Factors that Affect the Participation in Irrigation Practice and Its Effects on Rural Household Farm Income: The Case of Boloso Sore Woreda, Wolayta Zone, Southern Ethiopia

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Abstract:
This study was conducted at Boloso Sore Woreda. The woreda lacks in-depth studies factors that affect the participation in irrigation practice and also there was not well known to what extent the households using irrigation water are better-off than those who depend on rain-fed agriculture. This study was focused on to assess factors that affect the participation in irrigation practice and its effects on rural household farm income. Descriptive statistics, inferential statistics and binary logistic regression analysis were used to analyzing quantitative data. The model result showed that education level, household labor and land holding size had significant positive effect on the use of irrigation water at 5% significance level. However, age and farm distance from river had significant negative effect on the use of irrigation water at 10% and 5% significance level respectively. Out of the total irrigation user respondents (79.7%) have harvested perennial crops more than two times and grown annual crops two times per year from the same farm. While out of the total irrigation non-user respondents’ household depended on only rain fed agriculture (56.4%) have grown annual crops only one time per year from the same farm. Consequently, the independent sample test result showed that the irrigation user respondents’ household obtained significantly larger mean annual gross farm income than irrigation non-user respondents’ household at 1% significance level. As a result, the irrigation user respondents’ household obtained excess of 17067.98 birr of mean annual gross farm income that obtained by irrigation non-user respondents’ household. According to the finding, in addition to river water it should be better to initiate farmers to develop and use spring water at community level and shallow wale at household level. It is likely to be valuable for future irrigation development. And also the concerned bodies should give emphasis on adult education to improve farmers’ awareness; provision of credit, which improves their financial capital to purchase irrigation technologies and to hire labor which fills the gap of family labor shortage.

Key Words: Irrigation, Income and logistic.
Introduction:

Ethiopia is a country where around 95% of the country’s agricultural output is produced by smallholder farmers. Agriculture contributes substantial share to the GDP of many low-income countries. It is often the leading sector of the economy as source of income, employment and foreign exchange. In Ethiopia agriculture employs more than 70 percent and contributes 41 percent of the gross domestic product (MoFED 2010).

Ethiopia is predominantly an agrarian country with the vast majority of its population directly or indirectly involved in agriculture. Agriculture in the country is mostly small-scale rainfall dependent, traditional and subsistence farming with limited access to technology and institutional support services (Desta, 2004).

Irrigation in Ethiopia contributes to increase farmers’ income, household resilience and buffering livelihoods against shocks and stresses by producing higher value crops for sale at market and to harvest more than once per year. In turn, this provided them to build up their assets, buy more food and non-food household items, educate their children, and reinvest in further increasing their production by buying farm inputs or livestock. However, the benefits are very unevenly distributed among households (Eshetu et al, 2010).

In the same way, Zhou et al. (2009) mentioned that irrigation contributes to agricultural production in two ways: increasing crop yields, and enabling farmers to increase cropping intensity and switch to high-value crops. Therefore, irrigation can be an indispensable technological intervention to increase household income.

Modern small-scale irrigation schemes use technologies for irrigating up to 200 ha and are constructed by the regional governments or NGOs with active involvement of farmers. Due to the availability of water resources for irrigation in selected Kebeles of the Woreda, Boloso Sore is one of the Woredas with high irrigation potential in Wolaita Zone. The irrigation potential of the Woreda was estimated about 4548 hectares (WOAD, 2015). However, the Woreda lacks in-depth studies factors that affect the participation in irrigation practice and also there was not well known to what extent the households using irrigation water are better-off than those who depend on rain-fed agriculture. Therefore, this study was focused on to identify factors that affect the participation in irrigation practice and its effects on rural household farm income.

Research Methodology:

In this study a multi-stage sampling procedure was employed. In the first stage, the study area is selected purposively as small-scale irrigation practice is available in the woreda. In the second stage, three Kebeles modern small-scale irrigation system were selected purposively. In the third stage, sampling frame (complete village household lists) was obtained from each Kebele’s administrative office. In the fourth stage, the total households in the three sample Kebeles were stratified in to the two strata (irrigation water user and non-user households). In the fifth stage, simple random sampling technique was applied to select the sample unit from each stratum at each kebele via probability proportionate to size procedure. From the total of 2625 households found in three samples Kebeles 118 respondent households were determine for this study by using the Yemane formula.

The sample size of irrigation user and non-user respondent households was 79 and 39 respectively. This determined sample size of irrigation user and non-user respondents’ household were selected from the population frame of irrigation users and non-users household of the respective Kebele through Systematic probability sampling (list sampling) technique. Primary data for the study has been collected from selected sample households, focus group discussion, and interview with key informants (committee members of water user's associations, peasant association executive committee members, Women development army, development agents and Wereda irrigation development experts) and field observations. Secondary data were also collected from written documents from Woreda agricultural and Natural Resource Management office and from other published and unpublished materials.

