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Impact of Akaki Small-scale Irrigation Scheme on Household Food Security

Molla Deribie*

St. Mary's University, Institute of Agriculture and Development Studies, Ethiopia

Abstract

The study aims to evaluate the impact of Akaki small scale irrigation scheme on household food security of smallholder farmers. Out of 700 farming households with systematically stratified random sampling technique, this causal type of study analyzed 246 household survey based primary data (personal interview questionnaire) with inferential statistics (Heck man two stage). It shows that food security is not as such observed in the study area. At 0.05 probability level; sex, land size (ls), educational level (ed), off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are significant correlates of food security with respect to the three food security indicators (food consumption expenditure score, copying strategy index and dietary diversity score). At 0.05 probability level; sex, off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are statistically significant determinants of the joint indicators and they reliably predict participation in small scale irrigation scheme, citrus paribus. Collective action among governments, NGOs and farming households on flood control and market linkage (perfect information on price of their product) should be taken to let farming households harvest two times per year and prosper.

Keywords: Small-scale irrigation; Household food; Akaki

List of Abbreviations: ANNO: Anonyms; N/A: Not available; CSI: Copying Strategy Index; ETB: Ethiopian Birr; FAO: Food and Agriculture Organization; FCS: Food Consumption Score; FANTA: Food and Nutrition Technical Assistant; Ha: Hectare; HDDS: Household Dietary Diversity Score; M: Meter; Mofed: Ministry of Finance and Economic Development; NGO: Non-Governmental Organization; Pcs: Packets; PASDEP: Poverty Accelerated and Sustainable Development and Eradication Program; UN: United Nation; WFP: World Food Program

Introduction

This study relies on impact of Akaki small-scale irrigation scheme on household food security. Introducing the whole study based on the research story is advisable. Background, problem statement, objectives, research hypothesis, significance of the study, organization of the study and conclusion are the brief synopsis of the content of the entire chapter.

Background

Alongside cities horizontal expansion foundation of urban and pre urban agricultural schemes do have an important indication for agricultural policy development. Even though City Government of Addis Ababa has recognized urban agriculture as one of the important tools to end urban poverty; its contribution has remained negligible. Agriculture is indeed a not negligible reality of the urban economy, involving anywhere between about10–70 percent of urban households [1]. Among these established urban and pre urban agricultural schemes, small scale irrigation package/intervention is vital for reducing food insecurity problem of vulnerable groups in the city. On top of this City Government of Addis Ababa Bureau of Urban Farming has ratified a workable and sound policy of urban agriculture on small scale irrigation to ensure food security of urban settings. Based on that, stating background of food security pillars and impact of river Akaki small scale irrigation scheme on household food security is a crucial task. Food availability, accessibility, stability and utilization and income (adequate benefit from traditional irrigation and hold dairy cows) are the potential pillars of food security and impact of small scale irrigation scheme respectively.

Different economists highlighted that urban agriculture does appear to be associated with greater dietary diversity and calorie availability. Akaki small scale irrigation scheme households have availed/produced vegetables (lettuce, swiss charade, carrot, kale, cabbage, potato, cucumber, cauliflower, beans, tomato, pepper and onion) along river Akaki with surface irrigation for both their family and community. Regarding food accessibility these households have used the machine/generator to pull water from the source and gotten about 85% improved vegetable seeds from Agricultural Input Services Corporations (AISCO); the remaining 15% seed bulk is grown and supplied by farmers themselves. These farmers have supplied about 30% of vegetable demand for Addis Ababa city [2]. Small scale irrigation facilities play a crucial role in ensuring food security. It is therefore paramount for government, NGOs, interest groups and individuals to give small scale irrigated agriculture the needed attention to ensure adequate food supply all year round as food stability [3]. Water management as food utilization river Akaki small scale irrigation schemes was very poor and some of the traditional irrigations schemes are located in the river course and face frequent over flooding during the heavy rainy season. Apart from that there is great concern using fresh vegetables from this schemes as they are irrigated with municipal wastewater [2]. As far as food security role of small scale irrigation scheme is concerned, these four indicators should be fulfilled which are associated in with. Traditional irrigation and dairy cows benefit are impact of river Akaki small scale irrigation scheme.

***Corresponding author:** Molla Deribie, St. Mary's University, Institute of Agriculture and Development Studies, Ethiopia, Tel: 902-420-5768; E-mail: mdraya3@gmail.com

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How the world population is going to produce enough and health food to feed more than 9 billion world populations within 2015 [4]? At the rethinking of global food security, world economic forum has focused and believed on a sustainable way of agricultural production as a means but not an end. One of the means is small scale irrigation facilities. It can play a crucial role in ensuring food security and improvement of the nutritional status of vulnerable populations such as children and the sick [5]. Empirically as Henehan [6] stated urban agriculture has improved food supply and security. Thirty percent of vegetable supply is urban or peri-urban produced. River Akaki small scale irrigation is a small but mighty scheme that is largely visible as far as urban household level food/nutrition security studies are concerned. Farmers get adequate benefit from traditional irrigation and dairy cows in river Akaki small scale irrigation scheme [2].

In sum food availability, accessibility, stability and utilization are the potential pillars of food security in farm households. Farmers get adequate benefit/income from traditional irrigation and hold dairy cows in river Akaki. Therefore understanding of those factors which can reliably and significantly predict food security of Akaki small scale irrigation is a growing intention of every agricultural economist. To this end this paper has focused on estimation of food security on its determinant.

Statement of the problem

City Government of Addis Ababa Bureau of Urban Farming has endorsed a workable and sound policy of urban agriculture on small scale irrigation to ensure food security of urban settings. Identification of gaps of the past research findings which did align with this research area did not have taken time. Based on this stating the major research gaps clearly in this doing is rational. The major research gaps in this study area are enough information accessibility and methodology deficiency (indicators, conceptualization, construction of terms and research design problem) on net impact of Akaki small scale irrigation scheme on farm households' food security, correlates of households food security and determinants of participation on small scale irrigation scheme.

Accordingly, there has no study in this study area on net impact of small scale irrigation scheme on food security at large, correlates of households food security and determinants of participation on small scale irrigation scheme in particular. None whatsoever has evaluated the impact of Akaki small scale irrigation on its goal achievement; even the government. Urban agriculture in Addis-Ababa was benefitting urban farmers and had enabled them to bridge the food gap by supplying fresh vegetables [6]. Thirty percent of vegetables found in the city are grown in the city (60%-70% of leafy vegetables) [6]. It is only food availability, but no indication of food security. It is a necessary condition of food security. More importantly there has no a quantitative type of research on food security impact of small scale irrigation at this study area. On the other hand urban farmers in Addis Ababa produced about 16,220 tons of different vegetables within an area of 433 ha. But this is something which has location issue, conceptualization and methodology deficiency/data analysis problem. In terms of data analysis, the above listed past researchers employed the descriptive approach. There is a methodology deficiency-data analysis and no economic measurement of food security performance of the households. Total production by any means cannot be a sufficient condition for food security. There are other food security indicators with pillars of food security (food availability, accessibility, utilization and stability).

