

Non-Economic Factors Associated with Adoption of Sprinkler Irrigation among Farmers in Kariandusi Location of Nakuru County, Kenya

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Abstract – As the country embraces irrigation farming to mitigate the effects of unreliable rainfall, sprinkler irrigation is perhaps the most appropriate technology for agricultural areas with sloppy terrain. The ministries of agriculture and water have been partnering with other organizations to promote this type of irrigation through capacity building and limited input assistance. Kariandusi location was one beneficiary of such initiatives between the ministry of water and African Institute for Capacity Development, AICAD. Three years after the implementation of the project, mixed results were achieved with some farmers adopting the technology while others either opted for other irrigation methods or were stuck with rain-fed agriculture. This study was therefore carried out to understand the non-economic factors associated with adoption of the technology. It emerged that education level of the farmers, land tenure system and social capital are key non-economic factors associated with the adoption of sprinkler irrigation in Kariandusi Location.

Keywords – Sprinkler Irrigation, Adoption, Social Capital, Land Ownership.

I. INTRODUCTION

The occurrence of erratic rainfall has created uncertainty for agricultural production and emphasized the need for irrigation in Africa (Kamara et al., 2004). In Kenya, irrigation development has been identified as an important tool to stimulate economic growth and rural development, and is considered as a cornerstone of food security and poverty reduction. Despite the water shortage in Sub-Saharan Africa, irrigation is usually carried out through surface methods with the maximum efficiency of approximately 30 to 40% (Kohansal and Rafeie, 2008). Improved water use efficiency in agriculture is advocated to reduce water use among existing users and to increase the supply available for new users.

Modern irrigation technologies are often cited as central to increasing water use efficiency and reducing the use of scarce inputs, while maintaining current levels of farm production, particularly in semi-arid and arid agricultural areas. One such method of modern irrigation is sprinkler irrigation system which is becoming more and more popular among farmers. Sprinkler irrigation has been reported to save up to 50% of water and increase agricultural productivity by 15 – 25% (Kamara et al., 2004). Despite the advantage, however the adoption of the technology has not been as good as was expected.

The analysis of adoption and diffusion patterns of modern irrigation technologies is at the core of several empirical studies in both developed and developing countries (Dridi and Khanna 2005; Koundouri, Nauges, and Tzouvelekas, 2006). Previous studies provide clear evidence that economic factors such as cost of irrigation equipment (Abotaleb et al. 2014), farm organizational and demographic characteristics (e.g. size of farm operation, educational level and experience of household members), extension services (Adeoti, 2009) and environmental conditions (Saeed et al. 2014), do matter to explain adoption and diffusion of modern irrigation technologies.

However, Conley and Udry (2010) found that economic factors cannot explain accurately the diffusion patterns as they are conditional on what farmers know about the new technology at any given point in time. Saeed et al. (2014) argued that choosing irrigation methods solely on the basis of economic viability may not result in selection of the best alternative. Several studies indicate that individual characteristics, organizational support (Adeoti, 2009; Abotaleb et al. 2014) and social factors may play an important role in attracting farmers to use of new irrigation systems. It is in view of this argument that the study focused on non-economic factors associated with the adoption of sprinkler irrigation in Kariandusi location where irrigated farming is practiced.

Irrigation in the study area is made possible by abstraction of water from river Kariandusi that is fed by Kariandusi hot spring. However, with a spring outflow of approximately 26 litres per second, the available water is not sufficient for domestic and irrigation purposes and this called for the application of water saving irrigation methods (AICAD, 2012).

AICAD in collaboration with the ministry of water initiated and implemented an integrated irrigation farming project which enhanced efficient utilization of available water for crop farming and related activities. The project aimed at empowering the community to produce crops using appropriate water saving irrigation methods particularly sprinkler irrigation which, according to Karani (2006), saves water, time, and is easy to operate. In addition to in-house training on the said irrigation methods the project had three on-farm demonstration sites where the irrigation technologies were demonstrated. Despite the training and demonstrations of the sprinkler technology, some of the project beneficiaries have not adopted it. Therefore, the study aimed at establishing the non-economic factors that affected its adoption.

