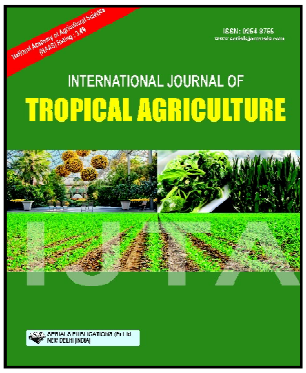

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Determinants of Household Food Security Status of Peri-Urban Modern Small Scale Irrigation Project Beneficiary Female Headed Households in Kobo Town, Ethiopia

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Abstract: The overall objective of this study was to identify the dominant factors that determine household food security status of female headed peri-urban modern small-scale irrigation project beneficiaries. To attain this objective, a cross sectional survey method was employed on randomly selected 333 households. Descriptive and econometrics techniques were used to analysis the data. Binary Logit model was employed to identify determinants of household food security. The Chi-squared and t-test result of this survey depicted that food secure and food insecure households have statistically significant variation with respect to household heads' educational and health status, family size, number of active family labour forces, land holding size, total livestock holding, aggregate per capita agricultural production, access to credit services, savings and remittances. Moreover, the binary logit model analysis also revealed that household food security was significantly and positively determined by age and literacy status of household head, number of active family labour forces, livestock possession, farm land size, savings and remittances. In contrast, family size had a significant and inverse association with household food security. Accordingly, in spite of the attempts of expanding peri-urban modern small scale irrigation projects, due emphasis should be given to the mentioned determinants of household food security.

Keywords: binary logit model, determinants, female headed households, food security, participants, non-participants

INTRODUCTION

Designing and implementing appropriate food security policies remain a challenge in developing countries (Babu and Sanyal, 2009). The economic policy of the current government of Ethiopia aims at ensuring rapid and sustainable development through agriculture centered development strategy and food self-sufficiency. Despite the stated goals and attempts of the government, with fragile social and economic conditions, the country still remains one of the poorest and food insecure countries in the world for decades. For instance, on Human Development Index, the nation was listed number 174 out of 188 countries (UNDP, 2016). Furthermore, due to poor rain and effects of the El Niño, Ethiopia experienced its worst drought in 50 years where 9.7 million people were in need of emergency assistance in August 2016 (UNICEF, 2017).

In line with this, the study area has also been identified amongst the drought prone, moisture deficit and the people are food insecure. Accordingly, efforts have been made by KGVDP and Amhara Water Works Construction Enterprise to expand the practice of modern small-scale irrigation since 2003 as a means of poverty reduction and food security achievement. In spite of this effort, it was apparent form my previous survey that of the sample total 333 households, 198 (59.46%) households were found to be food secure and the remaining 135 (40.54%) households were food insecure employing the Adult Equivalent annual per capita threshold of 225 kg of available food grain. Furthermore, the household food security measurement of the study also further discovered the existence of household food security status disparity between participant and non-participant households; where 65.49% of participants and 56.36% of non-participant households were found to be food secure. However, the Chi-square test statistical association result indicated no significant differences between participant and non-participant households in their food security status at all probability levels (Goitom, 2017). This in turn inquires to further identify the determinants of household food security in addition to participation in peri-urban modern small scale irrigation projects.

Household food security is a complex and multi-dimensional phenomenon accredited to varieties of interrelated factors. Theoretically there are various determinants of food security both at individual and household level. According to Devereux (2001), over the past few decades there has been a debate between the academic disciplines and in development thinking on determinants of household food security, giving rise to a proliferation of demographic, economic, and political emphasis across the food security literatures (Devereux, 2001). Similarly, in Ethiopia the determinants of food security at household level are quite complex and attributed to differences in resource availability, topography, time dimension and other factors (Birara *et al.*, 2015).

The available bulk of empirical evidences on the analysis of determinants of household food security/insecurity in different corners of Ethiopia identified various demand and supply side factors; Abonesh, 2006; Bogale and Shimelis, 2009; Getinet, 2011; Ejigayhu and Abdi-Khalil, 2012; Teshome, 2013; Abafita and Kim, 2014; Kelilo et al., 2014; Gutu, 2015; Tagese and Berhanu, 2015; Guyu, 2016. However, a majority of these studies were conducted without giving due attention to gender. On the other hand, in Ethiopia women constitute 49.5% of the total population and 41% of females engaged in agricultural forces (CSA, 2014; CSA and World Bank, 2017). This study therefore, attempted to fill such a gap, by identifying determinants of peri-urban modern small-scale irrigation project beneficiary female headed households' food security status in Kobo town, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

Kobo Province which currently constitutes Kobo town and Raya Kobo *Wereda* is one of the eleven *Weredas* of North Wollo administrative zone. The *Wereda* is bordered by Tigray region in the north, Habru and Gubalafto *Weredas* in the south, Afar region in the east and Gidan *Wereda* in the west. With an estimated total area of about 2576.05 km^2, the district is astronomically located between 11^o 54$^{'}$04$^{"}$ and 12^0 20$^{'}$ 56$^{"}$North latitude and between 39^0 25$^{'}$ 56$^{"}$ and 39^0 49$^{'}$ 04$^{"}$ East longitude.

Kobo town is the administrative seat of Raya Kobo *Wereda* and Kobo town administration with five administrative (The lowest administrative units in Ethiopia). It is situated in the north-eastern tip of Amhara National Regional State, North Wollo administrative zone (Goitom, 2009). The town lies on Addis Ababa-Mekelle national highway, about 570 kilometers north of Addis Ababa (the national capital) with geographical coordinates of 12^0 06' to 12^0 18' North latitude and 39^0 23' to 39^0 39' East longitudes (Goitom, 2009).

