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Full length Research Paper

Quality of natural environment and reduced incidence of crime and violence in Ethiopia

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The combination of agricultural extension system with small scale irrigation development helps to reduce poverty, and now utmost attention is given to it. Extension system development can increases the production and income of the households and helps to improve their overall economic welfare. This study was conducted to assess the strengths and constraints of the public extension system and to provide suggestions on "best fit" solutions and their scale-up opportunities in the small scale irrigation user; furthermore it examines the impact of agricultural extension system on small-scale irrigation on total income, and the probability of being poor or not at household level. Survey was carried out involving 900 extension users' households and 875 non-extension users in Afar, Oromia and Somali regional states of Ethiopia which was a total of 1775 households. The result of the study by taking indicators of family size extension service users had more families 6.3 to 5.6 in non-user. The total crop income for one season was 41,282 Ethiopian birr while it was 16,276 for non-users. At the time of the data collection the exchange rate for a dollar was 19.67 Ethiopian Birr. Using a Tobit model to determine the total income parameters of education, extension service access, total land holding had a significant level of increment, while with marginal analysis (dy/dx) factors like household leaders' age, access to credit and dependency ratios were negatively related with total income. In general, the average annual income of extension users with application of small scale irrigation households was significantly greater than non-extension users. This shows that extension users in small-scale irrigation significantly promote total income of a household. The poverty incidence in non-extension user households is by far greater than user households. Thus, for the agrarian country, Ethiopia, extension system development in small-scale irrigation districts has significant impact on poverty reduction, so agricultural extension development should be given emphasis in development planning.

Key words: Income, poverty, small-scale irrigation, extension service, Logit, Tobit, marginal effect.

INTRODUCTION

The quality of agricultural extension services is an especially important issue in Ethiopia, where agriculture dominates the economy, accounting for 85% of employment, 50% of exports, and 43% of gross domestic product (GDP). Over 80% of the country's 91 million people live in rural areas (FAO, 2010; CIA, 2011), and most are extremely poor, with a daily per capita income of less than $0.50, and access to one hectare or less of

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land (IFAD, 2011). In recognition of the centrality of agriculture in most Ethiopians' lives, government policy emphasizes what it calls agricultural development–led industrialization (ADLI).

The extension service has historically been top-down with inadequate adaptation to local agro ecological conditions and needs. The government of Ethiopia has taken diverse initiatives to advance agricultural development in the last two decades. The agricultural sector is developing with increasing participation from the private sector, including progressive farmers and farmer cooperatives, and this participation requires revisiting the extension system to better fit it to emerging demands in the agricultural sector (from small farmers, farmer investors, and the private sector) (Cohen and Lemma, 2011).

Agriculture is central to the federal government's national development plan through the ADLI policy (MOFED, 2010), and indeed, development and agriculture are often used as synonyms in Ethiopia. The share of public expenditures devoted to agriculture and natural resources was 21% in 2005, well above the Sub-Saharan African average of 4% and more than double the African Union target of 10% (Mogues et al., 2008). Nevertheless, at present most Ethiopian farmers do not use modern agricultural technology, and the innovation system (agricultural research, extension, and education) is poorly integrated (Lemma, 2007).

The literature on agricultural extension in Ethiopia emphasizes the top-down approach to extension service provision. DAs have received relatively hard quotas for enrolling farmers in technology packages, and their supervisors evaluate them on the basis of how well they meet these quotas. Extension also works through "model" or "progressive" farmers, who tend to be better off and males. Communication is mostly one-way, with agents transferring knowledge to farmers. There is little effort to marry new agricultural research and development with farmers' own knowledge or to learn what kind of services farmers themselves would like to receive (Buchy and Basaznew, 2005; EAA and EEPRI, 2006; Lemma, 2007). Most agents have been men, except in the field of home economics, and have provided services mainly to heads of household, regardless of gender (Buchy and Basaznew, 2005; EAA and EEPRI, 2006). Historically, extension policy was made in Addis Ababa and merely implemented in the field. Changing the delivery mode can have positive benefits: Deployment of extension teams to kebeles can facilitate communities' ability to plan and manage development activities for themselves on a sustainable basis (Cohen et al., 2008). Extension services generally have positive impacts on nutrition and poverty reduction (Dercon et al., 2009).

