutritious diet. Additionally, food availability is said to be achieved when sufficient quantities of food are consistently available to all individuals within a country [10, 12, 13].

Food utilization refers to the consumption of food through adequate diet, clean water, sanitation, and health care to reach a state of nutritional well-being where all physiological needs are met. Food sustainability, on the other hand, refers to a situation where the above three components of food security are fulfilled at any time [10]. In other words, to be food secure, a population, household, or individual must have access to adequate food at all times. This component of access to food security implies that people should not be in any situation of risks owing to sudden shocks of economic or climatic crisis or cyclical events. The concept of stability can, therefore, refer to both the availability and access dimensions of food security. Food insecurity, in contrast, is viewed as the denial of the above rights either at household, individual, or community levels [3, 5].

The food system is another broader concept which encompasses food security. It refers to all human food chain activities of producing, processing, distributing, and consuming food to a range of social and environmental contexts [14]. It is quite evident that any of the

above human food chain activities are affected by climate changes directly or indirectly. On the other hand, human activities of producing, processing, packaging, distributing, retailing, and consuming food are partly responsible for changing the world's climate through emissions of greenhouse gasses. These activities contribute also to global climate change through changing fresh water supplies, air quality, nutrient cycling, biodiversity, and soil.

All the definitions above imply that food security is a wide concept and requires taking into account a wide array of causes and measurements. This paves the way for approaching the issue from a different perspective and provides evidence for consideration of the wider definition given by FAO (1996) encompassing all elements of availability, accessibility, utilization, and sustainability.

Agricultural shock is another important term to be defined in this study. It refers to any unexpected, intense, and distressing experience in agricultural activities, which has a sudden and often devastating effect on agricultural yield. The collapse in agricultural yields can be attributed to several underlying causes. These factors include untimely rainfalls, lack of water, too much rain, pest infestation, floods, and animal disease outbreaks, and frost [7]. The occurrences of any of the above factors profoundly affect the quantity and quality of agricultural yields leading to immediate risks of an increased crop failure and loss of livestock.

In general, it is important to note that the impacts of agricultural shocks on food security must be viewed within the larger framework of changing global climatic dynamisms and observable changes in multiple socioeconomic and environmental variables. This paper seeks to illuminate the impacts of such shocks on food security as viewed from availability and accessibility perspective.

The link between food security and agricultural shocks

Recently, one-sixth of humanity is undernourished more than ever before. Changing climatic conditions are projected to affect food security through their impact on local food systems. Climate change will generate significant and intensified weather events such as floods, tornados, and hurricanes; increased drought; loss of coastal areas and water shortages; and changes in the incidence of disease [6, 15].

Causes of food insecurity in sub-Saharan Africa

Limited rural development, weak infrastructural development of power, road, and market access aggravate food insecurity in SSA. Weak government policy that adversely afflicted the agricultural sector is another factor contributing to food insecurity in the region. Poor health condition also poses its impact on food insecurity. The region is also characterized by the prevalence of contagious and fatal but preventable diseases of HIV/AIDS, malaria, tuberculosis (TB), and other diseases. This reduces rural labor participation in agriculture and off-farming activities contributing to food insecurity. Moreover, rising global commodity prices and climate change will likely further exacerbate food insecurity in the region. Agricultural productivity in SSA, as measured by grain yield, is only about 40% of the rest of the world's developing countries, and the gap has widened over the years [5, 13].

Food security in Ethiopia

Food insecurity emerged as a key problem and development challenge in Ethiopia in the early 1970s and became pervasive in the subsequent decades although the issue is a century-old concern for FAO and other donating institution in the country. More significantly, since the 1980s the happening of severe drought and large-scale starvation ignited the need for food security and food aid initiatives in the country. Conversely, the concept has become more complex due to a move in the level of analysis from global and national to household and individual levels [16].