The quantitative data were analyzed by using descriptive statistics such as frequency, mean and percentage. The statistical significance of the
variables in the descriptive part was tested by t-test. To identify the determinants that influence the use of irrigation water, the binary logistic regression analysis was employed. It is selected because of the model relevance to deal with dependent variables that are dichotomous.

**Result and Discussion:**

**Factors that Affect the Participation in Irrigation Practices in the Study Area**

**Age of respondent:**

had significant negative effect on the use of irrigation water at 10% significance level. The odds ratio disfavors the use of irrigation by a factor of 1.238 for the respondents’ age increased by 1 year. Therefore, a farmer who was large age group has less chance to use irrigation water. Because of the elders have less interest to adopt improved irrigation technologies and also irrigation practices need high physical labor. However, the elders are physically weak and access to use irrigation water also decreases. In agreement with this finding, Morris et al., (2000) have reported that, age is one of the factors that determine decision making of a person. Advanced aged household heads are more reluctant to accept new technology than younger household heads. Even after controlling for key confounding variables identified in prior organizational behavior research i.e., income, occupation, and education levels, compared to older workers, younger workers’ technology usage decisions were more strongly influenced by attitude toward using the technology.

**Household labor:**

had significant positive effect on the use of irrigation water at 5% significance level. The odds ratio favors the use of irrigation by a factor of 48.5 for the respondents’ household labor force increased by 1adult equivalent. Therefore, the respondents’ household who has large labor size has better chance to use irrigation water.

**Education level:**

had significant positive effects on the use of irrigation water at 5% significance level. The odds ratio favors the use of irrigation by a factor of 2.237 when the education level of respondent increased by 1grade. Therefore, educated respondents have more chance to use irrigation water. The result obtained from key informants interview revealed that in the study area the educated farmers easily understood the operation and adopt improve irrigation technologies which is increase their access to use of irrigation water through lifting with irrigation technologies (motorized water pump) from the sources even if their farm is not accessible to irrigate through gravity force. In agreement with this finding, Riddell, et al., (2012) have reported in their study that highly educated workers tend to adopt new technologies faster than those with less education workers.

**Farm distance from the rivers:**

had significant negative effect on the use of irrigation water at 5% significance level. The odds ratio disfavors the use of irrigation by a factor of 0.0006 for the respondents’ farm distance from Rivers increased by1Km. Therefore, the respondents’ household farm located far from the rivers has less chance to use irrigation water and vice versa. Because, in the study area the major water source for irrigation is rivers. When the farm distance far from main irrigation canals which was constructed from the rivers, it needs high labor, financial and time costs to construct sub-canals towards individual farm and minimize the chances to use irrigation water.

**Land holding size:**

had significant positive effect on the use of irrigation water at 5% significant level. The odds ratio favors the use of irrigation by a factor of 4.673 for the farmers’ farm land increased by 1hectar. Therefore, for the better land holder respondents’ household have more chance to use irrigation water.
Table 1: The binary logistic regression results of independent variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>Df</th>
<th>Sig.</th>
<th>Exp(B)</th>
<th>95.0% C.I.for EXP(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEX(1)</td>
<td>6.464</td>
<td>52.923</td>
<td>.015</td>
<td>1</td>
<td>.903</td>
<td>641.880</td>
<td>.000 7.171E47</td>
</tr>
<tr>
<td>Age</td>
<td>-.214*</td>
<td>.128</td>
<td>2.796</td>
<td>1</td>
<td>.095</td>
<td>1.238</td>
<td>.964 1.590</td>
</tr>
<tr>
<td>Education</td>
<td>.805**</td>
<td>.394</td>
<td>4.173</td>
<td>1</td>
<td>.041</td>
<td>2.237</td>
<td>1.033 4.843</td>
</tr>
<tr>
<td>Land size</td>
<td>10.752**</td>
<td>5.317</td>
<td>4.089</td>
<td>1</td>
<td>.043</td>
<td>4.673</td>
<td>1.392 1.569</td>
</tr>
<tr>
<td>Distance</td>
<td>-10.697**</td>
<td>4.792</td>
<td>4.984</td>
<td>1</td>
<td>.026</td>
<td>.0006</td>
<td>.000 .271</td>
</tr>
<tr>
<td>Number of ox</td>
<td>.666</td>
<td>1.344</td>
<td>.245</td>
<td>1</td>
<td>.620</td>
<td>1.946</td>
<td>.140 27.122</td>
</tr>
<tr>
<td>Use of credit(1)</td>
<td>-1.390</td>
<td>1.398</td>
<td>.989</td>
<td>1</td>
<td>.320</td>
<td>.249</td>
<td>.016 3.858</td>
</tr>
<tr>
<td>Training(1)</td>
<td>-3.823</td>
<td>2.527</td>
<td>2.290</td>
<td>1</td>
<td>.130</td>
<td>.022</td>
<td>.000 3.092</td>
</tr>
<tr>
<td>Contact with DAs</td>
<td>.171</td>
<td>.301</td>
<td>.323</td>
<td>1</td>
<td>.570</td>
<td>1.187</td>
<td>.658 2.140</td>
</tr>
<tr>
<td>TLU</td>
<td>.949</td>
<td>.757</td>
<td>1.572</td>
<td>1</td>
<td>.210</td>
<td>2.584</td>
<td>.586 11.395</td>
</tr>
<tr>
<td>Labor</td>
<td>3.882**</td>
<td>1.969</td>
<td>3.889</td>
<td>1</td>
<td>.049</td>
<td>48.518</td>
<td>1.024 2.299E3</td>
</tr>
<tr>
<td>Constant</td>
<td>-19.711</td>
<td>11.517</td>
<td>2.929</td>
<td>1</td>
<td>.087</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