Poverty alleviation has been largely a result of economic growth (Roemer and Gugerty, 1997). Because Ethiopia is an agrarian country, agriculture is the leading sector as source of income, employment and foreign exchange and national economic growth is determined by the performance of agriculture. Irrigation plays the key role in the performance of agriculture, which increases income growth. Income growth is essential for economic growth (Hussain and Biltonen, 2001). Developing countries that ensure sustainable economic growth can reduce their poverty levels, building up their democratic and political stability. They also improve the quality of natural environment and even reduce their incidence of crime and violence (Loayza and Soto, 2002).

The goal of the research

The goal of this research is to evaluate the economic impact of selected extension user agro-pastoral communities who apply small-scale irrigation on income and poverty reduction at household level. It compares households with and without access to extension systems.

The specific objectives of this research are as follows:

- To examine the major constraints encountered in the use of extension users and non-users in small-scale irrigation systems
- To examine the effects of extension on the gross income at household level
- To determine the difference in prevalence of poverty between extension users and non-user households.

Hypotheses

The hypotheses of this research are:

(i) Extension information has a positive impact on household gross income, cropping income and livestock income but has a negative impact on non-farm incomes.

(ii) Extension information has a negative impact on poverty. The probability of being poor is lower among users compared to non-users in the small scale agricultural sector.

(iii) Extension users have more agricultural productive assets

Table 1. Summary of variables.

Variable	Variables definition and measurements	Expected sign
IH_h	Annual household gross income in ETB	Dependent
EX_s	Extension service (1=extension service user 0= non users)	+
TL_h	Total cultivated land in hectares	+
FS_h	Family size of the household in adult equivalent	+
ED_u	Education level of the household head (1= read and write 0= does not)	+
AG_e	Age of a household head in years	-
AI_p	Access to input[1] (1=access to inputs 0 = no access)	+
LI_v	Livestock number owned in TLU	+
DR_h	Dependency ratio of the household	-
AC_s	Access to credit service (1 = access to credit and 0 =no access)	+
AO_h	Asset owned by household in ETB	+
SH_h	Sex of the household head (1= male and 0 = female)	+

N.B. [1]Access to input means the application of agricultural inputs like improved seed, fertilizer, pesticide etc.

and non-agricultural asset holdings than non-extension users.

METHODOLOGY

Approach for data collection, entry and checking

Household data collection was undertaken in six woredas from each woredas three PAs were selected that have access to extension services and non-extension users. Data collection methods included a survey, semi-structured interviews and focus group discussions. Data were collected at household and community level with the assistance of development agents. Each PA has three developmental agents who live and work with the agro pastorals. Using development agents as assistance for data collection is important for the reliability of the data because the communities are more likely to report accurate information to development agents, especially on income, land size and other assets.

The sample households were selected by utilizing the following three-stage stratified sampling procedure. The first stage involved consultation with District Agricultural offices, and eighteen PAs were selected purposively on the basis of their similarity in agricultural practices, potential for irrigation, and the type of small-scale irrigation they used.

In the second stage, household lists in the selected PAs were obtained from village administration and Development agents' office. Extension service users and non-users households were selected from this list.

In the final stage, households were listed by each small-scale irrigation category with extension service users and non-users then the random sampling technique was used to select sample households from each household type using a random number table. The aim is to carefully examine and compare the income and poverty level of small-scale irrigation users with extension service users and non-users.

Based on these multi-stages sampling processes the total sample households were selected on a random sampling basis from eighteen villages in the six district of Afar (Amibara, Chifira), Oromia (Meiso and Fentale) and Somalia (Kebribeyah, Aware and Lagahida).

