

Effect of Institutional Factors on the Adoption of Small Scale Irrigation System in Rwanda

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Abstract: *Small scale irrigation has contributed significantly to poverty alleviation, food security, and improving the quality of life for rural populations however, the adoption of small scale irrigation remains low. The study aims to analyze the institutional factors on the adoption of small scale irrigation in Rwanda. A survey of 317 households was carried out in Nasho sector of Kirehe district in Rwanda. Multi stage sampling techniques was applied in Logit Model to the data collected. The study findings concluded that distance to markets, access to extension services, credits accessibility were the key institutional factors affecting the adoption of small scale irrigation in Rwanda. The study recommends that in order to increase adoption of small scale irrigation in Rwanda, policy makers and implementers should strengthen current polices of linking farmers to financial services, increase extension work ratio to farmers and availing rural roads to help farmers access markets*

Keywords: Irrigation, adoption, logit model, Rwanda

1. Introduction

In 2018 the government of Rwanda endorsed a strategic plan for agriculture transformation whose main vision for irrigation was to achieve by 2024 a developed irrigation sector that is sustainable, dynamic and efficient to transform agricultural production for wealth creation and national food security. The irrigation policy endorsed in 2014 highlighted the major challenges restricting growth of the irrigation sector as high cost of irrigation development, poor organization in schemes, small and fragmented private lands not attractive to big investors, inadequate capacity (skills and equipment) within public and private sector, lack of irrigation culture within communities, undeveloped and inefficient marketing infrastructure, poor water use efficiency, lack of strategic plan for irrigation development. The current status of the area developed with formal irrigation infrastructure is 48,508 ha. This translates to about 7.5% of the potential irrigable area in Rwanda and less than 50% of the target set for 2024. It is clear from these figures that there is need to urgently energize the sector in order to realize the goal of 102,284 ha by 2024 (MINAGRI, 2018).

Marshland irrigation schemes have been developed by reclaiming swamp areas. Marshlands are public (state) owned lands where farmers are allocated plots on lease. The improved surface irrigation systems used in the marshlands are gravity stream diversions or from valley dams used to supply canal networks for flooding basins planted with rice. The land holding in a marshland scheme is on average 0.1-1.0 ha per farmer. Farmers in the marshland share common irrigation infrastructure. Small Scale Irrigation (SSI) is an initiative being implemented by Rwanda Agriculture and Animal Resources Development Board (RAB).

The low level of land productivity is due to unpredictable and sporadic seasonal rainfall and low adoption of advanced farming technology. While small scale irrigation technology is being promoted in many developing countries, there is low level of adoption thus the need to conduct this on the

effect of institutional factors on the adoption of small scale irrigation farming in Rwanda.

2. Methodology

The present study was conducted in Nasho sector of Kirehe district in Eastern Province with total population of 26,954 people and where different types of irrigation activities are undertaken that include; sprinkler irrigation, drip irrigation and center pivot irrigation. Currently the total area covered by the new irrigation system is about 1,280 ha (NISR, 2016).

Multi-stage sampling techniques were used to select respondents from the selected sectors. In the first stage purposive sampling was used to select the farmers using irrigation technology with emphasis on land size of more than one hectare and less than one hectare. Finally, the selection was done by means of simple random sampling from members of cooperative society. The data collection involved farmers using irrigation technology and farmers not using irrigation as control. The primary data was collected by use of structured questionnaire with the help of trained enumerators that understood the local language. The structured questionnaire was first pre-tested before it was administered to the sampled farmers. Secondary data was collected at farmer level either from cooperative members or individual farmers with irrigation system.

Logit regression analysis was used to estimate factors that are independently associated with adoption of small scale irrigation farming. The logit model was preferred due to the nature of dependent variable.

According to Heinrich and Green (2010), the logit distribution is better in applied research over the probit model because of computational complexity arising from lack of a closed form of the normal cumulative density function on which the probit model is based. With awareness as the dependent variable, farmers who were aware were assigned the value of $Y = 1$ and 0 otherwise. The logit model in this study is presented as:

$$P = \frac{e^z}{1 + e^z} \dots\dots\dots (i)$$

Where p= is the adoption of irrigation

There have been many studies that have used logit model. A similar equation was used to specify the dependent and independent variables. In this study, the following general specification of the logit model is presentation as:

$$Z = \ln\left(\frac{p}{1-p}\right) = Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} X_7^{\beta_7} X_8^{\beta_8} X_9^{\beta_9} X_{10}^{\beta_{10}} u \dots\dots\dots (ii)$$

Where:

β_0 = Constant

$\beta_1 - \beta_7$ = Parameters to be estimated

Y = Adoption (1 for insured, 0 otherwise)

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + \beta_{10} \ln X_{10} + \epsilon \dots\dots\dots (iii)$$

X1 = Distance to market, X2 = Access to credit, X3 = Distance to extension agents, X4 = Information on use of irrigation, X5 = Access to extension services, X6 = Cooperative membership, X7 = Trainings, X8 = Distance to extension agents, X9 = Distance to extension agents, X10 = Distance to water source, Ln = Natural logarithm = Error term

3. Results and Discussion

The logit regression model with dependent variable of adoption of small scale irrigation technology in the study area is presented in table 1. The results show that only distance to markets, distance to extension agents, access to extension services, credits accessibility and access to improved seeds were the Institutional factors affecting the adoption of small scale irrigation technology. The findings from logit model indicated that the likelihood ratio statistics as indicated by chi-square statistics is moderately significant (P < 0.0000) and Log likelihood = -42.536 with LR χ^2 (9) = 40.31, suggesting the model has a moderate explanatory power. The Pseudo R² = 0.3215 (32.15%), indicating the specification fits the data. The variables included in the model explain 32.15% of the variation in the adoption of small scale irrigation technology by farmers.

