Journal of Sustainable Development; Vol. 10, No. 2; 2017
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Determinants of Smallholder Farmers' Willingness to Pay for Irrigation Water in Kerio Valley Basin, Kenya

Jonah Kiprop[1], Kelvin Mulungu[2], Noah Kibet[3] & Antony Macharia[4]

[1] Kenya Forestry Research Institute, Muguga, Nairobi, Kenya

[2] The University of Zambia, Institute of Economic and Social Research, Lusaka, Zambia

[3] Department of Agricultural Bio-systems and Economics, University of Kabianga, Kenya

[4] Department of Agricultural Economics, Egerton University, Kenya

Correspondence: Jonah Kiprop, Kenya Forestry Research Institute, Muguga, Nairobi, Kenya. E-mail: jonahkipsat@gmail.com

Received: January 15, 2017 Accepted: February 23, 2017 Online Published: March 30, 2017

doi:10.5539/jsd.v10n2p135 URL: https://doi.org/10.5539/jsd.v10n2p135

Abstract

Food security is the major outcome of irrigation development activities. However, this cannot be achieved without sustainable water resources management. With the increasing budgetary constraints in many developing countries, governments have recognized the need to delegate irrigation scheme management to Irrigation Water Users' Associations (IWUA's) as much as possible. Despite the majority of these associations being operational, the major challenge has been poor performance due to inadequate farmer participation. This study examines the factors which influence farmers' willingness to pay for irrigation water in a smallholder irrigation scheme in Kerio Valley Basin, Kenya. Using a multi-stage sampling method, a representative sample of 216 smallholder farmers from the Basin were interviewed. Results show that education level, access to training on irrigation, participation in construction of the irrigation system, crop income from irrigation and membership in IWUA significantly and positively influence farmers' decisions to pay for irrigation water. Distance to the water source reduces the willingness to pay for irrigation water. Differential pricing based on income levels of farmers, rather than uniform pricing is recommended. We further recommend formulation of policies to train farmers in water management and to support farmer participation in IWUA's.

Keywords: smallholder irrigation, irrigation water users' association, willingness to pay, Kenya

1. Introduction

Declining availability of fresh water and increased competition for water use has resulted in declining food production more specifically in the semi-arid lands of Kenya (Ngigi, 2002). This has necessitated scaling up of irrigation development activities in order to contribute to the attainment of enhanced food security. Irrigation expansion and development has been identified as a key approach which can boost food production in marginal lands and improve livelihoods. In Kenya, irrigation uses over 69% of the limited developed water resources (Torori *et al*., 1995), with smallholder irrigation activities accounting for a third of the total irrigated area (National Irrigation Board, 2010). Despite this high water use, the rate of irrigation development has declined over the years. It is estimated that about Kenya shillings 7.5 (Note 1) and 5 billion has been invested so far by the private sector and/or smallholder farmers and donors respectively (Gichuki*, et al*., 2010). A substantial amount of these resources has been used to support smallholder irrigation development in a bid to expand irrigation through the development of sustainable production systems (Government of Kenya, 2010).

In line with global trends, where governments have been facing budgetary constraints, many policy makers have adopted various programs to devolve responsibility of irrigation management to users' groups (Johnson *et al*., 1995). Kenya has adopted this new paradigm of development of irrigation projects with a major shift from the top-down approach involving centrally managed large-scale projects to a bottom-up approach (Rangwa et al., 1998). The recognition of limited efficiency of the state in managing a common-pool resource like irrigation water has justified the need for appropriate role for farmers in the management process (Howart *et al*., 2005). Consequently, the Government has been giving increased responsibility to irrigation water user's associations (IWUA's) to manage irrigation schemes. This approach views the farmers as the drivers of development where

they take full responsibility for project operation, maintenance, and management for long-term sustainability (Ministry of Water and Irrigation, 2003). This is further underpinned by the draft National Irrigation Policy, which advocates for the full participation of farmers and other stakeholders in the identification, planning, design, implementation, operation and maintenance of irrigation schemes (Ministry of Water and Irrigation, 2008).

