

Social Capital and Agricultural Technology Adoption among Ethiopian Farmers

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Abstract Despite the recent efforts to increase agricultural productivity in Ethiopia, food insecurity remains a major challenge in the country. Improving smallholders' productivity requires the adoption of suitable agricultural technologies and practices. Previous researches highlighted the importance of socio-economic factors; but widely overlooked the role of social capital in technology adoption and its potential to create collective actions, reduce transaction costs, relax supply side constraints, and disseminate information. Using socio-economic data of 398 farming households, the study assessed social capital as a determinant for soil and water conservation practices (SWC) such as terraces, bunds and agro-forestry as well as adopting productivity enhancing technologies (PET) such as fertilizers and improved high yielding seed varieties applying a probit model. The result showed that members of *Iddir* (informal funeral group) were more likely to adopt SWC (18.2%). For the case of PET, *Iddir* members were 12.8% less likely to adopt. Being members of *Jarsumma* (informal conflict resolution) increased the likelihood of SWC and PET adoption by 12.87% and 17.8%, respectively. Therefore, technology transfer should consider different types of social capital as an alternative policy option to the prevailing top down approaches in order to improve smallholder livelihoods.

Keywords: social capital, technology adoption, Ethiopia

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1. Introduction

Agriculture is one of the most important sectors of the economy of Ethiopia [12]. The sector is vital for food security at the national level and accounts for the livelihoods of nearly 85% of the population. Although the transformation towards a more manufacturing and industry oriented economy is in progress, the sector still accounts for 46% of the GDP, 73% of overall employment, and close to 80% of foreign export earnings [6]. The major part of the sector consists of smallholder farmers operating on less than 2 hectares of land [6]. On the other hand, the productivity of the sector was and is almost stagnating over the last decades, e.g. for cereal crops it is approximately 1.2 tons/ha [17]. Realizing the sector's low productivity problems, research findings by Dadi et al. [12], Wossen et al. [39], or Teklewold et al. [35,36] suggested that the adoption of agricultural technologies by smallholder farmers is a promising alternative to get out of the poverty trap. However, the level of technology adoption in the country is not going as fast as expected. For example, Wossen et al. [39] found an adoption rate of 4.7% for land management practices (bunds), and Teklewold et al. [36] reported less than 10% for the adoption of productivity enhancing technologies such as fertilizers.

This kind of challenge motivated researchers to begin asking the rational question "what are the determinants of technology adoption?" In order to give a reasonable answer to this question, studies such as Dadi et al. [12], Asayehegn et al. [4], Deressa et al. [14], and Gebregziabher et al. [22] investigated the adoption factors and found that the major determinants are socio-economic factors such as age, education and gender of the farmers. They also identified economic incentives, supply side constraints such as access to extension services, agricultural inputs and credit as major determinants. Furthermore, the literatures also included physical factors such as land endowment, livestock and other agricultural assets, as well as agro-ecology as factors influencing technology adoption. These factors are usually relevant in adoption studies since they are adopters' adoption capacity indicators. However, almost all studies omitted the role of social capital in agricultural technology adoption. There are some exceptions such as Wossen et al. [39] or Di Falco & Bulte [16]. For example in the case of Wossen et al. [39], the study investigated the effects of social capital on adoption of land management practices under different risk scenarios. The authors concluded that some social capital such as *Ikkub* and *Debo* influence adoption of the practices positively while social capital such as *Iddir* and *kinship* influence adoption negatively. However, the actual prevalence of social capital indicators may differ according to norms, culture, agro-ecology and

tradition of the respective farming community. For Di Falco & Bulte [16], the study was conducted in the Nile basin of northern part of Ethiopia. The main social capital that the researchers dealt with was *kinship* (number of relatives) and its effects on the adoption of land management practices. The study concluded that larger numbers of kin living close to each other influences the adoption of the practices negatively, because this might create a free rider problem. In our view, the dimensions of social capital are not limited to one social capital indicator only. Generally, economists usually capture social capital by asking “are you a member of any organization?” without deeply looking into different types of social capital existing in the community, their dimensions, and influences on adoption of different technologies. Therefore, this paper focuses on analyzing different types of social capital that exist in the farming community of Ethiopia and their influences on improved soil and water conservation practices (SWC) and productivity enhancing technologies (PET).

