

Full Length Research Paper

Contribution of adoption of motorized water pump on the household farm income of smallholder farmers: Evidence from Lake Abaya and Chamo Basins of Gamo Gofa Zone, Southern Ethiopia

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This study aims to analyze effects of adoption of motorized water pump on household farm income of smallholder farmers in Mirab Abaya and Arba Minch Zuria Woreda. The total sample size (n=196) was purposively selected from two Woredas and five Kebeles. Descriptive analysis, inferential analysis and Heckman two-stage mode were employed for data analysis. The ordinary least squares (OLS) model result revealed that among the 12 explanatory variables included in the model, four had significant effect on the household annual gross farm income. A unit increase in irrigated land of a household increases annual gross farm income of the households by Birr 6620.9 at 5% significance level. Adoption of motorized water pump has a positive effect on household annual gross farm income. The annual gross farm income of adopter households was higher by Birr 18555.35 than non-adopter households. Market distance and market information is found to influence income and hence well-being, significantly. The results indicated that a 1 km increase in distance of commodity supply market decreases annual gross farm income of farm households by Birr 3992.8 at 1% significance level. Male household heads had obtained significantly higher income compared to female household heads.

Key words: Water pump, farm income, T-test, Chi-square, ordinary least squares (OLS), Heckman two-stage.

INTRODUCTION

The current government has undertaken various activities to expand irrigation in the country. The country's Agricultural Development Led Industrialization (ADLI) strategy considers irrigation development as a key input for sustainable agricultural development. Thus, irrigation

development, particularly small-scale irrigation is planned to be accelerated. Ethiopia is believed to have the potential of 3.7 million hectares of land that can be developed for irrigation through pump, gravity, pressure, water harvesting, and other mechanisms (MoFED, 2010).

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The evidence from the survey conducted at Central Tigray by Kinfе Asayehegn showed that the ratio of mean income of irrigation users to non-users exceeds by 37.03%. This study also showed that family labor at adult equivalent, irrigable land size, access to irrigation, livestock holding and access to credit are found to have a positive and significant association with household income. The results further indicate one unit increase in the active labor force of an average household would raise the total income of the household by ETB 3987.14. To this end, keeping other variables constant at their respective mean values, a unit increase in irrigable land of a household increases total income by ETB 23,327.8. In other words, irrigation user households with one hectare irrigable land are better-off in well-being by ETB 23,327.8 than non-user households (Kinfе, 2012).

The study conducted at Hare irrigation project of Arba Minch Zuria Woreda showed that crop production with animal husbandry is the main farming system in the Hare irrigation system. The main crops grown in the project area are banana, cotton, sweet potato, maize, mango, and avocado. The average size of landholdings in the scheme is 0.8 ha. Crop yields differ from district to district in the schemes due to differences in access to irrigation water, soil type, irrigation and crop management. Chano Chalba enjoys the highest average yield with regard to banana (219 q/ha) followed by Chano Dorga (153 q/ha) and the smallest productivity is at Kolla Shara (144 q/ha). Crop productivity varies from 7 to 22 q/ha for Cotton and 22 to 29 q/ha for maize in the irrigation schemes. The nearby marketing center for local consumption was Arba Minch town. As the area is now known for its banana production, farmers are selling their products at reasonable prices and they are good at bargaining prices. Some farmers even started to get involved in the other sectors such as transport, by owning vehicles like minibuses and trucks, from the benefits they gained from their irrigated farms (Girma and Awulachew, 2007).

Statement of the problem

In Ethiopia out of the total potential, about 10 to 12% of this potential is put under irrigated agriculture (both traditional and modern irrigation systems). The major limitations that constrained the development of the irrigation sub-sector are: (i) predominantly based on traditional farming systems, (ii) inadequate improved agricultural inputs, (iii) limited access to improved irrigation technologies, (iv) inadequate trained human power, (v) inadequate extension services and capital, (vi) absence of appropriate institutions at different levels responsible for the promotion, planning and development of irrigated agriculture, and (vii) inadequate information system on agricultural water management and irrigation development (MoA, 2011).

The study area lacks in depth studies on analyzing the

effects of the adoption of motorized water pump on the household farm income of small holder farmers. Therefore, this study was initiated to analyze the effects of the adoption of motorized water pump on the household annual gross farm income of small holder farmers.

RESEARCH METHODOLOGY

In this study, a multi-stage sampling procedure was employed for the selection of Woreda, sample Kebeles and respondent households. In the first stage, the two Woredas were selected purposively as they were located at the basins of Lake Abaya and Chamo. Moreover, there is better use of motorized water pump and irrigation practice in the study area that gives opportunity to local government in developing modern irrigation schemes; and accessible and availability of enough information about the practice.