However, the major challenge has always been poor performance due to inadequate farmer participation. Hence, this policy effort will only result in desired effects if farmers respond by increasing their participation in the management of the system. These issues point to the fact that the sustainability of newly developed or rehabilitated projects is largely pegged on farmers' ability to take responsibility for operation and maintenance in the spirit of the new development paradigm (Burger, 1998). The need to use water much more efficiently and productively is, therefore, more pressing. Without attaching a price to water, farmers cannot use it efficiently and productively. The objective of this study is to understand what influences farmers' willingness to pay for irrigation water. Results from the study are important in the design of policies for sustainable management of irrigation schemes under this new paradigm that places emphasis on water users managing the scheme. Sustainable management of these water resources is crucial for socio-economic well-being and environmental quality.

2. Method

2.1 Study Area

This study was conducted in the Kerio valley basin, Elgeyo Marakwet County in Kenya. Altitude ranges from 1,000 meters in the Kerio valley to 3,350 meters above sea level in the highlands, with Kerio River as its main drainage (Government of Kenya, 1997). The County receives a bimodal type of rainfall with long rains received in March through April and short rains starting from July to September. Mean annual rainfall ranges from 1000 mm for the highlands and between 200 mm to 800 mm in the dry lowland. The Kerio valley Basin is characterized by high temperatures that reach a maximum of 40°C and high evaporation rates (Saina, 1996). Based on the 2009 national census the county has a total population of 369,998 (Kenya National Bureau of Statistics, 2009). The main sources of water are streams and seasonal rivers that all drain into River Kerio.

2.2 Data and Sample

The target population was smallholder irrigation farmers in the whole of Kerio valley Basin. This study used multistage sampling procedure. In the first stage, the study purposively selected Elgeyo Marakwet County because of the large number of smallholder irrigation farmers. In the second stage, Arror and Chepsigot irrigation schemes were purposively selected given the schemes have a larger concentration of smallholder farmers and well-managed water users' associations. In the third stage, the study applied simple random sampling to choose 108 farmers from each scheme giving a total of 216 respondents. Primary data was collected from the respondents through the administration of a structured questionnaire and other information relevant to scheme management through focus group discussions.

2.3 Analytical Framework

The decision taken by smallholder irrigation farmers' on whether to pay or not for irrigation water depends on the unobservable utility index, P_i, influenced by the socioeconomic, institutional and attributes of the new system of irrigation. It is expected theoretically that the larger the expected utility index, P_i, the higher the probability of paying for irrigation water. The index is expressed as:

$$P(0, 1) = \beta_1 + \beta_2 X_i \ldots \beta_n X_n \ldots + \varepsilon \quad (1)$$

To show the relationship between the utility index and the decision to pay or not (denoted by *Y),* an assumption is made such that *Y*= 1 if the household is willing to pay and *Y*= 0 if not willing to pay for irrigation water. Another assumption is the critical utility *u** such that if the expected utility (*u)* from using irrigation water exceeds *u** then *Y*=1, otherwise *Y*=0 if the expected utility is less than the critical threshold, meaning that the farmer will not be willing to pay. Mathematically, this is expressed as:

$$\text{Y= 1 } if\ u > u^* \text{ and Y =0 } if\ u \leq u^* \quad (2)$$

The outcome equation of the probit model is estimated and presented as:

$$Y_i(\ , 1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots \beta_n X_n + \varepsilon \quad (3)$$

Where B_0 is the constant and $\beta_1 \ldots \beta_n$ represent the estimated coefficients while $X_1 \ldots X_n$ are respective factors hypothesized to influence the willingness to pay for irrigation water. The variables that were used are presented in table 1. ε is the error term.

Table 1. Variables used in the probit model

Variable	Variable code	Type of	Unit of measurement	Expected
Willingness to pay for irrigation	WTP	Dummy	1= Willing; 0=	
Independent variables				
Education level of household head	EDULHH	Continuous	Years	-
Age of household head	AGEHH	Continuous	Years	-
Participation in construction and	PARTC-MAI	Dummy	1 if participated, 0	+
Distance to the market	DIST-MKT	Continuous	Kilometres	+ / -
Household family size	FAMSIZE	Continuous	Number of people in	-
Livestock ownership	TLU	Continuous	Number of livestock	+ / -
Access to credit service	CRD-ACC	Dummy	1 if accessible,0	+ / -
Access or contact with extension	EXT-CTC	Dummy	1 if accessible,0	+ / -
Income from irrigated farm	INCOME-IRR	Continuous	Kenya shillings	+
Access to training	TRAING	Dummy	1 if trained,0	+
Membership in irrigation water	MEMB-IWUA	Dummy	1 if member,0	+
Distance to the water source	DIST-WS	Continuous	Kilometres	+