The study *Wereda* had an aggregate human population of 221, 894, of which 111, 571(50.28%) were men while the remaining 110,323 (49.72%) were women. Moreover, out of the total population, 33,135 (20.15%) were urban dwellers; of these urban dwellers male and female population constitutes 16311 (49%) and 16824 (51%) respectively. The study town had a population density of 119.7 persons per square kilometre with a total area of 2001.57 km^2 (CSA, 2008, 2010). Furthermore, the *Wereda's* total population in 2017 was projected to be 275, 891; of whom 138, 726 (50.28%) and 137, 165 (49.72%) were

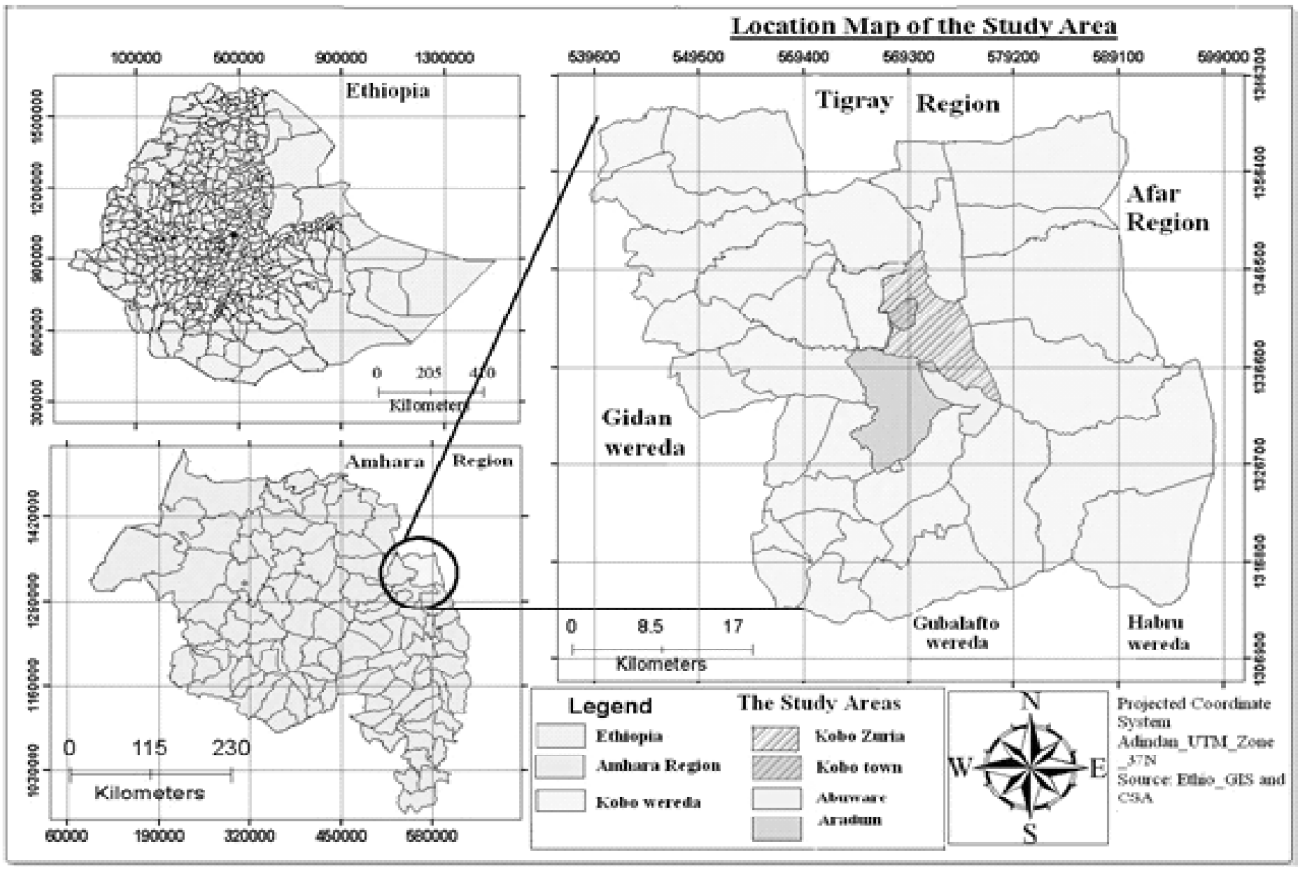

Figure 1: Location Map of the Study Area

men and women respectively. On the other hand, the proportion of urban population was projected to reach 20.95% in the same year (CSA, 2013).

Agriculture practiced in the sub-urban areas of the study town serves as the main economic stay and means of livelihood to the majority of the towns' people. It is characterized by traditional mixed farming as it includes both crop production and livestock rearing, dependent mainly on rainfall. The main crops produced through rainfall are cereals (*Teff*, sorghum and maize) and pulses (chick peas). Furthermore, as of 2003, horticultural crops (onion, tomato, pepper) and fruits such as Mango, Papaya, Banana and Avocado are being produced with the help of modern small scale irrigation (Goitom, 2009).

Research Design

This study adopted the cross- sectional survey technique to collect primary data as a survey technique is popular and ideal mode of observation in the social sciences. On a cross-sectional survey design data are collected from samples at a specific point in time. According to Babbie (1990), surveys are suitable for descriptive, explanatory or exploratory studies. Survey is especially ideal for studies that have individual people as units for analysis. As a result, survey is suitable for this study as it centred both the individual and the household as units of investigation and analysis. The head of the household (females) served as the chief respondent to whom the study questionnaire was administered. Targeting household heads was important as decisions whether to participate in irrigation are mostly made by them.

To effectively asses the determinant variables that affect participation of female headed households in peri-urban modern small scale irrigation projects, a mixture of qualitative and quantitative research method was employed. The central argument behind the use of mixed method design is that the combination of both forms of data offers a better understanding of a research problem than either quantitative or qualitative design by itself.

Data Sources

Both primary and secondary sources of data were consulted to address the raised research question. Primary data was collected from sample female household heads (both participants and non-participants) through structured questionnaires. The head of the household served as the chief respondent to whom the study questionnaire was administered. Moreover, as they also determine the type and amount of food available from varied sources, their demographic characteristics were used as determinants of household food security. Structured questionnaire was preferred among the other techniques because it could reach to the relatively large number of respondents. Most of the items of the structured questionnaire were closed ended with some partially open-ended items. The data were collected through trained assistants and by the researcher after conducting the appropriate test on the constructed questionnaire. Moreover, Key Informant Interview (KII) and Focus Group Discussion (FGD) were also employed to substantiate the data collected through questionnaires.

In-depth Key Informant Interviews were administered by the researcher himself with semi-structured open-ended questionnaire to five elderly female headed households about determinants of household food security. Key informants provide detailed information on key issues that were not provided by other respondents. Moreover, Focus Group Discussions were also held to gather in-depth information on concepts, perceptions and ideas of a group pertaining to determinants of household food security. Accordingly, by preparing checklists and triangulating issues, subsequent discussions were held by forming three groups (composed of a minimum of seven members) from the three respective study *kebeles*.

For reference purpose or to use as benchmarks against which the findings of a study can be tested, secondary data sources like books, articles and other unpublished reports related to the issue were also referred.