Data analysis

To control for other factors that influence household incomes this study uses an econometric modeling approach. As stated by Zhou *et al*. (2009), household gross income is a function of many determinants including household characteristics, asset holding, village location characteristics, and the prices of goods and services. Mathematically, this can be written as (Table 1):

$$IH_h = f\,(EX_s, TL_h, FS_h, ED_u, AG_e, AI_p, LI_v, DR_h, AC_s, AO_h, SH_h) \quad (1)$$

Following previous studies, the determinants of household gross income were analyzed by multiple regression models. The model is of this form:-

$$Y = \alpha + hx + gx + \ldots + \quad (2)$$

Where:- α = intercept, h and g are parameter estimates

Some households may not derive income from livestock, off-farm and other activities; therefore in this study, the impacts of extension service on income were estimated using a Tobit model. This approach was developed by Nobel laureate economist James Tobin in 1958 for analyzing situations whenever dependent variable can take zero values. There are many previous studies with similar works (Zhou et al., 2009; Aschalew, 2009; Barket et al., 2002). The specific form of the Tobit model is described as follows:

$$Y_i^* = \beta x_i + \quad (3)$$

We define a new random variable Y transformed from the original one, y*, by

$Y^* = 0$, if $y \leq 0$
$Y^* = y$, if $y \geq 0$

Where:- Y_i is the observed dependent variable measuring combined livestock income, off-farm income, cropping income and household total income, y* is a latent variable, x is a vector of explanatory variables that influence incomes , β is a vector of parameters to be estimated, and ε is a random disturbance term with mean 0 and variance σ^2. On the basis of the Tobit model specification, the unknown parameters of the explanatory variables can be estimated by maximizing the corresponding likelihood function.

$$L(\beta, \sigma) = {}_{Y_i=0}\; 1 - \frac{\beta x_i}{\sigma} \quad {}_{Y_i>0}\; \frac{1}{\sigma} \left(\frac{Y_i - \beta x_i'}{\sigma} \right)$$

Where:

Y_i = income of a household
X'_i= explanatory variables create influence on household income
β = Coefficient of the independent variables
 = the normal density function
 = the normal distribution function
σ^2 = Variance of the error term epsilon in the third equation

The coefficients of dependent variables in Tobit model are not directly proportional with change of the independent variable. Therefore, to understand the change of household income as a result of a unit change of the coefficient of independent variables, the estimators of the variables should be transformed in to the vector of first derivatives. The marginal effect in Tobit model illustrate that the change of the dependent variables as a result of the changes of respective independent variable (X_i) by a unit. On the basis of the above Tobit model specification. The marginal effects of the independent variables on household income are represented as:

(4)

The marginal value helps to understand the direct impact of irrigation on household income. The hypothesis of extension service user household is better-off in income than non-user household is observed by the marginal analysis of the variable for extension service access. This marginal value is easy to interpret, because it indicates the impact of extension on household income, controlling for other factors. That is, it fulfills a main aim of this study to analyze the marginal effect of the service on user household income compared with non-user household income being other things constant. This helps policy makers to understand the value of future extension service development and research.

Poverty level estimation

Poverty is a multidimensional concept and its definition and measurement has been the subject of much debate. The household poverty line often is represented as a very basic living standard. Poverty indicators are often constructed by comparing household income with the mean income or median income (midpoint).Poverty usually is analyzed on the basis of income or consumption indicators. The World Bank uses poverty line of one dollar (PPP[2]-adjusted) per day, but this has been criticized for being too narrow. According to Bergh and Nilsson (2010), there is no obvious best way to calculate measures of absolute purchasing power that are comparable both across time and space when relative prices vary both over time and between countries. Following pervious literature, combined sample households (both users and non-users) are ranked according to their current income. This ranking is then used to determine which quartile a household is in based on current income. The households in the lower quartiles are relatively poor where as those in the upper quartiles are relatively well-off.

