The Impact of Small Scale Irrigation on Household Food Security: The Case of Filtino and Godino Irrigation Schemes in Ada Liben District,

East Shoa, Ethiopia

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Abstract

Irrigated production is far from satisfactory in the country. The country's irrigation potential is estimated at 3.7 million hectare, of which only about 190,000 hectare (4.3 percent of the potential) is actually irrigated. The aim of this paper is to identify the impact of small-scale irrigation on household food security based on data obtained from 200 farmers in Ada Liben district of Ethiopia. Different studies revealed that access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. In the study area also about 70 percent of the irrigation users are food secure while only 20 percent of the non-users are found to be food secure. Access to irrigation enabled the sample households to grow crops more than once a year; to insure increased and stable production, income and consumption; and improve their food security status. The study concludes that small-scale irrigation is one of the viable solutions to secure household food needs in the study area but it did not eliminate the food insecurity problem.

1. Introduction

1.1 Background

Ethiopia is faced with complex poverty, which is broad, deep and structural (MoFED, 2002). Despite the importance of agriculture in its economy, the country has been a food deficit country for several decades, with cereal food aid averaging 14 percent of total cereal production

(FAO, 2001). Irrigation is one means by which agricultural production can be increased to meet the growing food demand in Ethiopia (Awulachew *et al*., 2005). However, in Ethiopia irrigated production is far from satisfactory (Woldeab, 2003). While the country's irrigation potential is about 3.7 million hectares (WSDP, 2002), the total irrigated area is 190,000 ha in 2004, that is only 4.3 percent of the potential (FAO, 2005).

It was claimed that Ethiopia can not assure food security for its population with rain fed agriculture alone without a substantive contribution of irrigation. Thus, the government of Ethiopia has prepared a water sector development program to be implemented in 15 years between 2002 and 2016. this program assigned a prominent role to the development of irrigation in the country for food production (mowr, 2001). this paper reports the results of a study conducted to assess the efficacy of irrigation led food insecurity eradication and poverty reduction policy objectives of ethiopia based on data collected from godino and filtino small scale irrigation schemes found in ada liben district of the oromia regional state of ethiopia.

1.2 Irrigation and Household Food Security: some empirical evidences

Chamber (1994) based on some empirical studies confirms that reliable and adequate irrigation increases employment, i.e., Landless laborers as well as small and marginal farmers have more work on more days
of the year, which ultimately contributes to food security. A study conducted in 10 Indian villages in different agro-climatic regions shows that increasing irrigation by 40 percent was equally effective in reducing poverty (reducing food insecurity) as providing a pair of bullocks, increasing educational level and increasing wage rates (Singh *et al*., 1996). Kumar (2003) also stated that irrigation has significantly contributed to boosting India's food production and creating grain surpluses used as drought buffer. A study by Hussain *et al*. (2004) confirms that access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This in turn opens up new employment opportunities; both on farm and off-farm, and can improve incomes, livelihood, and the quality of life in rural areas. The same study identified five key dimensions of how access to good irrigation water contributes to socioeconomic uplift of rural communities. These are production, income and consumption, employment, food security, and other social impacts contributing to overall improved welfare.

According to a study carried out on five irrigation schemes in Zimbabwe, the schemes were found to act as sources of food security for the participants and the surrounding community through increased productivity, stable production and incomes (Mudima, 1998). The same study reported that farmers participating in irrigation schemes never run out of food unlike their counterparts that depend on rain-fed agriculture.

Ngigi (2002) disclosed that in Kenya for the two decades agricultural production has not been able to keep pace with the increasing population. To address this challenge the biggest potential for increasing agricultural production lies in the development of irrigation. According to the same study, irrigation can assist in agricultural diversification, enhance food self sufficiency, increase rural incomes, generate foreign exchange and provide employment opportunity when and where water is a constraint. Nigigi concluded that the major contributions of irrigation to the national economy are food security, employment creation, and improved foreign exchange earning.

