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Willingness to pay for irrigation water and its determinants among rice farmers at Doho Rice Irrigation Scheme (DRIS) in Uganda

Namyenya Angella[1], Sserunkuuma Dick[2]* and Bagamba Fred[3]

Department of Agribusiness and Natural Resource Economics, School of Agricultural Sciences, Makerere University, P. O. Box 7062, Kampala Uganda.

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The government of Uganda is currently rehabilitating its irrigation schemes. The largest of these is Doho Rice Irrigation Scheme (DRIS), where farmers will after rehabilitation bear the costs of its maintenance through payment of user fees. This study analyzes farmer's willingness to pay (WTP) user fees and its determinants, using data gathered from 200 rice farmers at DRIS in 2012. The contingent valuation (CV) bidding game approach and Ordinary Least Squares (OLS) methods were used to elicit WTP and analyze the determinants of WTP, respectively. The study findings show that while farmers are willing to pay Ush 20,000 (USD 8)/acre/season on average, Ush 15,000 (USD 6) acre/season is actually needed to cover maintenance costs as per the 2013/2014 work plan for DRIS. The study recommends charging Ush 15,000/acre/season, however, which not only generates sufficient revenue to cover the maintenance costs, but also lies below the average WTP, which several farmers should be willing to pay without coercion. However, because not all farmers are willing to pay Ush 15,000, it is necessary to incentivize voluntary payment and strong enforcement of penalties against non-payment among those with low WTP. The OLS regression results suggest need for additional intervention that enhances private benefits to farmers, such as improved access to credit, markets and training in soil/water management and rice growing.

Key words: Irrigation water, user fees, willingness to pay, rice, Uganda.

INTRODUCTION

Uganda has of late witnessed erratic rainfall seasons (MWE, 2007) and increasing occurrence of drought conditions which has frustrated rain-fed agriculture and rendered irrigation investment critical for increased agricultural production in Uganda (MAAIF, 2012). Consequently, the government of Uganda (GOU) has prioritized rehabilitation of the existing irrigation schemes whose infrastructure broke down over a long period of misuse and poor maintenance (MWE, 2012a; MWE, 2009). Currently, the schemes under rehabilitation include

* Corresponding author. E-mail: sserunkuuma@caes.mak.ac.ug, Tel: +256-772504454.

Doho, Mubuku and Agoro irrigation schemes in Butaleja, Kasese and Lamwo districts, respectively (MAAIF, 2012). Construction of the major irrigation schemes in Uganda started in the 1960's. Doho Rice Irrigation Scheme (DRIS) in particular was constructed between 1976 and 1985 by the GOU to promote rice production in eastern Uganda through the provision of irrigation water,improved rice seeds, farm tools, marketing and milling services. Following its completion, the GOU partitioned DRS into ten blocks covering a total area of 1,012 ha; and each block was partitioned into smaller plots (0.10 to 0.40 ha) that were leased to individual farmers on a first come, first served basis. GOU retained the role of maintaining the irrigation structures through the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) up until the early 1990s (MWE, 2012b). During this period, the irrigation and drainage channels were regularly de-silted by the GOU which enabled sustainable flow of irrigation water to the rice fields.

However, driven by budgetary constraints around 1994 and examples of successful collective action in irrigation water management in other parts of the world (Meinzen-Dick et al., 2000), the GOU withdrew its support[1] and devolved management of the irrigation scheme to Doho Rice Scheme Farmers' Association. The association adopted an earlier resolution made by farmers, district officials and local leaders, which required all farmers to pay an irrigation user fee of Ush 5,000 (USD 5.1)[2]/acre per season towards the cost of mechanized de-silting of the irrigation and drainage channels. In addition, farmers were required to contribute labor towards the collective cleaning and weeding of the channels. A committee composed of an elected Chairperson and 10 block-level executive members and counselors was set up to collect user fees; mobilize farmers for the collective cleaning of the channels; and monitor collective action on each block. A bylaw was enacted stating that those who did not comply with user-fee payment or participate in collective channel maintenance in any cropping season would have their plots of land withdrawn from them the following two seasons and rented out to willing farmers, and the money realized would go toward the cost of maintaining the scheme.