3. Results and Discussion

Firstly, in Table 2 we present the inferential statistics for some of the variables that were collected. We determine any associations that may be there between the variables and the willingness to pay for irrigation water or not. Though they provide vital revelations in terms of relationships between for example gender and willingness to pay, the statistics in themselves do not provide much information needed for conclusions and policy. In Table 3, the results of the probit model are presented.

3.1 Descriptive and Inferential Statistics

Analysis of farmers' occupation status and participation in farm activities is presented in table 2. The results indicate that 57.4% were full-time farmers while 26.4%, 1.4% and 14.8% were employed, retired and casual laborers respectively. With respect to the decision to pay for irrigation water, 59.4% of full-time farmers were willing to pay. For employed farmers working off-farm, 27.4% were willing to pay. A closer look at the farmers working as casual laborers in the scheme indicates that only 11.7% were willing to pay. However, there is a statistically strong association between farmers' occupation status, farm labour participation and farmers' willingness' to pay for irrigation water which is significant at 99% confidence interval.

Table 2. Inferential statistics for selected variables

Variable	Category	Willing to pay (N=197) %	Not willing to pay (N=19) %	Overall (N=216) %	χ^2
Access to training	Yes	70	26	66	14.37***
	No	30	74	34	
Access to extension	Yes	81	84	81	0.470
	No	19	19	19	
Access to credit services	Yes	28	11	26	2.69
	No	72	89	74	
Membership in irrigation water users association	Yes	84	37	81	23.34***
	No	16	63	19	
Gender	Male	65.5	73.7	66.2	0.470
	Female	34.5	26.3	33.8	
Occupation status	Full-time farmers	59.4	36.8	57.4	17.615***
	Salaried /employed	27.4	15.7	26.4	
	Retired	1.5	0	1.4	
	Casual laborer's	11.7	47.3	14.8	
Education level	No education	10.7	42.1	13.4	18.405***
	Primary	57.8	31.6	55.6	
	secondary	17.2	26.3	18	
	Tertiary/college	14.3	0	13	

***, significant at 10% confidence level

Results of *chi-square* test indicate a significant association between farmers' access to education and farmers' willing to pay for irrigation water. That is, 10.7% of the farmers willing to pay for irrigation water had no formal education, 57.8% had primary school, 17.2% reached secondary school and 14.3% attended tertiary education. Among those not willing to pay, 42.1% had no formal education while 31.6% attained primary education. At least 26.3% attained secondary education and no farmer attained tertiary education as indicated in table 2

Agricultural support services provided by various institutions are important sources of information on improved agricultural technologies and acquisition of farm inputs. These services include agricultural training, extension, and provision of credit. Results in indicate that, 66% of farmers had access to agricultural training. Results further show that at least 70% of the farmers who had access to training were willing to pay for irrigation water compared to 26% who were not willing. There is a strong statistical association between access to agricultural training and willingness to pay for irrigation water. The probable reason for this is that farmers who have attended training courses on irrigation farming and water resource management have good knowledge on the importance of paying for irrigation water hence they would be willing to pay for it.

Agricultural extension services, which include advisory and consultation on improved agricultural practices, are important in enhancing agricultural production. The results in table 2 indicate that 81% of willing farmers had access to extension services. In the category of farmers not willing to pay, 84% accessed extension services. There was, however, no significant statistical association between access to extension services and farmers willingness' to pay for irrigation water. The frequency of contact with extension staff can be used to gauge the effectiveness of extension services delivered to the farmers. Out of the total number of farmers who had contact with the extension officers, 23% attested to having received the visit only once a year, 51% had received at least

4 times a year and 25% received at least once every month. The availability of sufficient credit to the smallholder farmers contributes positively in enhancing production and income. Access to credit enables farmers to overcome working capital constraints. 26% of farmers had access to credit. On the category of farmers willing to pay for irrigation water, 28% had accessed credit. These results indicate that most farmers in the scheme had no access to credit service. No significant statistical association between access to credit services and farmers willingness to pay for irrigation water was found.