In the second stage, five Kebeles (three from Mirab Abaya and two from Arba Minch Zuria Woreda) purposively selected because of farmers living in these Kebeles have well used and adopted motorized water pump. In the third stage, the total households residing in the five Kebeles were stratified into two strata: adopter and non-adopter households. The population frame in the selected Kebeles and the lists of adopter households in those Kebeles were obtained from Kebele Administration Offices. Accordingly, Ali (2003) and Glenn (2013) recommended that the total sample size was determined using published table. This table was designed exactly in the same way that the internet calculators are. Based on this criteria, for this study, the total sample size for the population size of 4492 with $\pm 7\%$ precision levels, 95% confidence level and $P=0.5$ (variability) is equal to 196.

In this study, all adopters (83) from five sample Kebeles were included purposively due to their small size. However, the total sample sizes for non-adopter (113) from sample Kebeles were determined via probability proportionate to size procedure through the following formula:

$$P_i = N_i/N$$

where P_i is the proportion of the population included in stratum i , N_i is the number of elements (total sample size), and N is the total number of the population.

Therefore, the number of sample households from five sample Kebeles for two strata are shown in Table 1.

This determined sample size of non-adopter respondents was selected from the population frame of non-adopter households of the respective Kebele through systematic probability sampling (list sampling) technique (Kothari, 2004). In this study, both primary and secondary data sources were employed. Primary data were obtained from primary data sources (respondents' household and focus group discussions). Important variables on physical, demographic, economic, social and institutional aspect were collected. Depending on the objective of the study and nature of data available, descriptive analysis (mean), inferential analysis (chi-square and t-test) and econometric model (Heckman two-stage selection model) were used to analyze the effects of the adoption of motorized water pump on household annual gross farm income.

RESULTS AND DISCUSSION

Major crops grown by motorized water pump

The results obtained from focus group discussion, key

Table 1. Sample Kebeles and number of sample households for two strata from each Kebele.

Sample Woredas	Sample Kebeles	Non-adopter households		Adopter households		Total sample household
		Total HH	Sample HH	Total HH	Sample HH	
Arba Minch Zuria	Kanchama	1325	34	20	20	54
	Elgo	1123	29	22	22	51
Mirab Abaya	Fura	485	13	11	11	24
	Alge	517	14	9	9	23
	Yayke	876	23	21	21	44
Total		4326	113	83	83	196

Source: Field Survey (2017).



(a) Cabbage farm



(b) Tomato farm

Figure 1. Some dominant vegetables grown in the study area through motorized water pump by the small holder farmers.

informant interview and respondents' household revealed that in the study area farmers engaged in both rain-fed and rain-fed + irrigated agriculture (traditional river diversion, concrete canal river diversion and lifting through motorized water pump) and grown different types of annual and perennial crops with the help of rain fall and supplementary irrigation.

The major crops grown by irrigation through motorized water pump in the study area are: industrial crop (tobacco) and dominant vegetables (cabbage, tomato, onion and pepper). Figure 1a and b shows some of dominant vegetables grown in the study area through motorized water pump by the small holder farmers.

Descriptive and inferential statistics result of explanatory variables

The chi-square result in Table 2 shows that adoption of motorized water pump, sex and education level of respondents had significant relationship with the household farm income at 1% significance level, while use of credit had significant relationship with the household farm income at 10% significance level. Therefore, maleness of household head, increase in education level and use of credit have its own effect on the household farm income.

The t-value result also shows that the motorized water

Table 2. Descriptive and inferential statistics result of explanatory variables.

Variable	Mean		χ^2 and t-value	p-value
	Adopter (N=83)	Non-adopter (N=113)		
Adoption of MWP	-	-	153.5***	0.000
Sex of respondents'	-	-	110.47***	0.006
Age of respondents'	42.8	45.9	-2.68***	0.008
Household labor in AE	4.36	3.16	5.47***	0.000
Education level of respondents'	-	-	19.98***	0.000
Land holding size	1.4	1.39	0.454	0.65
Irrigable land size	1.18	0.002	30.59***	0.000
Livestock holding in TLU	3.86	3.78	0.342	0.733
Use of credit from institution last year	-	-	87.78*	0.087
Contact with DAs per month.	1.77	1.47	2.76***	0.006
Farm distance from water source	0.77	1.4	-8.79***	0.000
Market distance	0.799	0.791	0.106	0.915

*** Significance at 1% level.
Source: Field Survey (2017).

pump adopter households had significantly less mean age and farm distance from water source than non-adopter households. On the other hand, the motorized water pump adopter households had significantly exceeded in the mean of household labor in AE irrigated land size and contact with DAs per month than non-adopter households.