The remaining parts of the paper are organized as follows. In the following section procedure followed to conduct the research is elaborated, followed by the main findings with their interpretation in section three. Section four presents a detailed insight of the discussion supported by related literatures. Finally, the paper highlighted the main lessons learned from the research and forwarded the policy recommendations. To the authors’ knowledge, this study is the first to investigate the effects of social capital in Ethiopia on both SWC and PET at the same time. The study incorporated the social capital with socio-economic factors to indicate the appropriate policy implications for smallholder farmers’ livelihood improvement in selected districts of Southern and Oromia regional state of Ethiopia.

2. Material and Methods

This paper uses data collected in a socio-economic household survey that is carried out during March to May 2014 among Ethiopian farmers. The sample is based on the ATA 2012 survey, but limited to a sub-sample of 398 households living in a 200 km radius around Hawassa town. Information was collected using a standardized quantitative questionnaire. Following the works of Besley

& Case [19], Tadesse & Belay [33], Wossen et al. [39], Kassie et al. [26], Gebregziabher et al. [22], and Teklewold et al. [35,36] on evaluating determinants of adopting profitable technologies, the study adapted a probit model to determine relevant factors. The underlying assumption is that any given farmer accepts and implements SWC or PET if the expected utility from adoption is higher compared to non-adoption. Accordingly, the adoption decision is modeled using the utility framework. Denoting the utility from adoption of at least one of the technologies as (U_{hA}), utility of non-adoption as (U_{hN}), and then the difference between the two as y^* . Thus, a utility maximizing household (hh) makes a choice of adoption if the utility gain from adoption is greater than non-adoption ($y^* = U_{hA} - U_{hN}$). In the empirical probit model, the decision of a farmer to adopt at least one of SWC and/or PET was specified and written as follows:

$$y_i = \begin{cases} 1[\beta x_i + \hat{\epsilon}], & \text{if } y^* > 0 \\ 0, & \text{otherwise.} \end{cases} \quad (1)$$

In the model, y_i represents the binary dependent variable of the individual farmer i^{th} whether he/she was willing or not to adopt the technologies and practices, β shows the coefficient of independent variables which needs to be estimated, x_i represents various social capital and other socio-economic, demographic and physical factors that are expected to influence the adoption, whereas $\hat{\epsilon}$ indicates the error term.

3. Result

The detailed analysis of social capital characteristics of SWC and PET adopters and non-adopters was used for comparison. Using χ^2 -test was used for the dummy social capital to compare its differences among the adopters and non-adopters of the two technology categories. Accordingly, 82% of the respondents, regardless of technology types or whether the respondents were adopters or non-adopters were members of an *Iddir*. With regard to *Ikkub*, only 15% of the adopters were members whereas membership from the non-adopters side was about 8% for SWC (Table 1).

Table 1. Social capital comparison of adopters and non-adopters

Social capital indicators	SWC			PET		
	Adopters (N=131)	Non-adopters (N=267)	χ^2 -test	Adopters (N=226)	Non-adopters (N=172)	χ^2 -test
	(%)	(%)	P-value	(%)	(%)	P-value
<i>Iddir</i> (funeral insurance)+	91.60	82.78	0.018**	84.07	87.64	0.310
<i>Ikkub</i> (informal saving)+	15.27	8.42	0.037**	9.73	11.80	0.504
<i>Debo</i> (labor sharing)+	22.90	23.44	0.904	23.45	23.03	0.921
<i>Jarsumma</i> (resolution)+	25.95	0.26	0.000***	19.47	10.11	0.010**
Agric. Producers+	4.58	1.47	0.059*	3.10	1.69	0.364
Water use group+	0.76	1.47	0.550	1.77	0.56	0.276
Watershed group+	3.82	1.83	0.229	3.10	1.69	0.364
Forest use group+	1.53	0.00	0.041**	0.88	0.00	0.208
Business group+	3.82	1.47	0.134	3.98	0.00	0.007***
Connection to local government+	3.82	0.73	0.026**	1.33	2.25	0.482
Women association+	14.50	4.40	0.000***	8.41	6.74	0.532