Sample Size and Sampling Techniques

Multi-stage sampling procedure was employed to select sample households. Accordingly, primarily, the study town was selected purposively due to its familiarity to the researcher and extensive implementation of modern small scale irrigation projects. In the second stage out of 41 modern small scale irrigation projects located in the study *Wereda*, 15 irrigation sites situated in the three *kebeles* namely Kobo Zuria, Aradum and Abuware were selected purposively; due to their accessibility, proximity to the study town and number of irrigation beneficiaries. These irrigation sites covered 946 hectares of land and are benefiting 2367 household heads of which 1619 (68.40%) are male headed and 748 (31.60%) are female headed households. In the second stage, to obtain representative samples, the sample size was determined through Creative Research Systems (2012) online sample size determination software. The size was calculated using 95% confidence level and 4% margin of error (confidence interval). As a result, 333 female headed households (44.52%) who are beneficiaries of peri-urban modern small scale irrigation; both participants (113) and non-participants (220) proportionate to their number were incorporated in this study through simple random sampling technique. The Water User Association members' registry was used as a sampling frame. On the other hand, judgemental sampling technique was also used to identify key interview informants and Focus Group Discussion members.

Data Analysis

To identify determinants of household food security a combination of qualitative and quantitative research method was used. Bivariate analysis using cross tabulations were conducted to identify the association between household food security and independent explanatory variables. Accordingly, Chi-square and independent sample t-test were employed to test the statistical significance of dummy and mean value of continuous variables respectively. Furthermore, for the sake of examining the statistical association between the independent demand and supply side explanatory variables (bio-physical, socio-economic, demographical, institutional and/or organizational factors) and the dependent variable (household food security), binary logit model was employed.

Household food security is a dependent dummy variable with two alternatives and takes a value of 1 if the household is food secure and 0 otherwise. However, the independent variables are both continuous and dummy. There are different options of models for analysing such a categorical dependent variable; linear regression analysis and discriminate analysis methods are widely employed. Linear regression is applied when the dependent variable is measured on a continuous scale. On the other hand, discriminate analysis is employed when all the predictors are continuous and nicely distributed. Nonetheless, outcomes derived from linear regression analysis and discriminate analysis may lead to fairly unreasonable estimates (Pindyck and Rubinfeld, 1981 in Agerie, 2013; Guyu, 2016). Logistic regression (either logit or probit model) is often used when predictors are both continuous and categorical without any assumption about their distribution. Accordingly, the use of either logit or probit model is recommended as a universal remedy of the drawbacks of the linear regression model (Gujirati, 1995 in Mequanent and Esubalew, 2015). While Probit is based on standard normal distribution, logit is based on standard logistic distribution, the choice between logit and probit model is, however, difficult as they lead to plausible conclusions in most applications. Furthermore, extensive empirical household food security/ insecurity studies employed logit model to identify

the determinant variables (Bogale and Shimelis, 2009; Getinet, 2011; Tagese and Berhanu, 2015; Guyu, 2016). As a result, there is no obligatory reason to choose one over the other but for its relative mathematical and interpretational simplicity; binary logit model was preferred for this study.

The choice of determinant variables in empirical household food security studies has often lacked a firm theoretical basis. Consequently, household food security can be viewed as being determined by a host of demand side and supply side factors. Cognizant to this fact, the independent potential explanatory variables used in this model were derived based on review of intensive related literatures, previous empirical study findings, experts' and researcher's knowledge and familiarity about the household food security situation of the study area inhabitants. As a result, the following potential explanatory variables were considered for this study; age of household head, health status of household head, literacy status of household head, family size, active family labour force, cultivated farm land holding size, aggregate agricultural production, total number of livestock, participation in irrigation, access to credit services, saving accounts in modern financial institutions and access to remittances.

The dependent variable (Household Food Security Status) being a dichotomous variable having a value of 1 if the household is found to be food secure and a value of 0 otherwise.

$$P_i = \left(Y = \frac{1}{X_i}\right) = \frac{1}{1+e^{-z_i}} = \frac{e^{z_i}}{1+e^{z_i}} \qquad (1)$$

Where, e is an exponential term,

P_i = is the probability of household i being food secure. It is 1 if a household is food secure otherwise 0.

Y = is the observed food security status of a household.

X_i = is the household set of explanatory variables

Z_i = is a function of n-explanatory variables (X_i) which can be expressed in linear form as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots \beta_n X_n$$

From Equation 1, the probability of a household being food insecure is given by $(1 - P_i)$ which can be written as Equation 2:

$$1 - \frac{1}{1+e^{-z_i}} = \frac{1+e^{-z_i}-1}{1+e^{-z_i}} = \frac{e^{-z_i}}{1+e^{-z_i}} \qquad (2)$$

Therefore, the odds ratio $\frac{P_i}{(1-P_i)}$ is given by equation 3

$$\frac{P_i}{(1-P_i)} = \frac{1+e^{z_i}}{1+e^{-z_i}} \qquad (3)$$

Now, $\frac{P_i}{(1-P_i)}$, is the odds ratio in favour of food security. It is the ratio of the probability that a household would be food secure (P_i) to the probability that a household would be food insecure ($1\text{-}P_i$).

Finally, taking the natural logarithm of equation 3 and assuming linearity produces equation 4

$$L_i = \ln\left[\frac{p_i}{1-p_i}\right] = Z_i \qquad (4)$$

Where, L_i is the logarithm of the odd ratio which is assumed linear for both variables and parameters.

If the disturbance term is introduced, the logit model in equation 4 is represented by equation 5

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots \beta_n X_n + \varepsilon_i \qquad (5)$$

Where, β_0 = is the regression constant which implies the combined impact of these fixed factors on household food security

β_1, β_2, β_n= is the partial regression coefficient for the independent variables 1, 2,...., *n* respectively

X = is the number of independent variables and ε_i = error term.

From the estimated logit model, the marginal effects of each explanatory variable on household food security can be calculated using equation 6.

$$\frac{\partial P_i}{\partial X_i} = P_i(1 - P_i)\beta_i \qquad (6)$$

SPSS version 23 and STATA version 12 software were employed to organize and analysed the collected primary data.

Qualitative data mainly opinions and perceptions obtained from open ended questionnaires, Key Informant Interviews and Focus Group Discussions were also analyzed qualitatively by using common expressions and similar opinions.

