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Factors Influencing Farmers Participation in Smallholder Irrigation Schemes: The Case of Ntfonjeni Rural Development Area

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Abstract
Most Swazi households depend on rainfed agriculture for food production, which limits the output because of the unreliable rainfall in the country. To mitigate this, the government has invested in rehabilitation of irrigation schemes to reduce the dependence on rainfall. This study therefore determined the factors influencing participation of farmers in small holder irrigation schemes in Swaziland, using Ntfonjeni Rural Development Area (RDA), as a case study. A multistage sampling technique was used to select 96 farming households, 48 participants of local irrigation scheme and 48 non participants. Data was collected using questionnaires. Analysis involved descriptive statistics and probit model. The study revealed that the participation in small holder irrigation schemes is significantly influenced by households distance to the scheme, age and occupation of household head, farm size and access to credit and membership in other groups. Participation improves output and income for households. Hence it is recommended that peasant farmers should be assisted with credit facilities as an incentive to participate in irrigation schemes.
Key words: Participation, small scale irrigation schemes, Probit, Ntfonjeni, Swaziland

1. Introduction

Most Sub- Saharan African countries are characterized by low agricultural productivity. One of the reasons for poor production is that African agriculture is predominantly rain fed, which is in most cases unreliable resulting poor yields and the changing weather conditions would further exacerbate the situation, exposing small farmers to negative impact of climate change (Todaro, 2012). It has been argued that one strategy which would be used to mitigate water scarcity and dependence on rainfall is irrigation. Indeed Pinstrup (2011) and Hussain (2004), revealed that investing in smallholder irrigation schemes is one of the strategies to improve production levels especially for small holder farmers. The general belief is that irrigated agriculture limits crops failure, external shocks and increases yield thus leading to better food security, and hence Swaziland has seen development of new and rehabilitation of existing irrigation schemes.

Government investment in small holder irrigation system (SHIS), reduces the risk of relying on rainfall and ensures continuous supply of produce throughout the year which improves the income of the peasant farmers. Although access to irrigation water may be the potential to improve production, it needs to be complemented with other agrarian reforms (access to credit, market restructuring, access to extension), institutional restructuring of land reform issues, change in the farming system by using appropriate technology which uses less labor, and finally investment in infrastructure (Todaro, 2012).
Households participation in SHIS leads to community empowerment, through the use of collective action benefits. Hence empowerment and participation are two most important issues in agricultural development programs. Participation is critical, in order to come up with successful and accepted programs since they facilitate the development plans (Nxumalo and Oladele, 2013).
The current total irrigated land in the country is 54 933 ha, with sugar cane, which is the main cash crop sector occupying 50 000 ha, while smallholder irrigation schemes cover an area of more than 5000 ha (MOA, 2013). These sugar cane schemes are located in the low veld region and mostly owned by estate companies. In the other parts of the country, the smallholder schemes grow mainly vegetables which add to the consumption basket of the households as well as income through surplus output sold locally. Despite the many interventions some households still do not participate in these irrigation schemes. Low participation in any agricultural development projects could be due to inability of the project to meet the production needs of farmers (Martey et., al, 2013). Participation is a necessary condition for adoption of technology but not a sufficient condition. Hence, the present study examined the socioeconomic and institutional factors that influence participation of smallholder irrigation schemes in Ntfonjeni, Swaziland. The objectives of the study were: to compare the socioeconomic dimensions of participants and non participants and to determine the factors that influence farmers to participate in the irrigation scheme

2. Literature review

2.1 Irrigation schemes in Swaziland

Irrigation schemes in Swaziland started in 1968 by the Ministry of Agriculture as means of ensuring food security and poverty alleviation for the rural poor (SADP/IFAD, 1998). The mandate of the ministry of agriculture is to develop irrigation schemes countrywide in suitable productive areas. In the 2008-2013 strategic plan, the government intended to create 18 irrigation schemes country wide with a budget of SZL54.6 Million. (E/SZL1=ZAR 1= 0.1 US$). Ministry of Agriculture 2013 performance report reflected major irrigation schemes in Swaziland to be the following:

The Komati Downstream Development Project (KDDP) is under Swaziland Agricultural Development (SWADE) extends over 27,000 hectares (ha) with a population of about 22,000 people. The aim is to develop 6,000 ha of new irrigation schemes along the Komati basin in collaboration with smallholder farmers using water from the recently completed Maguga dam. It was being implemented by the Swaziland Komati Project Enterprise (SKPE), and funded by the Swaziland Government. The budget allocation for this project for 2013 is SZL26 Million of which SZL16 Million comes from the government of Swaziland and the rest from the donors.