A study by IFAD (2005) states that in Ethiopia, the construction of small-scale irrigation schemes has resulted in increased production, income and diet diversification in the Oromia and Southern Nation and Nationalities People (SNNP) regions. According to this study, the cash generated from selling vegetables and other produce is commonly used to buy food to cover the household food demand during the food deficit months. The same study further added that during an interview conducted with some farmers, it was disclosed that the hungry months reduced from 6 to 2 months (July and August) because of the use of small scale irrigation. Moreover, the increase in diversity of crops across the schemes and the shift from cereal-livestock system to cereal-vegetable-livestock system is starting to improve the diversity of household nutrition through making vegetables part of the daily diet. A study conducted by Woldeab (2003) also identified that in Tigray region irrigated agriculture has benefited some households by providing an opportunity to increase agricultural production through double cropping and by taking advantage of modern technologies and high yielding crops that called for intensive farming.

However, these studies were descriptive than analytical in that they did not formally account for/ isolate the possible contribution of other confounding variables such has household/village characteristics, and other policies and interventions that might have as well contributed to the food security status differences between irrigators and non-irrigators. Moreover, the empirical works in this area are very scant in Ethiopia in particular and in Africa in general. Thus, the study aims to contribute to the small scale irrigation-food security literature and to provide policy conclusions and implications for future planning of irrigation systems.

2. Research methodology

2.1. Study area, sample size and sampling techniques

godino and filtino small scale irrigation schemes are found in ada liben district and were constructed by oromiya irrigation development authority (oida) in 1996 and 1998, respectively (oida, 2000). the water source for godino irrigation scheme is wedecha dam, which has the capacity to irrigate about 310 ha. while the water source for filtino irrigation scheme is belbela dam, which has a capacity of irrigating 100 ha. the irrigable land in the respective command areas is distributed to farmers by the government. except few farmers who lease-in additional irrigable land almost all farmers in the area own quarter of a hectare. the major types of crops grown by irrigation are onion, tomato, potato and chick pea among others.

Out of the 45 Peasant Associations (PA) that are found in the Ada Liben district, two PAs namely *Godino* and *Quftu* were purposely selected mainly because of availability of irrigation schemes. To select sample respondents from the two PAs, first the household heads in the two PAs were identified and stratified in to two strata: irrigation users and non-users. Then the sample respondents from each stratum were selected randomly using simple random sampling technique. Since the number of household heads in the two groups was proportional, equal number of sample is drawn from each group, i.e., 100 household heads were selected from each group. In total 200 household heads were interviewed.

2.2. Data collection

The data required for this study was collected from sample respondents using a semi-structured questionnaire. The enumerators for the data collection were selected on the basis of their educational background and their ability of the local language. One week training was given to the enumerators about method of data collection and the contents of the questionnaire. Data collection proper was started after pretest was conducted and modifications were made based on the feedback from the pretest. Secondary information that could supplement the primary data was collected from published and unpublished documents obtained from different governmental and non-governmental organizations.

2.3. Method of data analysis

The study employed both descriptive and econometric techniques. The descriptive analysis was performed using frequencies, means, and maximum and minimum values. The econometric analysis employed the Heckman two-step procedure to identify the impact of small scale irrigation on household food security from among possible other household food security influencing factors.

Heckman two-step procedure: Evaluating the impact of a project/program on an outcome variable using regression analysis can lead to biased estimate if the underlying process which governs selection into a project/ program is not incorporated in the empirical framework. The reason for this is that, the effect of the program may be over (under) estimated if program participants are more (less) able due to certain unobservable characteristics, to derive these benefits compared to eligible non-participants (Zaman, 2001).
To evaluate the impact of a program, a model commonly employed can be expressed as:

$$Y = X\beta + \alpha I + u \qquad (1)$$

Where Y is the outcome/impact, X is a vector of personal exogenous characteristics and I is a dummy variable (I=1, if the individual participates in the program and 0 otherwise). From this model, the effect of the program is measured by the estimate of α. However, the dummy variable 'I' can not be treated as exogenous if the likelihood of an individual to participate or not to participate in the program is based on an unobserved selection process (Maddala, 1983). Some studies have shown the limitations of applying the classical linear regression methodology to the analysis of samples with selectivity bias (Heckman, 1979, Dardis *et al*. 1994, Sigelman and Zeng, 1999, Maddala, 1992). Application of the classical linear regression model does not guarantee consistent and unbiased estimates of the parameter. One solution to this problem in econometrics is the application of Heckman two-step procedures. It is considered as an appropriate tool to test and control for sample selection biases (Wooldrige, 2002).