On the other hand the past researchers did have failed on research methodology problem on correlates of households food security and determinants of participation on small scale irrigation scheme. Most of the above listed researches done were relied at regional level and economic sector at large (urban agriculture) so that they are more generic in purpose, environmental, qualitative and descriptive in type. Although many researchers have studied impact of small scale irrigation scheme on household food security in different areas, there did not have been a scientific research done at Akaki small scale irrigation scheme with this research area. Still the problem is existed. If this problem is not existed in this area, analyzing impact of small scale irrigation scheme on household food security cannot be compulsory [7].

In general, so far what this research project mean is the major research gaps in this study area are information accessibility and methodology deficiencies (indicators, conceptualization, construction of terms and research design problem) net impact of food security, correlates of households food security and determinants of participation on small scale irrigation scheme.

Objectives

General objectives: In line with the research topic the general objective of this research project is to evaluate impact of Akaki small scale irrigation scheme on household food security of smallholder farmers. Specific objectives:

1. To evaluate impact of Akaki small scale irrigation scheme on farm households food security;

2. To identify correlates of food security and;

3. To identify determinants of access to small scale irrigation scheme.

Research hypothesis

There are specific questions raised at the beginning of this study. As a positive economics so far this position is very clear in stressing to guess tentative answers for these questions. Questions related to objectives of the study require clear and unambiguous declarative sentence. Based on that a realistic set of hypothesis would be:

1. Coefficient of irrigation access estimator (lambda-**λ)** in the household food security function (yi) is expected to be significant, ceteris paribus;

2. Participation to irrigation (w) (if the household participate in irrigation=1, 0 other wise), family size (fs), sex of the household head (male household head=1, female=0), land size (ls), school year of the household head (ed), irrigation experience (exep), off-farm income (offfarmi), on- farm income (onfarmi), non farm income (nonfarmi) and distance from home to water source (dhomeland) are individually statistically significant correlates of household food security (yi), ceteris paribus;

3. Sex of the household head, irrigation experience, off -farm income, on farm income, non - farm income, access to generator and distance from home to water source are relevant variables of participation to small scale irrigation scheme, ceteris paribus.

Significance of the study

The local government and community (farm households and researchers) at large will be benefited via solving food insecurity

prevalence by doing performance evaluation so as to input for policy making or revision.

As part of the community, farm households will be benefited from this study is that it is going to highlight areas of nutritional concern in Addis Ababa urban settings at large and Akaki small scale irrigation farmers in particular. Not only this, even the study will draw the attention of food security to areas they should investigate further who would repeat this research area. And also it will be useful for academic reference for students at school.

All in all the local government and community (farm households and researchers) at large will be benefited from this study. The two decision makers will use this study as a tool for performance evaluation on small scale irrigation, solving food insecurity prevalence and input for policy making or revision.

Scope and limitation of the study

River Akaki small scale irrigation scheme is practiced by smallholder farmers who are more vulnerable to prevalence of food insecurity [8]. In the city of Addis Ababa there is a vast urban farming practice in the sub cities. But this research covered only river Akaki small scale irrigators and non-irrigator farmers who are more vulnerable in food insecurity prevalence. Therefore, the result of this study accepted only with 95% of confidence level, 246 sample sizes for inferential statistics analysis and causal type of research limitations.

Organization of the study

This is the structure of the research. Stating organization of the study clearly is an interesting. Chapter one, two, three, four and five are structures of the research.

Background, problem statement, objectives, hypothesis, significance, scope and limitation of this study are included in chapter one as an introduction. The later is chapter two. Theoretical and empirical literature is included under this chapter. Methodology; results and discussions and summary, conclusion and recommendation are the main constitute of chapter three, four and five in this study area respectively.

Conclusion

In sum potential pillars of food security, benefits of households, research gaps (information accessibility and methodology deficiencies, performance evaluation importance of the study limitation-location issue, concept, and methodology deficiency) were the main issues raised based on the review of different literatures in the entire chapter at river Akaki small scale irrigation scheme in Akaki-Kality sub-city in the city of Addis Ababa.

Literature Review

Different researchers did have researches on food security. In this part this study outlines both theoretical and empirical evidence that will enable the researcher to estimate the magnitude and direction of explanatory variables quantitatively and to interpret the scheme role on household food security. In light of this different literatures have been organized based on sequential, topical, methodological and theoretical that has already studied. Theoretical (definition of concepts/ food security indicators) and empirical literatures in connection with identifying strategies that have been attempted, results obtained, gaps or shortfalls of past studies and refining, revising and extending this research to some extent is the supportive reviews of this task.

Theoretical literature

In this part the literatures has been reviewed based on the themes which have been written in the past by different authors. So that it has been carefully observed what has said about objectives of this research than ever before. Definition and Concepts of food security, impact of small-scale irrigation on household food security, correlates of food security, and determinants of participation on small scale irrigation and mean value of food consumption expenditure given its factors have been reviewed from mathematical and econometric theory stand point of view.

Definition and concepts of food security

Regardless of meanings of economic terms, defining concepts of key words prior to conceptual framework of different researches is believed to be important. World food summit [8] has defined food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Based on this defining different concepts has been emphasized. The potential pillars of food security (Food availability, accessibility, stability and utilization), label of food security/ insecurity and small scale irrigation are the key words that inquire definition. There are four pillars of food security [1].

Food availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid).

Food access: The access to adequate resources (entitlements) to acquire appropriate foods for a nutritious diet. Entitlements are defined here as the set of all commodity bundles over which a person can establish command, given the legal, political, economic and social arrangements of the community in which he or she lives (including traditional rights such as access to common resources).

Food utilization: The utilization of food through adequate diet, clean water, sanitation, and health care, to reach a state of nutritional well-being in which all physiological needs are met.

This highlights the importance of non-food inputs in food security. For example, it is insufficient for an individual to receive an adequate quantity of food, if he or she is unable to make use of the food due to illnesses resulting from inadequate sanitation or poor sanitary practices.

Food stability: The stability of access to adequate food at all times, independent of shocks (such as economic or climate related crises) or cyclical patterns. This includes issues of seasonal food insecurity, such as the agricultural period before harvest known as the hunger season. In doing so, what has not been said on this study is definitions on four pillars and indicators of food security about.

Having this in mind, USDA-2006 did have labeled ranges of food security/insecurity.

High food security (old label=Food security) is to mean that no reported indications of food-access problems or limitations. Marginal food security (old label=Food security): one or two reported indications-typically of anxiety over food sufficiency or shortage of food in the house. There is little or no indication of changes in diets or food intake. Low food security (old label=Food insecurity without hunger): is to mean that there is a report of reduced quality, variety, or desirability of diet. There is little or no indication of reduced food intake. Very low food security (old label=Food insecurity with hunger):

Reports of multiple indications of disrupted eating patterns and reduced food intake.

Small scale irrigation: Small scale irrigation scheme is, first and foremost, a policy intervention for curving food insecurity problem for those who are more vulnerable groups.