Poverty line

Although the relative poverty approach has some advantages, it is also possible to develop more specific absolute poverty, typically defining a somewhat arbitrary "poverty line" on the basis of income or consumption indicators. Ethiopia has not established any official poverty lines, so Schreiner and Chen (2009) used the international poverty lines in dollars at 2005 purchase-power parity, with the lowest of their thresholds at 1.00 USD per person per day. According to Dercon (1997), the threshold for absolute poverty is 0.45 USD per day and the moderate poverty level is 0.60 USD per day.

Poverty level comparison

The poverty level comparison between extension service users and non-users households is valuable to estimate the impact of extension access or scaling up of technologies on poverty reduction. Poverty level comparison helps to estimate the extent of extension impact on rural poverty alleviation. Poverty level comparisons between households were done by following poverty measures developed by Foster et al. (1984).

α (5)

Where:- P_α = poverty level indicator for a sample of households

[2]PPP (purchasing power parity) means the application of one price across countries for all goods and services, or representative groups (baskets) of goods and services. PUS = (EUS$ /ETB$) x (P ETB) PUS = Price of goods in USA PETB = Price of goods in Ethiopia EUS$ /ETB$ = US dollar/Ethiopian birr exchange rate.

M= number of households below the poverty line
N= number of households
Z= poverty line
Y_i = income per adult equivalent of i^{th} household α = poverty sensitivity parameter

Poverty sensitivity parameter that can take on a variety of values when α = 0, the result is the prevalence of poverty or the head count ratio, that is the proportion of people falling below the poverty line. When α = 1, the equation gives the depth of poverty. It is also called poverty gap index. This shows the amount of income necessary to bring everyone in poverty up to the poverty line, divided by total population. This can be thought of as the amount of income that an average person in the economy would have to contribute for poverty to be eliminated.

Econometrics model specification

Assessing the impact of extension scaling out of technologies on the likelihood that; a household is in poverty is one of the objectives of this study. Thus, poverty is the dependent variable, and determined by independent variables such as education, household characteristics, asset holdings and access to services. In this analysis, the independent variable is binary (1 if the household is classified as poor when its annual income is in the lowest quartile, and 0 if the household is classified as non-poor). Under this limited dependent variable model, the probability that the i^{th} household is being poor is given by:

Prob (y = 1/x) = f (x_i, β) = (6)

Z_i= function of explanatory variables (x_{ki}), and expressed as:-
$Z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \ldots \beta_k x_{ni} + \mu_i$
μ_i = error term

Table 7. Mean value of agriculture production assets in ETB.

Characteristics	Extension service user households (N=900)	Non user households (N=875)	Total households (N=1775)	t-test
Production assets, ETB	110,243	49,867	80,055	3.9***

***, ** and * are significant at 1, 5 and 10% significant level, respectively. N.B. 1 USD = 19.69 ETB.

Table 5. Total Mean annual cropping income in ETB.

Characteristics	Extension service user households (N=900)	Non user households (N=875)	Total Households (N=1775)	t-test
Mean annual cropping income	157,231	98,874	128,053	8.9***

***, ** and * are significant at 1%, 5% and 10% significant level, respectively. N.B1 USD = 19.69 ETB.

depends on the quality of the land and the access to irrigation.

The average rental values of land accessed with irrigation and land without access to irrigation were ETB 5,816 and ETB 2,867 per ha per one crop season, respectively. This is consistent with the hypothesis that extension user households keep their land management in fertility that increases the value of net returns to land. Households who have farm plots with access to irrigation water thus will have higher incomes per ha from land rent (Table 6).

Agricultural production assets include motor pumps, treadle pumps, plough sets and equipment necessary for agricultural activities. The production assets in extension service users and non-extension households are valued by considering the salvage value of each asset. As mentioned in the literatures review section of this paper, irrigation development has several benefits and roles, one of these benefits are increasing wealth of households. Extension service users have, on average, more agricultural production assets than non-user households. This difference is statistically significant at the 1 % significant level (Table 7).