The Heckman two step procedures involves two equations. The first equation (i.e., the selection or participation equation) attempts to capture the factors governing membership in a program. This equation is used to construct a selectivity term known as the 'Mills ratio' which is included as independent variable to the second equation known as response or outcome equation. If the coefficient of the 'selectivity' term is significant then the hypothesis that the participation equation is governed by an unobserved selection process or selectivity bias is confirmed. Moreover, with the inclusion of extra term, the coefficient in the second stage 'selectivity corrected' equation is unbiased (Zaman, 2001). Therefore, to evaluate the impact of small scale irrigation on household food security, we use the Heckman two-step procedure.

Specification of the Heckman two-step procedure:

Let Z_{ik} be a group of K variables which represent the characteristics of a household i which influences the probability of participation in irrigation agriculture measured by a latent variable D_i^* and γ_k are the coefficients which reflect the effect of these variables on the probability of being an irrigation farmer, and X_{is} is a group of variables which represent the characteristics of household i which determine household's food security (C_i) and β_s are the coefficients which reflect the effect of these variables on household food security. Thus, the Heckman two-step procedure takes the following form:

$$D_i^* = \sum_{K=1}^{K} \gamma_k Z_{ik} + u_i \qquad (2)$$

$$C_i = \sum_{S=1}^{S} \beta_s X_{is} + \varepsilon_i \text{ Observed only if } D_i^* > 0... \qquad (3)$$

Where the disturbances u_i and ε_i follow a bivariate normal distribution with a zero mean, variance σ_u and σ_ε respectively, and covariance $\sigma_{\varepsilon u}$. Therefore, we define a dichotomous variable D_i which takes a value 1 when a household is an irrigator and 0 otherwise. The estimator is based on the conditional expectation of the observed variable, household food security (C_i):

$$E\left(C_i / D_i^* > 0\right) = x\beta + \sigma_{\varepsilon u}\sigma_\varepsilon \lambda(-\gamma z) \qquad (4)$$

Where λ is the inverse Mills ratio defined as $\lambda(-\gamma Z) = \phi(-\gamma Z)/(1-\varphi(-\gamma Z))$; β and γ are the vectors of parameters which measure the effect of variables X and Z, ϕ and φ are the functions of density and distribution of a normal, respectively. The expression of conditional expectation shows that C_i equals $x\beta$ only when the errors ε_i and u_i are non correlated, i.e., $\sigma_{\varepsilon u} = 0$; otherwise, the expectation of C_i is affected by the variable of equation 2. Thus, from expression 4 we find that:

$$C_i / D_i > 0 = E\left(C_i / D_i^* > 0\right) + V_i = x\beta + \sigma_{\varepsilon u}\sigma_\varepsilon \lambda(-\gamma Z) + V_i \qquad (5)$$

Where V_i is the distributed error term, $N\left(0, \sigma_\varepsilon\left(1 - \sigma_{\varepsilon u}\left(\lambda(\lambda - \gamma Z)\right)\right)\right)$

3. Results and discussion

3.1. Descriptive Results

The variables included in the model are defined in table 1. The dependent variable for the first stage of the Heckman two-step procedure is participation in irrigation. This variable is a dummy variable (given a value of 1 if the household participates in the irrigation scheme and 0 otherwise) for the second stage of the model household food security status is a continuous variable measured by the annual food expenditure in Birr of the household per adult equivalent. Before discussing the econometric results, however, we present some interesting descriptive results.

One of the pervasive features of food insecurity in Ethiopia is that it is usually seasonal. It mainly coincides with the active agricultural season or wet season. To this effect we have tried to see if there is discernable difference in the timing of food inadequacy between irrigators and non-irrigators. Surprisingly, there is no difference regarding the timing of food shortages between irrigators and non-irrigators (See Figure 1). The food shortage months start as early as June (which is the beginning rainy season and therefore agricultural activities in the study areas) and extends up to November (which is the beginning of harvest season). No household from the irrigators group has reported food shortage in June. September is the most serious food shortage month among non-irrigators, while October is the peak food shortage month for irrigators. About half of the non-irrigators reported food shortage in the month of September. However, there is a stark difference regarding the incidence rate of reported food shortage between the two groups. The proportion of farmers reporting food shortage in every month is significantly lower for irrigators group. It is interesting to note that irrigation has not eradicated the food insecurity problem even in this seemingly better off part of the country indicating the depth of the problem.