Calogero [1] even though undernourishment[1] indicator has an advantage on allowing for frequent updated comparisons of energy deficiency across countries and over time nationally, it relies on often poor quality data and unwillingly to the analysis of food insecurity determinants' profiles below the national level. Using either household survey food consumption data or caloric intake[2] indicator (individual level) has a possible solution in this circumstance. Calogero [1] stated even if household survey food consumption data and caloric intake indicators have big advantages on food security monitoring and analysis, these aggregates are therefore both have high data collection cost, data analysis time and skill level required.; as such, they are not always feasible to collect on a regular basis. Furthermore, collecting detailed food consumption data requires lengthy lists of food items, an approach that may be unattractive when the objective is to keep interview time to a reasonable length. In lieu this using coping strategy index[3] indicator is easy, feasible and observable in terms of cost to collect data. But it is a subjective measure, high susceptibility to misreporting, for focus group discussion and emergencies –for early warning purpose. Dietary diversity indicator[4] incur low data collection cost, data analysis time, moderately low skill level required and low susceptibility to misreporting, but does not record quantities and difficulty involved in interpreting comparisons across studies, since the food groupings as well as the reference periods often vary between approaches. To clear these ambiguities undernourishment, household survey food consumption data and caloric intake indicators have been taken out in favor of coping strategy index (food stability), dietary diversity and food consumption score[5] indicators jointly. Food consumption score lacks the ability to differentiate between processed and unprocessed foods utilization, the indicator is also unsuitable for emergency assessments. Regardless of food insecurity emergency, furthermore, this study also due considerations to food utilization (non food indicators) on the basis of joint indicators.

Impact of small-scale irrigation on household food security

From Heckman model and its two-step estimator anyone can develop both mathematical and econometric models as:

Mathematical model

$S=X\beta + \lambda p$

Econometric theory: A model commonly employed in evaluating program impacts is the following:

$S=X\beta + \lambda p + \varepsilon$

where P is the participation dummy variable defined above. The estimate of λ is interpreted as the program net impact (Heckman).

In this study $yi=\beta Xi + \lambda w^*i + \varepsilon i$, where the estimate of λ is interpreted as the small scale irrigation scheme net impact.

In short, theories on impact of small-scale irrigation on household food security are results of theoretical past studies that have been found out. But lack of information on theory of magnitude and direction of small scale irrigation on food security is one of the most important point in the review process. Heckman and world food summit [8] did have better theories on correlates of food security.

Correlates of food security

In doing so this study has been outlined theoretical evidence that will enable to estimate the magnitude and direction of explanatory variables quantitatively and interpret the scheme net impact on household food security.

Mathematical model

Food security is depending on four variables/pillars (World Food Summit) [8].

$$y=FA + FAc + FU + FSt \quad (1)$$

Mathematical model,where y is food consumption expenditure score. Food availability (FA), food accessibility (FAc), food utilization (FU) and food stability (FSt) are the correlates of food security. But it lacks some relevant variables.

$$\text{Food consumption}=f(yd, s) \quad (2)$$

Consumption theory yd is disposable income and s is saving of the consumer (household).

As disposable income of the household increases, then food consumption score so does, keeping other variables constant. This is to mean that they have a direct relationship.

From Heckman model and its two-step estimator

$$y=\beta Xi \quad (3)$$

Econometric theory

This can be framed by the Heckman model and its two-step estimator.

A sample selection model always involves two equations:

i. The regression equation considering mechanisms determining the outcome variable and;

ii. The selection equation considering a portion of the sample whose outcome is observed and mechanisms determining the selection process.

Heckman, stated although logit and probit models offer practical solutions to various types of evaluation problems, they lead biased estimate if the underlying process which governs selection into the institution or a program is not incorporated in the empirical frame work. One solution for this problem is a treatment effect model. It is sensitive to model misspecification and producing improved estimates of average treatment especially when the causes of selection processes are known and are correctly specified in the selection equation. But Heckman criticizes this parameter of interest by stating that picking a millionaire at random to participate in program is not policy relevant or feasible, it may be of interest if the population of interest is appropriately defined. One solution to this problem in

[1]Undernourishment: it is FAO's food security indicator that measures average availability of food against requirements at thenational level [1].

[2]Caloric intake: the most accurate measure of food security status of an individual [1].

[3]Coping Strategy Index: it measures household food consumption vulnerabilities [1].

[4]Dietary diversity indicator: number of food groups that a household consumes over a reference period [1].

[5]Food consumption score: FCS is calculated from the types of foods and the frequencies with which they are consumed during a seven-day period [1].

econometrics is the application of Heckman's two-step procedures through controlling of sample selection biases. Therefore Heckman model is more appropriate in correcting selection bias, consistent, program evaluation, asymptotically efficient estimates and estimating the probability (i.e., the propensity score) of a participant. If this is so, the collected data will be analyzed with an econometric tool-Heckman model and its two-step estimator.

Based on that to express the model, Heckman stated there will be two equations, the regression equation of household food security and the selection equation of participating in small scale irrigation scheme. For the purpose of modeling any sample selection process, two equations are used to express the determinants of outcome y.

Regression equation: $y=ßX_i + u_1$ observed if w=1 (4)

Selection equation: $w^*=\gamma Z_i + u_2$, w=1 if $w^* >0$ and w=0, otherwise, (5)

Prob $(w_{i=}1|z_i)=\phi (z_i \gamma)$ and Prob $(w_{i=}0|z_i)=1 - \phi (z_i \gamma)$, X_i is a vector of exogenous variables determining outcome yi, and w* is a latent endogens variable, Z is a vector of exogenous variable determining the selection process or the outcome of w*, ϕ is the standard normal cumulative distribution function; and u_1 and u_2 are error terms of the two regression equations.

A model commonly employed in evaluating program impacts is the following:

$S=Xß + \lambda p + \varepsilon$

where P is the participation dummy variable defined above. The estimate of λ is interpreted as the program net impact**.** If λ is statistically significant, then the program can show an impact.

In this study $yi=ßXi + \lambda w^*i + \varepsilon i$, estimate of λ is interpreted as the small scale irrigation scheme net impact, Xi and w* are aggregated determinants of food security and access to irrigation respectively

Note that the selection equation indicates that household food security will be observed only for those households whose food security in terms of household food consumption expenditure score/dietary diversity/coping strategy index were greater than 0 (i.e., households will be considered as having participated in the irrigation if and only if their food security in terms of household food consumption and income survey was above a certain threshold value). Using a zero value in this equation is a normalization convenience small scale irrigation scheme will be greater than their reservation food security (i.e. $y > y^*$). The fact that the household food security of none irrigators (those are food insecure) will be less than their reservation food security (i.e., $y < y^*$) is expressed in the above model through the fact that these household food security will not be observed in the regression equation, that is it will incidentally truncated:

Therefore, determinates of food security can be developed from (4) as:

$y=ßXi + u_1$, regression equation (food security) (6)

Determinants of participation on small scale irrigation scheme

From Heckman model and its two-step estimator anyone can develop both mathematical and econometric models as:

Mathematical model

$w^*=\gamma Z_i$ (7)

Econometric theory: Someone can develop Econometric model from equation (5) as:

Selection equation:

$w^*=\gamma Z_i + u_2$, w=1 if $w^* >0$ and w=0, otherwise (8)

Mean value of food consumption expenditure given its factors

According to WFP/ FANTA/FAO, the concept of household food security (outcome-yi) will be measured with household food consumption expenditure score /household dietary diversity[6] score/ coping strategy index. Food frequency is determined by recording the number of days on which a particular food group is consumed over a reference period, usually 7 days. The FCS is calculated from the types of foods and the frequencies with which they are consumed during a seven-day period. The score produced is a continuous variable and statistics are usually presented including the mean over time and across categories, as well as frequencies and cross tabulations for food consumption groups. The selection equation/irrigation participation (Maximum Likelihood Estimator) will be represented by w*and food security determinant will be represented by Xi.