II. METHODOLOGY

A. Description of Study Area

Kariandusi location is located in Gilgil Division in Nakuru County. The area is semi-arid with erratic rainfall patterns. The region has a characteristic undulating terrain that is served by river Kariandusi whose source is Kariandusi hot spring located in the upper part of the region (AICAD, 2012). Agricultural production in the target community is mainly rain-fed. Owing to the fact that the area is a semi-arid region and characterized by low and unreliable rainfall, farmers often incur losses. The maximum and minimum daily recorded temperatures are 33°C and 12°C respectively. Records from the Ministry of agriculture, Gilgil Division indicate that the area receives a mean annual precipitation of between 600 and 700 mm. The rainfall distribution is bimodal in nature with the long rains occurring between April and June and short rains between October and December. Due to the climatic conditions, rain fed agriculture is not reliable and thus irrigated farming is practiced to supplement the limited amount of rainfall received.

B. Study Design and Data Analysis

The study was carried out primarily through a survey of 80 farmers comprising 40 adopters and 40 non-adopters of the sprinkler irrigation technique. A multistage sampling technique was used to select the 80 respondents. All the farmers in the area who benefited from an irrigation training project jointly carried out by African Institute for Capacity Development and Ministry of Water were listed and stratified into adopters and Non-adopters through farm visits. A simple random sampling technique was then used to select 40 farmers from each stratum. A structured questionnaire was used to obtain farm and household level information from adopters and non-adopters of the sprinkler irrigation technique. The data were analyzed using descriptive statistics. Cross tabulation and chi-square statistics was used to test for significance of relationships between selected non-economic characteristics and adoption of sprinkler irrigation.

III. CONCEPTUAL FRAMEWORK

In this study, we hypothesized three main factors affecting adoption of sprinkler irrigation as follows:

Personal Characteristics – Gender of the farmers trained was expected to influence adoption of sprinkler irrigation. Men were expected to adopt the technology more than women since the former are expected to own and control the capital assets particularly land. Consequently, adoption was expected to have a positive relationship with the level of education of household head. Farmers with post-secondary level of education were expected to be early adopters while those with primary education were expected to be poor adopters of the technology. The influence of marital status on adoption of the techniques was also examined. However no negative or positive relationships were hypothesized for this relationship.

Land Tenure System – Ownership of land being used for farming was expected to affect the adoption decision. Since sprinkler irrigation requires infrastructural development including laying conveyance pipes from the water sources, farmers who own the land and have title deeds to the said land are expected to be willing to adopt the technology. On the other hand farmers whose tenancy on the land is not permanent are less likely to invest in the technology.

Social Capital – This was represented by membership in the farmers' and self help groups, spirit of cooperation, social trust and social support as well as exposure to farming activities outside study area. It was hypothesized that membership to farmers groups or self help groups increases adoption of the technology. Those groups are useful in enabling farmers to not only share skills and experiences but they also pool financial resources to assist each other. Spirit of cooperation and social support were hypothesized to have a positive relationship with adoptions. Cooperation and social support is thought to be useful in pooling labour resources which is necessary for irrigated farming.

IV. RESULTS AND DISCUSSION

A. Personal Characteristics Associated with Sprinkler Irrigation

The researchers sought information relating to personal characteristics of the farmers and their association with adoption of sprinkler irrigation. The personal characteristics were gender, marital status and education level. The results are presented in Table 1-3.

Marital Status

The farmers were categorized as being married or not married. The Un-married farmers constituted those who were separated, divorced or widowed. The marital status was then cross tabulated with adoption of sprinkler irrigation and the results presented in Table 1.

Table 1. Relationship between Marital Status and adoption of sprinkler irrigation

Marital Status	Adopted irrigated farming				Total	
	Yes		No		Freq	%
	Freq	%	Freq	%	Freq	%
Married	34	42.5	28	35.0	62	77.5
Not married	6	7.5	12	15.0	18	22.5
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 1, Chi-square = 2.58, significance = 0.108

Results in Table 1 shows that majority of the farmers who reported to be married were practicing sprinkler irrigation while majority of those who indicated that they were not married were not practicing sprinkler irrigation. These results imply that married farmers were more likely to adopt sprinkler irrigation than their unmarried counterparts. However, the relationship between marital status and adoption of sprinkler irrigation is not statistically significant as indicated by a chi-square value of 2.58 significant at 0.108.

Gender

The farmers were categorized into male and female and the variable cross tabulated with adoption of sprinkler irrigation. The results are presented in Table 2.