Water users' manage the majority of smallholder irrigation schemes in Kenya since irrigation farming requires collective and coordinated action in case of any problems with the systems. The proportions of farmers who are members of the irrigation water users association and willing to pay for irrigation water were 84% as compared to 16% who were not willing to pay yet they were members of the association. For farmers who were not willing to pay, 37.5% were members of the water users association while 63.5% were not members. From the results, it is apparent that the majority of the farmers in the scheme who are members of the water users association are willing to pay for irrigation water. There is a significant association between membership in the association and willingness to pay for irrigation water.

3.2 Econometric Results

Various demographic and socio-economic factors that influence farmers' decision to pay for irrigation water are determined. The probit regression model results are presented in Table 3. Out of the total number of variables considered in the model, six variables significantly influenced the farmers' decision to pay for irrigation water. The variables are the education level of the farmer, farmers' participation in the construction and maintenance of the irrigation scheme, access to extension, total income irrigation farming, membership in irrigation water users association and distance to the water source.

Table 3. Probit estimates for the determinants of willingness to pay for irrigation water

Variables	Marginal Effect	Coefficient	Std. Err.	Z
Education level	0.0297	2.88	1.34	2.14**
Age of farmer	-1.46e-09	-0.017	0.023	-0.74
Participation in construction	0.02	1.50	0.75	2.01**
Household size	.0000272	0.25	0.18	1.42
Gender of household head	-0.005	-0.74	0.71	-1.03
Distance to the market	-3.06e-08	-0.35	0.12	-2.76
Total livestock ownership	1.47e-09	0.008	0.015	0.54
Access to credit service	-0.004	-0.064	0.90	-0.07
Access to extension service	-0.001	-1.64	0.83	-1.97**
Total income from irrigated farm	0.182	5.80	1.53	3.79**
Access to agricultural training	0.0067	1.88	0.71	2.62
Membership in IWUA	0.16	1.72	0.81	2.10**
Distance to water source	-0.04	-0.352	0.12	-2.88*
Constant		4.18	1.62	2.58
N	216			
LR χ^2	95.10			
Prob> χ^2	0.000			
Pseudo R^2	0.7707			
Log likelihood	-14.143			

*, **, *** significant at 10, 5 and 1 percent level, respectively

Education level of the household head had a positive and significant influence on the decision to pay for irrigation water. That is, an additional year of schooling increased the probability of a farmer deciding to pay for

irrigation water by about 2.97%. The probable reason is that educated farmers understand better issues of water scarcity. They could also perceive better the future risk of reduced water flows on crop production and hence may understand the importance of paying for irrigation water. This is consistent with the findings by Ndetewio *et al,* (2013) who found education as a significant positive factor in influencing farmers' willingness to pay for watershed and conservation in Lower Moshi irrigation scheme in Tanzania.

Farmers' participation in the construction and maintenance of the irrigation scheme had a positive and significant effect on willingness to pay decision. Farmers' participation in the construction and maintenance of the irrigation structures increased the probability of willingness to pay for irrigation water by 2%. Farmers' participation in formulation and project implementation process builds a sense of ownership. The reason is, as farmers perceive the existence of a furrow maintenance problem, then there is a potential threat of production loss. This pushes them to seek for a sustainable solution of which financing the capacity of the irrigation scheme through water charging appears a better option. Hence, the farmers will be willing to actively participate in contributing water fees and maintenance of the irrigation systems. This finding corroborates with IFPRI (2010) study on improved water supply in Ghanaian Volta Basin, in which farmers who were aware of problems in their irrigation water supply participated regularly in construction and maintenance and were more willing to pay for water supply improvements. Another study by Tsehayou (2013) on the challenges facing smallholder irrigation schemes in Amhara region, Ethiopia found that participation of water users in the management of the schemes had a positive impact on a sense of ownership and active involvement in matters regarding the scheme.

Unexpectedly, results show that access to extension service had a negative and significant influence on the farmers' willingness to pay for irrigation water. Access to extension service reduced the probability of farmers' willingness to pay by 1%. The probable reason might be that farmers who have access to extension are better placed to have other sources of water and may have adopted more efficient technologies compared to those who have no access to the service. Nirere *et al.,* (2013) found contact with extension service providers significantly influenced farmers' willingness to pay for protection of the Nyaborongo river system in Rwanda. However, these results are contrary to a study done by Falola *et al.,* (2013) who found that access to extension services positively influenced farmers' willingness to take up agricultural insurance.