+indicates the dummy social capital membership ***, **, * shows significance at $\alpha=1\%$, 5% and 10% respectively

Source: Own data.

Similarly, the membership rate was low for PET, i.e. 9% and 12% for adopters and non-adopters, but still members of *Ikkub* respectively. *Debo* is a labor sharing mechanism among Ethiopian farmers. The members of *Debo*, and adopters and non-adopters of both SWC and PET were nearly 23%. The *Jarsumma* is one of the strongest types of social capital among the farmers showing significant differences between adopters and non-adopters of both SWC and PET regarding respondents' membership. Accordingly, 26% of the SWC adopters were members of *Jarsumma*, but very few (0.26%) non-adopters were members. Similarly, 19% of PET adopters were members and 10% of non-adopters were members. The result implied that *Jarsumma* membership is critical for the adoption of the two technology categories. About 15% of the SWC adopters were members of women's association whereas less than 5% of the SWC non-adopters were members of it indicating how strong this particular social capital is for adoption of the practices.

In order to understand the adoption pattern of different technologies and practices, it is important to look into their adoption rate, awareness, plan and land allocated for each of the technology. The SWC practices include the practices that already exist in the farming community and improved from time to time. Whereas the PET are improved high yielding seed varieties, drought resistant seed varieties, fertilizers and pesticides. Among the SWC practices, 82% of the respondents were aware of terraces. The adoption rate for the terraces was 27% with nearly 29% had a plan to adopt while more than 26% of the respondents were already aware of it, but didn't have a plan to adopt in the future. 34% of the respondents were

aware of agro-forestry, whereas 8% of them already adopted it. However, about 22% of our respondents had a plan to adopt the practice allocating about 1.6% of their land to the practice, while less than 5% of them have no plan. With regard to bunds about 28% of the households were aware of it while adoption rate is not more than 6%. Similarly, 15% of the respondents had a plan to adopt and allocated about 1.5% of their land to it. Among the PET, high yielding seed varieties are the main. Among our respondents, 81% of them were aware of the technology, 38% of them already adopted and majority of them still have a plan (40%) to adopt it allocating 9% of their land (Table 2).

In order to determine the factors influencing adoption of PET and SW, two econometric estimation models were run (see Table 3). Literacy was found to be a positive and significant variable among the socio-economic factors for both PET and SWC. Land slope was a significant determining factor that encouraged the adoption of SWC positively and adoption of PET negatively implying that the types of technology matters.

Surprisingly, access to credit influenced adoption of SWC negatively while it was not significant for PET. For SWC, both soil fertility and parcel distance were found influencing adoption negatively, yet agricultural extension influenced PET positively and significantly. Among the social capital, *Iddir*, *Jarsumma* and women's associations influenced adoption of SWC positively and significantly, whereas *Iddir* and connection to the local government influenced adoption of PET negatively and significantly. Among all the social capital, *Jarsumma* was found to be the strongest social capital affecting adoption SWC and PET positively and significantly.