Total cropping income

Total cropping income is the amount of mean annual income of a household obtained from both types of sample households, user and non-user (Table 8).

The mean annual income of a household from cropping income in the sample PAs was ETB 22,824.The total mean annual cropping income of extension service user households was substantially higher than that for non-user households. The t-test shows that there is significant difference between them at 1 % level of significant (Table 8).This suggests that extension intervention with scaling out of technologies markedly increases income, but this will be more appropriately tested using econometric analysis.

Income sources at household level

The total mean annual household income in the study area was ETB 26,251 (Table 9), which is roughly equal to the average per capita income for Ethiopia as a whole. From the total mean annual income of a household, cropping contributes the highest income share (86%) followed by livestock (11%) and off-farm (3%), respectively.

Scaling up technology user households earn higher income from cropping than non-user households. However, there is no significant difference between user and non-user households in their off-farm incomes. The total income significant difference arises from the cropping income difference, which is suggestive of the both the mechanism and the degree to which technologies access increases household incomes. The next section discusses the results of econometric analysis that assesses the impact of extension service controlling for other factors that influence income.

Econometrics model analysis

The income analysis was estimated using a Tobit (censored regression) model. The analysis was carried out using STATA software. Multi-collinearity was examined using Variance inflation factor (VIF) and correlation coefficients. The values of the VIF for explanatory variables were found to be less than 10 and total of eleven explanatory variables were entered in to the regression analysis.

On the basis of this alternative, the observed total

Table 9. Total Mean annual cropping income in ETB.

Characteristics	Extension service user households (N=900)	Non user households (N=875)	Total households (N=1775)	%	t-test
Crop income	32,282	13,366	22,824		8.9***
Livestock income	3,132	2,433	2,783	11	1.4
Off-farm income	622	667	645	3	- 0.3
Total income	36,036	16,466	26,251	100	7.6 ***

***, ** and * are significant at 1, 5 and 10% significant level, respectively. N.B1 USD = 19.69 ETB.

Table 10. Tobit estimates of the determinants for total income.

Variable	Coef.	Std. Err.	P>|t|
AG_e	-16.54	50.7	0.74
ED_u	4915.29 ***	1487.4	0.0
EX_s	3359.46***	1222.01	0.01
TL_h	10291.91***	1607.31	0.00
FS_h	1554.59 ***	505.83	0.00
AI_p	4688.55***	1738.96	0.01
LI_v	2285.07 ***	374.29	0.00
DR_h	-1031.12	692.57	0.14
AC_s	-894.16	1052.57	0.39
AO_h	2.81***	.34	0.00
SH_h	98.65	1755.29	0.96
Constant	-1696.12	3561.15	0.00
Sigma	6778.27	358.72	
Number of obs.	1775		
Prob > chi^2	0.00		

***, ** and * are significant at 1, 5 and 10% significant level, respectively.

minimum income at household level is ETB 1,256; it is non-zero value. By considering the above revised approaches Tobit regression model was used with 1255 as lower limit. The estimates of coefficients by the Tobit regression model as tool of parameter estimation are depicted in Table 10.

The Tobit analysis suggests that several variables have a statistically significant impact on the total income of the household, many of which are consistent with the hypothesized relationships. The analysis indicates which determinants are more important for the improvement of total household income. Some variables appear to be insignificant; this may be due to the relatively small sample size involved.

Education (ED_u) has significant positive impact on income. This seems rational; educated human capital can more easily adopt technologies and make more informed production decision. This can increase the marginal productivity of labor. The increase in productivity of labor is one of the important factors to increase income of a household (Table 10).

Household family size in adult equivalent (FS_h) and livestock holding in TLU (LI_v) are positively associated with household total income; both of them are significant. Household family size in adult equivalent means a larger amount of labor available to the household. Labor increases productivity per ha of land, and in turn, household total income increases for a given land base. The positive association between labor and household total income seems reasonable. Livestock holding in have high contribution on total household income by directly sale of livestock and their products, and by used as source of draught power for ploughing in crop production activities.