The Lower Usuthu Smallholder Irrigation Project (LUSIP) also under SWADE involves the construction of three dams to form an off-river storage reservoir to impound water that will be diverted from wet season flood flows on the lower Usuthu River. The project is in two phases, and aims to develop a net of 11,500 ha for irrigation. It is being financed through agreed loans from several organizations including the African Development Bank, the Development Bank of Southern Africa, the Arabic Bank for Economic Development in Africa, the International Fund for Agricultural Development, and the European Investment Bank. The budget allocation for 2013, was SZL140 Million of which SZL85 Million come from the government of Swaziland and the rest from the donors.

The Smallholder Agricultural Development Project for irrigation development (SADP), was designed to assist the most disadvantaged agricultural producers in the Swazi Nation Land. In 1993 a loan was approved from the International Fund for Agricultural Development (IFAD). Its subcomponents consist of development of 185 ha of new small-scale irrigation and consolidation of another 257 ha of existing schemes to promote farmers' management of irrigation schemes. There are a total of 20 irrigation schemes created to benefit households (MOA, 2013). Irrigation schemes under this project include Nkwene, Emavulandlela, Mancubeni, Mahhulumba, Mswati, Mphatheni, Mkhondvo, Ekuvinjelweni, Mgubundla, Mbekelweni, Ntamakuphila, Mgofelweni, Nkwungwini, Mahhulimbe,Mashobeni and KaLanga irrigation schemes . Most of these schemes specialise in vegetable production.

Lavumisa Irrigation Project (Maplotini) has developed 300 ha of land, and uses water from Jozini Dam in South Africa pumped by the South African Government as a compensation for flooded land in Swaziland, adjacent to the dam. A total of 75 smallholder farmers are participating in the scheme.

2.2 Rural Development Areas (RDA) programme in Swaziland

There are 18 RDAs in the kingdom of Swaziland which are located in the Swazi Nation Land (SNL), which were established from 1970, through the help of many donors (RDAP, 2009). The first phase of RDAs in Swaziland was established in 1970 and was financially assisted by the UK government which financed four RDA. The second phase was in 1977-1983 where the UK government funded four more RDAs and ten RDAs were jointly funded by the World Bank (IBRD), the African Development Bank (ADB), European Development Fund (EDF), and United states Agency for International Development (USAID) and the Government of Swaziland (GOS) provided counterpart funds.

The main objective for RDAP is to improve the income and general standard of living of Swazi farmers, especially the peasant farmers and at the same time to protect land resources. This was to be achieved through improving crop and livestock production by strengthening the extension services, highly subsidized tractor hire for farmers, ensuring that soil conservation practices are followed by farmers, building dams for irrigation, and other infrastructure such as roads that will assist farmers to improve their production, and ensuring farmers that they get access to both credit and output markets.

RDA centers in Swaziland are located in all the four climatic regions. In the Highveld there is Mahlangatsha/Mponono, Ngwempisi,and Motshane. In the Midleveld there is Ntfonjeni, Southern, Central, Mayiwane, Ebulandzeni, Mahlalini, Zombodze, Hluthi, Mliba, Sandleni and Madlangempisi. In Lowveld region,there is Siphofaneni, Masala and Sithobela RDA and in Lubombo Platue there is Mpolonjeni RDA

2.3 Conceptual framework

Previous studies have found that the major determinants of farmers choice to participate in small holder irrigation schemes is mainly due to socioeconomic dimensions of households, the institutional and technical factors,(Bunclark, 2010).