Total income from irrigation farming had a positive and significant influence on farmers' decisions to pay for irrigation water. A unit increase in farm income from irrigation increases farmers' probability to pay for irrigation water by 18.2%. That is, if farmers earn more income from irrigation farming, they are most likely to pay for the irrigation water. This is because they have more disposable income and thus more ability to withstand risks. Farmers with higher income may also command more financial capital to make better economic use of water allotted. On the contrary, farmers who earn low farm income from irrigation farming may face difficulty in paying for the irrigation water. Similar findings by Bamidele *et al*. (2010) indicate that total farm income significantly affects farmers' ability to pay for irrigation facilities in Nigeria.

Membership in Water Users' Association increases the probability of farmers paying for irrigation water by 16%. Farmers who are members of the irrigation water users association are easily influenced by their acquaintances than those in isolation. They get to exchange ideas and learn about the benefits of new systems of irrigation and new farming methods in view of sustainable agricultural production. A study by Wegerich *et al*. (2000) on water users associations' sustainability in the management of irrigation water resources in Uzbekistan and Kyrgyzstan indicates that farmers are willing to pay full price for operational and maintenance costs as well as invest their labour in maintaining the irrigation systems collectively. Changes in institutional structures of irrigation water users association from individual to groups affect farmers' willingness to pay for water farmers in groups being more willing to pay even from the influence of their peers (Frija *et al*., 2008; Amondo *et al*., 2013). Finally, as expected distance to the water source significantly and negatively influenced the farmers' decisions to pay for irrigation water. Results indicate that holding other factors constant a farmer's decision to pay for irrigation water decreases by 4% as the distance from the water source increases by 1 km.

4. Conclusion and Policy Implications

The study estimated the determinants of willingness to pay for irrigation water. Results show that improving accessibility and provision of adequate irrigation water is crucial for the success of farming under irrigation. The study found that education level significantly influences farmers' willingness to pay for irrigation water. More capacity building initiatives such as training and field days will also enhance the farmers' willingness to pay for the irrigation water. Further, farmers who regularly participated in the construction and maintenance of irrigation scheme are more willing to pay for irrigation water than those who do not. Membership to water users group is a good avenue for educating and training the farmers on the community-owned irrigation scheme.

The findings imply that improvement of irrigation systems in terms of developing physical infrastructure and allowing the users to own the scheme can enhance farmers' participation in the scheme. Moreover, farmers training and guidance provided through the irrigation water users association can contribute to increasing farmers' participation. The level of income obtained from irrigation farming significantly influenced the farmers willingness to pay, hence, pricing of irrigation water in the scheme should follow a policy of differential pricing based on income levels of farmers, rather than the administering of uniform pricing that has the potential of abuse or overexploiting water (for those who can afford it) as well as discouraging especially the poor farmers from it since they cannot afford. Though it must be acknowledged that identifying households according to income levels may be a major challenge, differential pricing has the potential of ensuring that most households, if not all, have the ability to pay for irrigation water. Establishing a feasible water charging system in the schemes such as the volumetric basis will be helpful. Water users associations should be strengthened through training of technical staff such as plumbers who will ensure water systems are properly maintained. On the other hand, adequate extension support should be delivered more specifically on irrigation farming so that farmers would be able to make efficient use of their irrigated land. Implementing an irrigation water management system that would ensure equitable water distribution and effective enforcement of existing rules and regulations would further enhance not only the farmers' willingness to pay but also the intensity of payment they would commit.

Acknowledgments

We are indebted to the African Economic Research Consortium (AERC) for their financial support in carrying out this study. Enumerators who collected the data are also highly acknowledged, finally, we wish to sincerely thank all the farmers who answered our questions through the questionnaires.

References

Amondo, E., Kironchi, G., & Wangia, S. (2013). Willingness to pay for improved water supply due to spring protection in Emuhaya district, Kenya. *International Journal of Education and Research, 1*, 220-238.