Access to extension service (EX_s) influences the household total income significantly with a positive sign as expected. As Norton et al (1970) suggest, access of technology shifts the production function and offsets the diminishing marginal return by doing so increases income and used as a source of economic growth. According to Makombe and Dawit, (2007), the production function analysis of irrigated and non-irrigated farm plots, the result shows that irrigation shifts the agricultural production frontier to a higher level. The marginal productivities of land and labor for the irrigated farms are almost four, and five times more, respectively. Thus, access to irrigation is one among many factors that increase household incomes.

Household production asset value (AO_h) influences the household total income significantly with a positive sign. This tells us households with high production assets can produce more and increase their total income. This is consistent with the economics of transformation and growth principles (Norton et al, 1970) as people accumulate physical capital allows the people to expand production by changing the marginal productivity of inputs like land and labor.

Education (ED_u) is also the important factor that influences the annual total income of a household. The analysis shows that access to education significantly increases the household's total income by ETB 4,903.3 (1USD = 19.67 ETB at the time the study) (Table 11).

The previous discussion indicated the sign and statistical significance of the coefficients from the Tobit

Table 11. Marginal effects of determinants on household total income.

Determinant	dy/dx	Std. Err.	P>|z|
AG_e	-12.1	50.4	0.7
ED_u	4203.7	11.1	0.0
EX_s	3843.9	2.5	0.0
TL_h	12744.9	6.4	0.0
FS_h	1457.0	5.9	0.0
AI_p	4359.4	2.1	0.0
LI_v	2811.9	3.7	0.0
DR_h	-102.3	91.43	0.2
AC_s	-992.6	87.5	0.9
AO_h	2111.8	0.4	0.0
SH_h	8.8	72.0	0.8

model. However, in that model the coefficients do not directly represent the marginal-effect, that is, the impact on household income from a one-unit change in the independent variables. The marginal effect estimates reveal that the land size (TL_h) has the largest impact. That is, a one ha land change has an impact on income for 10,274.9 ETB per year (Table 11). Thus, land holding size is very important input in rural poor households to increase their annual income. Since, the agrarian nature of the country; agriculture is the main source of income and livelihood for more than 85% of the country's population. Thus, land is critical and sensitive political issue in contemporary history of Ethiopia (Helland, 1999). In the study area, land is very scarce resource. Land share in/out and rent in/out is common. Even though the cost in cash of land is not far from the estimated marginal impact of land, the additional costs such as transaction cost and monitoring cost are high. Therefore, it is not easy to increase a land as required.

Extension service (EX_S) has a significant impact on the total income of a household, ETB 3843.9 per year. This supports the initial hypothesis that extension service use increases households' income. Households who have access to agricultural extension service can cultivate their irrigated land two or more times a year. Although the econometric analysis cannot indicate directly why the increase in income occurs, extension allows the farmers to practice crop intensification [2] and diversification, which increases crop yields and revenues from crop sales. Irrigation likely also increases the marginal land and labor productivity, increases the crop production and then promotes household income.

Livestock holding (LI_V) also affects annual total income of a household. An increase of household's livestock holding by one TLU is estimated to increase the total income of a household by ETB 2811.9 per annum. As expected, the value of productive assets owned by the household (AO_h) also increases total income of a household. The increase in asset holding of a household by ETB1000 significantly increases the household total income by ETB 2800. This suggests that households should invest in more productive assets. There should be credit or surplus income to invest on these production assets. The source of credit in the study area is ACSI, the interest rate is high (18%) compared to the Commercial bank of Ethiopia (5%). Thus, both surplus income and credit are unaffordable by subsistent farmers. Household size in adult equivalent (FS_h) also increases the annual income of a household. A one-unit increase family size in adult equivalent increases the total income of a household by about ETB 1,600.