In Ethiopia, the special programs for food security (SPFS) have begun in 1995 in two regions: Amhara and Tigray. In the year 1996, the food security strategy was launched and it was revised in 2002, to include elements of water harvesting, environmental rehabilitation, and the introduction of high-value crops, livestock, and agroforestry development. The project was continued by Italian support in 1998 supporting 4062 participating households and 24,500 beneficiaries. The project was further expanded to other regions of the country in 2001 with a view to improving the nutritional status and food security of the population. New coalition for food security was established in 2003 with the aim of supporting chronically food-insecure households to reach a level of food security necessary to survive and thrive. In 2004, the government of Ethiopia designed and implemented new collusion program of Food Security Program (FSP) and expanded its endeavor to fight against food insecurity, malnutrition, and hunger by allocating more resources [16].

In mid-2005, the National Program for Food Security (NPFS) was launched focusing on three broad components: productive safety nets (PSN), household asset building (HAB), and voluntary resettlements. Like other developing countries, Ethiopia applied a wide array of strategies to lessen incidences of food insecurity risks to ensure food security at household, local, and regional levels. In addition, in 2006, improving food security was recognized within the framework of Sustainable Development Poverty Reduction Paper (SDPRP) as a central

concern of government [17]. This program, on food security, in the country was guided by two fundamental principles: firstly, by the principle of reliance, where rural food-insecure farmers are made reliant on food aid to help them use their own resources to overcome food insecurity. Secondly, by breaking away the perpetual food aid dependence, so that they become food self-sufficient.

In many parts of Ethiopia, as a cause of food security combinations of natural and man-made factors have resulted in serious and growing food insecurity problem. The immediate causes of food insecurity include frequently recurring droughts and erratic rainfall patterns. Ecosystems degradation, rapid population growth, poor rural infrastructure, and legacies of the past policy constraints are also considered as basic causes of food insecurity and widespread poverty in the country [18–20].

Operational definitions

Food insecurity occurs in two forms as chronic and transitory. Chronic food insecurity happens when a household is unable to meet the minimum amount of food needed for healthy life over a long period (three or more months). But if this food insecurity is less than 3 months, it will be transitory food insecurity [2, 20].

Food security is ascertained in the households if the given household is free from the two kinds of food insecurity: chronic and transitory.

Extension visit is simply a situation where the household's land is visited by an extension agent during the last main season.

Off-farm income is any kind of income that households had got beyond farm activity including the government food aid.

Rain shock refers to the unexpected event regarding rain such as over rain, less rain, the rain out of the rain period, and rain at a time of harvesting and collection of crops.

Methodology

Data source, study design, and Analysis

A database describing each of a number of individuals, households, etc., across a sequence of time periods is known as pooled data. Thus, this blends characteristics of both cross-sectional and time series data. Pooled data are vital to the analyst because they contain the information necessary to deal with both the intertemporal dynamics and the individuality of the entities being investigated [21].

A pooled cross-sectional study was conducted by using the last two datasets of the Ethiopian Rural Household Survey (ERHS), 6th and 7th round datasets. After pooled the two datasets and cleaned the missing information in all variables, 2722 rural households have been included in the study. The households' information under the study is presented through the use of frequency distribution tables and bar chart. The bivariate binary logistic regression was employed to show the crude association between the food security and the exposure variables. Lastly, the multivariable binary logistic regression has been used to identify the determinants of food security, by using the adjusted association between food security and the exposure variables. STATA-14 was the tool to make all the analyses.

Results and discussion

From the total 2722 households included in the study, the food-secure households from pooled data were only 1040 (38.21%) households. But when we explore it at different single data, the food security level was boosted from 35.64% in 2004 to 40.28% in 2009 (Fig. 1).

The sample households were identified from the four regions of Ethiopia based on proportional to size allocation method. As a result, the minimum, 261 (9.59%) households were from Tigray, and the majority of households 591 (37.48%) were from Oromia. In the pooled result, rain and crop shocks were among the main constraints of agricultural productivity, 2385 (87.62%) being affected by rain shock and 2302 (84.57%) by crop shock, respectively. The study identified that more than half of the population were not visited by extension workers; only 901 (33.1%) had the chance to be visited. Nearly half (49.71%) of the population in the rural Ethiopia did not have off-farm income during the study periods, and only 10 (0.37%) of husbands died (Table 1).