Mathematical model: Food consumption can be expressed as:

Food consumption (fc=y)=food consume at home (fh) + food consume outside of home (foh)=f (yd, s) (9)

It is based on dietary diversity (food groups) and its frequency within 7 days. Econometric theory

A model commonly employed in evaluating program impacts is the following:

$S=Xß + \lambda p + \varepsilon$ (10)

where P is the participation dummy variable defined above. The estimate of λ is interpreted as the program net impact.

In this case[7] $yi=ßXi + \lambda w^*i + \varepsilon i$, where the estimate of λ is interpreted as the small scale irrigation scheme net impact from empirical result.

Empirical literature

Unlike to theoretical, empirical review can benefits this study with what is happening in reality. In this part the literature has been reviewed based on the themes which have been written in the past like theoretical review. Objectives of this study have been thoroughly observed in line with past studies. Impact of small-scale irrigation on household food security, correlates of food security, determinants of participation to irrigation and food consumption expenditure score of farm household have been reviewed with empirical evidence accordingly.

Impact of small scale irrigation scheme on food security

A number of scholars have disputed on the findings of Asayehegn [9]. Positive coefficient of irrigation access is the commonplace opinion on food security. Asayehegn [9] have described participation with small scale irrigation do have a positive impact on household food

[6]Dietary diversity is represented by recording the number of food groups that a household consumes over a reference period. This is the sum of the number of different foods consumed by an individual over a specified time period. It may be a simple arithmetic sum, the sum of the number of different food groups consumed, sums of the number of different foods within a food group, or a weighted sum—where additional weight is given to the frequency by which different foods are consumed.

[7]If there are no unmeasured variables that predict selection into the sample/ selection into the sample is random, we can just include the selection factors in the outcome equation.

security. Alberto [1] described that a relationship with greater calorie consumption, with fruits and vegetables being the food group more consistently found to contribute to the increase in calorie consumption associated with the engagement in urban agriculture. Use of irrigation showed a statistically significant and negative relationship with food insecurity. Use of irrigation showed a statistically significant and negative relationship with food insecurity [10]. As Amankwah and Ocloo [3] concluded that small scale irrigation facilities play a crucial role in ensuring food security in the upper west region. On the other hand Ernest [11] the irrigation scheme enhanced household food security. But there is no such type of research at Akaki small scale irrigating scheme. That is why this study has conducted in this study area.

Correlates of food security

Economists generalized that food security can depend on food availability, food accessibility, food stability and food utilization. Bogale and Shimelis [10] from Table 1 here in above in their logit model analysis of household food security survey postulated family size, land size and level of agricultural production have got relative importance in determining whether a household is food secure or not. Among/between variables considered, family size, annual income, amount of credit received, access to irrigation, age of household head, farm size, and livestock owned showed theoretically consistent and statistically direct significant effect on food security. As can be seen from Table 1 here in above, however Kinfe [9] has described household with larger size of active labor force, sex of the household head, access to small scale irrigation, cultivated land size, self-help cooperatives, saving and credit associations and market information significantly influence food security status of farm household.

Determinants of participation to irrigation

Both hydrologic nature of water resource (efficient) and access to irrigation has deep roots in and close ties with issue of riparian and prior appropriation right (property rights structure-inefficient). The past researchers did have scrutinized that households that live around their catchment area and the first person to arrive (superior claim on the water) expected to have an access of small scale irrigation scheme. Asayehegn [9] concluded that house hold size, size of cultivated land, on-farm income, livestock holding, farmers' perception of soil fertility status, access to credit, nearest to water sources and household size square are the significant variables of access to irrigation. On-farm income, large livestock holding size, ownership of relatively fertile land and nearest of water source have a probability to increase participation in irrigation. The marginal effect shows that as on-farm income of households increases by 100 ETB, the probability of a household's participation in small-scale irrigation increases by 1%. Large house hold size, large cultivated area and access to credit have a probability to reduce access to irrigation. Asayehegn [9] access of credit is a determinant factor. But Rushad and Syed [12] have stated in their findings sex of household head has not been found to be a statistically significant factor even at 10% level of significance, though the sign of the coefficient is negative. Furthermore Asayehegn [9] found access to market information and utilization of credit has positively and significantly associated with probability of participation in small-scale irrigation at less than 1% probability level.

On the other hand Alberto [1] did have highlighted urban agriculture does appear to be associated with greater dietary diversity and calorie availability, both measures of an improved diet and hence closely related to food security.

To sum up from the Table 1 Asayehegn [9] and Alberto [1] in their recent research found that irrigation have positive consequences on

Source	Method they used	location	Key findings
Bogale and Shimelis [10]	two-stage random sampling procedure, survey, structured, questionnaire and logit model.	Dire Dawa,	• The odds ratio in favor of the probability of food insecure increase with an increase in the family size • Access to better income opportunities are less likely to become food insecure than those households who had no or little access • Use of irrigation showed a statistically significant and negative relationship with food insecurity.
Amankwah and Ocloo [3]	Questionnaires with structured and non structured inter-views, field observation and complication of reports from relevant institutions.	Ghana	Small scale irrigation facilities play a crucial role in ensuring security in the Upper West region.
Ernest [11]	In-depth interview, schedules and Observation and simple random sampling.	Ghana	Irrigation scheme enhanced household food security and well being during the off farming (dry)
Asayehegn [9]	Stratified random sampling structured interview, descriptive statistics and casual (Heckman two stage estimation)	Tigray, Ethiopia	Irrigation has positive consequences on food security
Asayehegn [9]	Stratified and random sampling, semi-structured, questionnaire, descriptive, econometric(Heckman two step procedure) techniques.	East Shoa Ethiopia	• Off-farm employment is the most important copping strategy among both irrigators and non- irrigators; • Irrigators have small household size, higher level of education, large livestock holding size, and better quality (fertility) cultivable land and • Irrigation had positive significant impact on household food security.
Alberto and Luca	Casual type research design , inferential an descriptive statistics, multivariate analysis, quantitative survey and questionnaire	Asia,Africa, Eastern Europe and Latin America	• Urban agriculture may have a role to play in addressing urban food insecurity problems and • Urban agriculture associated with food security.
Arega [14]	Questionnaire survey, in-depth interview and focus group discussions, both quantitative and qualitative methods of analysis were employed.	The Amhara region of Ethiopia: The Case of Lay Gaint District	HDDS showed that sample households were severely constrained in dietary diversity and were highly dependent on only two food groups (cereals and pulses)

Table 1: Summary of review of literature.

food security. Asayehegn [9] summarized that 70% of irrigation users are food secure while 20% non-irrigators are food secure. In addition to that small scale irrigation is one of the viable solutions to secure household food needs, but it did not eliminate the food insecurity problem. But this research is going to focus on vegetable producers with small scale irrigation only.

On the one hand, Asayehegn [9] suggested irrigation can improve health condition of farm households. As he concluded, the health condition of 61.54% of the users of irrigation is improved due to capacity of the farm households for medication and purchasing power of medicines while for the rest is due to improved feeding system and hygiene. But whatever research is done in Ethiopia, non what so ever has done causal type of economic research at Akaki small scale irrigation scheme independently.