However, following the devolution of management from the GOU to the farmers' association, a collective action problem arose and hindered achievement of the desired outcome of adequate supply of irrigation water to rice plots through collective effort. This was attributed to shortage of funds to de-silt the channels caused by the failure of farmers to comply with the by-law requiring each farmer to pay the irrigation user-fee and participate in collective channel maintenance, coupled with poor enforcement of this bylaw[3]. Literature shows that only two thirds (66%) of the farmers at DRIS fully complied with the bylaw on user-fee payment in 2001 (Sserunkuuma et al., 2009) and only about 40% of the irrigation fees are collected on average. In addition, active participation by farmers in collective channel maintenance is limited and the penalty of barring obstinate farmers from growing rice on their plots for the following two seasons is rarely enforced (Nakano and Otsuka, 2011).

The main factors emasculating compliance were found to be poor awareness of the bylaw and the associated benefits; poor enforcement of the bylaw[4]; and the negative perception by farmers of the private benefits they derived from compliance. One fifth to one quarter of the farmers surveyed in 2001 perceived the private benefits derived from the scheme not to be worth the cost incurred; and the study found a significant negative relationship between compliance with the bylaw and the perception that benefits of compliance are lower than the costs.

This negative perception was caused by the extensive silting of the channels, which significantly reduced water conveyance to some rice fields. The lack of sufficient incentives (in form of water supply) for payment of user fees partly explains why one-third of the farmers did not comply with the user-fee bylaw (Sserunkuuma et al., 2009). Failure to adequately de-silt the channels had set up a cycle of failure in which an insufficient number of farmers paid user fees in a given season, which translated into inadequate de-silting of the channels, which in turn lowered the amount of irrigation water supplied to the rice plots, limiting rice yields and farmers' ability and willingness to pay (WTP) the user fees in the following season.

To break this cycle, rehabilitation of the entire irrigation system was recommended to increase water supply to farmers and improve rice yields on their fields as well as their willingness and ability to pay the user fees. In accord with this recommendation, GOU has since October, 2011 embarked on the rehabilitation and revitalization the irrigation scheme at Doho as well as those at Mubuku and Agoro. After completion of the rehabilitation process, the responsibility of maintaining the scheme at Doho will again revert to the farmers (MWE, 2012b); and it is envisaged that a user fee will be charged per acre per season to raise funds for operating and maintaining the irrigation scheme. Poor awareness and enforcement of the user-fee and collective action bylaw at Doho and the associated poor compliance

[1] except for payment of salaries of a few staff like irrigation engineers and agricultural extension agents
[2] The official average mid-rate for 1994 is Ush 979 to 1USD.

[3] To manage irrigation facilities effectively and allocate water resources efficiently, it is critically important to enforce the rules of water allocation and maintenance of irrigation channels and drainages (Ostrom, 1990).
[4] The administration at DRIS attributes poor bylaw enforcement to the physical characteristics of the irrigation system, with no means of blocking water supply to individual defaulters as a way of incentivizing them to pay the user fees. For similar reasons, it is not possible to levy user fees based on the volume of water received.

cited above can be attributed to the manner in which the bylaw was enacted, with limited involvement, sensitization and consultation of farmers, which led to low farmer buy-in.

Nkonya et al. (2001) observe that it is difficult to effectively enforce and educe compliance with bylaws that are not clearly understood or ratified by farmers. With the impending transfer of management responsibility to farmers after rehabilitation of DRIS and the accompanying need for farmers to contribute towards the maintenance costs, it is imperative to determine how much farmers are willing to contribute; and to use this information to guide the setting of appropriate user fees.