Heckman two stage model estimates for the effect of motorized water pump on household annual gross farm income

Here, the discussion focused on the second stage of Heckman model, which describes the effect of adoption of motorized water pump on household annual gross farm income.

The second stage of Heckman's procedure also referred to as the outcome or selection equation uses Ordinary Least Square (OLS) for analyzing household annual gross farm income. The likelihood function of the two-step Heckman model was significant showing a strong explanatory power. Also, the coefficient of the Inverse Mills Ratio (IMR) was significant ($P < 0.01$) providing evidence for the presence of self-selection and hence justifying the use of Heckman's two-stage procedure.

Irrigated land

This is a key asset of rural farm household and a unit increase in irrigated land of a household increases annual gross farm income of the households by Birr 6620.9 at 5% significance level. In other words, motorized water pump adopter households with one-

hectare irrigated land are better off in their income by Birr 6620.9 than non-adopter households. Access to irrigated land by allowing households to use family labor and other farm resources more intensively makes households more productive and hence better off.

Adoption of motorized water pump

This has a positive effect on household annual gross farm income. This evidenced as, keeping other things constant, the annual gross farm income of adopter households was higher by Birr 18555.35 than households who do not participate in adoption of motorized water pump. The use of irrigation technology allows farm households to use farm resource in a more productive way. It enables the production of vegetables and cereal crops twice and sometimes three times a year and it helps to improve livestock productivity by providing feed during the dry seasons and minimizing the cost of paying for fodder.

Therefore, participation in adoption motorized water pump for irrigation enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption.

Market distance

Access to market and market information is found to influence income and hence well-being, significantly. The results indicated that a 1 km increase in distance of commodity supply market decreases the annual gross farm income of farm households by Birr 3992.8 at 1% significance level. Households having less access to

Table 3. Ordinary Least Square estimation of model variables.

Model	Coefficient	t-value	P-value
(Constant)	3216.255	0.418	0.677
Age of respondent	68.518	0.735	0.463
Education level of respondent	447.464	0.449	0.654
Household labor	275.538	0.571	0.569
Land holding size	-222.122	-0.067	0.946
Irrigated land size	6620.968**	-2.441	0.016
Adoption of MWP	18555.352***	4.998	0.000
Farm distance from water source	-150.300	-0.092	0.927
Livestock holding in TLU	141.375	-0.296	0.767
use of credit from institution	946.036	-0.333	0.739
Contact with DAs per month	771.602	0.806	0.422
Market distance	-3992.815***	2.669	0.008
Sex of respondent	7486.572***	-2.632	0.009

Dependent variable=annual gross farm income mean=9541.7birr
Number of observation=196
Adjusted R² =0.269
R²=0.317
Prov. value=0.000

** , *** , significance at 5 and 1% level, respectively.
Source: Field Survey (2017).

market and information negatively influence farm income than households having better access to market and market information. Market information helps farm households to market perishable farm products at the right time without loss of quality and quantity. Access to market information would also play a key role by providing accurate information on the demand and supply of farm inputs and outputs.

Sex of the household head

Male household heads have higher income compared to female household heads because of better labor inputs used in male-headed households than the female headed ones. In addition, females of the study area have triple burden (production, reproductive and child care), and also they have less access to information about the technology, then due to the case of sex difference of household head has influence in the level of income of households.

Moreover, it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the adoption of technologies as early as possible and their income is higher than their counterpart. The study result revealed that this variable is statistically significant at 1% significance level and the coefficient of this variable also shows keeping all other

variables constant, on annual gross farm income of those male headed households exceeded by birr 7486.57 compared to those households headed by female. This finding agreed with that of Agerie (2013) (Table 3).

CONCLUSION AND RECOMMENDATION

The study has explored the potential factors that affect the household annual gross farm income in the study area.

Irrigated land is a key asset of rural farm household and it had significant effect on the household annual gross farm income at 5% significance level. Access to irrigated land by allowing households to use family labor and other farm resources more intensively makes households more productive and hence better off. Therefore, it should be better to give attention by the concerned bodies on the different irrigation technologies to create access to their irrigation water.

The participation in adoption motorized water pump for irrigation enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption. Therefore, the GOs and NGOs should focus their attention in provision of credit to farmers in extended repayment period; it may improve their initial capital to adopt the technology.

Access to market and market information is crucial for

the farmers to improve production practices, to diversify their farm income, to sale their crops at an appropriate time, etc., which enable them to have better capital as well as better household asset. Therefore, the concerned bodies should focus their attention on provision of information about supply and demand market and creation of market accesses.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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