Table 2. Adoption patterns of agricultural technologies and practices

Technologies and practices	Awareness (%)	Adoption rate (%)	Plan to adopt (%)	No plan to Adopt (%)	Allocated land (%)
Terraces	82.18	27.05	28.71	26.42	1.10
Counter plough	75.74	41.34	19.55	14.85	26.55
Mulching	27.77	3.96	12.62	6.19	0.98
Hedgerow	19.55	5.20	10.64	3.71	1.04
Agro-forestry	33.66	7.92	21.53	4.21	1.65
Vegetation strip	21.54	5.45	11.63	4.46	1.42
Cover crops	29.95	8.17	16.58	5.20	3.17
Crop rotation	73.76	49.26	19.80	4.70	27.76
Bunds stone/soil	28.22	5.94	15.84	6.44	1.56
Planted Bunds	13.12	0.99	9.41	2.72	0.20
Trenches/channel	27.50	3.96	15.12	8.42	0.95
Water harvesting	23.51	0.74	14.85	7.92	0.11
Irrigation	69.31	4.70	39.11	25.50	2.30
Composting	83.17	21.78	56.19	5.20	9.27
High yielding Varieties	81.19	37.87	39.85	3.47	14.95
Drought tolerant variety	13.37	2.23	9.16	1.98	1.27
Conservation tillage	24.51	5.20	14.36	4.95	2.00

Source: Own data.

Table 3. Determinants of SWC and PET adoption

Explanatory variables	Marginal effect	
	SWC	PET
Age (year)	0.0017	-0.0010
Gender+	-0.0842	-0.0573
Literacy+	0.1623 ***	0.0965 *
Farm size (ha)	0.0151	0.0139
land slope (1-5 scale)	0.1461 ***	-0.0556 *
Access to credit+	-0.2186 ***	0.0647
Dependency ratio	-0.2958 **	-0.0353
TLU per capita	-0.0045	-0.0505
Soil quality (1=fertile)	0.0356	0.0053
Parcel distance (min)	-0.0025 **	-0.0012
Access to extension service	0.0532	0.2185 ***
<i>Iddir</i> ⁺ (informal funeral insurance)	0.1820 ***	-0.1277 *
<i>Ikkub</i> ⁺ (Informal saving and credit)	0.0114	-0.0478
<i>Debo</i> ⁺ (informal labor sharing)	-0.0446	0.0064
<i>Jarsumma</i> ⁺ (informal dispute resolution)	0.1287 **	0.1777 **
Women associations+	0.1791 ***	0.0051
Connection to local government+	n.a.	-0.4396 **
N	398	398
Prob>chi2	0.0000	0.000
Pseudo R2	0.2399	0.0940

⁺ indicates the dummy social capital membership ***, **, * shows significance at $\alpha=1\%$, 5% and 10% respectively

Source: Own data.

4. Discussion

Iddir is a social capital indicator considered when the household head got a membership in the funeral arrangement. It is established to provide service to family members following the death of a family member or relatives [27,39]. The same studies showed that being member of *Iddir* may help members during livestock loss, crop failure, illness of a family member, and/or fire loss. In this regard, Wossen et al. [39] argued that *Iddir* can discourage the adoption of land management practices since the members contribute to the arrangement through cash, kind or labor which diverts the financial and labor resources from the adoption of the practices. But it is also possible to argue that it might facilitate adoption through relaxing financial shortage, creating social bond and trust, and reducing transaction costs, especially in the absence of formal credit. Among the adopters of SWC practices above 90% were members of *Iddir*. Whereas the non-adopters of SWC practices were about 83% indicating significant difference between adopters and non-adopters of SWC, while high percentage of membership to *Iddir* indicated to be a member of *Iddir* is social responsibility. Similarly, there was significant differences between the adopters and non-adopters of SWC with regard to *Ikkub* at 5% and 10% significant level [39]. *Ikkub* is a particular social capital indicator which also acts as financial source during financial limitation. According to a study by Wossen et al. [40], Wossen et al. [39], *Ikkub* is an informal local social capital of a group of people, which may be established based on their mutual benefits, and

contributes fixed amount of money monthly, weekly or every two weeks depending on their agreement and income. The authors also argued that membership in this particular social capital indicator facilitates adoption of SWC through provision of access to the informal financial sources which may relax the supply side constraints the farmers are facing. The members of *Ikkub* and adopters of SWC were about 15% whereas the non-adopters of SWC but members were 8%.