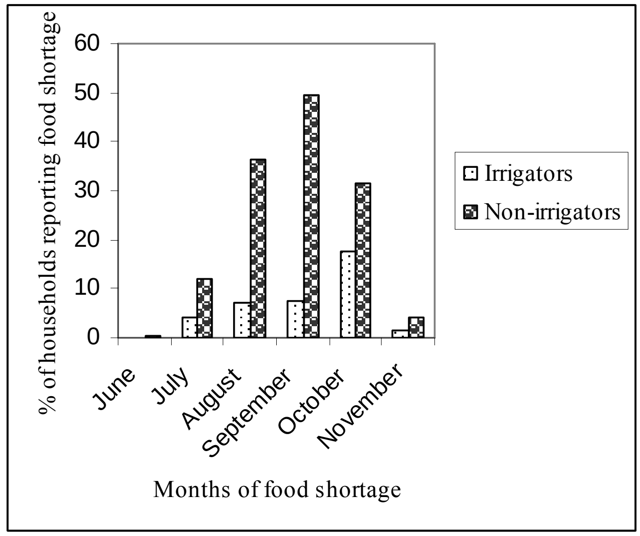

Figure 1. Incidence of reported food shortage by months

The irrigators and non-irrigators have slightly different copping mechanisms in the advent of food deficit problem (See figure 2). None of the irrigators have reported off-farm employment as a coping strategy and also relatively fewer irrigators reported to have used credit as a means of copping with food shortage. It must be noted that using wage employment and consumption credit as a strategy to avert food insecurity is considered as a distress measure or strategy in Ethiopia. Small animals (such as sheep, goats and chicken) is the most important copping strategy among both irrigators and non-irrigators.

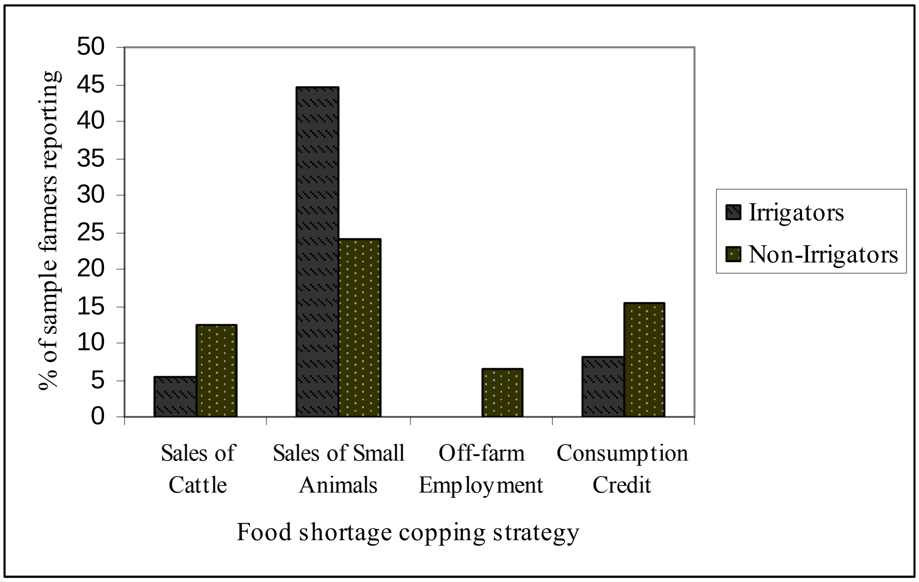

Figure 2. Food shortage coping mechanisms

Based on how households adapt to the presence or threat of food shortages, the overall Coping Strategy Index (CSI) has been calculated for each of the sample households and the resulting values were averaged for irrigators and non-irrigators. It was found that the average CSI for irrigator households is 11.4, while for non-irrigators the corresponding value is 31.4. The mean difference is statistically significant (Table 2). The higher the CSI, the more food-insecure is a household (reference). Therefore, based on CSI the non-irrigator households are more food insecure as compared to irrigator households.