From the result of Table 2, among 1682 food-insecure households 1517 (90.19%) have experienced rain shock and 868 (83.46%) food-secure households also experienced seasonal rain shock. In addition, 1440 (85.61%) food-insecure and 862 (82.88%) food-secure households experienced crop shock. Therefore, this shows that rain shock and crop shock affected both food-secure and food-insecure households. In general, food-insecure households had the following characteristics; 90.19 and 85.61% of them experienced rain shocks and crop shock, respectively, only 32.05% of them are visited by extension agents, and 54.16% of insecure households have off-farm income. The concentration of food-secure households across regions is 3.08% in Tigray, 40.29 in Amhara, 37.21 in Oromia, and 19.42% in SNNPR households were in food security status. Relatively speaking, households in Tigray region were the least food-secure households when we compare with the other three regions (Table 2).

In the crude analysis, the association of food security with the exposure variables has been identified. Accordingly, from the exposure variables, rain shock, crop shock, region, off-farm income, and extension visit have

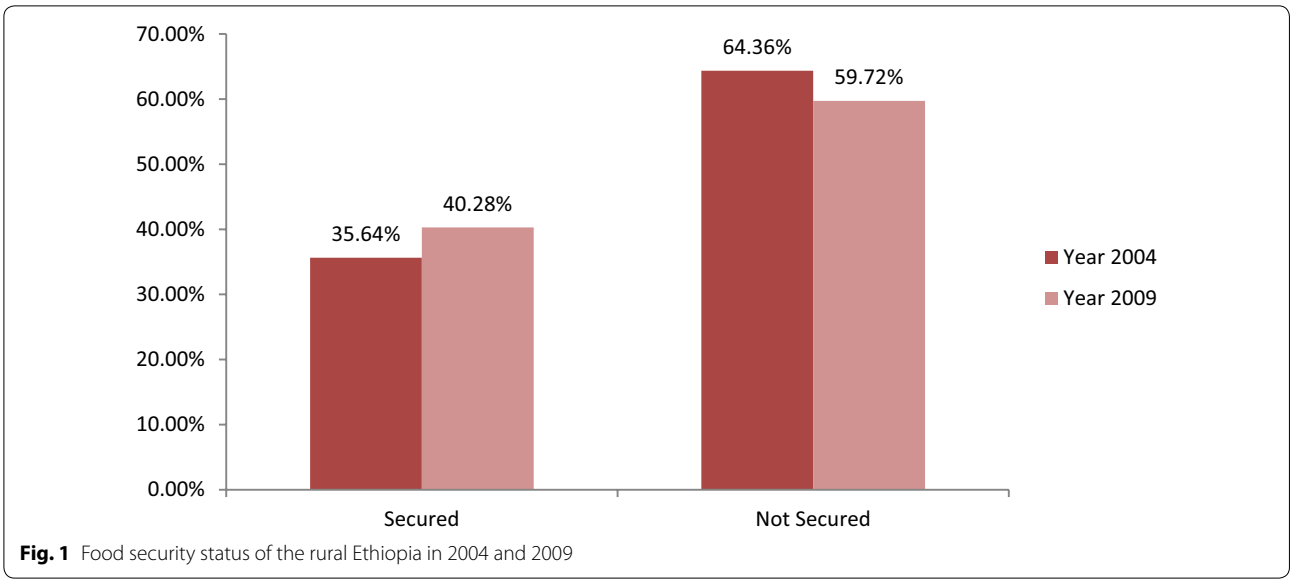

Fig. 1 Food security status of the rural Ethiopia in 2004 and 2009

Table 1 Descriptive details of food security and the determinants in rural Ethiopia

Variables with category	Frequency	Percentage
Food security		
Secured	1040	38.21
Not secured	1682	61.79
Region		
Tigray	261	9.59
Amhara	760	27.92
Oromia	900	33.06
SNNPR	801	29.43
Rain shock		
Yes	2385	87.62
No	337	12.38
Crop shock		
Yes	2302	84.57
No	420	15.43
Husband death		
Yes	10	0.37
No	2712	99.63
Year of the survey		
2004	1215	44.64
2009	1507	55.36
Extension visit		
Yes	901	33.10
No	1821	66.90
Off-farm income		
Yes	1369	50.29
No	1353	49.71