This study was undertaken with the objective of determining farmers' WTP user fees; and how this varies across rice farmers at DRIS. The study shows that while the provision of private incentives to farmers is important for improved management of devolved irrigation schemes, it is not a panacea but must go hand in hand with strong enforcement of penalties against free riders, and investment in provision of supporting services that enhance the private benefits to farmers. While this study shows that education attainment enhances farmers' willingness to contribute money towards maintenance of the irrigation scheme at DRIS, available literature shows that education emasculates willingness to participate when farmers are required to contribute labor.

WTP is a commonly used Contingent Valuation Method (CVM) approach for valuing goods and services that are not traded in the markets, including natural resources and resource services (Lipton et al*.,* 1995) such as water for household use and irrigation; amenities such as national parks; and private non-market commodities such as reductions in the risk of death or days of illness avoided. It is the economic value of a good to an individual (Yang et al., 2007) or the maximum sum of money an individual is willing to part with in exchange for an increase in the quantity or quality of a natural resource good or service (Agudelo, 2001).

Akter (2007) estimated the value of irrigation water in a small scale irrigation project in the Homna sub-district in Bangladesh. He used CVM to elicit farmers' WTP for the irrigation water, using irrigation charges per decimal land area per cropping season as the payment vehicle. He found the mean WTP to be 1670 Taka (US$ 27.83) per kani (30 decimals of land) per cropping season; and a significant impact of age, education, family size, number of income sources and ownership of farmland on WTP. Basarir et al. (2009) used the Torbit and Heckman sample selection models to study the WTP of vegetable producers for high quality irrigation water in the Turhal and Suluova regions of Turkey and found a significant relationship between WTP and gender and water quality.

Whittington et al. (1990) used the bidding game format to estimate WTP for water services in Laurent, a rural community in Haiti and found it to be 5.7 gourdes (US$ 1.14) per month; and observed that developing countries are likely to produce better quality CVM surveys compared to industrialized countries.

Casey et al. (2005) studied WTP for improved water services in Manaus, Amazonas, Brazil, using both open-ended and bidding game approaches. They found the mean WTP to be R$11 (US$ 5.61) per month; and also observed that the respondents were willing to pay more for drinking water than the current charges. Other studies have found significant relationships between WTP for water or other natural resources and education of the household head, household size, farming experience, farm size, proximity to the resource, access to markets, extension services, credit and training, peoples' attitudes and perceptions on payment (Adepoju and Omonona, 2009; Mezgebo et al*.*, 2013; Ogunniyi et al*.,* 2011; Wendimu and Bekele, 2011; Addis, 2010; Moffat et al*.*, 2012; Calkins et al*.,* 2002; Rodriguez and Southgate, 2003; Kassahun, 2009; Latinopoulos, 2001; Ulimwengu and Sanyal, 2011; Farolfi et al*.*, 2007; Alhassan, 2012; Illukpitiya and Gopalakrishnan, 2004; Calatrava and Sayadi, 2005). These studies guided the choice of variables used in the model explaining variation in WTP user fees across the sampled households at DRIS.

METHODOLOGY

Study area, sampling procedure and data

This study was conducted at Doho Rice Irrigation Scheme (DRIS) located 34° 02'E and 0° 50'N on the right bank of river Manafa in Mazimasa and Kachonga sub-counties of Butaleja district in Eastern Uganda (Figure 1).

DRIS occupies an area of 2,500 acres (1,012 ha), sub-divided into 10 blocks of unequal size, namely; 1A, 1B, 2A, 2B, 3, 4A, 4B, 5A, 5B and 6 (Figure 2). The 10 blocks are connected by three layers of channels, namely; main, sub and tertiary channels. The main channel provides irrigation water from River Manafwa to the scheme and branches out into the sub-channels, which provide irrigation water to each of the 10 blocks. Basically, each block has one sub-channel and consists of 5 to 15 smaller zones called strips, each surrounded by a tertiary channel that provides irrigation water to plots belonging to 20 to 30 farmers by a tertiary drainage channel. The tertiary drainage channel for one strip serves as the tertiary irrigation channel for the strip next to it. After flowing through paddy fields, water is collected in the main drainage channel through the tertiary and sub-drainage channels and drained back into River Manafwa (Nakano and Otsuka, 2011).