The calculated food consumption expenditure per adult equivalent values also confirms the food security status difference between irrigators and non-irrigators (table 2). The average food consumption expenditure per adult equivalent per annum for irrigation user households is 1322.4 Birr, while the corresponding figure for non-users is 774.4 Birr. The mean difference is statistically significant. Moreover, the total consumption expenditure (both food and non-food) for irrigators is almost double that of non-irrigators.

The minimum food consumption expenditure per adult equivalent above which a household is considered to be food secure (alternatively below which a household is considered as food insecure) was calculated based on the estimated cost of acquiring the recommended daily calorie allowance, which was taken as 2200 kcal per adult equivalent per day[15]. This cut-off value is estimated to be Birr 900.0 per adult equivalent per annum. Thus, households having food consumption expenditure per adult equivalent of less than Birr 900 are considered as food insecure, while those earning more than Birr 900 are considered to be food secure. Based on this indicator, again there is substantial difference in food insecurity incidence rate between irrigator and non-irrigators households (see figure 3). Generally out of the 200 sample households 45 percent of them are food secure and 55 percent of them are food insecure.

15 This cut-off value was calculated following Greer and Thorbecke (1986) food energy intake method of measuring household food security

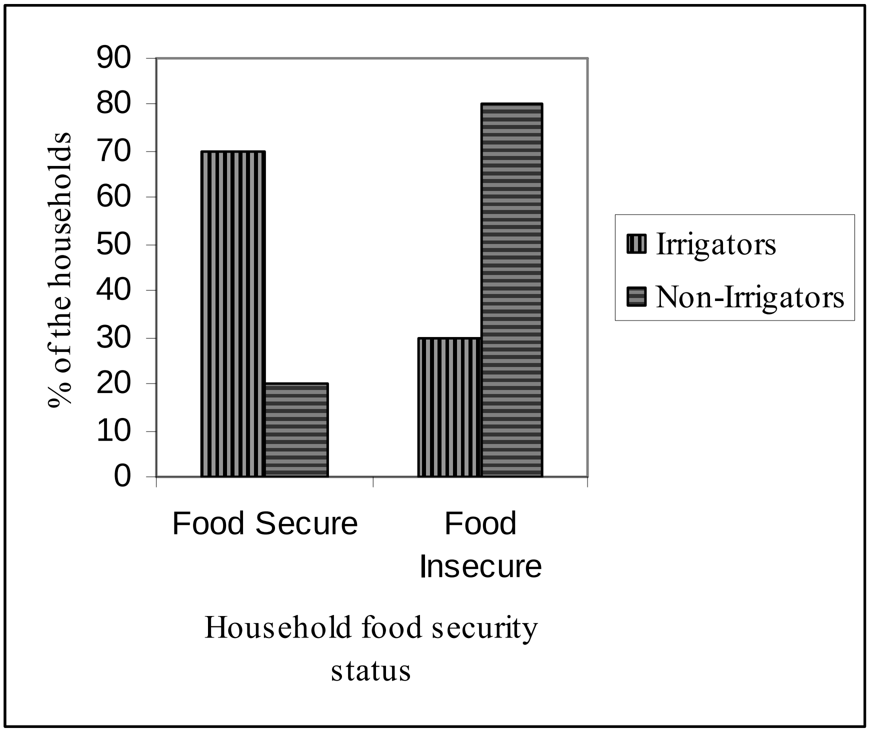

Figure 3. Household food security status differentiated by access to irrigation

When comparing other indicators of welfare between irrigation and non-irrigators, statistically significant differences were detected (Table 3). For example, irrigators have small household size, higher level of education, large livestock holding size, and better quality (fertility) cultivable land. The irrigators had also better access to extension and credit services (Table 4). In conclusion, the descriptive analyses indicate that irrigators are better off in terms of food security status and other welfare indicators. But is this due solely to access to irrigation? Other observable and unobservable variables might have contributed to the observed food security status difference between irrigators and non-irrigators. Therefore, we know turn to the presentation of Heckman's two stage regression model to show the impact of access to irrigation on food security while controlling for the effects of other observable and unobservable confounding factors.