Description of Explanatory Variables and Hypotheses

Dependent variable (Household Food Security Status): By employing Household Food Balance model, the annual Net Available Food (NAF) of the sample households was estimated. The estimated annual mean NAF value for each respondent household was therefore compared against to 225 kg of food grain, which is approximately cereal equivalent of the recommended average daily kilocalorie of 2100 for a healthy adult person. The variation between the available grain and the recommended grain was used to determine the household food security status of sample households. Thus, households whose annual net available per capita food grain is greater than the recommended demand were regarded as food secure households, while those experiencing a food grain deficit were labelled as food insecure households.

Definitions, measurements and working hypothesis of the potential explanatory independent variables are presented in table 1.

RESULTS AND DISCUSSION

Descriptive Statistics Analysis

Employing the Adult Equivalent annual per capita threshold of 225 kg of available food grain, of the surveyed total households, 198 households (59.46%) and 135 households (40.54%) were found to be food

Table 1
Description of Explanatory Variables and Hypotheses

Variable name	*Description and measurement*	*Expected sign*
Age of Household Head	Number of years	+/-
Health status of Household Head	Number of months in a year household heads reported to feel healthy and engage in activities	+
Literacy status of household head	1 for literate (read and write) and 0 otherwise	+
Household Family Size	Household members in Adult Equivalent	+/-
Active Family Labour Force	Number of active labour force in the household	+
Participation In Irrigation	1 for yes and 0 otherwise	+
Livestock Ownership	Tropical Livestock Units (TLUs)	+
Farm Landholding Size	Total cultivated farm land holdings in hectares	+
Per capita Agricultural Produces	Total annual grain produces in quintals	+
Remittances	1 if the household received remittances and 0 otherwise	+
Access to Credit Services	1 for yes and 0 otherwise	+/-
Bank Saving Accounts	1 for yes and 0 otherwise	+

secure and food insecure households respectively (Goitom, 2017). The descriptive statistics of potential explanatory variables used are discussed and interpreted hereunder.

Age of household head: Age of household head is one of the demographic variables that can determine household food security situation. As displayed in table 2, the minimum, maximum and mean age of sample household heads' was found to be 25, 80, and 49.53 years respectively. On the other hand, the mean age of food secure and food insecure household heads' was computed to be 48.96 and 50.36 years respectively. As food secure household heads' average age is a bit lower than the food insecure household heads' average age, it can be said that there was a tendency for households headed by younger heads to be food secure than households headed by older heads. However, the independent samples t-test statistical association result showed no significant differences between food secure and food insecure household heads' age at all probability levels.

Table 2
Descriptive statistics summary of the explanatory continuous variables

Variables	*Total*		*Food secure*		*Food insecure*		*t-value*
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	
Age of household head (Years)	49.53	10.76	48.96	10.89	50.36	10.55	1.165
Health status of household head (Months)	8.77	3.62	9.27	3.034	8.04	4.24	2.900***
Family size (Adult Equivalent)	2.28	1.21	1.79	1.02	3.00	1.09	10.269***
Livestock endowment (TLU)	1.27	1.60	1.40	1.71	1.09	1.42	1.774*
Farm land size (Hectares)	0.75	0.18	0.76	0.17	0.73	0.18	1.805*
Aggregate agricultural production	6.27	5.03	6.71	5.35	5.62	4.46	2.027**
Active family labour force	1.37	0.86	1.47	0.97	1.21	0.62	3.059***

*, ** and *** refers significant at 10%, 5% and 1% probability level respectively, SD-Standard Deviation

Source: Computed from field survey, 2016

Health Status of household head: Health status of household head is one element of human capital that can determine human resource of the household. Household heads with good health condition will necessary have good command of labour and effective accomplishment of their livelihood activities. Cognizant to this, an attempt was made to compute number of months household heads reported to feel healthy and actively engaged in different income generating activities in the year prior to the survey. Accordingly, as shown in table 2, the minimum, maximum and average number of months household heads reported to feel healthy and actively engaged in different income generating activities ranged from 0 to 12 months with a mean value of 8.77 months. Furthermore, the computed mean month for food secure and food insecure household heads was found to be 9.27 and 8.04 months respectively. The independent sample test was associated with a statistically significant effect $t(225.396) = 2.900$, $p<0.01$ at 99% level of significance. This significant value of the t-test assured that food secure and food insecure household heads had varied health status. Therefore, household heads who were frequently sick and forced to be absent from any income generating activities in the year prior to the survey were found to be relatively food insecure households than their counterparts.

Family Size: The link between rapid population growth and food security could be explained in the two divergent discourses. Food Availability Decline Thinking of Malthusian and Neo-Malthusians stated that population growth which is faster than the rate of increase in food production will result in fall in per capita consumption. In other words, if increasing and high population remains unchecked, it leads to famine and food shortages. On the other hand, Easter Boserup (1965) discloses that rapid population growth is one of the stimulant factors for the intensification of agriculture and ensures increased level of food supply (Degefa, 2005; Guyu, 2016). Thus, the situation of the household and the context determines whether large family size would be an advantage or not.

Family size as one of the most important demographic variable was identified to determine household food security. Accordingly, by employing a standardized Adult Equivalent Conversion Factor, family size of each sample household was converted in to Adult Equivalent family size which considered the age and sex of each family member of the household. Consequently, the computed minimum, maximum and average Adult Equivalent family size of the sample households as presented in table 2 were 0.74, 5.40 and 2.28 respectively. Furthermore, sample food secure and food insecure households also showed variation in their computed average Adult Equivalent family size; 1.79 and 3.00 was for food secure and food insecure households respectively. The independent sample test was associated with a statistically significant effect t (331) = 10.269, $p<0.01$ at 99% level of significance. This significant value of the t-test indicated that food secure and food insecure households had different family size. Subsequently, compared with food secure households, food insecure households had relatively extended family size.

Active Family Labour Force: Number of active family labour force in the household as one element of human capital and demographic variable can determine effective accomplishment of household's livelihood activities which in turn affect household's food security situation (Yared et al., 2000; Degefa, 2005). Hence, an effort was made to estimate number of economically active family members of each sample household. Accordingly, as indicated in table 2, the computed minimum, maximum and average active family labour force of the sample households was found to be 0, 4 and 1.37 respectively. Furthermore, sample food secure and food insecure households also had variation in their active family labour force size; where 1.47 and 1.21 was the computed mean active family labour force for food secure and food insecure households respectively. The independent sample test was associated with a statistically significant effect t (329.996) =3.059, $p<0.01$ at 99% level of significance. This significant value of the t-test specified that food secure and food insecure households had different size of active family labour force. Consequently, compared with food insecure households, food secure households were relatively equipped with large number of economically active labour forces available to engage in various income generating activities and augmented their household food security status.