This study involved a survey of 200 households randomly drawn from among the rice farmers at DRIS in September 2012. A stratified random sampling procedure was employed, using the 10 blocks that make up DRIS as the strata to ensure that farmers on all blocks are represented in the study sample. Using the list of households for each block, a proportionate number of households was randomly drawn based on the household population of that block relative to the total number of households at DRIS[5]. Data was gathered from the sampled farmers using a structured questionnaire administered through in-person interviews with the household head. To elicit farmers' responses on WTP for irrigation

[5] 14 households were drawn from the smallest block and 33 households from the largest

Figure 1. Map of Uganda showing the study area; Source: www. mapsofworld.com.

water, the study used a contingent valuation (CV) approach involving the iterative bidding game (Randall et al., 1974).

The game starts by querying individuals at some initial monetary value and keeps raising (or lowering) the value until the respondent declines (accepts) to pay. The final amount of money is interpreted as the respondent's WTP. Despite criticism of the bidding game approach as being prone to starting point bias, which makes the final WTP amount at the end of the bidding game systematically related to the initial bid value, Whittington et al. (1990) argue that the bidding game produces better quality WTP data in developing countries than in industrialized countries. This is because it is well understood and accepted by respondents in developing countries, who are used and prepared to negotiating over the price of just about any item they purchase on a regular market, unlike their cohorts in the industrialized countries.

In this study, the starting bid price was set at Ush 5000/acre per season, which the farmers at DRIS were required to pay according to the existing bylaw enacted in 1994. Since the commodity to be valued (irrigation water) was familiar to the respondents, the bidding game was not framed in a probabilistic sense, but rather the respondent was asked if they were willing to pay the starting bid price of Ush 5000/acre per season to experience adequate supply of irrigation water following the de-silting of irrigation and drainage channels. If the respondent answered "yes", the bid was increased until the respondent answered no. The highest yes response value was recorded as the maximum WTP. If the respondent answered "no", the bid was reduced until the respondent answered yes, and the highest yes response value was recorded as the maximum WTP. Farmers were not actually required to pay the bid amount they stated, which could have rendered this measure of WTP biased and subjective. This is a key limitation of this study. However, the fact that the study involved valuation of a familiar commodity for which they were already paying helped to purge some of the bias. Additional data was collected on household-level characteristics (age, gender, education, household size, years of irrigation farming), farm size, rice production and marketing in the first cropping season of 2012, access to training and extension related to rice production and irrigation water management, access to credit, and farmers' perceptions and attitudes about who should be responsible for paying the cost of maintaining the supply of irrigation water.

The theoretical model

The economic value of a non-market good to an individual can be measured by the magnitude of their WTP for the good. Formally, WTP is defined as the amount that must be taken away from an individual's income (to meet the costs of providing the non-market good) while keeping their utility constant as shown in the equation below:

$$V(y - WTP, p, q_1; Z) = V(y, p, q_0; Z)$$

Where V denotes the indirect utility function, y is the income of the

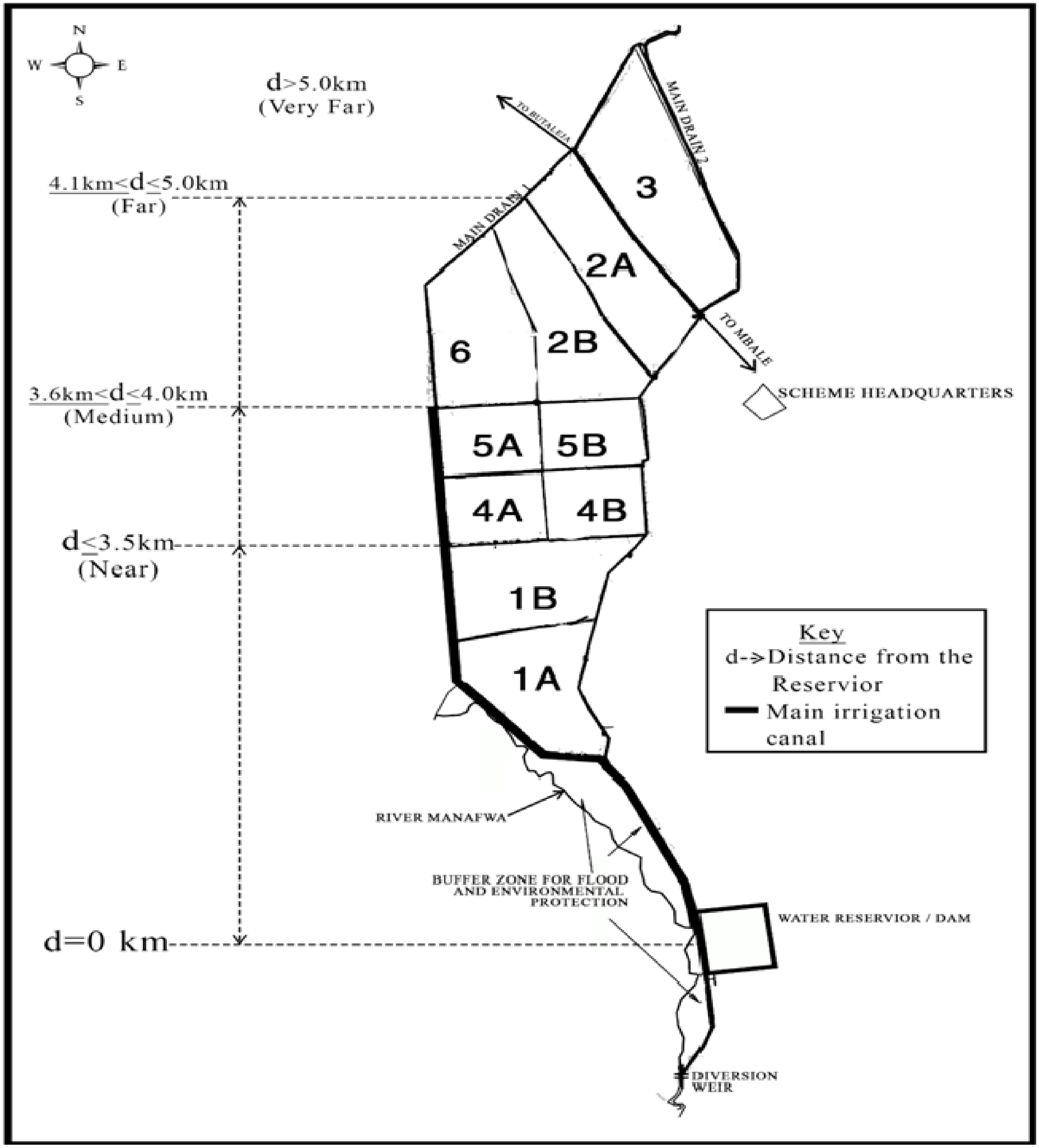

Figure 2. Map showing location of the 10 blocks with respect to water source/ reservoir.

individual, p is a vector of prices faced by the individual, q_0 and q_1 are the alternative levels of the non-market good under baseline and improved conditions, respectively (with $q_1 > q_0$ indicating an improvement from q_0 to q_1), and Z is a vector of individual characteristics affecting the trade-off that the individual is prepared to make between income and the non-market good. This equation implies that WTP depends on (i) the initial and final level of the good in question (q_0 and q_1); (ii) respondent income; (iii) prices faced by the respondent; and (iv)other respondent socio-economic characteristics.