Labor sharing arrangement (*Debo*) is crucial in the farming community especially during the weeding, ploughing or harvesting times. The system is arranged in a way that the members contribute the same working hours to work on their private land such as their crop lands, or communal land such as watershed management. As Wossen et al. [39], Wossen et al. [40] argued, *Debo* is organized to facilitate the adoption of improved land management practices through provision of labor exchanging option during labor shortage period. In rural Ethiopia, the system of land and water management practices also have some common pool resources characteristics where one can argue that it creates the free rider problem. In this regard the study debates that for adoption SWC, it has typical governance challenge which is a free riding problem. This means, the final results of the common pool resource will be shared among all the participants regardless of their level and frequency of participation. However, argument regarding PET is that *Debo* might have positive effects on adoption since the farmers can control the performance of the *Debo* members. The *Jarsumma* as investigated by Bayeh et al. [7] in

western Oromia, is derived from the word “*Jaarsa*” in *Afan Oromo* (the language of Oromo people) which means elders. The *Jarsumma*, therefore, is the procedure of solving dispute among individuals, groups or tribes on common or private resources or ethnic based conflicts through truth and win-win mechanism. In this study there was statistically difference between adopters and non-adopters of both SWC and PET (regarding *Jarsumma*) at 1% and 5% respectively. That indicated that the *Jarsumma* is the most powerful social capital among others. Even though a study by Bayeh et al. [7] did not focus on adoption of agricultural technologies, the authors justified that this kind of dispute resolution preferred than the formal court. This is because, the authors justified, it is less time consuming and has less transaction costs, future fortune creation among the conflicting parties and win-win results unlike the formal court where one must be a winner and the other must be a loser. Therefore, it is not a surprise in this case to come up with that it is the most powerful in both categories of the technologies. For women associations there was significant difference among adopters and non-adopters of SWC practices indicating the members and adopters are more than the members but non-adopters. The finding supported result of Personal et al. [31] in India that showed the women associations create strong social bonds among the members.

For the SWC adoption pattern, nearly 82% of the respondents were aware of terraces. The adoption rate for the terraces was 27% and nearly 29% had a plan to adopt. Surprisingly more than 26% of the respondent didn't have a plan to adopt in the future though they were aware of it. That could be due to terraces are mostly built on the steeper, highly flood and erosion prone land types. About 1.1% out of the total land allocated for terraces supporting that terraces are typically slope dependent. Counter plough is practiced every year to reduce erosion and remove deep rooted grass while ploughing the farm [29]. About 76% of the farming households were aware of the practice. Its adoption rate was 41% holding the second rank after crop rotation. Among those who were aware of it, 19% of them planned to adopt in the future whereas 15% of them did not have plan to adopt due to the land type the farmers have might not require the practice. About 27% of their land was also allocated for this practice which was comparable to the crop rotation practice.

Mulching is used to conserve soil and moisture. About 28% of the respondents were aware of mulching; however its adoption rate was not more than 4%. Nonetheless, about 3 fold of current adopters had a plan to adopt it. At the time study, the percentage of allocated land for the practice was nearly 1% and about 6% of the respondents had no plan to adopt. That low level of plan indicated labor requirement and availability of the material as mulching input [8]. Agro-forestry is the critical conservation measure among the Ethiopian farmers [38]. Our analysis showed that 34% of the respondents knew what agro-forestry is and its adoption was nearly 8%. However, the farmers had a plan to adopt (22%) understanding its advantages to mitigate effects of drought and climate change [29]. Even though the farmers had a plan to adopt, currently, less than 2% of their land was allocated for the practice. As Jasa et al. [25] explained,