Table 2. Relationship between gender and adoption of sprinkler irrigation

Gender	Adopted irrigated farming				Total	
	Yes		No		Freq	%
	Freq	%	Freq	%		
Male	21	26.3	20	25.0	41	51.3
Female	19	23.8	20	25.0	39	48.8
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 1, Chi-square = 0.05, significance = 0.823

According to the results in Table 2 an equal proportion of male and female farmers were not practicing sprinkler irrigation. A slight majority of male had adopted sprinkler irrigation compared to their female counterparts. However, the chi-square value does not establish a statistically significant relationship between gender and adoption of sprinkler irrigation.

Education Level

Information was obtained from the respondents on their highest level of education. The level of education was categorized as primary, secondary or post secondary. The variable was then cross tabulated with adoption of sprinkler irrigation. The results are presented in Table 3.

Table 3. Relationship between education level and adoption of sprinkler irrigation

Education Level	Adopted irrigated farming				Total	
	Yes		No		Freq	%
	Freq	%	Freq	%		
Primary	23	28.8	27	33.8	50	62.5
Secondary	11	13.8	3	3.8	14	17.5
Post Secondary	6	7.5	10	12.5	16	20.0
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 2, Chi-square = 5.891, significance = 0.053

Results in Table 3 shows that majority of the farmers with primary level education were not practicing sprinkler irrigation. Consequently majority of the farmers with post secondary education were not adopters. Conversely, majority of the farmers with secondary level education were practicing sprinkler irrigation. The chi-square statistics also established a statistically significant relationship between education level and adoption of sprinkler irrigation at 0.05.

B. Relationship between Land Ownership and Adoption of Sprinkler Irrigation

Land ownership was measured in terms of whether or not the farmers had title deeds to the land on which they farm. Farmers without title deeds were likely to have leased the land for agricultural purposes while those with title deeds were permanent residents with their homes within the farming land. The land ownership was cross

tabulated with adoption of sprinkler irrigation and the results presented in Table 4.

Table 4: Relationship between land ownership and adoption of sprinkler irrigation

Land Ownership	Adopted irrigated farming				Total	
	Yes		No		Freq	%
	Freq	%	Freq	%		
No title Deed	12	15.0	22	27.5	34	42.5
With title Deed	28	35.0	18	22.5	46	57.5
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 1, Chi-square = 5.115, significance = 0.024

Results in Table 4 show that majority of farmers without title deeds were not practicing sprinkler irrigation while majority of those with title deeds were practicing sprinkler irrigation. The chi-square statistics also established a statistically significant relationship between land ownership and adoption of sprinkler irrigation technology.

C. Relationship between Social Capital and Adoption of Sprinkler Irrigation

Social Trust

Respondents were asked a set 8 statements formulated to establish their level of social trust in their neighbourhood. They were required to respond on a 4 point Likert scale whose scores were used to categories the respondents social trust as low, average or high. The variable was then cross tabulated with adoption of sprinkler irrigation. The results are presented in Table 5.

Table 5. Relationship between social trust and adoption of sprinkler irrigation

Social Trust	Adopted Irrigated Farming				Total	
	Yes		No		Freq	%
	Freq	%	Freq	%		
Low	2	2.5	9	11.3	11	13.8
Average	23	28.8	18	22.5	41	51.3
High	15	18.8	13	16.3	28	35.0
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 2, Chi-square = 5.207, significance = 0.074

Results in Table 5 show that majority of the farmers who reported having average to high trust in their neighbours and the community adopted sprinkler irrigation while majority of those who reported low trust in their fellow neighbours did not adopt the irrigation method. This implies that farmers in neighbourhood with higher social trust were more likely to adopt sprinkler irrigation as opposed to farmers with neighbourhoods that are not trustworthy.

Spirit of Participation

The farmers were asked to indicate in their own opinion the spirit of participation among fellow farmers in their neighbourhood in solving individual or collective problems. The variable was then cross tabulated with adoption of sprinkler irrigation. The results are presented in Table 6.

Table 6. Relationship between spirit of participation and adoption of sprinkler irrigation

Spirit of Participation	Adopted Farming		Irrigated		Total	
	Yes		No		Freq %	
	Freq	%	Freq	%		
Low	0	0.0	5	7.5	6	7.5
Average	21	26.3	16	20.0	37	46.3
High	19	23.8	18	22.5	37	46.3
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 2, Chi-square = 6.703, significance = 0.035

The chi-square statistics in Table 6 show that all the five farmers whose opinion on the spirit of participation in their neighbourhood was low, were not practicing sprinkler irrigation. On the other hand majority of the farmers whose opinion on the spirit of participation in their neighbourhood was average to high were reported to be practicing sprinkler irrigation. This implies that farmers whose neighborhood depicts a high spirit of participation were more likely to adopt the sprinkler irrigation methods than otherwise.