Conceptual framework in figure 1 shows that government policies towards investment in irrigation, increase output by increasing irrigable area, reducing rainfall risk, improves productivity through multi-cropping and use of high variety crops. However, the household decision to participate in influenced by the socioeconomic, institutional and technical factors. Conceptual framework for this study was adopted from a study by Nedumaran (2009), in Ghana.

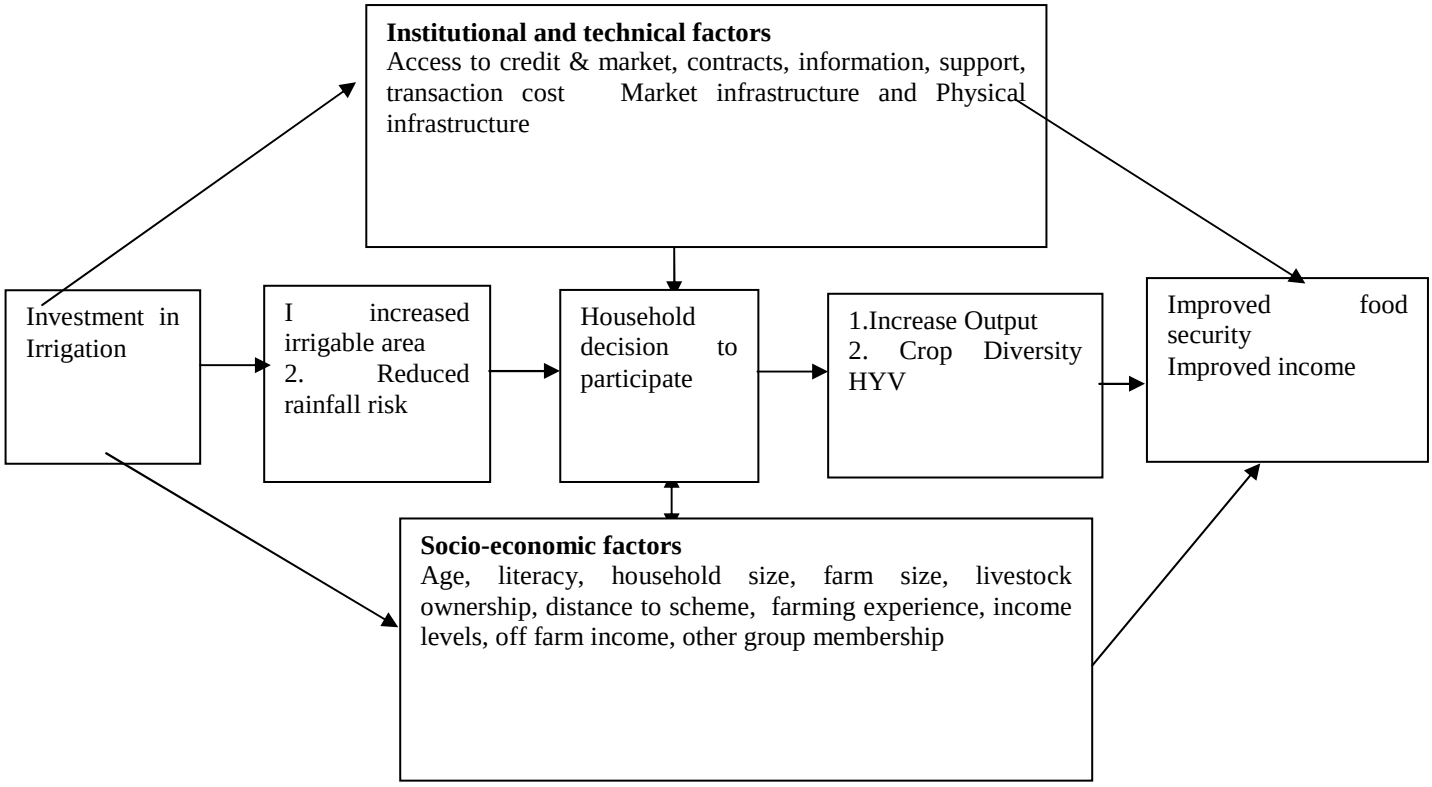

Figure 1: Conceptual framework

3. Methodology

3.1 The study area

Nfonjeni area is located in the Moist Middle veld (MMV) livelihood zone of Swaziland, latitude 25.82^0 S and longitude 31.42^0E, (Figure 2), and altitude 835M. Average annual rainfall is 1099.4mm/year which comes from August to February and maximum temperatures of 34^0c. The area is located in the top north of Swaziland next to RSA border to Mpumalanga province. MMV zone is characterized by moderate in cereal production (SAVAA, 2009). Agriculture is mainly rainfed and the major crop is maize, although some famers practice livestock farming.