crop cover is soil and water conservation method where suitable crops are grown to recover soil degradation. It is proved that “*it ensures soil health*” and reduces sedimentation and erosion. Among the respondents, about 30% of them were aware of it though the adoption rate was 8%. Eventually, the plan to adopt it in the future was quite higher (17%) and allocated land for the practices was also ranked fourth (>3%). Crop rotation was the most popular among our respondents in terms of adoption rate (49%). It was the 5th ranked practice in terms of farmers' awareness. Similarly, it was the 5th ranked technology that the farmers having a plan to adopt it in the future. As Ahmed [1] argued, crop rotation is an alternative measure even to fertilizer or other conservation techniques in terms of enhancing productivity and ensuring fertility of the soil and resist crop diseases.

Soil and stone bunds are one of the best conservation techniques in Ethiopia. For example Gebremichael et al. [24] indicated that 7 tons/ha/year soil lost every year by sheet erosion due to lack of bunds. In this study, 28% of the respondents were aware of soil and/or stone bunds. However, its adoption rate was only 6% but 16% of adoption plan with less than 2% allocation of land. That low level of adoption might still be due to the character of the plots as the farmers need bunds only on specific area. According to Vancampenhout et al. [37], some farming areas of Ethiopia are prone to flood specially during the main rainy seasons between June and September. The same study showed that crop yield in the land with constructed bunds is 17% higher than those without bund situation in Hararge zone in the eastern Ethiopia.

According to Alem. (2000), water harvesting system in Ethiopia is water reservation strategy if the plot faces water deficit. The same study argued that water harvesting system can be done through rain water harvesting and catching run-off or flood spreading into traditional or modern ponds. Accordingly, the descriptive results of the study indicated that 24% of the farming community knew about the technique. Nonetheless, the adoption rate was low (0.74%), the future adoption plan was higher (15%).

Irrigation could contributed about 140 billion Ethiopian Birr to the economy of the country provided that it is successful, yet it is not a simple bullet that is made up of silver [5]. About 70% of the sample were aware of irrigation, but the adoption rate was <5% with higher (39%) adoption plan. During the study time, only about 2.3% of the farmers' land was irrigated. The finding implied that farmers were well aware and had a plan to apply the practice provided that the farmers had capacity to acquire the irrigation equipment. Finally the argument by Awulachew et al. [5] could also be practical.

A study by Edwards S. et al. [19] elucidated that, compost is applied to increase soil fertility and enhance crops yield. The same study recommended 15 tons/ha assuming that the recommended rate of chemical fertilizer of 120 kg/ha is applied by farmers in Tigray region. For maize, for example, the study showed that without application of fertilizer or compost the yields was 1,760 kg/ha, whereas the yield was 3,748 kg/ha and 2,900 kg/ha by applying compost and chemical fertilizer, respectively. The findings of this study also supported the argument where awareness of compost was ranked first among other technologies and practices. Accordingly, about 83% of the

farmers were aware, among which 22% were already applying the practice. Furthermore, 56% of the respondents had a plan to adopt the practice, but very few of them had no plan to adopt (5%). Similarly, the share of land allocated to compost was ranked fourth (9%).