a. Variable(s) entered on step 1: SEX, Age, Education, LANS, DSWS, OX, USCR, TIAN, CODA, TLU, and Labor.

*, And ** represent significant at 10% and 5% level respectively.

Source: Computed from field survey data, 2017.
Crop production:
The results obtained from key informant interview and respondents’ household revealed that in the area farmers engaged in both rain feed and rain feed + irrigated agriculture and grown different types of annual and perennial crops. The major crops grown by using small-scale irrigation schemes in the study areas are: Maize, Teff, Root crops and dominant vegetables (Pepper, Cabbage and Tomato).

Photos in the figure 4 below show that some of dominant vegetable grown in the study area on irrigated farm.

Cabbage production at small holder level irrigated farm.

Tomato at small holder level irrigated farm. 
Source: Own field observation, 2017.

Cropping Frequency of the Respondents’ Household:
The results in Table 15 show that out of the total respondents’ household 53.5% have been grown two times annual crops (Maize, Tef, Vegetables and Root Crops) and harvesting more than twice from perennial crops (Mango and Avocado) per year. However, from the total irrigation user respondents’ household (79.7%) have been grown two times annual crops (Maize, Tef, Vegetables and Root Crops) and harvesting more than twice from perennial crops (Mango and Avocado) per year and (12.7%) of irrigation user respondents’ household and (43.6) irrigation non user have been grown two times annual crops per year from the same farm. On the other side, more than half (56.4%) of irrigation non-user respondents’ household have been grown only one time annual crops (Maize, Tef, Vegetables and Root Crops) per year from the same farm. Additionally, this result also shows that, the respondent farmers’ engagement in growing of perennial crops mostly depends up on access to use of irrigation water. Information gathered from Key informant interview revealed that, supplementary irrigation crucial during dry season. Thus, use of irrigation water is initiate farmers to grow annual crops more than one time per year from the same farm. This is similar to the finding access to irrigation has been regarded as a powerful factor that provides a greater opportunity for multiple cropping, cropping intensity, and crop diversification (Saleth et al. 2003). Households
who have access to small-scale irrigation can cultivate twice a year. Thus, irrigation increases the intensity of cropping.

**Table 2: Cropping frequency (growing and harvesting) from the same farm per year.**

<table>
<thead>
<tr>
<th>Growing and harvesting frequency</th>
<th>User</th>
<th>Non user</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Only one time annual crops.</td>
<td>6</td>
<td>7.6</td>
<td>22</td>
</tr>
<tr>
<td>Two times annual crops.</td>
<td>10</td>
<td>12.7</td>
<td>17</td>
</tr>
<tr>
<td>Two times annual crops and perennial crops more.</td>
<td>63</td>
<td>79.7</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Own field survey, 2017.

Additionally, the results obtained from key informant interview revealed that, most of irrigation non-use farmers live in the sample Kebeles have refused and hesitated to use of improved seeds and chemical fertilizer due to lack of access to use of irrigation water. However, the use of improved seeds and chemical fertilizer are crucial to improve the farm productivity and then maximize total farm production. Therefore, the use of irrigation increases the farmers’ interest to use improved seeds and chemical fertilizer as well as improve the farm productivity and then maximize total farm production. In agreement with this finding, Nhundu et al. (2010) have reported that use of irrigation water supplements moisture, which enables farmers to maximize agricultural production and improves gross farm income of a household.