Multivariate logit regression

The estimated coefficient for dummy variable access to extension service with the odd of being poor over non-poor was negatively correlated and significant. This suggests that the probability to being poor decreases if one has access to extension services, other factors being constant. This probably is due to the influence that extension service on agricultural intensity and diversification. Agricultural intensity is higher in extension service user household as compared to non-user households. Because the definition of the poverty threshold in this study is based on current income, and previous results suggest that access to extension services increases income, it is not particularly surprising that the likelihood of poverty is lowered by extension service implementers.

However, other factors also influence the likelihood that a household is in poverty. As expected, the coefficient of household education is negatively correlated with poverty and significant. The result suggests that household head who is literate had a lower probability of being poor compared with those who are illiterate. Education is assumed to increase productivity and thereby lead to higher levels of welfare for the household (Table 12).

The estimated coefficient for dummy variable access to extension service with the odd of being poor over non-poor was negatively correlated and significant. This suggests that the probability to being poor decreases if one has access to extension service technologies, other factors being constant. This probably is due to the influence that extension on agricultural production intensity and diversification. Production intensity is higher in extension user household as compared to non-user households (Table 12).

The coefficient of land holding per capita was negatively correlated with the probability of a person being poor and statistically significant. The odds ratio illustrates that a one-ha increase in land holding per capita, the odds of being poor decrease markedly(although this is not surprising given that it would result in a doubling of average farm size).

Table 12. Parameter estimates of a logit model for determinants of a household poverty.

Variables	Coef.	St. error	Odds ratio	Std. Err.
AG_e	0.02	0.0	1.0	0.0
ED_u	-1.73 ***	0.2	0.2	0.1
EX_s	-1.95 ***	0.5	0.1	0.0
TL_h	-1.95 **	0.5	0.1	0.0
DR_h	0.08	0.3	1.1	0.3
AO_h	-0.01	0.0	1.0	0.0
SH_h	-1.58 **	0.7	0.2	0.1
Cons.	3.26	1.6	-	-
LR chi^2	92.4	-	-	-
Prob > chi^2	0.0	-	-	-
Log likelihood	61.8	-	-	-
Pseudo R^2	0.43	-	-	-

***, ** and * are significant at 1, 5 and 10% significant level, respectively.

Table 13. Poverty comparison in %.

Parameter	Absolute poverty line		Moderate poverty line	
	Head count ratio (P_0)	Poverty gap (P_1)	Head count ratio (P_0)	Poverty gap (P_1)
EX_s- users	0.07	0.01	0.10	0.01
Non-EX_s users	0.43	0.09	0.50	0.10

A number of variables had no statistically significant impact on the odds ratio. Asset holding per capita was negatively correlated with the probability of a person being poor, but somewhat surprisingly was not statistically significant. Household head age also had no statistically significant impact on the probability of a person being poor which contrasts with findings of previous studies such as Bigsten and Shimeles (2002).

Consistent with the initial hypothesis, the Logit regression analysis indicates that access to irrigation markedly reduces the odds that a household will be in poverty, at least based on the poverty definition used in this study .Also reducing the likelihood of poverty are household head education, per capita land holding, ownership of oxen and male headed of household head.

Poverty analysis

The absolute poverty head count ratios of irrigating and non-irrigating households were 7 and 43%, respectively (Table 13). The moderate poverty head count ratios of irrigating and non-irrigating households were 10 and 50%, respectively. In the study area, of the sample population who live below the absolute poverty level, 88% are non-irrigating households and only 12% are irrigating households. This suggests that irrigation may have a significant impact on rural poverty alleviation.

For irrigating households, the gap was only 1%, but was significantly larger for non-irrigating households (9 and 10% for the absolute and moderate poverty thresholds, respectively). Thus, the poverty gap is much larger for non-irrigating households, which again suggests that irrigation may play a role in poverty reduction (Table 13).