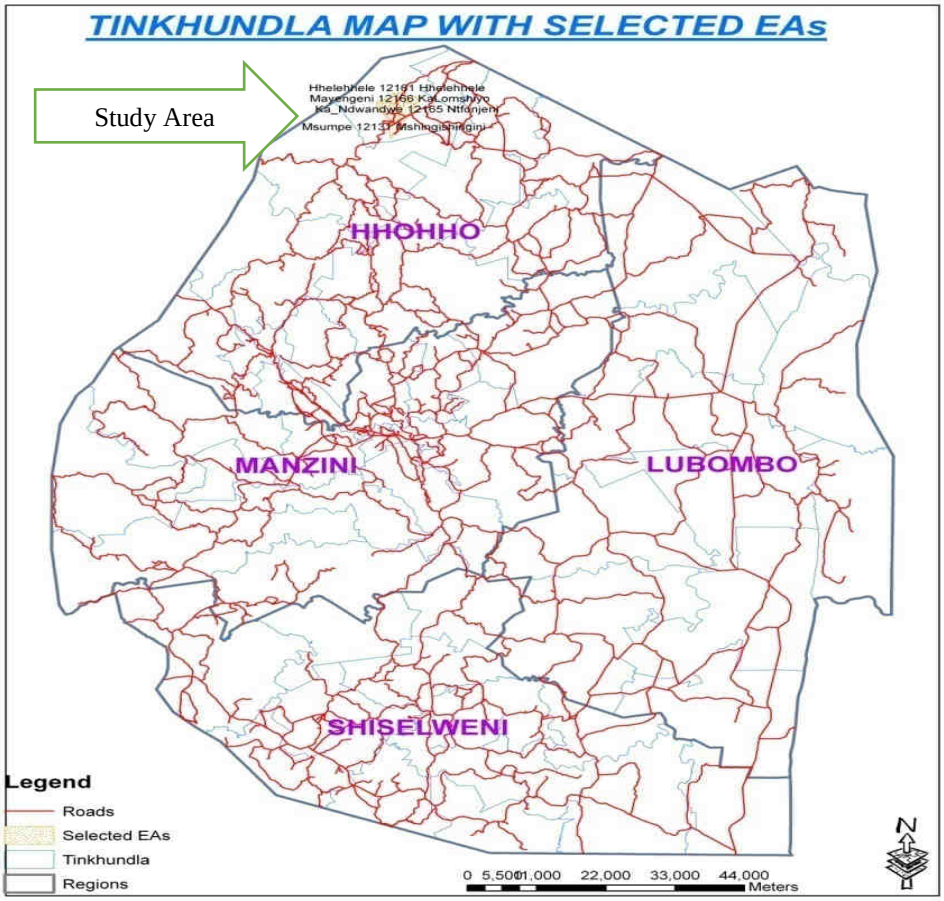

Figure 2. Study area map: Source: Central Statistics Office

3.2 Sampling and data collection procedure

A multiple stage sampling procedure was used to select 96 households in Ntfonjeni RDA. Households residing close to the irrigation schemes were sampled comprising 48 households who are participants and 48 non participating households. A semi-structured questionnaire was used to collect data from selected participants and non-participants on a one to one interview. Relevant secondary data was obtained from reports from central statistics office, ministry of agriculture, extension officers, and the meteorology station.