Empirically, impact of small-scale irrigation on household food security, correlates of food security and access to irrigation are results of empirical past studies that have been found out. But lack of empirical evidence on mean value of food consumption expenditure given its factors is one of the most variable that has found in the reviewed process. Asayehegn [9] and Bogale [10] did have investigated better analytical evidence on impact of small scale irrigation on food security, correlates of food security and access to irrigation. Positive relationship between food security and household irrigation access is how many researchers do better at all.

Conclusion

In sum, no other strategies have worked they tried to define concepts, evaluate impact of small scale irrigation on food security, identify correlates of food security and identify determinants of participation on irrigation, household food consumption score in cause and effect way with inferential statistical analysis and Heckman model at Akaki small scale irrigation scheme. Researchers did have tried for looking both quantitative and qualitative data from Akaki small scale irrigation scheme; they done cost benefit, environmental and health impact analysis. All kind these nothing works, but my method well.

Research Methodology

Introduction

Different agencies have developed approaches that suit their individual needs on food security survey. Whatever the case, stating scientific ways of how this research project was studied is logical. Study area description, research design, sample size and sampling procedure, data sources/collection and analysis method are the main scientific constituents of this research methodology.

Study area description

Akaki kalit district is the place where both irrigators and non-irrigators of vegetables producers found. Therefore describing Akaki small scale irrigation scheme with its tremendous attribute is important. Its location, population size and density, land use, irrigable land sizes are the main essence of this area.

Akaki small scale irrigation scheme is located at Akaki-Kality sub-city in the South of the city of Addis Ababa, Ethiopia through which river Akaki crossed. During the pilot study as a key informant Mulugeta stated this river has two tributaries namely, little Akaki- drains from Torhailoch and big Akaki- drains from bulbula/legedadi and they create the so called river Akaki at Aba Samuel and drainage in the city with in the area in general to the South-to River Awash basin.

Based on a report gotten from Federal Democratic Republic of Ethiopia population census survey commission [13], there is total of 181,202 populations in Akaki kality sub city with 1,653.7 Population per meter square. As Mulugeta, informed from his key note speech out of these populations 700 use this river actively for urban vegetables source. Right now this catchment area is an inhabitant of smallholder farmers.

Furthermore as Mulugeta said River Akaki small scale irrigation area is one of the catchment areas of urban agriculture (vegetable crop production) in the city of Addis Ababa. Out of 310 expected ha of arable land, 120 ha is cultivated for beetroot, cabbage, carrot, garlic, lettuce, onion, pepper, pumpkin, tomato, salad with in bega/winter season.

Research design

This research project has been technically designed on the bases of research method it followed. As research design is considered it can be either exploratory, descriptive or causal/joint. Causal type research design is clear in decision making; highly structured; confirmatory oriented, impact evaluation and no further research is needed (managerially action able) on the representative of a given population. Therefore, in this research due to amount of high certainty for decision making, research approach it follow, problem statement and objective of the study and nature of result; causal research design was preferred to both exploratory and descriptive research design.

Sample size and sampling procedure

In the study area there are 700 farm households who are more vulnerable with food insecurity prevalence. These are both irrigator and no irrigator farmers. If this is so, it is better to stratify them as "households who use small-scale irrigation" and "households who are not using small-scale irrigation". Out of 355 sampling frame of households who use small-scale irrigation with random sampling technique, 123 sample sizes were drawn. Out of 345 sampling frame of households who are not using small-scale irrigation with systematic random sampling technique, 123 sample sizes were drawn.

Ethical considerations were taken on informed consent of the research participant, protect research participants from harm, honesty in presenting results and errors, participant's rights to privacy; especially phone call and observational studies, refrain from data cooking/manipulation and confidentiality in sharing results in this research. Pilot study/pre-test on program adjustment was conducted before the full research has done based on the sample draw.

As Scott Smith has conducted the correct sample size was determined by the following formula.

$$\text{Necessary sample size} = \frac{(\text{Z}-\text{score})^2 \times \text{Std Dev} \times (1-\text{Std Dev})}{(\text{margin of error})^2},$$

where Z-score= Z-score of Confidence level at 95% (standard value of 1.96), Std Dev =Standard of Deviation or estimated prevalence of food insecurity (.2).

In this study area, even if some studies have conducted, there is no margin of error. If this is so,

Scott Smith has decided to use 5% margin of error which is the safe, forgiving number and ensures large enough sample in this case about.

$$\text{Necessary Sample} = \frac{(1.96)^2 \times 0.2 \times (1-0.2)}{(0.05)^2} = 246$$

Based on a report gotten from Federal Democratic Republic of

Ethiopia population census survey commission [13], there is a total of 181,202 population in Akaki kality sub city. Out of these population 700 are urban farmers (vegetable producers). Because of a complete list of the population exist in the sub city, with stratified random sampling technique 246 sample sizes were drawn from farm households by grouping the farming households in to two. Three hundred fifty five of these households are irrigators and the rest are none irrigators. Therefore, 123 samples from participant and non-participant with systematic random sampling were drawn out of 700 households. Sample interval was determined by dividing total population with sample size; i.e 355/123=3 for irrigators and 345/123=3 for non-irrigators. Then, the first respondent was determined by randomization table. That is number 2 from the list of 355 and 345 households between one and the sampling interval, every other respondent was selected every 3 interval up to the end (123) starting from number 2 to collect the necessary data from its source.

Data sources and data collection method

Stating data sources, variables and the way the data was collected from its source are certainly a crucial task. The basic variables in food security survey are undernourishment, household survey food consumption data, caloric intake, coping strategy index, dietary diversity and food consumption score which have stated herein above in the literature review part. No single indicator can able to fully capture food security. Due to poor quality data and unwillingly to analyze estimators of food security below the national level, high data collection and analysis cost, skill level required, undernourishment, household survey food consumption data and caloric intake indicators at an average was not selected in this study. In lieu this to clear these ambiguities, undernourishment, household survey food consumption data and caloric intake indicators in favor of coping strategy index (food stability), dietary diversity and food consumption score indicator jointly for data collection were omitted out.

In this study quantitative data type was collected from both primary and secondary data sources. With highly structural questionnaire and personal contact interview; primary data was collected as per the due date. According to WFP/ FANTA/FAO, household food security was measured with household food consumption expenditure score/ household dietary diversity score/ coping strategy index indicators The food consumption expenditure score was collected from the types of foods and the frequencies[8] with which they are consumed during a seven-day period. The score produced is a continuous variable and statistics are usually presented including the mean over time and across categories. Dietary diversity was collected by recording the number of food groups that a household consumes over a reference period. On the other hand coping strategy index was collected from household food consumption vulnerabilities.

The person within the household (hereinafter called household head) who has primary responsibility for and most knowledgeable about this activity was asked a series of questions.

Unlike to primary data, secondary data were collected in such a way that reviewing *cross-sectional data*[9] from Ethiopian MoFED-Ethiopian Statistical Agency and Addis Ababa urban agriculture office with desk review for data analysis.

[8]Food frequency is determined by recording the number of days on which a particular food group is consumed over a reference period, usually 7 days.

[9]In a pure cross section analysis we would ignore any minor timing differences in collecting the data. If a set of families was surveyed during different weeks of the same year, we would still view this as a cross-sectional data set.