Total Livestock Holding: In mixed farming communities, livestock and its by-products are basic sources of livelihood. In the study areas livestock provides milk, meat, eggs and other products for home consumption and source of cash income as well as serve as a financial buffer during crop failure and other disasters. As a result, livestock possession is believed to be considered as a wealth indicator and household food security (Bogale and Shimelis, 2009; Abafita and Kim, 2014; Kelilo *et al.,* 2014).

As per the inventory of livestock possession in TLU, table 2 revelled that the minimum, maximum and the average calculated TLU value for the sample households was 0.00, 6.89 and 1.27 respectively. Furthermore, difference was also observed in

computed average TLU between food secure (1.40 TLU) and food insecure households (1.09 TLU). The independent sample test was associated with a statistically significant effect t (318.656) =1.774, p<0.10 at 90% level of significance. This significant value of the t-test denoted that food secure and food insecure households owned different size of livestock. Therefore, compared with food insecure households, food secure households were more likely to possess large stocks of livestock to guard their livelihood and to use them as a safeguard against risks from the external tremors.

Farm Land holding size: Per capita farm land holding sizes as one element of agricultural assets is the most significant factor and denotes differences in agricultural production and wealth disparities between farm households (Degefa, 2005; Haile, 2008). Household land holding size was an indispensable resource that profoundly determined the amount and type of grain produces, income and households' food security (Yared et al., 2000; Degefa, 2005). Limited access to land and other natural assets (especially water) is one of the most binding constraints on smallholder farming investment. For instance, according to Devereux (2000), a farmer with less than half hectare of farm land holdings is unable to meet his/her subsistence food requirements even in good rainfall years. As vividly presented in table 2,The survey result of this study revealed that the computed average per capita cultivated land holding size was less than a hectare (0.75 hectare) with a minimum of 0.5 hectare to a maximum of 1.25 hectares. Moreover, the average computed household farm landholding size for food secure and food insecure households was found to be 0.76 and 0.73 hectares respectively. The independent sample test was associated with a statistically significant effect t (331) = 1.805, p<0.10 at 90% level of significance. This significant value of the t-test indicated that food secure and food insecure households possessed different size of cultivated farm landholdings. Accordingly, as farmland is the most important source of livelihood in the study area, compared with food insecure households, food secure households were relatively endowed with large per capita tract of cultivated farm land holding.

Aggregate per capita Agricultural Production: Food insecurity in Africa is the outcome of both low agricultural produces and low incomes (Devereux and Maxwell, 2001). Aggregate production is concerned with the availability element of food security and is the main determinant of household food security/insecurity in rural areas of developing nations (Degefa, 2005; Khan and Gill, 2009 in Guyu, 2016). As the sample households' livelihood was highly dependent on agriculture and their major source of food comes from their own production, an effort was made to estimate the per capita annual aggregate agricultural produces. Accordingly, the survey result as depicted in table 2 revelled that the mean annual total per capita grain produced was found to be 6.27, 6.71 and 5.62 quintals for the whole sample households, food secure and food insecure households respectively. Hence, food secure households were found to have relatively more per capita quintals of yields than food insecure households. The independent sample test was associated with a statistically significant effect t (317.814) =2.027, p<0.05 at 95% level of significance. The result of independent samples t-test assured that there was a significant mean per capita annual aggregate produce volume difference between food secure and food insecure households. Therefore, based on the t-test result, it is possible to infer that compared with food insecure households, food secure households had relatively more per capita aggregate production quantity in the year preceding the survey.

Literacy status of household head: Education as a human capital creates awareness and helps for better innovation and invention through acquisition of new information. It increases household's

Table 3
Descriptive statistics summary of the explanatory discrete variables

Variables	*Total*		*Food Secure*		*Food Insecure*		*Chi-square value*
	No	*%*	*No*	*%*	*No*	*%*	
Literacy Status of household head							
Literate	136	40.8	97	49.0	39	28.9	13.42***
Illiterate	197	59.2	101	51.0	96	71.1	
Participation in irrigation							
Yes	113	33.93	74	37.4	39	28.9	2.578
No	220	66.07	124	62.6	96	71.1	
Remittances							
Yes	86	25.8	66	33.3	20	14.8	14.370***
No	247	74.2	132	66.7	115	85.2	
Bank and Microfinance Saving accounts							
Yes	119	35.7	105	53.0	14	10.4	63.610 ***
No	214	64.3	93	47.0	121	89.6	
Access to Credit facilities							
Yes	96	28.8	48	24.2	48	35.6	5.007**
No	237	71.2	150	75.8	87	64.4	

** and *** refers significant at 5% and 1% probability level respectively

Source: Computed from field survey, 2016

awareness about the possible rewards of modern agriculture which in turn would enhance households' food availability (Haile, 2005; Mequanent et al., 2014; Guyu, 2016). According to Meskerem and Degefa (2015), education is believed to affect food utilization through production management. For this study, sample household heads were grouped as illiterate (who cannot read and write) and literate. Therefore, as presented in table 3 the computed average literacy rate of sample household heads was 40.8% (of which about 49 and 28.9% were food secure and food insecure households respectively). Compelled with lack of awareness on long run benefit from modern education, poor access to modern educational infrastructures were major responsible for the existing high illiteracy status of sample female headed households. The existing significant variation in literacy status between sample food secure and food insecure household heads was found to be significant in Chi-square test of association 1, N=333) =13.42, $p<0.01$. Hence, compared with food insecure households, food secure households were more likely to had literate heads. Consistent with this, Degefa (2005) reveled that in subsistence farming, literate farm household heads are better than their counterparts in numerous ways though the role of indigenous knowledge in realizing household food security should not be underestimated. Moreover, according to DFID (1999) livelihood approach, lack of education is one of the central dimensions of poverty and food insecurity that undermines household's capacity to build their resilience (Guyu, 2016).

Participation in irrigation: In the study area it was noticed in the survey that, households who do not plough their farm land by themselves were compelled to lose half of their produces through

sharecropping arrangements. Accordingly, as displayed in table 3, of the total 333 sample households, only 113 (33.9%) households participated in peri-urban modern small-scale irrigation projects while the rest 220 (66.1%) households did not participate and were forced to sharecrop out their farm land based on half-half basis losing around half of the yields in the process. As a result, the Net Available Food (NAF) survey result portrayed the existence of household food security status disparity between participant and non-participant households. Of the sample households, 198 (59.46%) were found to be food secure households. Moreover, the NAF survey result also indicated household food security status disparity between participant and non-participant households; 74 (65.49%) and 124 (56.36%) were food secure participant and non-participant households respectively. Yet, the Chi-square test statistical association result showed no significant differences between participant and non-participant households in their food security status at all probability levels.