3.2. Econometric Analysis Results

Determinants of likelihood of access to irrigation: The first stage of the Heckman model predicts the probability of access to the irrigation scheme of a household. Among the observable hypothesized variables, those that significantly influenced the probability of participating in irrigation farming include nearness to the water source, household siz size of cultivated land, livestock holding, the quality of land owned by a farmer and access to credit (Table 5). The relationship between household size and participation in irrigation project is non-linear. As the size of a household increases by one adult equivalent, the probability of access to irrigation decreases by 30.4% but only up certain point beyond which a unit increase in household size starts increasing the likelihood of participation in irrigation. As the size of cultivated area increases the probability of being an irrigator decreases. This may imply that irrigators tend intensify their cultivated land, while rain-fed farmers try to put more land under cultivation.

Irrigators have significantly more livestock than their rain-fed only farmers. They also possess more fertile land.

Determinants of household food security: The significance of the lambda term in the second stage of the Heckman procedure, confirms the presence of selectivity bias (Table 6). As expected, access to irrigation had significant impact on household food security. In the study area irrigation enable households to grow crops more than once a year, to insure increased and stable production, income and consumption thereby improving food security status of the household. This result is consistent with the finding of Abebaw (2003). The other variables that significantly enhance household food security are experience (as indicate by farmers age in years), access to extension service, and size of cultivated land. .
The relationship between household size and food security is non-linear (see the coefficients for household size and its square variable). The negative and significant coefficient of household size reveals that larger household size leads to food insecurity, but only up to a certain point. The coefficient of the variable indicates that as the household size increases by one adult equivalent the food consumption expenditure of the household decreases by 391.9 Birr. This result is consistent with the finding of Mulugeta (2002) and Yilma (2005). Contrary to other similar studies (Belayneh, 2005), in this study female headed households had better food security status than the male headed households. The coefficient of the variable shows that when the head of the household is male, food consumption expenditure of the household decreases by 331.1 Birr. The possible justification for this inverse relationship could be that though male headed households are in a better position to pool resource to increase production, they might spent more money on nonfood expenses rather than spending on food items to meet the household's food needs.

The regression result also shows that as the cultivated land size increases, a household is able to increase and diversify the quantity and type of crop produced, which may in turn lead to increased consumption and household food security. The coefficient of the land size variable shows that as the household gets one more hectare of land food consumption expenditure of the household increases by 85 Birr. This result is consistent with the findings of Mulugeta (2002), Ayalew (2003), Abebaw (2003) and Yilma (2005).

Access to extension service and nearness to the water source are also found to have a positive relationship with household food security. The positive effect of access to extension service may indicate that in the study area, those households who get technical advice and training or those who participated in field demonstrations are well aware of the advantage of agricultural technologies and adopt new technologies and produce more, thereby improving the household food security status. The nearness to the water source may be a surrogate variable for access to irrigation. It has already been shown that to the irrigation scheme, significantly improves household's food security status. The possible other justification could be that the nearness to water source may proxy the location of the farms in relation to the irrigation water source . Therefore, households who are closer to the irrigation scheme do not incur much cost to access their farm so they can follow up the farm activity closely and frequently and may get a better yield.

4. Conclusion and Implications

The variables that significantly predict access to irrigation are: household size, size of cultivated land, livestock holding, farmers' perception of soil fertility status, access to credit, nearness to the water source and household size square. The variables that reduce the probability of access to irrigation are large household size, large cultivated area and access to credit. Rain-fed farmers tend to have large cultivated area. The negative relationship between access to credit and access to irrigation may be explained by the fact that: (1) in Ethiopia, the institutional credits usually give priority to rain-fed agriculture, and (2) the demand for credit among farmers with access to irrigation may be lower for they can satisfy cash needs through sales from their irrigated crops.