Data analysis method

It is the stage of application of reasoning and to generate meaningful information from the collected data. Once the quantitative data is collected; clarifying, categorizing- breakdown by socioeconomic category and/or livelihood group, processing and coding how the collected data was analyzed is better. Having this in mind, the collected data were analyzed in such a way that employing inferential statistics (Heckman's two-step procedures). However; significance of estimators and interpretation was based on post estimation of marginal effect.

Evaluating the effect of irrigation scheme on an outcome variable using regression analysis such as logit and probit models can lead biased[10] estimate if the underlying process which governs selection into the institution or a program is not incorporated in the empirical frame work. One solution to this problem in econometrics is the application of Heckman's two-step procedures through controlling of sample selection biases. If this is so, the collected data was analyzed with an econometric tool -Heckman model and its two-step estimator.

Conclusion

In sum this causal type of research, stratified random sampling technique, 246 sample sizes, highly structured questionnaire-for quantitative primary data and desk review of performance reports-for secondary data and Heckman model and its two-step estimator was used to get accurate research result.

Results and Discussion

Introduction

In this study the current data on food security impact of small scale irrigation scheme was collected, analyzed and interpreted based on the data gathered from 246 farming household respondents. It is clreared that all objectives were addressed. Based on that it is important to state results and discussion in relation to past findings and theories done ever before. So some clear hints came from this analysis is that Akaki small scale irrigation scheme impact, correlates of food security and determinants of participation to small scale irrigation scheme were investigated on the basis of food consumption score, copying strategy index and dietary diversity score indicators of food security.

Model findings/results and discussion

The quantitative analysis of results of actual economic phenomena were provided based on the hypotheses mentioned.

Interpretation and discussion: Results were interpreted and discussed showing how they agree or disagree with earlier published works based on meanings of observations made. These observations and findings were compared with those of other researcher's result which have done ever before. Principles, relationships and generalizations that come out of the results were presented or discussed based on each respective specific objectives or hypotheses mentioned in the study.

Correlates of food security: Based on the marginal effect of the post estimation of food consumption expenditure score (annex1), copying strategy index (annex2) and dietary diversity score indicator of food security (annex3), irrigation participation (w), family size (fs), sex, land size (ls), educational level (ed), off farm income (offarmi), onfarm income (onfi), non farm income (nonfin), irrigation experience (exep) and distance from home to water source (dhomeland) were estimators of food security at 5% probability level. Therefore interpretation was based on the significance of estimators from marginal effect.

[10]No response.

At 0.05 probability level; sex, land size (ls), educational level (ed), off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are significant correlates of food security in the regression result. Based on that as the model result showed Prob > chi2 =0.0000 which is less than 0.05, then null hypothesis is rejected. Here sample mean and population mean are similar. Therefore the model is good fit, accepted, reasonably good approximation of reality and good estimator of the true population. The Log likelihood=264.617 is greater than 6.63, the probability of being food secured- happening by chance is less than 1%. So this model is 99% certain.

When sex estimator is considered; keeping other variables (land size, educational level, off farm income, irrigation experience and distance from home to water source) constant, the probability of being food secured (saying accepted) for male is higher by 26.29% than female household heads at 5% level of probability. This result confirms the result of Asayehegn [9]. As land size changes marginally; citrus paribus, then the probability of being food secured (saying accepted) is higher by 6.16%. This result confirms the result of Bogale and Shimelis [10] and Asayehegn [9]. The other significant estimator is school year of the house hold head. When school year changes by small amount marginally (1 year) keeping other correlates (land size, off farm income, irrigation experience and distance from home to water source) constant, then the probability of being food secured increased by 38.5%. Here households are well equipped and skill full in preparing fertility (decreasing soil aggregate/compaction problem and increasing soil infiltration rate) of their land and they have good preference and high food consumption pattern than non educated households. The other significant correlate of households food security is off farm income. As off farm income changes from its average (1.0 ETB birr), then the probability of being food secured (food consumption score) changes by 0.04%, citrus paribus. This implies that a unit increase in off farm income observed, then the probability of being food secured (saying accepted) increases by 0.04%, citrus paribus. This is because of both income and/or consumption multiplier effect of irrigation they earn from. Here 0.04 is the households' marginal propensity to consume food. Households have a potential to be employed to another farmers' farm to generate additional income. This result is consistent to the result of Asayehegn [9]. Experienced household heads have the probability of being food secured than non-experienced. Irrigators have huge experience or skill (from 1966EC) than non-irrigators. When irrigation experience changes marginally, then the probability of being food secured (saying accepted) increase by 2.63%, citrus paribus. Directionally this result is similar with the result of Bogale and Shimelis [10] and Asayehegn [9]. Distance from home to water source is the other correlate of food security. Households live near the water source are food secure than households that live far from the water source. This is because of households who live nearest to the water source incur less cost of production. As distance changes marginally, then the probability of being food security changes by 7.87%. As distance decreased by one km, then the probability of being food secured can be increased by 7.87. Irrigators are living near the water source (they are early settler) and endowed resource than non-irrigators. This result confirms the result of Asayehegn [9].

At 0.05 probability level; sex, educational level (ed), off farm income (offarmi) and irrigation experience (exep) are significant correlates of food security in the regression result. Based on that as the model results showed Prob > chi2=0.0000 which is less than 0.05, then null hypothesis is rejected. Therefore the model is good fit, accepted, reasonably good approximation of reality and good estimator of the true population.

Log likelihood=210.906 is greater than 6.63, the probability of being food secured- happening by chance is less than 1%. So this model is 99% certain.

As a key informant, Mulugeta noted in the study area as a result of over flooding risk and uncertainty at rainy season, farmers were forced to produce crops in their irrigable land once per year.

As a result of this production of vegetable crops decreased so does income and food consumption of households. In lieu this they used to rely on less preferred and less expensive foods, restrict consumption by adults in order for small children to eat, reduce number of meals eaten in a day as a copying strategy index.

When sex correlate of food security is considered; keeping other variables (ed, offi and ex) constant, the probability of being food secured changes by male changes by 25.3% marginally than female household heads. Although female household heads are large in number in the study area, the result shows male household heads have a probability of being food secured. This is because of male household heads have more power/energy to produce than female. The other significant of food security correlate is school year of the household head. Educated household heads have a probability being food secured by 38.3% than non-educated, citrus paribus. Literate households have a probability of being food secured by 38.3% than illiterate. As far as off farm income is considered, the probability of being food secured is 0.037%, as off farm income changes marginally by 1 ETB. This result confirms the result of Asayehegn [9]. Experienced households heads are more food secured than non-experienced. The probability of being food secured for experienced household heads is 2.47% than non-experienced. As irrigation experience changes by one year, then the probability of being food secured (saying accepted) changes by 2.4%.

At 0.05 probability level; sex, educational level (ed), off farm income (offarmi), distance from home to water source (dhomeland) and irrigation experience (exep) are significant correlates of food security in the regression result. Based on that as the model results showed Prob >chi2=0.0000 which is less than 0.05, then null hypothesis is rejected. Therefore the model is good fit, accepted, reasonably good approximation of reality and good estimator of the true population. Log likelihood=263.5313 is greater than 6.63, the probability of being food secured-happening by chance is less than 1%. So this model is 99% certain.