The average income gap of extension households was lower than non-irrigating households. This suggests that access to irrigation reduces the poverty gap (and thus reduces poverty). The numbers of households below the moderate poverty line are fifty four (based on the thirtieth %ile of current income and N=1600 total households). Of these 54, 49 (91%) are non-irrigating households. The number of irrigating households below the poverty line is small, which makes it difficult to assess the impact of irrigation types on the likelihood of a household being in poverty. The overall income gap of poor people was ETB 1,338 (Table 14).

Conclusion

Access to irrigation increases the opportunity for crop intensity and diversification, which increase cropping income. Irrigation is becoming a practice to increase total annual income for many households in the study area. In addition to their normal rain-fed cultivation, irrigating

Table 6. The average income poverty gap.

Parameter	Mean income per adult equivalent of the poor in ETB	Mean of income poverty Gap in ETB
Extension service users	2282	943
Non-user	1826	1399
Total	1887	1338

households cultivate cash crops using small-scale irrigation. The main irrigated crops were onion, tomato, potato, maize, oat and vetch. Irrigated crops were selected due to good production potential, economic returns and ease of cultivation, respectively. Onion and rice were the major income source crops for irrigating and non-irrigating households, respectively.

Econometric analyses that control for other factors that influence household income indicate that accesses to small–scale irrigation increases mean household income significantly (about ETB 3,353 per year, or a 27% increase over non-irrigating household),which is hypothesized to occur primarily through crop intensification and crop diversification. It is important to note that other factors (such as input access) also had large effects on household income, and this study did not explore in detail the complementarities between irrigation access and other input use.

The other objective of this study is to assess the impact of irrigation on the likelihood that a household was in poverty. The results indicate that irrigation development has a profound impact in alleviating poverty. The poverty analysis indicates that a much higher proportion of those who are poor are non-irrigating rather than irrigating households. Thus, the poverty prevalence in non-irrigating households is by far greater than irrigating households. This suggests that irrigation has an important influence on rural poverty alleviation. Additional econometric analyses indicate that use of irrigation reduces the probability of a household being poor.

RECOMMENDATIONS AND POLICY IMPLICATION

This study has found that extension service development helps to increase household income and reduces the incidence of poverty at the household level. Based on these findings as well as the outcomes of focus group discussions and key informant interviews, further development and refinement of small-scale irrigation systems appears merited. This, of course, raises the question about this might best is undertaken. Although a formal analysis of strategies for future scaling out development is beyond the scope of this research, following actions are suggested to facilitate future extension service development.

1. Equip the research wing with: materials, human resource and other facilities because the generation technologies lie on the research institutes. Research institutes are the power house and key for development (thoughts, economical, technologies…) sustainability, Economic growth, poverty eradication, invention and innovation incubating different ideas that can upgrade the extension system.
2. Ensure extension services development: extension needs to address vulnerability as well as productivity and to offer new options from which poor households can choose according to their circumstances. The design of extension strategies must take account of differing degrees of market integration, which determine the degree to which the poor can take advantage of market opportunities.
3. Access to quality service of extension out of political influences in a manner of professional dimension and service access Extension strategies need to differentiate between highly and weakly integrated areas and acknowledge the need to take difficult decisions between supporting production strategies, on the one hand, and broader based livelihood extension, on the other.
4. Renewed and improved the existed irrigation canal development for small irrigation
5. Supply access to technologies: Extension should offer a wider range of services, some focused on support to production and others focused on wider livelihood support, targeted according to an analysis of a particular area's market integration, degree of vulnerability, and production prospects.
6. Strengthen education and training (adult training and farmers training).

Future studies questions

This study focuses on the impact of extension service access on gross income and poverty reduction at household level. However, there are limitations which need further and depth analysis in net income of technologies using cost-benefit.

Choice of scaling out technology types for small-scale, medium scale or large scale irrigation and their impact on income and poverty. The impact of extension scaling out technologies on actual livelihood change on the community like feeding habit, nutritional contribution and urbanization.

Scaling out technologies were cultivated and harvested by all farmers at the same time which cause the problems of marketing and post-harvest handling in the study area.

Conflict of Interests

The authors have not declared any conflict of interests.

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