3.3 Methods of data analysis

Participation in irrigation schemes is an important platform for joint learning and technology transfer (Martey, et al., 2013). When an individual's choice is discreet and there are only two choices involved, it is binary choice and a Logit or Probit model is applicable. In this study a probit model was used in the analysis because and there is no rule compelling the choice of the two models (Gujarati, 2004). The dependent variable is participation assuming the value of 1 for participant, and 0, otherwise. The general formula for probit is specified as:

$$y_i^* = \beta x_i + \varepsilon$$

Where $\varepsilon \sim N(0,1)$……..…1

In probit we observe only

$$y_i = \begin{cases} y_i^* > 0 \text{ is } = 1 \\ y_i^* \leq 0 \text{ is } = 0 \end{cases} \quad \text{…….2}$$

$$\text{Prob}(y_i = 1|X) = \int_{-\infty}^{X'\beta} \Phi(t)dt = \Phi(X'\beta) \text{……..……....……...3}$$

The general probit function is

$$Y(0,1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots \beta_n X_n + \varepsilon_{ij}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where β_0 is the constant term or intercept and β_1, β_2 …. β_n represent the parameters to be estimated and **ε** is the error term.

3.4 Description of explanatory variables

Sex of household head: is a dummy variable 1 if male and 0 if female and is expected to determine the difference in decision to participate in small holder irrigation schemes between male and female household heads. Males are expected to have a high probability of participating as compared to females because they make the final decisions in the households. On the other hand women are sometimes discriminated to access to land and are often occupied with other household's activities hence the probability of them to participate is very low.

Age: is a continuous variable. Previous empirical studies found a two way relationship between age and participation in irrigation scheme as well as other agricultural technologies. Younger household heads are more dynamic with regards to adoption of innovations than older household head; however they are usually more occupied with other job opportunities as compared to farming. Also older household members are assumed to have more experience in farming and hence an increase in the probability of participation. Therefore, this study did not hypothesize the sign of relationship between age of the household head and participation in irrigation scheme

Marital status: is a dummy variable 1 if married 0 otherwise. Due to joint decision making, married households are expected to have a higher probability of participating as compared to single headed households, hence divorced and widow were treated as not married in this study

Education: is a continuous variable indicating formal years in schooling**.** There is also a two way relationship with education and the probability of household willingness to participate. Most previous studies indicated that the possibility to adopt and apply new methods of farming increased along with education level is posited to have a positive effect on participation since it enables an individual to make independent choices and to act on the basis of the decision, as well as increase the tendency to co-operate with other people and participate in group activities (Etwire. et al., 2013). However, it is also possible that education could increase the chances of the household head earning non-farm income and opting for white collar jobs as compared to farming. This could reduce the household dependency on agriculture and thus participation.

Household size: is a continuous variable indicating the number of people who live and eat together. This variable is expected to positively influence farmers' participation. Household size serves as a form of family labour and complements the effort of the household heads on the farm (Martey. et., al 2013). The availability of family labour provides the household head the opportunity to share responsibility and save time for other development activities. Also, larger households spend more on food and other household needs and hence the need for external support.

Farm size includes total land size that the household has which is irrigated and non-irrigated. This variable is continuous and hypothesized to have a positive influence on household decision to participate. Household head with more land will require improve seed varieties that are more yielding. However farm size alone is not sufficient to influence the probability of participation as peasant farmers will also need access to HYV of seeds and also the issue of labour of which most of them depend on family labour.

Off-farm income is expected to have a negative relationship with probability of participation. Household head that earns off-farm income may have little time to participate in farming activities in small holder irrigation schemes.

Livestock is a continuous variable which is expected to have a negative relationship. Households that are more into livestock farming may not see the need of also doing a lot of vegetable production since both activities are time consuming

Other groups' membership: is a dummy variable with 1 if there is other group excluding the scheme joined and 0 otherwise. It is expected that household head membership of group will negatively affect participation. However, savings, and other agricultural groups are expected to increase the probability of participation.

Credit availability is essential input in peasant farmers to purchase inputs. Access to credit serves as an incentive for farmers to increase their production and overcome the financial constraints in participating in development projects which also has a direct impact on their livelihoods. This variable is dummy with 1 if a farmer has access to credit and 0 otherwise, hence a positive relationship is hypothesized.