Bamidele, F., Ogunlade, I., & Olabode, P. (2010). Factors affecting farmers' ability to pay for irrigation facilities in Nigeria: the case of Oshin irrigation scheme in Kwara State, Nigeria. *Journal of Sustainable Development in Africa, 12*, 334-349.

Burger, R. (1998). *Water users' associations in Kazakstan: an institutional analysis.* Harvard Institute for International Development, Central Asian Republics.

Falola, A., Ayinde., O. E., & Agboola., B .O. (2013). Farmers Willingness to take agricultural insurance by cocoa farmers' in Nigeria. *International Journal of food and agricultural sciences, 1*(1), 97-107.

Frija, A., Chebil, A., Speelman, S., & VanHuylenbroek, G. (2008). Effects of the changes in institutional structure of irrigation water property rights on the willingness to pay to pay of farmers for water: Case of Tunisia. A paper presented at the 12th EAAE congress 26th -29th august 2008 in Gent Belgium.

Gichuki, F. N., Gichuki, S. G., & Matsuoka, N. (2010). Framework for Irrigation development: Attaining Vision 2030 through sustainable irrigation. Nairobi Ministry of Water and Irrigation. Government of Kenya (1997). *Republic of Kenya, Marakwet District Development Plan (1997-2001).* Government Printers, Nairobi.

Government of Kenya. (2010). *Agricultural Sector Development Strategy 2010-2020*.

Howarth, S. E., Parajuli, U. N., Baral, J. R., Nott, G. A., Adhikari, B. R., Gautam, D. R., & Menuka, K. C. (2005). Promoting good governance of water users' associations in Nepal. Department of irrigation of his majesty's government of Nepal.

IFPRI. (2010). What is the irrigation potential in Africa? A Combined Biophysical and Socioeconomic Approach. *IFPRI discussion paper 00993*. Retrieved October 20, 2012, from htpp://www.ifpri.org/publications

Johnson, S. H. III, Virmillion, D. L., & Sagardoy, J. A. (Eds.). (1995). Irrigation Management Transfer: Selected papers from the International Conference on Irrigation management Transfer, Wuhan, China, 20-24 September 1994. Water Report 5. Rome:FAO and IIMI.

Kenya National Bureau of Statistics. (2009). *Kenyan facts and figures*. Ministry of planning and National Development Nairobi, Kenya.

Ministry of Water and Irrigation. (2003). *Framework for Formation of Water Users Associations towards sustainable.* Nairobi, Kenya.

Ministry of Water and Irrigation. (2008). *Ministerial Strategic Plan 2009-2012.* Nairobi, Kenya.

National Irrigation Board. (2010). *National irrigation board website*. Retrieved November 3, 2012, from

www.nib.org

Ndetewio, P., & Mwakaje, A. (2013). Factors influencing willingness to pay for watershed services in lower Moshi, Pangani Basin, Tanzania. *International Journal of Agriculture and Environment, 2*, 57-75.

Ngigi., S. (2002). Review of irrigation development in Kenya. *The changing face of irrigation in Kenya: Opportunities for anticipating change in eastern and southern Africa.*

Nirere, S. (2013). *An assessment of farmers' willingness to pay for the protection of Nyamborongo River System, Rwanda*. Unpublished Master's Thesis. University of Nairobi.

Rangwa, P. K., Kamau, N. R., & Mbatia, E. D. (1998). Irrigation and drainage branch position. Paper presented during the Workshop on promotion of sustainable smallholder irrigation development in Kenya, November, 1998 Kenya Embu.

Saina C. K. (1996): *Drought and Famine Coping Strategies and Environment among the Keiyo living in Kerio valley, Kenya.* Unpublished M.Phil. Thesis, Moi University, Kenya.

Torori, C. O., Mumma, A. O., & Field-Juma, A. (1995). Governance of water resources in Kenya. Ecopolicy Series No.8 Naiobi: ACTS press.

Tsehayou, G., & Krish, H. (2013). Challenges in farmer managed small-scale irrigation schemes: Case study on south Achefer Woreda of Amhara region, Ethiopia. *Journal of Scientific Research and Review, 22*, 19-29.

Wegerich, K. (2000). Water user associations in Uzbekistan and Kyrgyzstan: Study of conditions for sustainable development. School of Oriental and African studies, University Of London.

Note

Note 1. Kenyan Shilling 87=1 US dollar at the time of the survey