The variables that increase the probability of participation of farmers in irrigation farming include large livestock holding size, ownership of relatively fertile land and nearness to water source. Obviously, those households that are situated near the water source are more likely to participate in irrigation scheme. However, it does not mean that placement of an irrigation scheme in the village is solely governed by hydrological considerations. It involves political process and power relations.

In the study area the use of small-scale irrigation contributes significantly to improve household food security. In addition to access to irrigation, access to irrigation, household size, sex of the household head, size of cultivated land, and access to extension service significantly influence the food security status of a farm household.

The relationship between a household food security status and household size is non-linear (see the signs for the variables household size and the square of household size). As the size of a household increases the per capita food expenditure decreases, but up to a point, after which the per capita food expenditure starts to increase as the household size increases. Contrary to expectation, female headed households are less likely to be food insecure as compared to male headed households. This needs further investigation, however, tentatively it may be explained by differences in the expenditure behavior of male and female farmers-female members of a farm household tend to spend more on food items to guarantee the food needs of the family before anything else. Another possible explanation may be that the male members of a female-headed household may have gainful employment elsewhere thus contributing to household food security.

Size of cultivated land and household food security are positively related indicating larger farm size improves household food security. Households with large farm size are found to be food secure; however, there may not be a possibility of expanding cultivated land size any more because of increasing family size and degradation of the existing farm land. Therefore, household must be trained as to how to increase production per unit area (productivity).

Access to extension service is also positively related to household food security. Extension workers could play a key role in transferring knowledge to the rural people easily there by improving production and consumption. Capacity building of the existing ones and training more extension workers might help address the issue.

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Table 1. Definition of model variables

Variable code	Variable type	Variable definition	Mean	Std.	Expected sign
ACCIRRG	Dummy	Access to irrigation of the household			Positive
HEADAGE	Continuous	Age of household head in years	48.0	13.5	Positive
HEADAGE2	Continuous	Age of the household head square			Positive
HHSIZEAE	Continuous	Household size in adult equivalent	4.7	1.7	Negative
HHSIZEAE2	Continuous	Household size in adult equivalent square			Positive
EDUCATA	Category	Education of the household head /illiterate, read and write, grade 1-4, grade 5-8 and grade >8/			Positive
SEXHEAD	Dummy	Sex of the household head (1=male, 0=female)			Positive
CUTLAND	Continuous	Cultivated land size in hectare	1.5	1.2	Positive
LIVESTOC	Continuous	Total livestock holding in TLU	6.7	4.2	Positive
DISMARKE	Continuous	Distance from the market place in km	6.7	2.1	Negative
SOILFERT	Dummy	Farmers' perception of soil fertility status (1= fertile, 0= infertile)			Positive
SUPPEX	Dummy	Access to extension service (1= access, 0=no access)			Positive
CREDIT	Dummy	Access to credit (1=access, 0=no access)			Positive
NEARNESS	Continuous	Nearness of households to water source in km	13.0	9.7	Positive

Table 2. Comparison of consumption expenditure per adult equivalent between irrigators and non-irrigators

	User		Nonuser		MD	t - value
	Mean	Std	Mean	Std		
Food consumption expenditure	1322.3	563.4	774.4	369.7	547.8	8.0***
Total expenditure	1,780.3	946.4	955.6	434.5	824.7	7.9***
Coping strategy index	11.4	13.9	31.4	16.1	19.93	9.1***

Source: survey result (2006)

*** indicates significance level at 1 percent.

Table 3. Summary of descriptive statistics of sample households by access to irrigation /continuous variables/

	User		Nonuser		MD	t - value
	Mean	Std	Mean	Std		
HEADAGE	46.8	14.4	49.5	12.5	2.7	1.4
HHSIZEAE	4.3	1.7	5.1	1.8	0.7	3.0***
DEPRATIO	0.4	0.1	0.5	0.1	0.0	3.1***
CUTLAND	1.5	1.5	1.4	0.7	0.1	0.9
LIVESTOC	7.3	3.4	5.0	2.6	2.2	3.6***
TOTPRODUC	13,689.1	21,706.8	2,255.4	3,487.0	11,433.7	5.2***
TOTEXPEN	1,780.3	946.4	955.6	434.5	824.7	7.9***
DISMARKE	7.3	2.2	6.1	1.9	1.2	4.0***

Source: Survey result (2006)
*** indicates significance level at 1 percent.