Distance to the irrigation scheme: is a continuous variable which is hypothesized to have a negative relationship. Households near to the irrigation scheme are expected to participate more as compared to far households.

Occupation: is a dummy variable taking the value of 1 if the household primarily depend on farming to support the family and zero otherwise. A positive relationship is hypothesized for this variable. Household heads which have got no other sources of income are expected to participate in the irrigation development.
Market and extension: are dummy variables taking the value of 1 if the household has access to market or extension and zero otherwise. A neutral relationship is hypothesized for these variables, due to different results from past studies.

Table 1: Description of variables

Independent variable	Unit of measure	a priori expectation
Sex	Dummy(1=male, 0=female)	+
Age	Years	+/-
Distance to scheme	Kilometers	-
Education	Numbers of years in school	+/-
Household size	Number of household members	+
Farm size	Hectare	+
Off- farm income	SZL	-
Livestock	Number of cows	-
Extension	Dummy (1= access, 0=no access)	+/-
Access to market	Dummy (1= access, 0=no access)	+/-
Credit	Dummy (1= access, 0=no access)	+
Occupation	Dummy (1=peasant, 0= otherwise)	+
Other group membership	Dummy (1= yes, 0=no)	-

4. Results and Discussions

4.1 Socio Demographic characteristics of sampled households

Table 2 presents the demographic characteristics of participant and non participant households. The mean age for participant household heads was 54 years and non participants 50 years, however, the difference was not significant. About 65% of the households were male headed with no significant difference between the participants and non participants. The participants had larger land sizes of 2.64 ha compared to 0.94 by non participants. The difference in holdings was significantly different at 1%. The main source of livelihoods was from agriculture evident from 88% of the participants and 59% of non participants. The difference was significant at 1 %.. There was also a significant difference at 1% level in the number of cows owned by participants as compared to non participants. This is an indication that participants were more diversified practicing both horticulture and livestock farming.

Table2: Household demographic characteristics in Ntfonjeni RDA.

Variables	Participants		Non participants		Total		t test	p-value
	Mean	Std	Mean	Std	Mean	Std		
Age	54.3	14.49	50.17	14.61	52.25	14.63	1.38	0.168
Sex	0.68	0.51	0.63	0.48	0.65	0.49	0.41	0.681
Hshld size	6.57	2.62	5.68	2.64	6.12	2.66	1.64	0.103
Farm size	2.64	1.06	0.94	0.76	1.79	1.25	8.91	0.000***
Education	6.76	4.38	6.17	4.52	6.46	4.44	0.64	0.518
Occupation	0.88	0.30	0.59	0.32	0.74	0.54	12.6	0.002***
Dep Ratio	1.29	0.18	1.30	0.18	1.29	0.18	0.47	0.638
Livestock	5.00	7.84	1.08	3.12	3.04	6.25	3.17	0.002***

*,**,***: refers to significance at 10, 5, and 1% level, respectively

4.2 Factors influencing participation in small holder irrigation schemes

The household participation in small holder irrigation schemes was significantly influenced by distance to the scheme, age, occupation of household head, farm size, and access to credit and memberships in other groups

(Table 3), while marital status, sex, education level, household size, extension, market access and non-farm income and livestock ownership had no influence with the household head decision to participate in the irrigation scheme.

The relationship between age and choice to participate in smallholder irrigation schemes (SHIS) was negative. A unit increase in age of household head significantly decreased the likelihood of participation by 0.1%. Similar results were obtained by Martey et al., (2013) that younger household heads are more innovative in terms of technology adoption and are more likely to take risk than older household heads. However, on the contrary, studies of Etwire et al., (2013); Khalherili (2008) and Oladele (2013) established that age was not significant in the household head decision to participate in agricultural projects.

Distance to the scheme significantly influences of households head decision to participate in SHIS. However, the relationship is negative, which means that the further the households are from the scheme, the less likely they are to participate as compared to households that are located at close proximity. A one kilometer increase in distance significantly decreases the likelihood of the households head's participation by 4.6%. However, Asayehegn (2011), found that distance had no impact on participation in Ethiopia.