**Annual Gross Farm Income Obtained by the Respondents’ Household:**

The results in Table 18 show that out of the total respondents household (44.9%) had obtained annual gross farm income between 1000-10,000birr. However, irrigation user respondents’ household (32.9%) had obtained annual gross farm income between 10001-20,000birr while out of the total irrigation non-user respondents’ household (84.6%) had obtained annual gross farm income between 1000-10,000birr. The mean annual gross farm income obtained by irrigation user and non-user respondents’ household was 21017 and 3949 respectively.

The t-value also shows that at 1% significance level, the mean of annual gross farm income obtained by irrigation user respondents’ household was significantly differs and better than that was obtained by irrigation non-user respondents’ household. As a result, the irrigation user respondents’ household obtained excess of 17067.98 birr of mean annual gross farm income that was obtained by irrigation non-user respondents’ household. In agreement with this finding, the study conducted by Ayele et al (2013) at Lake Tana basin has reported that access to irrigation has a significant positive role on the mean income of a household (3353birr per year) a 27% increase over the mean income for non-irrigating households and Kinfe (2012) at Central Tigray has also reported that irrigation user households with one hectare irrigable land are better-off in well-being by 23,327.8birr than non-user households.
Table 3: Annual gross income obtained by the respondents’ household in 2015/16.

<table>
<thead>
<tr>
<th>Income</th>
<th>User N</th>
<th>User %</th>
<th>Non-user N</th>
<th>Non-user %</th>
<th>Total N</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1000</td>
<td>1</td>
<td>1.3</td>
<td>5</td>
<td>11.4</td>
<td>6</td>
<td>5.1</td>
</tr>
<tr>
<td>1000 - 1000</td>
<td>20</td>
<td>25.3</td>
<td>33</td>
<td>84.1</td>
<td>53</td>
<td>44.9</td>
</tr>
<tr>
<td>10001 - 20000</td>
<td>26</td>
<td>32.9</td>
<td>1</td>
<td>4.5</td>
<td>27</td>
<td>22.9</td>
</tr>
<tr>
<td>20001 - 30000</td>
<td>13</td>
<td>16.5</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>&gt;30000</td>
<td>19</td>
<td>24.1</td>
<td>-</td>
<td>-</td>
<td>19</td>
<td>16.1</td>
</tr>
<tr>
<td>Mean</td>
<td>21017</td>
<td></td>
<td>3949</td>
<td></td>
<td>15376</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>1766</td>
<td></td>
<td>2470</td>
<td></td>
<td>15211</td>
<td></td>
</tr>
<tr>
<td>t-value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.73***</td>
<td></td>
</tr>
</tbody>
</table>

Source: Own field survey, 2017. P-value = 0.000 *** Significant at 1% level.

In the study area, irrigation user respondents’ household has grown annual crops two times and harvesting perennial crops more than twice from the same farm per year. The use of irrigation increases the farmers’ interest to use improved seeds and chemical. The use of improved seeds and chemical fertilizer are crucial to improve the farm productivity and then maximize total farm production. Therefore, these are its own implication on the mean annual incomes obtained from crop production. Consequently, these implications show that, the use of irrigation water might be made the significant difference on the mean annual gross farm income between irrigation user and non-user respondents’ household.

Conclusion:

In the study area one of main constraints for irrigation non-user respondents’ household was distance from rivers. These factors had and signifcant negative effect on the use of irrigation water at 5% significant level. The major sources of irrigation water in the study area are rivers. The availability of water from rivers is decreases during dry season so it was not reliable even for irrigation users’ farm that located far distance from the rivers. Moreover, in the study area there is an opportunity to use Shallow Wate due to due to favorable agro-ecological location. Some farmers in the study area have used Motorized Water Pumps for irrigation purposes and it creates access to them to use irrigation water through lifting from water sources even if their farms are not accessible to irrigate through gravity force. However, the access to use such equipment is limited due to high purchasing, maintenance, fuel and hose cost. The Committees and DAs have high responsibility to manage irrigation water used from rivers. However, these committees have not well function their responsibilities. Therefore, it was negatively affects the fair distribution of irrigation water for the users in sample Kebeles.

Recommendations:

- Distance from rivers had significantly negative effect on the use of irrigation water at 5% significance level and the major sources of irrigation water in the study area are rivers. Therefore, in addition to river water it should be better to initiate farmers to develop and use springs at level and shallow wale at household level. It is likely to be valuable for future irrigation development.
- Education level had significant positive effect on the use of irrigation water. Therefore, governmental and non-governmental organizations should give emphasis on the adult education for farmers and that improves farmers’ awareness about adoption of technologies and increases their access to use irrigation water in the study area.
- Household labor had significant positive effect on the use of irrigation water. Therefore, governmental and non-governmental
organizations should give emphasis on provision of credit for farmers and that improves their financial capital to purchase improved irrigation technologies like motorized water pump and hire labor and that fill the gap of family labor shortage. Consequently, creates an opportunity to shift non-users to use irrigation water in the study area.

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