Saving Accounts: Savings in modern financial institutions such as Banks and Credit and saving institutions (Micro-finances) as a self-insurance financial capital implied that households have money to be saved which in turn significantly safeguards households' economic viability, food security and livelihood situation positively (Yared *et al.,* 2000). Accordingly, an attempt was made to assess sample households' habit of saving in modern financial institutions. Hence, as presented in table 3 the survey result revealed that 119 (35.7%) of the sample households had saving bank accounts and saved some share of their incomes in modern financial institutions in the year prior to the survey. Moreover, the survey result also showed disparity among food secure and food insecure households in their saving habits; where 105 (53%) and 14 (10.4%) of food secure and food insecure households reported to save their share of income in modern financial institutions respectively. The saving habit disparity between sample food secure and food insecure household was found to be significant in Chi-square test of association 1, N=333) =63.610, $p<0.01$. Hence, compared with food insecure households, food secure household heads were more likely to save their share of income. Generally, the survey result exposed the low saving habits of sample households which in turn urge the need of awareness creation programmes about savings besides increasing their farm, off-farm and non-farm productivity. Consistent with this study finding, the 2016 Ethiopian Demographic and Healthy survey report also confirmed Ethiopians' low access to saving accounts where only 15% of women and 25% of men have a bank account (CSA and ICF, 2016).

Access to Credit services: Household food security and livelihood literatures showed that households' access to credit services as a financial capital provides an opportunity to engage in various income generating activities; which in turn can strengthen households' purchasing power and enable them to escape the risk of household food insecurity at times of food shortage (Yared et al., 2000). In line with this view, an attempt was made to identify sample households with and without access to rural microfinance credit services. Accordingly, as shown in table 3, only 96 (28.8 %) households had access to credit services in the year prior to the survey; out of which 24.2 and 35.6 % were food secure and food insecure households respectively. Therefore, the Chi-square test statistical association was found to be significant 1, N=333) =5.007, $p<0.05$. This significant value of the chi- squared test declared that food secure and food insecure households had prominent disparities in access to credit services. Therefore, it can be concluded that compared with food secure households, food insecure households were more likely to benefit from rural credit services to support their insufficient farm produces.

Access to Remittances: Remittances, which households reported to obtain regularly or irregularly

from individuals living inside or outside the country as a social capital are one of the most important elements of urban and rural livelihood strategies (DFID, 2001; Ephrem, 2015). According to ILO (2011), the study area was identified for its high incidence and historical emigration to the Gulf States, mainly Saudi Arabia and Kuwait. Furthermore, the Key Interview informants as well as Focus Group Discussion participants also assured the development of migration culture towards the Arab countries. As a result, household heads were asked whether their family had received remittances from any individual or institution during the year preceding the survey. Accordingly, as presented in table 3, 86 (25.8%) of the sample households reported to receive remittances; of which 66 (33.3%) and 20 (14.8%) were food secure and food insecure households respectively. Thus, the Chi-square test statistical association was found to be significant 1, N=333) =14.370, p<0.01. This significant value of the chi- squared test stated that food secure and food insecure households did not have equal access to remittances. Thus, it can be concluded that compared with food insecure households, food secure households were more likely to be beneficiaries of remittances.

Result from the Regression Analysis

Before the estimation of the parameters of the model, the collected data was tested for the serious problem of multi co-linearity and association among the potential explanatory variables. Multi co-linearity happens when at least one of the independent variable has a linear combination of the others. Hence, for this study the effect of multi co-linearity was checked employing Variance Inflation Factor (VIF) and Contingency Coefficient (CC) for continuous and discrete variables respectively.

For continuous variables, a rule of thumb having a VIF value below 10 are believed not to have multi co-linearity while a VIF value greater than 10 are obliged to the problem and should be omitted from the model (Gujarati, 2004). As displayed in table 4, the computed VIF value for all the continuous variables of this survey was below 3 (mean VIF value of 2.75) which confirmed the absence of multi co-linearity.

Table 4
Variance Inflation Factor value for continuous variables to test multi co-linearity

Variables	*VIF*
Age of household head (Years)	5.21
Health status of household head (Months)	4.89
Family size (Adult Equivalent)	1.73
Active family labour force (Number)	2.37
Livestock endowment (Total Livestock Unit)	1.85
Farm land holding size (Hectares)	1.29
Aggregate Agricultural Production (Quintals)	1.91
Mean VIF	2.75

Source: Model output from own survey, 2016

On the other hand, the value of CC is a chi-square measure of association between variables and it value ranges between 0 and 1; 0 designates absence of association amongst variables while values close to 1 entitles high degrees of association. As a rule of thumb a variable with CC value less than 0.75 indicates weak association and a value greater than it specifies a strong association between variables. In this study, the CC value of the five discrete variables incorporated in the model was computed to be less than 0.75 which did not portray the existence of serious multi co-linearity problem. Therefore, all the hypothesized potential variables were included in the model.

The model's goodness of fit was measured by the count R^2 which designates the number of sample observations properly predicted by the model. The count R^2 is understood based on the standard that if the predicted probability of the event is less than 0.50, the event will not occur, and if it is greater than 0.50, the event will occur (Maddala, 1981).

Hence, as shown in table 5, the pseudo R^2 of the maximum likelihood estimate of the logit model was found to be 0.7379. This revealed that almost 73.79% of the likelihood of a household being food secure was strongly explained by the independent variables in the model. Moreover, the computed log likelihood estimation of -58.92 and a highly significant chi-squared value (331.81) at $p<0.001$ also designated the model's goodness of fit and its strong explanatory power. Thus, it can be inferred that for this study the model fits very well.

Of the twelve explanatory variables hypothesized to determine household food security, output of the binary logistic model as presented in table 5, indicated that eight variables were found to be statistically significant determinants of household food security. These variables were age of household head, educational status of household head, family size, number of active family labour forces, livestock possession, cultivated farm land holding size, savings in modern financial institutions and remittances. The significant explanatory variables in the model are discussed and interpreted hereunder.