High yielding seed varieties (HYSV), according to Alwang et al. [2], showed improvement of yield that found to be 44-63% advantageous over the local varieties where producers are able to gain additionally about 9 USD benefit per person per year. This study found that more than 80% of the respondents were aware of HYSV. Among those who were aware of it, 38% were adopters whereas 40% had a plan to adopt and 15% of the land is grown by HYSV. Melkasa 2 and Melkasa 4 drought tolerant maize seed varieties have shown significant yield increment, from 44.8% to 55.2% per ha as compared to open pollinated varieties in Ethiopia [11]. Based on the findings, 13% of the farmers were aware of the technology, whereas its adoption rate was not more than 2.2%. For conservation tillage, 24.5% of the respondents were aware of it, while 5% and 14% adopted and had a plan to adopt respectively. At the time of study, about 2% of their land was allocated to the practice. According to Teklewold et al. [35,36], conservation tillage leads to higher level of pesticide application and higher demand for labor. This is due to compensation of the minimized cultivation. Generally, the level of adoption as well as plans of adoptions varied across farmers for SWC and PET. Therefore, it is an interesting area of intervention for the government, development organizations and other stakeholders to further advance awareness about profitable technologies and practices while at the same time design strategies to promote the adoption of such practices. In the model, switching from illiterate to literate increased the SWC adoption likelihood by 16.23% keeping other things constant. The finding was not surprising as literate farmers might have more access to information and the may better understand the advantages and disadvantages of a particular technology and/or practice. It supported the findings of Wossen et al. [39] and Challa et al. [10]. Relative to households with low dependency ratio, those with high dependent individuals were 29.58% less likely to adopt SWC. This result agreed with Tadesse & Belay [33] on that when dependency is high in a given household, the priority of that particular household is to fulfill the immediate needs such as growing crops for the household consumption. SWC practices, however, leads to capturing some part of their land, creates appropriate environment for grass to grow in the farm that might be difficult later on to cultivate, and this finally requires labor to manage the land whose benefit comes in the long run.

Surprisingly, credit access discouraged adoption of SWC. If a farmer had access to credit, the probability of adoption was less by 21.86% as compared to those who had no access. This can be explained as those who have access to credit might not be willing to invest into the practices, and rather they are more interested to invest in other non-agricultural activities. The findings agreed with Wossen et al. [39] where they found the negative effects of credit on land management practices. Another explanation could be that SWC are more traditional among the Ethiopian farmers [30]. This implied the necessary conditions including financial and labor

requirements for the conservation obtained from their traditional social capital such as *Iddir*, *Ikkub* and/or *Debo*. Therefore, credit provision is not the priority for these kinds of practices where there exists the traditional social capital. This confirms our hypothesis that “*If farmers have no access to credit, social capital promotes adoption by relaxing financial constraints*”.

Land slope also achieved the expected sign and significantly influenced adoption probability. Applying a scale variable that ranges from the value of (1) for flat land to the value of (5) for the steepest land, the steeper land slope encouraged SWC adoption (14.61%) as compared to flatter land, holding other factors constant. The finding also supported the idea of “*farmers usually want to reduce the soil erosion and increase the productivity of their land*” by several studies such as [24,33,39,40].

The time the farmers need to walk from their homestead to their parcel was also a significant variable that achieved the expected sign. An additional minute walk to their parcel, farmers decreased their adoption of SWC by 0.25% as compared to farmers living near to their farm parcel. The study argued that the more distance the farmers walk from their land, the less likely they manage their farm land properly. The result was supported by the findings by Gebremedhin & Swinton [23] that showed 29.3% less likelihood of adoption probability of soil conservation practices as compared to their counterpart.

The major social capital types dealt with in this study were *Iddir*, *Ikkub*, *Debo*, *Jarsumma*, connection to local government and women association. All of the social capital indicators achieved the expected signs anticipated at the beginning our study. Ultimately, switching from non-member to member of social capital *Iddir* increased adoption likelihood of SWC by 18.20% compared to non-members. The findings contradicted the findings by Wossen et al. [39] that *Iddir* discourages adoption of land management practices by 26.5%. The authors justified that the *Iddir* might divert labor and financial investment from the conservation towards burial ceremony though they did not support their findings by literatures as no one investigated *Iddir* as adoption factor prior to their study. Being the second to consider *Iddir* as adoption factor, this study argued that it provides the financial support, especially in the absence of or limited credit, and encourages adoption of SWC practices. For the *Jarsumma* social capital, switching from non-member to member increased adoption likelihood by 12.87%. Though the study could not support the findings by literatures, it was not surprising to end up with that finding as *Jarsumma* is dealt with by well recognized, elders, tribe or religion leaders in the society. The *Jarsumma* is characterized by the collection of *Jaarsa* (elders) from the society members in which the rest accept and implement their advice [7,18]. With regard to women associations, being a member of women association increased adoption of SWC by 18% as compared to being non-member.