Table 2 Association between food security and determinant variables

Variables with category	Food security		Crude OR (CI)	*p* value
	Not secured	Secured		
Region				
Tigray	229	32	–	
Amhara	341	419	8.79 (5.91–13.07)	0.000
Oromia	513	387	5.39 (3.64–7.99)	0.000
SNNPR	599	202	2.41 (1.61–3.61)	0.000
Rain shock				
No	165	172	–	0.000
Yes	1517	868	0.59 (0.44–0.69)	
Crop shock				
No	242	178	–	0.056
Yes	1440	862	0.81 (0.66–1.01)	
Husband death				
No	1675	1037	–	0.595
Yes	7	3	0.69 (0.18–2.68)	
Extension visit				
No	1143	678	–	0.137
Yes	593	362	1.13 (0.96–1.33)	
Off-farm income				
No	771	582	–	0.000
Yes	911	458	0.67 (0.57–0.78)	

an association with the dependent variable, food security. However, husband death has no association with food security (Table 2).

In the adjusted analysis, the households that have experienced rain shock are 73% less likely to be food secured

when it is compared to the households which were not experiencing the rain shock by keeping other variables constant. The association was statistically significant with a p value of 0.000. Households that have got off-farm income are 62% more likely to be food secure than those without off-farm income by controlling the other variables, and it has a significant association with food security, with p value 0.000. The sample households in Amhara region are 7.97 times, in Oromia region 5.15 times, and in SNNP region 2.14 times more likely to be food secure than the households in Tigray region, respectively (Table 3).

I have greatly worked on data cleaning before the study begins. Also, I have used the stepwise logistic regression for the model selection. Having this, it was checked for confounding, interaction, and the changes in coefficients (β). On the selection procedure, variables having a p value of less than 0.15 [22] were included in the final model then there was no any confounding or interaction effect in the final logistic model.

Finally, to check the correctness of the final formulated model, Hosmer–Lemeshow test for overall goodness of fit was used through a level of significant value $\alpha = 0.005$, and the value became 0.1649 that is insignificant, which means the final fitted model was correct. To ensure whether the fitted model was predicted well, I used the receiver operating characteristic (ROC) curve and its value of the area under the curve was 0.6261. Therefore, the determinant variables were capable of predicting well food security.

Conclusion and recommendation

Though the majority of the households were found to be food insecure, the figure of food insecurity decreased in 2009 when it is compared with 2004. Food security was significantly determined by rain shock, lack of off-farm income, and region of the households. Thus, these households were suffering from food insecurity by rain shock, lack of off-farm income, and their region of residence.

Based on the result of this study, the following conclusions can be drawn:

First, rain shock is found to be the main determinant for households' food security. The problem of rain shock is a result of global climate change. As a result, the following points are forwarded as a recommendation; there is a need for an international policy regarding the adoption of mitigation strategies to control climate change, the main cause of agricultural and rain shocks, and this strategy should be integrated into the development planning.

Second, off-farm income has a significant contribution in moving households to food security. As a result, off-farm employment opportunities should have to be created and expanded.

Third, region of the households was also the main determinant of food security. In response to this, the agricultural experiences have to be modified in all of the regions, to make households food secured.

Table 3 The adjusted analysis of pooled food security of the rural Ethiopia

Variables with category	Adjusted OR (CI)	p value
Region		
Tigray	–	–
Amhara	7.97 (5.34–11.89)	0.000
Oromia	5.15 (3.46–7.65)	0.000
SNNPR	2.14 (1.42–3.21)	0.000
Rain shock		
No	–	–
Yes	0.73 (0.58–0.93)	0.011
Off-farm income		
No	–	–
Yes	1.62 (0.53–0.73)	0.000

Acknowledgements
None.

Competing interests
The author declares that he has no competing interests.

Availability of supporting data
The dataset was demanded and retrieved online from the International Food Policy Research Institute (IFPRI) Web site that is released for public use; the link is https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/15646 with a title of Ethiopian Rural Household Surveys (ERHS), 1989–2009.

Consent for publication
Not applicable.

Ethical approval and consent to participate
Ethical approval and participant consent were not necessary, as this study involved the use of a previously published and de-identified database by IFPRI.