The binary logit model result shown in table 5 declared the significant and positive association between household heads' age and household food security. The positive relationship indicates that the odds ratio in favour of the probability of being food secure increases with an increase in the age of household head. The odds ratio in favour of being food secure increases by a factor of 1.2086 when age of the household head increases by one year at 1% probability level holding other determinants of household food security unchanged. Hence, households headed by older heads were more likely

Table 5
Parameter estimates of the determinants of household food security

Variables	*Coefficients*	*Odd ratio P-value*	
Age of household head (Years)	.1894886	1.208631	0.004***
Health status of household head (months)	.2211535	1.247515	0.198
Educational status of household head	1.10748	3.026722	0.068*
Family size (Adult Equivalent)	-5.274654	.0051197	0.000***
Active family labour force (Number)	4.597177	99.20384	0.000***
Livestock endowment (Total Livestock Unit)	.6515392	1.918492	0.023**
Farm land holding size (Hectares)	4.288829	72.88105	0.022**
Participation in irrigation	1.816835	.1625394	0.121
Aggregate Agricultural Production (Quintals)	.0950702	1.099736	0.164
Savings in modern financial institutions	3.71786	41.17617	0.000***
Access to Remittances	1.08346	2.954886	0.083*
Access to Credit services	-.2579746	.7726148	0.690
Constant	-11.04983		0.029**
Number of observations 333	R^2	331.81	
Pearson chi-square (13) 0.0000	Pseudo R^2	0.7379	
Log likelihood -58.915541			

*, ** and *** refers significant at 10%, 5% and 1% probability level respectively

Source: Model output from own survey, 2016

to be food secure than households headed by younger heads. The possible justification could be as household head's age increase, she can acquire more experience in farming and weather forecasting as well as knowledge of risk aversion through intensifying and diversifying her production activities. Moreover, as per the Key Interview Informants' and Group Discussion participants' understandings, elderly household heads accumulated better assets over time; owned relatively large and fertile farm land than younger household heads as land re-distribution was done two decades ago in 1990s.

Results of previous various empirical studies showed mixed results on the relationship between age of household head and household food security situation. Consistent with this study, Bogale and Shimelis, 2009; Abafita and Kim, 2014 argued that a one-year increase in age of household head increases the probability of being food secure household. Contrary, the empirical studies of Ejigayhu and Abdi-Khalil, 2012; Tagese and Berhanu, 2015 identified the negative relation between age of household head and household food security.

The econometrics logit model result of this study presented in table 5 showed that literacy status of household head was significantly and positively associated with household food security. The positive association designates that the odds ratio in favour of the probability of being food secure increases with an increase in household heads' literacy status. The odds ratio in favour of being food secure increases by a factor of 3.0267 when educational status of household head changes from illiterate to literate at 10% probability level, other determinants of household food security being constant. Therefore, households who have literate heads were more likely to be food secure than their counterparts. The possible justification for this direct relation could be attributed to productive use of household heads' knowledge and information towards diversifying livelihoods, improve crop productivity and achieving household food security. In line with this study, empirical studies by Ejigayhu and Abdi-Khalil, 2012; Gutu, 2015; Tagese and Berhanu, 2015; Guyu, 2016 also established the positive relation between literacy status of household head and household food security.

The binary logit model result of this survey displayed in table 5 declared the significant and negative association between household family size and household food security. The inverse relationship specifies that the odds ratio in favour of the probability of being food secure decreases with an increase in family size measured in Adult Equivalent. The odds ratio in favour of being food secure decreases by a factor of 0.0051 as a family size increases by one Adult Equivalent unit at 1% probability level keeping other determinants of household food security constant. Coupled with degraded and fragmented farm land as well as incidence of frequent drought, large family size with high number of inactive family members exerted pressure and competition on household's limited resource and food basket. Hence, extended households were more likely to be food insecure than nucleated households. This finding lends support to the argument of Food Availability Decline Thinking of Malthusian and Neo-Malthusians which stated that population growth which is faster than the rate of increase in food production will result in fall in per capita consumption. The finding on the other hand, disproved the theory of Boserup (1965) which argues that large family size would increase agricultural productivity through intensification. Consistent with this study finding, Maxwell, 1996; Abonesh, 2006; Bogale and Shimelis, 2009; Getinet, 2011; Ejigayhu and Abdi-Khalil, 2012; Kelilo et al., 2014; Gutu, 2015; Tagese and Berhanu, 2015; Guyu, 2016 also identified the significant and negative relationship between large family size and household food security.

In line with the Neo-Malthusian thinking of Ethiopian population policy which has been implemented since 1993, the output of the model

urges the wide practice of family planning programs targeted to reduce rapid population growth.

As hypothesized, the model result displayed in table 5 clearly elucidated that household food security is positively and significantly determined by household's active family labour force availability. The positive relationship shows that the odds ratio in favour of the probability of being food secure increases with an increase in households' active family labour force. The odds ratio in favour of being food secure increase by a factor of 99.2038 when household's active family labour force increase by one active person at 1% probability level, *ceteris paribus*. Therefore, households with large size of active family labour force were more likely to be food secure and vice versa. This might be due to the fact that households with large number of active family labour forces involved in various income generating activities were endowed with supplementary incomes to satisfy the food demand of their family and were more likely to escape the problem of household food insecurity. Results of earlier different empirical studies told mixed stories about the association between number of active family labour force and household food security. The finding of this survey is in agreement with the empirical studies of Tagese and Berhanu (2015). On the contrary, Haile (2008) identified the coefficient for the number of adult labour force variable to have a significant positive effect on the probability of a household being poor.

The binary logit model result shown in table 5 vividly depicted that household's food security status was significantly and positively determined by size of livestock population. The positive relationship stipulates that the odds ratio in favour of the probability of being food secure increases with an increase in livestock possession. The odds ratio in favour of being food secure increases by a factor of 1.9185 when livestock possession increases by one TLU at 5% probability level, holding the other regressor in the model constant. The possible explanation is that in mixed farming communities, livestock and livestock products are basic sources of livelihood with many socio-economic benefits. In the study area livestock provides milk, meat, eggs and other products for home consumption and income as well as serve as a financial buffer during stress to purchase food and non-food items. Moreover, livestock serve as source of draught power for farming which again intends to determine food crop production. As a result, livestock ownership is considered as a wealth indicator. Hence, it can be inferred that households with better number of TLU were found to be more likely to be food secure households than those with less or no TLU. This result supports the findings of previous researches of Bogale and Shimelis, 2009; Abafita and Kim, 2014; Kelilo *et al.,* 2014.