Table 4. Summary of descriptive statistics of sample households by access to irrigation /discrete variables/

Variable	User	Nonuser	Total	$\chi2$
EDUCATAGORY				0.007***
Illiterate	69	58	127	
Read and write	1	13	14	
Grade 1-4	3	7	10	
Grade 5-8	15	15	30	
Grade >8	12	7	19	
SEXHEAD				0.6
Female	7	9	16	
Male	93	91	184	
SUPPEX				0.002***
Access to extension	67	45	112	
No access to extension	33	55	88	
CREDIT				0.01***
Access to credit	31	48	79	
No access to credit	69	52	121	
SOILFERT				0.001***
Fertile	93	67	160	
Infertile	7	33	40	

Source: Survey result (2006)
*** indicates significance level at 1 percent.

Table 5. Estimation result of the Binary Probit model and its Marginal Effect

Variable	Coefficient	Marginal effect
CONSTANT	2.634 (0.203)	1.050 (0.203)
AGEHEAD	-0.861 (0.248)	-0.343 (0.248)
HHSIZEAE	-0.764 (0.021) **	-0.304 (0.021)
SEXHEAD	0.414 (0.438)	0.165 (0.438)
EDUCATAGORY	-0.293 (0.764)	-0.117 (0.764)
DISMARKE	-0.324 (0.673)	-0.129 (0.673)
CUTLAND	-0.604 (0.004) ***	-0.241 (0.004)
LIVESTOC	0.362 (0.000) ***	0.144 (0.000)
SOILFERT	0.838 (0.019)***	0.334 (0.019)
SUPPEX	-0.427 (0.169)	-0.170 (0.169)
CREDIT	-0.615 (0.024)**	-0.245 (0.024)
NEARNESS	0.403 (0.008)***	0.160 (0.008)
AGEHEAD2	0.722 (0.302)	0.288 (0.302)
HHSIZEAE2	0.687 (0.034)**	0.274 (0.034)

Dependent variable	Access to irrigation
Weighting variable	One
Number of Observations	193
Logliklihood function	-69.13
Restricted log likelihood	-133.65
Chi squared	129.03
Degree of freedom	13
Significance level	0.00

Source: Model out put (2006)
*** and** are level of significance at 1 percent and 5 percent respectively
Values in parenthesis are p values

Table 6. Estimation Result of the Selection Equation and its Marginal Effect

Variable	Coefficient	Marginal effect
CONSTANT	1553.936 (0.000)***	1553.936 (0.000)***
ACCIRRIG	576.882 (0.000)***	576.882 (0.000)***
AGEHEAD	14.918 (0.348)	14.918 (0.348)
HHSIZEAE	-391.676 (0.000)***	-391.676 (0.000)***
SEXHEAD	-331.133 (0.001)***	-331.133 (0.001)***
EDUCATAGORY	1.736 (0.930)	1.736 (0.930)
DISMARKE	13.567 (0.378)	13.567 (0.378)
CUTLAND	85.751 (0.058)*	85.751 (0.058)*
LIVESTOC	-5.063 (0.717)	-5.063 (0.717)
SOILFERT	-47.613 (0.534)	-47.613 (0.534)
SUPPEX	117.729 (0.069)*	117.729 (0.069)*
CREDIT	-44.539 (0.429)	-44.539 (0.429)
NEARNESS	9.602 (0.009)***	9.602 (0.009)***
AGEHEAD2	-0.112 (0.441)	-0.112 (0.441)
HHSIZEAE2	25.607 (0.001)***	25.607 (0.001)***
LAMBDA	-243.448 (0.041)**	

Dependent variable	Total food (Total food expenditure per adult equivalent per annum)
Number of Observations	193
Selection rule is:	User =1
Log-L =	-1395.69
Restricted (b=0) Log -L =	-1489.70
R-squared =	0.58
Correlation of disturbance in regression and selection criteria (Rho)	-0.67
Prob value =	0.00

Source: model out put (2006)

*** ** and * show level of significance at 1percent, 5 percent and 10 percent probability level.

Values in parenthesis are p values