Funding
No organization funded this study.

Publisher's Note

Received: 21 November 2017 Accepted: 12 December 2017
Published online: 19 December 2017

References

1. UNDP. Africa Human Development Report in towards food Secure future UN. United Nation's Development Program: Piaza, New York. 2012. http://www.undp.org/content/dam/malawi/docs/general/Africa_HDR_EN_2012.pdf.
2. Welteji D, Mohammed K, Hussein K. The contribution of productive safety net program for food security of the rural households in the case of Bale

Zone, Southeast Ethiopia. Agric Food Secur. 2017;6(1):53. https://doi.org/10.1186/s40066-017-0126-4.
3. FAO. The state of food insecurity in the world, F.a.A. Organization, editor. Rome, Italy. 2008a. http://www.fao.org/tempref/docrep/fao/011/i0291e/i0291e00.pdf.
4. FAO. The state of food insecurity in the world. Rome, Italy. 2012. http://www.fao.org/docrep/016/i3027e/i3027e.pdf.
5. Tobin JC. Hunger effort and food security. New York: Nova Science Publishers, Inc.; 2009.
6. FAO. Crop and food security assessment mission in Ethiopia: integrating crop and food supply in the Emergency of Food Security Assessment. Rome: Food and Agricultural Organization; 2009.
7. DFID. Summary of DFID's Work in Ethiopia. D.F.I. Development, DFID Ethiopia. British Embassy, Addis Ababa; 2011.
8. Young H, Jaspers S, Brown R, Frize J, Khogali H. Food-security assessments in emergencies: a livelihoods approach. Overseas development institute (ODI). Humanitarian practice network (HPN). 2001. https://www.files.ethz.ch/isn/96840/networkpaper036.pdf.
9. World Food Summit. The world free from hunger. Rome; 1996.
10. FAO. Food security. F.a.A. Organization FAO, Paris; 2006.
11. Gregory PJ, Ingram JS. Climate change and the current 'food crisis'. CAB Rev Perspect Agric Vet Sci Nutr Nat Resour. 2008;3(99):1.
12. Schmidhuber J, Tubiello FN. Global food security under climate change. Proc Natl Acad Sci. 2007;104(50):19703–8. https://doi.org/10.1073/pnas.0701976104.
13. Ingram JS, Gregory PJ, Izac AM. The role of agronomic research in climate change and food security policy. Agr Ecosyst Environ. 2008;126(1):4–12. https://doi.org/10.1016/j.agee.2008.01.009.
14. Liverman D, Kapadia K. Food systems and the global environment: an overview. In: Ingram J, Ericksen P, Liverman D, editors. Food security and global environmental change. London, Washington, DC: Earthscan; 2010. p. 3–24.
15. Selvaraju R. World food security: the challenges of climate change and food energy climate change and food security in South East Asia. New York: Springer Science and Business Media; 2011.
16. Sabates-Wheeler R, Tefera M, Bekele G. assessing enablers and constrainers of graduation: evidence from the Food Security Programme, Ethiopia. http://opendocs.ids.ac.uk/opendocs/handle/123456789/2189.
17. Haan N, Nisar M, Darcy J. A review of emergency food security assessment practice in Ethiopia in a study commissioned by and prepared for the World Food Programme, HPG, editor. ODI, London; 2006. http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/864.pdf.
18. FAO. Crop and food security assessment mission in Ethiopia. Rome: Food and Agricultural Organization of the United Nation; 2012b.
19. FAO. Crop and food security assesment mission in Ethiopia. Rome: FAO/WFP; 2004b.
20. Galhena DH, Freed R, Maredia KM. Home gardens: a promising approach to enhance household food security and wellbeing. Agric Food Secur. 2013;2(1):8. https://doi.org/10.1186/2048-7010-2-8.
21. Sjursen IH. Determinants of child mortality in Angola: An econometric analysis. Master's thesis, The University of Bergen. http://hdl.handle.net/1956/5704.
22. Dielman TE. Pooled cross-sectional and time series data: a survey of current statistical methodology. Am Stat. 1983;37(2):111–22. https://doi.org/10.1080/00031305.1983.10482722.