Per capita farm land holding sizes as well as its fertility status are the most significant factors for difference in agricultural production and wealth disparities between farm households (Degefa, 2005; Haile, 2008). As farm land holding size is a common substitute variable for income and agricultural produces, it can determine households' food security status. With regard to households' available cultivated farm land holding size measured in hectares, the result of the model displayed in table 5 elucidated that it has a positive and significant impact on households' food security situation. The positive relationship designates that the odds ratio in favour of the probability of being food secure increases with an increase in farm land holding size. The odds ratio in favour of being food secure increases by a factor of 72.8811 when farm land holding size increases by one hectare at 5% probability level, other determinants of household food security being constant.

The possible justification for this relationship is the fact that land as a physical resource; its large size denotes the possibility of harvesting diversified and huge production which in turn signifies

availability of food grains for household consumption and sale. Furthermore, in the study area it is observed that households' major source of food grains comes from their own production. Accordingly, households who possessed large tract of cultivated farm land holding size had better likelihood of food security than those who possessed relatively small size of cultivated land. In line with this finding, empirical studies of Abonesh, 2006; Haile, 2008; Bogale and Shimelis, 2009; Getinet, 2011, also identified positive association.

Consistent with the hypothesis, the econometric result of the model demonstrated in table 5 verified that households' probability of being food secure was determined by their ownership of saving bank accounts significantly and positively. The positive relationship indicates that the odds ratio in favour of the probability of being food secure increases with an increase in households' saving bank account ownership. The odds ratio in favour of being food secure increase by a factor of 41.1762 when households' saving bank account ownership increases by one unit at 1% probability level, ceteris paribus. Since having a saving bank account means there is money to be saved, households with saving bank account in the year prior to the survey were found to be more likely to be food secure than those households with no saving bank accounts. This finding reaffirms the result of previous empirical research of Ejigayhu and Abdi-Khalil (2012).

In developing nations, the impact of remittances on poverty and income distribution has been extensively investigated with mixed discoveries (Nigussie *et al.,* 2013). On one hand, there are evidences which suggest that remittances, the share of migrants' income sent back to family members at the place of origin, as a financial capital provide optimistic role for household food and nutritional security as well as poverty alleviation in rural areas of developing countries. Contrary to this, there are also worries that a mass exodus resulting in the out flow of resources from the farm sector may aggravate the growing demand for food (Rozelle *et al.,* 1999).

With regard to the impact of remittances on household food security, reaffirming to the prior expectation, the model result displayed in table 5 verified the significant and positive association between household's access to remittances and household food security. The positive relationship specifies that the odds ratio in favour of the probability of being food secure increases with an increase in households' access to remittances. The odds ratio in favour of being food secure increases by a factor of 2.9549 when households' access to remittance increases by one unit at 10% probability level, other determinants of household security being constant. Hence, the likelihood of household food security increases with households' access to remittances in the year preceding the survey.

On the other hand, the Key Interview Informants and Group Discussion participants mentioned their threat about the proliferation of dependency syndrome culture as a result of remittances and culture of migration towards the Arab world. According to their opinion, this high incidence of international out migration will result in shortage of adult farm labor force for farm operations which in turn may result in decline in production and soaring price of food items in the study area. Moreover, they also further mentioned that as most of the emigrants to Arab countries are illegals exposed to human traffickers and smugglers, their unreliable and irregular remittances could not be considered as a sustainable source of finance to augment household food security.

Findings of previous diverse studies told mixed results of the relationship between access to remittances and household food security. Consistent with this study finding, Ejigayhu and Abdi-Khalil, 2012; Nigussie *et al.,* 2013 also identified a positive influence of remittances on household food security.

Yet, this finding is contrary to the findings of Abafita and Kim (2014).

CONCLUSION

Household food security as a multidimensional concept is determined by a complex set of demand and supply side variables. Cognizant to this, employing binary logistic regression model, an attempt was made to identify the dominant factors that determine household food security status of female headed peri-urban modern small-scale irrigation project beneficiary households. To this end, twelve potentially explanatory independent variables derived from review of related literatures, previous empirical study findings, experts and researcher's own knowledge and familiarity about the household food security situation of the study area were employed in this survey model. The Chi-squared and t-test result of this survey depicted that sample food secure and food insecure households have statistically significant variation with respect to household heads' educational and health status, family size, number of active family labour forces, cultivated farm land holding size, total livestock holding, aggregate per capita agricultural production, access to credit services, savings in modern financial institutions and access to remittances. Consequently, compared with food secure household heads, food insecure household heads were found to be relatively illiterate, frequently sick and forced to be absent from any income generating activities in the year preceding the survey. Moreover, compared with food insecure households, food secure households were also found to have relatively nucleated families, equipped with large number of economically active labour forces, owned large livestock population, harvest large agricultural produces, save their share of income in modern financial institutions, beneficiaries of remittances as well as rural credit services to support their farm produces.

Among the twelve potential explanatory variables hypothesized to determine household food security, output of the binary logistic model revealed that eight variables were found to be statistically significant determinants of household food security. These variables were age and literacy status of household head, family size, number of active family labour forces, livestock possession, cultivated farm land size, savings in modern financial institutions and remittances. Accordingly, household food security was significantly and positively determined by age and literacy status of household head, number of active family labour forces, livestock possession, cultivated farm land size, savings in modern financial institutions and access to remittances. On the other hand, family size was found to be significantly and inversely associated with household food security.

The result of the binary logistic regression also confirmed the insignificant relations between household food security status with participation in irrigation as well as per capita aggregate agricultural produces. The possible justification for this insignificant association could be attributed to the incidence of poor and untimely and heavy rain as well as effects of the El Niño which resulted in the worst drought and severe crop failure in the year prior to the survey. This phenomenon exposed the poor performance, inefficiency as well as uncertainty of modern small scale irrigation projects towards sustainable household food security attainment and increasing their resilience to natural shocks and stresses. Moreover, the positive but insignificant relationship between household food security and health status of household head could be attributed to women's low educational status and experience which obliged them to participate in non-farm income generating activities with less profit earnings than exploiting more advantageous market opportunities.

Based on the Econometrics results of the odds ratio, it can be conclude that female headed households' food security status was significantly determined by various demand and supply side

determinant variables. Accordingly, active family labour force, farm land holding size, savings in modern financial institutions, educational status of household head, access to remittances, livestock endowment, age of household head and family size are the identified dominant determinates ranked based on their level of significance consecutively.

The identified determinants of household food security can provide a focus for future household food security initiatives, with an understanding of their potential impacts and interactions. Accordingly, in spite of the attempts of expanding and developing peri-urban modern small scale irrigation projects as a means of sustainable poverty reduction and food security attainment strategy, the findings of this study proven that food security policies and intervention mechanisms should give due emphasis to other demand and supply side determinants of household food security.

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