Women associations play a role in relaxing the supply side constraints for such adoption. The argument was supported by Amakiri [3] who suggested that women are primarily cultivation units and prevent soil degradation in Ethiopia. In general, the SWC adoption determinants are various and complex in the farming community of

Ethiopia. Therefore, it is essential to include the social capital as a factor of adoption and promote technology transfer.

In the second component of the model, the study investigated the probability effects of dummy social capital on adoption of PET. The results suggest that being literate increased the likelihood of PET adoption by 9.65% as compared to illiterate respondents. The findings supported the results of Yu & Nin-Pratt [41], which indicated the education level of adopters and non-adopters are significantly different and the more the respondents were literate, the more they are likely to adopt agricultural technologies. Having extension services increased adoption probability of PET by 28.85% compared to farmers without extension services. The findings are also supported by similar results from Fufa & Hassan [20].

Agricultural extension was more important for adopting PET than SWC practices. This reflects the extension service provision that is directed towards PET. In the case of PET it was found that credit was not significant, but positively influencing the adoption of the technologies. The result indicated that credit is potentially playing a role in PET adoption, but it needs further investigation. Land slope, unlike the case of SWC, influenced adoption of PET negatively. This is not a surprising result as farmers might have no incentive to apply expensive inputs (seeds and fertilizers) on sloppy land that is prone to flood and their inputs can get lost over night. Results showed that farmers who owned steeper land were less likely to adopt PET (5.56%) than those who owned flat land. These results are supported by those of Fufa & Hassan [20].

With regard to the *Jarsumma*, similar to SWC, it was found to have positive and significant effects on adoption of PET. Switching from non-member to member increased PET adoption likelihood by 17.8%. With regard to connection to the local authority, the members with connections to local authorities were less likelihood (44%) to adopt PET than those without connections. These findings contradicted the results of Wossen et al. [39]. The study argued that government might use the members for other administrative issues than focusing on the technology. Therefore, it diverts the labor time and other resources from these technologies. In case of *Iddir*, it was found influencing PET significantly and negatively (13%), which agreed with findings of Wossen et al. [39] for land management practices. The justification for these findings was that for *Iddir* and *Ikkub*, the source of money or the farmers' periodic contribution is from the farmers' themselves, unlike credit. That indicated time preference problem where all the farmers need financial resources at the same time to purchase PET. Therefore, no one is willing to contribute during rainy season except the funeral ceremony.

5. Conclusion and Recommendation

Agriculture is a backbone for the economy of Ethiopia with a major contribution to the livelihood of Ethiopian people. Increasing the productivity of this sector is vital to insure food security of the people especially smallholder farmers. To achieve this objective, adoption of practices and transfer of agricultural technologies can benefit from

the society's social capital. Thus, identifying the types and dimensions of the social capital in order to estimate their probable effects is important. Accordingly, some social capital such as *Jarsumma* had positive and significant effects on adoption of SWC and PET. On the other hand, some social capital indicators were identified to have positive and/or negative effects on the two technology categories. For example, *Iddir* has positive and significant effects on the adoption of SWC whereas it influenced the adoption of PET negatively and significantly. Similarly, *Ikkub* influenced the adoption of the SWC positively and PET negatively. Yet in both cases the effect was insignificant. Therefore, the study concluded that different types of social capital affect the adoption of the two technology categories differently. Though adoption of technology is suggested as a corner stone addressing the food insecurity problem, the main stepping stone to build the whole livelihood of farmers shall integrate the social capital of the farmers. Therefore, this study recommends that promoting and strengthening social capital indicators as an alternative to the top down strategies. On top of this, consultation, involvement, and active participation of the community in agricultural technology development, improving agricultural practices and adoption throughout sharing the final results are inevitably important approach and a promising alternative to bring about sustainable development at the country level.

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