Farm size significantly influences the probability of participation. A unit increase in farm size significantly increases the likelihood of the households head participation by 3.8%. This means that households who have access to more land are more likely to participate in the scheme as compared to households who have less land. Martey et.,al (2013); Mohammed and Jema, (2013) and Nxumalo and Oladele (2013), also observed that farm size influenced the household heads decision to participate in agricultural projects.

Access to credit is associated with a positive effect on participation in SHIS. The probability of participation in SHIS by a household head with access to credit was higher than those without access to credit. A unit increase in credit significantly increases the likelihood of the households head participation by 26.8%. The result is consistent with the findings by Martey et al., 2013 Asante et al., (2011); Nxumalo and Oladele (2013) and Etwire et al., (2013). Access to credit enables farmers to overcome their financial constraints associated with production and adoption of innovations. It also encourages group formation and learning.

Occupation is associated with a positive effect on participation in SHIS. The household head with no other job except farming was 18.3% more likely to participate in the scheme than those with other sources of income. The result is consistent with the findings by Mohammed and Jema (2013). This is plausible because the main activity in rural areas of Swaziland is agriculture hence farmers are more likely to participate in agricultural projects which can change their wellbeing

Finally, membership in other groups had a negative effect on participation. The probability of participation by households with other community groups was less by 8%. This means that engaging in other self-help groups is time consuming and limits participation in irrigation activities

Table 3: Probit results of factors influencing participation in irrigation schemes

Membership	Coefficient	Std. Err.	Z	P>|Z|	Marginal effects
Distance	-1.483	0.569	-2.98	0.003***	-0.046
Household size	-0.322	0.226	-1.48	0.140	-0.009
Sex	-1.590	1.258	-1.33	0.185	-0.049
Age	0.063	0.053	1.23	0.080*	-0.001
Marital	0.304	1.443	0.21	0.833	0.009
Education	0.108	0.162	0.67	0.502	0.003
Occupation	5.925	1.991	3.50	0.000***	0.183
Nonfarm Income	0.014	0.294	0.05	0.962	0.397
Farm size	1.245	0.484	3.05	0.002***	0.038
Livestock	-0.004	0.043	-0.10	0.920	-0.001
Extension	-3.187	2.047	-1.60	0.109	-0.098
Market	1.904	1.662	1.18	0.237	0.059
Credit	8.671	3.075	3.26	0.001***	0.268
Other group	-2.710	1.451	-1.96	0.050**	-0.084
Constant	-6.849	4.466	-1.53	0.125	

Number of obs = 190
LR chi2(12) = 224.46
Prob > chi2 = 0.0000
Pseudo R2 = 0.8522

*,**,***: refers to significance at 10,and 1% level, respectively

4.3 Impact of irrigation schemes on household income

Although irrigation water is just one significant factor for improving production, it plays an important role, since there is no agricultural activity that can take place without water as an input. Access to reliable irrigation enables farmers to adopt technologies and intensify cultivation, leading to increase in productivity, high production and greater returns from farming. Overall irrigation water improves the income generating function in agriculture especially in the rural setting. Average Treatment Affects (ATE) results in table 4, access to irrigation water improved the households monthly income by SZL 244 (equivalent to SAR 244 or USD 24.4)

Table4: Average treatment Effects of irrigation in household income

Income	Coefficient	Std, Err	Z	P>|Z|
ATT	244.24	145.49	1.68	0.093
Observation 96				

5. Conclusion and recommendation

Participating in SHIS is one form of rural development, which empowers farmers and improve household incomes. Participation in SHIS is greatly influenced by the distance to the SHIS, age size, occupation, credit accessibility and other group membership. Farmers who have access to credit are more likely to participate. Most

of the farmers are more than 50 years and have primary education as the highest education level. Participation in small holder irrigation schemes contributes to household income. For active participation of farmers it is recommended that microfinance institutions should be available for farmers, and such projects should target farmers whose primary source of income is farming, this will ensure full time participation (Etwire et. al., 2013). There is also a need of improved marketing opportunities for farmers which will act as an incentive for farmers to participate.

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