Social Support

Social support is a resource that people particularly in rural African communities can draw upon in times of need. The support may come from spouses, relatives, friends and neighbours. Besides in other establishments it may come in form of work colleagues, self help groups or voluntary organizations. The research sought information to establish the relationship between social support (number of support sources) and adoption of sprinkler irrigation. The results are presented in Table 7.

Table 7. Relationship between social support and adoption of sprinkler irrigation

Social Support	Adopted Farming		Irrigated		Total	
	Yes		No		Freq %	
	Freq	%	Freq	%		
Low (<3)	23	28.8	18	22.5	41	51.3
Average (3)	3	3.8	2	2.5	5	6.3
High (>3)	14	17.5	20	25.0	34	42.5
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 2, Chi-square = 1.869, significance = 0.393

The results in Table 7 indicate that majority of farmers with low social support were practicing sprinkler irrigation. On the other hand, majority of farmers with high social support were not practicing sprinkler irrigation farming. However, the chi-square statistics does not establish a statistically significant relationship between social support and adoption of sprinkler irrigation technology. The results imply that having many sources of social support may not necessarily be useful in enabling farmers adopt sprinkler irrigation.

Farmer's Exposure

To establish the relationship between farmers' exposure, measured in terms of visits to other farmers, and adoption of sprinkler irrigation, the rate of visits to other farmers

outside the community was cross tabulated with adoption of sprinkler irrigation and the results presented in Table 8.

The results in Table 8 indicates that majority of the farmers who rarely left their neighbourhoods were not practicing sprinkler irrigation while the majority of those who often left their communities to visit other practicing farmers had adopted sprinkler irrigation.

Table 8. Relationship between visits outside community and adoption of sprinkler irrigation

Visits outside community	Adopted irrigated farming		Total			
	Yes		No			
	Freq	%	Freq	%		
Rarely	13	16.3	22	27.5	35	43.8
Often	27	33.8	18	22.5	45	56.3
Total	40	50.0	40	50.0	80	100.0

N = 80, df = 1, Chi-square = 4.114, significance = 0.043

The chi-square statistics also establishes a statistically significant relationship between rate of visits outside the community and adoption of sprinkler irrigation. Farmers who often visit outside the community were therefore more likely to adopt sprinkler irrigation as opposed to those who do not.

V. CONCLUSION

The findings of the study showed that selected non-economic factors were associated with adoption of sprinkler irrigation in Kariandusi Location in Nakuru County of Kenya. The education level of the farmers had an interesting relationship with adoption of sprinkler irrigation. It was established that farmers with post secondary education and those with primary level of education are poor adopters of sprinkler irrigation. While adoption level for farmers with secondary level of education was high. The poor adoption by farmers with post secondary education can be explained by the fact that they depend on other livelihoods other than farming owing to their additional skills. Consequently, farmers with primary level of education were generally hesitant to adopt new technologies until they confirm its benefits by observing early adopters.

Results of this study also showed that farmers with absolute ownership of land on which they practice farming were better adopters of sprinkler irrigation compared to those who had short term access to the land through leasehold. Sprinkler irrigation is a long term investment as it requires development of piped conveyance of water. As a result farmers who invest in it are those whose security of tenure is guaranteed. Observations made during data collection was that majority of farmers with leasehold tenure system were using other irrigation methods such as bucket, horse pipe and micro-catchments.

The trusts that respondents have in their neighborhood had a positive relationship with adoption of sprinkler irrigation as farmers with higher social trust were more likely to adopt the technique as opposed to those with low trust in their neighborhoods. One of the challenges of sprinkler irrigation in the study area was vandalism of

conveyance pipes and theft of sprinkler heads. Consequently neighborhood that experiences spirit of cooperation amongst the farmers motivated farmers to adopt sprinkler irrigation than otherwise. This was necessary since farmers have to share cost of laying down the main conveyance pipes before individual offshoots at their respective farms. Farmers' exposure to the farming conditions outside their communities was found to influence the adoption of sprinkler irrigation.



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