As far as sex estimator of food security/ household diary diversity considered; keeping other correlates (ed, offarmi, dhomeland and exep) constant, the probability of being food secured (saying accepted-eating diversity diet) is higher by 26.94% for male household heads than female at 5% of probability level. The other significant correlate of food security who eat diversify diet is educational level (ed) of the household. Educated household heads have a probability being food secured by 39% than non-educated, citrus paribus (sex, offarmi, dhomeland and exep). Literate households have a probability of being food secured by 39% than illiterate. As far as off farm income is considered; keeping other correlates (sex, ed, dhomeland and exep) constant, as off farm income changes marginally (1 ETB), then the probability of being food secured is higher by 0.037%. The other significant correlate of food security in household dietary diversity is distance from home to water source. Households live near the water source are food secure than households that live far from the water source. As distance changes marginally (from 1 km), then the probability of being food

secured changes by 8.17%, keeping other variables (sex, offi and ex) constant. As distance decreased by 1 km, then the probability of being food secured can be increased by 8.17. Irrigators are living near the water source (they are early settler) and have the potential to use the resource than non-irrigators. The other significant correlate of food security in household dietary diversity is irrigation experience of the household. Experienced household heads are more food secured. As irrigation experience changes marginally, then the probability of being food secured (saying accepted) changes by 2.56%, citrus paribus (sex, ed, offi and dhomeland).

Determinants of participation to small scale irrigation scheme: Based on the marginal effect of the post estimation of food consumption expenditure score (annex1); copying strategy index (annex 2) and dietary diversity score indicator of food security (annex 3); sex, off farm income (offarmi), onfarm income (onfarmi), non farm income (nonfarmin), irrigation experience (exep) and distance from home to water source (dhomeland) were estimators of determinants of access to small scale irrigation scheme at 5% probability level.

Food consumption expenditure score

Sex, off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are statistically significant determinants and they reliably predict participation in small scale irrigation scheme, citrus paribus.

As far as sex estimator of access to small scale irrigation scheme is considered; keeping other correlates (offarmi, exep and dhomeland) constant, the probability of being participate in small scale irrigation (saying yes) is higher by 26.29% for male than female household heads. The other significant determinant of irrigation participation is off farm income (offarmi). As off farm income changes marginally (1 ETB), then the probability of being participate in small scale irrigation is higher by 0.04%, keeping other determinants (sex, exep and dhomeland) constant. Distance from home to water source is the other significant determinant of small scale irrigation participation. As distance from home to water source changes magically (by 1 km); keeping other variables constant, then the probability of being participate in irrigation can be changed by 7.67%. As distance decreased by 1 km, then the probability of being participate in irrigation can be increased by 8.17. Irrigators are living near the water source (they are early settler and endowed of both land and water source) and have the potential to use the resource than non-irrigators. This result confirms the result of Asayehegn [9]. It is recall that more experienced household heads have a probability to participate in small scale irrigation. As irrigation experience changes marginally, then the probability of being participate (saying yes) changes by 2.63%, citrus paribus (sex, offi and dhomeland).

Copying strategy index indicator of food security

Sex, off farm income (offarmi) and irrigation experience (exep) are statistically significant determinants and they reliably predict participation in small scale irrigation scheme, citrus paribus.

As far as sex estimator of access to small scale irrigation scheme is considered; keeping other correlates (off farm income and irrigation) constant, the probability of being participate in small scale irrigation (saying yes) is higher by 25.34% for male than female household heads. The other determinant of irrigation participation is household off farm income. As off farm income increased marginally (1 ETB), then the probability of being participate increase by 0.03%. It is recall that more experienced household heads have a probability to participate in small scale irrigation. As irrigation experience changes marginally, then the probability of being participate (saying yes) changes by 2.4%, citrus paribus. It is recall that more experienced household heads have a probability to participate in small scale irrigation. As irrigation experience changes marginally, then the probability of being participate (saying yes) changes by 2.63%, citrus paribus (sex and offarmi).

Dietary diversity score indicator of food security

Sex, off farm income (offarmi), distance from home to water source (dhomeland irrigation experience (exep) are statistically significant determinants and they reliably predict participation in small scale irrigation scheme, citrus paribus.

As far as sex estimator of access to small scale irrigation scheme is considered; keeping other correlates (off farm income, distance from home to water source and irrigation experience) constant, the probability of being participate in small scale irrigation (saying yes) is higher by 26.94% for male household heads than female. The other determinant of irrigation participation is household off farm income. As off farm income increased marginally (1 ETB), then the probability of being participate increase by 0.03%. It is recall that more experienced household heads have a probability to participate in small scale irrigation. Distance from home to water source is the other significant determinant of small scale irrigation participation. As distance from home to water source changes magically (by 1 km); keeping other determinants (Sex, off farm income and irrigation experience) constant, then the probability of being participate in irrigation can be changed by 7.67%. As distance decreased by 1 km, then the probability of being participate in irrigation can be increased by 8.17%. Irrigators are living near the water source (they are early settler) and have the potential to use the resource than non-irrigators. It is recall that more experienced household heads have a probability to participate in small scale irrigation. As irrigation experience changes marginally (by 1 year), then the probability of being participate (saying yes) changes by 2.56%, citrus paribus (sex and offarmi).

Food security impact of small scale irrigation scheme

As can be seen from the Tables 1-3 above the *lambda* **(λ)** values in the three food security indicators (FCS= 0.0003614, CSI= 0.0002574 and HHDDS= 0.0003356) result were statistically insignificant and do not reliable predict the probability of farming households' food security status and indicates the absence of selectivity bias in the sample. Food security was not as such observed among the three indicators in the study area. This is to mean that small scale irrigation scheme did not give a role on farm household food security. No matter how these farming households produce more; since they score insufficient food consumption expenditure, ate less diversify food groups and used copying strategy index (rely on less preferred and less expensive foods, restrict consumption by adults in order for small children to eat, reduce number of meals eaten in a day), they are food insecure. Therefore null hypothesis is accepted. This confirms the result of Arega [14] and contrary with the results of Asayehegn [9] and Bogale and Shimelis [10]. This is because of a onetime agricultural crop harvesting season, low and fixed price of their product, and diseconomies of scale, low market share and low sales volume problem they faced on. Farmers produce one time per year, because of over flooding risk fear. Flood in the rainy season is always out break on the field that damages their crop (disease, flood/canals damage) [15-18].

Conclusion

In general correlates of food security, determinants of access to small scale irrigation scheme and Akaki small scale irrigation scheme

Variables		Heckamn analysis			Marginal effect
	Coef.	Std.err.	z	p>|z|	
w	0.016305	0.0114137	0.14	0.886	
fs	-0.0033991	0.0059858	-0.57	0.570	
sex	0.2629012	0.38449	6.84	0.000	
ls	0.061627	0.0306147	2.02	0.044	
ed	0.385457	0.0463756	8.30	0.000	
offarmi	0.0003656	0.0000816	4.48	0.000	
dhomeland	0.078725	0.0385255	-2.04	0.041	
onfarmi	0.00000778	0.00000609	1.28	0.201	
exp	0.0263073	0.0059483	4.42	0.000	
nonfarmi	0.0000135	0.00000901	1.50	0.134	
cons	-0.0058235	0.0475748	-0.12	0.903	
Dependant variable	**food security**				
sex	1.61-e06	2642.941	0.00	1.000	0.2629012*
offarmi	0.0000000067	6.778054	0.00	1.000	0.0003656*
dhomeland	0.00000394	3330.475	0.00	1.000	-0.078725*
onfarmi	0.000000000416	0.5325474	0.00	1.000	0.00000778
exp	0.00000023	472.33	0.00	1.000	0.0263073*
generator used	0.00000166	1988.425	0.00	1.000	N/A
Nonfarmi	0.000000000712	0.840.7871	0.00	1.000	0.0000135
Lambda	-0.0003614	88.52443	N/A	N/A	N/A
Cons	6.109908	1657.128	0.00	0.997	N/A
Dependant variable	**Household Irrigation participation**				
Number of observations	246				
Log likelihood	264.6417				
Wald chi2(10)	7968.24				
Prob>chi2	0.0000				

*indicates significant at 0.05 probability level.