Results from the logit model presented in table 1 indicate that distance to nearest market by small scale farmers was the institutional factor that affected the adoption of small scale irrigation technology and was statistically significant at 5% level of significance. The distance to nearest market had a positive and significant influence on SSIT adoption, given that proximity to good roads can significantly reduce the

cost of transportation and hence increase the profit margin to the farmers.

For each reduction of one kilometer (1km) from the household to the nearest market, the adopters of SSIT increased by 0.46 percent, which may also be a result of easier access to farm inputs and irrigation services (Kuwornu et.al, 2012).

Results from the logit model presented in table 1 indicate that distance to extension agent by small scale farmers was the institutional factor that affected the adoption of small scale irrigation technology statistically significant at 5% level of significance. There was negative relationship between distance to extension agent and adoption. The negative correlation implies that there are insufficient extension services and inaccessible roads to the market. Findings ascertain that each additional kilometer (1km) from the household to the extension agent decrease the probability of adopting irrigation technology by 0.69 percent. These findings will inform the public and private sectors to increase the mechanization services in the agricultural areas to improve and modernize agricultural production.

Results from the logit model presented in table 1 indicate that extension service to small scale farmers was the institutional factor that significantly affected the adoption of small scale irrigation technology at 10% level of significance. Findings indicated the positive relationship between extension services and irrigation adoption. The adopters of irrigation technology increased by 20%. Frequent visits by agricultural extension agents increase awareness among farmers about new farm activities through demonstrations and discussions. Although extension agents were also engaged in administrative activities, the mean frequency of extension agent to farm mechanization service users was 20% more than non-users of SSIT. The extension agents provide technical assistance, improved varieties of seeds and practical training to innovative farmers (Ghosh, 2010).

The findings presented in table 1 indicate that the access to credit was the institutional factor that significantly affected the adoption of small scale irrigation technology at 5% level of significance. The findings indicated positive relationship between credits accessibility and SSIT adoption. The findings from logit model indicated that one unit increase to credit up to 0.26 percent, the users of SSIT increased by 14%. The credits accessibility enhances the farmers' ability to afford farm inputs like fertilizers, agro chemicals, new irrigation equipments (drippers, pumps, tanks, engine etc) to boost the crop production. It empowers the producer to meet the production cost and increase his profit margin (Porgo et.al, 2017).

Table 1: Institutional factors affecting small scale irrigation adoption in the study area

Adoption of small scale Irrigation technology	Coef.	Std. Err.	Z	P>z
Institutional factors affecting adoption of small scale irrigation technology				
Distance to main Road	0.0072	0.0110	0.65	0.514
Distance to Markets	0.0459	0.0231	1.98	0.047**
Distance to Financial Institutions	0.0150	0.0164	0.91	0.363
Distance to Water source	-0.0120	0.0301	-0.4	0.691
Distance to Extension agents	-0.0688	0.0288	-2.39	0.017**
Distance to Irrigation technician	-0.0157	0.0132	-1.19	0.234

Access to Extension services	2.0289	1.1016	1.84	0.066*
Cooperative Membership	-0.7567	0.8061	-0.94	0.348
Credits Accessibility	1.3590	0.6095	2.23	0.026**
Trainings	0.06016	0.47407	0.13	0.899
_cons	1.1399	1.9258	0.59	0.554
Logistic regression; Number of Obs=317; LR chi2 (9) = 40.31; Prob > chi2 = 0.0000; Log likelihood = -42.536371 and Pseudo R ² = 0.3215 (32.15%)				

Note: *, **, and *** correspond to significance levels at 10%, 5% and 1% level of significance respectively

4. Conclusion and Recommendations

[6] MINAGRI. (2018). Strategic Plan for Agriculture Transformation 2018-2024

The study used logit model to determine institutional factors affecting small scale irrigation adoption in the study area. The findings from logit model confirmed that key institutional factors such as access to extension services, credit accessibility and distance to extension agents and markets affected the adoption of small scale irrigation technology. Access to credits by farmers from banks or similar institutions that provide agricultural finance will enhance efficiency and effectiveness in service delivery. This will empower farmers to increase production and hence raise their income. More farmers will be encouraged to adopt small scale irrigation.

The study recommends that more awareness programs should be created among farmers. This can be done through conducting meetings and demonstrations with farmers in order to educate them on the benefits and the importance of using irrigation technology. Policies that promote access to agricultural technology and information should be encouraged.

Development of good road network is important for easy access to market. This will increase the income to the farmers and improve their livelihoods and living standards. . This shows that farm income is fundamental to the living standards of famers. The farmers who invest much resources in farming would be able to get higher incomes and consequently increase their access to other essential services.

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