Table 2: Food consumption expenditure score estimates of Heckman two stage model.

role was investigated on the basis of food consumption score, copying strategy index and dietary diversity score indicators of food security [19].

Summary, Conclusion and Recommendations

The overall study evaluated impact of Akaki small scale irrigation scheme on household food security of smallholder farmers. Indicating summary, conclusions and recommendations reached for each specific objectives/research hypothesis mentioned clearly is a crucial task. Summary, conclusions and recommendations are a brief and main substance of this chapter [20].

Summary

Correlates of food security, determinants of access to small scale irrigation scheme and food security role of small scale irrigation scheme are the most appealing part of the study.

Based on the marginal effect of the post estimation, at 0.05 probability level; sex, land size (ls), educational level (ed), off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are significant correlates of food security in the regression result of joint indicators, citrus paribus [21-23]. At 0.05 probability level; sex, off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are statistically significant determinants of the joint indicators and they reliably predict participation in small scale irrigation scheme, citrus paribus. In sum food security is not observed in the study area. Households are still food insecure [24].

Variables	Heckman analysis				Marginal effect
	Coef.	Std.err.	z	p>|z|	
w	0.0117973	0.0142	0.83	0.406	
fs	-0.006117	0.007447	-0.82	0.411	
sex	0.2534232	0.047802	5.3	0	
ls	0.051071	0.038089	1.34	0.18	
ed	0.3836407	0.057697	6.65	0	
offarmi	0.0003737	0.000102	3.68	0	
dhomeland	-0.089084	0.047931	-1.86	0.063	
onfarmi	0.0000125	0.00000758	1.66	0.098	
exp	0.0247082	0.0074	3.34	0.001	
nonfarmi	0.0000107	0.0000112	0.95	0.341	
cons	0.0004044	0.059189	0.01	0.995	
dependant variable	**Food security**				
sex	0.000000602	2642.263	0	1	0.2534232*
offarmi	0.0000000025	6.508741	0	1	0.0003737*
dhomeland	0.00000147	3329.566	0	1	0.08908
onfarmi	0.000000000155	0.52771	0	1	0.000013
exp	0.0000000857	454.7253	0	1	0.0247082*
generator used	0.000000614	1015.318	0	1	N/A
nonfarmi	0.000000000266	0.76993	0	1	0.000011
lambda	0.0002574	153.1081	0	1	N/A
cons	6.109907	1693.629	0	0.997	N/A
dependant variable	**Household Irrigation participation**				
number of observations	246				
log likelihood	210.906				
wald chi2(10)	5088.98				
prob>chi2	0				

*indicates significant at 0.05 probability level.

Table 3: Copying strategy index indicator of food security estimates of Heckman two stage model.

Conclusion

Based on major debate/theory generalizations from findings as per each specific objectives, answers to hypotheses were provided in a broader and more encompassing/comprehensively way (Table 4).

Correlates of food security: At 0.05 probability level; sex, land size (ls), educational level (ed), off farm income (of farmi), irrigation experience (exep) and distance from home to water source (dhomeland) are significant correlates of food security in the regression result of joint indicators, citrus paribus [25].

- Male household heads have a probability to be food secured than female heads;
- All except distance from home to water source (dhomeland); land size, school year and experience have a positive impact on food security.

Variables	Heckman analysis				Marginal effect
	Coef.	Std.err.	z	p>|z|	
W	0.00402	0.01152	0.35	0.727	
Fs	-0.0012	0.00581	-0.21	0.835	
Sex	0.26943	0.03833	7.03	0	
Ls	0.05312	0.03007	1.77	0.077	
Ed	0.39158	0.0464	8.44	0	
offarmi	0.00037	0.000082	4.48	0	
dhomeland	-0.0817	0.0387	-2.11	0.035	
onfarmi	0.00000795	0.00000614	1.29	0.195	
Exp	0.02566	0.00596	4.31	0	
nonfarmi	0.000015	0.00000886	1.7	0.089	
Cons	-0.0212	0.00466	-0.45	0.649	
Dependant variable	**Households food security**				
Sex	0.00000149	2630.32	0	1	0.2694272*
offarmi	0.00000000628	6.49147	0	1	0.000366*
dhomeland	0.00000364	3331.41	0	1	-0.0817047*
onfarmi	0.000000000385	0.52921	0	1	0.00000795
Exp	0.000000212	451.988	0	1	0.000015
generator used	0.0000151	1016.02	0	1	N/A
nonfarmi	0.000000000656	0.75773	0	1	0.02566
lambda	-0.0003	94.2065	0	1	N/A
Cons	6.10991	1689.13	0	0.997	N/A
Dependant variable	**Household Irrigation participation**				
Number of observations	246				
Log likelihood	263.5313				
Wald chi2(10)	5020.43				
Prob>chi2	0				

*indicates significant at 0.05 probability level.

Table 4: House hold dietary diversity score indicator of food security estimates of Heckman two stage model.

Determinants of participation to small scale irrigation scheme: At 0.05 probability level; sex, off farm income (offarmi), irrigation experience (exep) and distance from home to water source (dhomeland) are statistically significant determinants of the joint indicators and they reliably predict participation in small scale irrigation scheme, citrus paribus. Females had not access to irrigation as compared to male head.

Food security impact of small scale irrigation scheme: In general food security impact of Akaki small scale irrigation scheme study was investigated. Food security was not as such observed in the study area.

Recommendations

It is difficult to give remedies for the problems and answers for the questions if problems cannot be known. But, the problems are on hand in this study. Generally these recommendations are logically linked to both the research hypothesis and conclusions. Actionable and further study recommendations are the two distinct types of recommendations in this study [26].

Recommendations for action or practice/policy implication: Based on the study findings and conclusions made, actionable recommendations on correlates of food security, determinants and food security impact of small scale irrigation scheme are suggested. As researcher what I need to give some suggestions here is that the woreda administration and farming households should work hand in hand to curve problems faced on.

Government should open schools (farmers field school) to increase production or skill around the study area. Magnitude of gender (sex) estimate on food security is absolutely high. Therefore head of farming households should be male for irrigation activities. Not only that even the concerning bodies particularly Institute of Sustainable Development (ISD) and others let the farming households to share experience from outsiders. Collective action among governments, NGOs and farming households on flood control and market linkage (perfect information on price of their product) should be taken to let farming households harvest two times per year and prosper.

Recommendations for further study: This investigation fails to consider impact of small scale irrigation scheme on households nutrition security in the study area and it focus only food security at household level. So if someone investigates this issue by emphasizing both food and nutrition security the finding may be relatively fruit full.

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