The empirical model

Determination of the factors influencing farmers' WTP for irrigation water at DRIS was achieved through estimation of a double-log

Table 1. Budget estimates for maintenance and operation of DRIS as per the 2013/2014 work plan.

Expenditure item	Estimated cost per season (Ush.)
Excavator maintenance (servicing)	3,000,000
Maintenance of canal gates (main, medium and small)	2,000,000
Maintenance of farm roads	7,500,000
Maintenance of irrigation canals	10,000,000
Maintenance of drainage canals	5,000,000
Maintenance of broken pedestrian or foot bridges	2,000,000
Servicing of other machines	5,250,000
Meetings	2,570,000
Total	37,320,000

Source: DRIS annual work plan for 2013-2014 (1 USD equals Ush 2,500).

Ordinary Least Square (OLS) regression model. The general form of the model is specified as:

$$lnY_i = \beta_0 + \beta_i lnX_i + \mu_i$$

Where; *ln* is natural logarithm, Y_i is the dependent variable, X_i is a vector of explanatory variables, β_0 and β_i are the parameters to be estimated, and μ_i is the random error term. Thus, the estimated OLS model explaining variation in WTP across sampled rice farmers at DRIS is specified as:

$$\ln WTP = \beta_0 + \beta_1 \ln EDU + \beta_2 \ln EXP + \beta_3 \ln HHS + \beta_4 \ln FSIZE + \beta_5 \ln DMKT + \beta_6 TRA + \beta_7 EXT + \beta_8 CRE + \beta_9 OFFA + \beta_{10} ATT + \beta_{11} PSOURCE + u_i$$

Where; WTP= Farmers willingness to pay for irrigation water, EDU= Education of household head measured in years of schooling, EXP= Practical experience in rice farming under irrigation measured in years, HHS= Household size, FSIZE= Farm size or total area of land owned at DRIS measured in acres, DMKT= Distance in kms from the household to the nearest market where rice is sold. TRA=Participation in training related to soil and water conservation, rice growing or irrigation water management (1= Trained, 0= Otherwise), EXT=Access to extension services (1= Accessed extension, 0= Otherwise), CRE=Access to credit in the past two years (1= Accessed credit, 0= Otherwise), OFFA=Involvement in an off-farm activities by at least one household member (1=Involved in off-farm activities, 0= Otherwise), ATT=Attitude towards payment for irrigation water (1= Positive attitude, 0= Otherwise), PSOURCE = Proximity to irrigation water source [(1= Very far (>5 km); 2= Far (4.1-5 km); 3=Medium (3.6-4.0 km); 4=Near (≤ 3.5 km)], ln= Natural logarithm, β_i= regression parameters, u_i = random error term.

RESULTS AND DISCUSSION

Findings from the contingent valuation survey show that rice farmers at DRIS are willing to pay an average of Ush 20,000 (USD 8) per acre or USD 20 per hectare as user fees per season. Based on the total acreage of DRIS of 2,500 acres (1,012 ha), this implies that charging Ush 20,000 per acre per season would generate Ush 50 million (USD 20,000) in total revenue per season.

However, the budget estimates for maintenance and operation costs of DRIS as per the 2013/2014 work plan (Table 1) show that only three quarters (75%) of this (Ush 37.32 million) is needed to cover the costs. This implies that charging Ush 15,000/acre per season would generate enough revenue for maintaining and operating DRIS. Before explaining the variation in WTP user fees across sampled rice farmers, their socio-economic characteristics which are hypothesized to influence WTP are hereby briefly examined. The sampled farmers are grouped into two categories based on whether or not the money they are WTP as user fees is adequate to cover the maintenance and operation costs of DRIS (Ush 15,000/acre per season). Analysis of farmers' WTP shows that 58% of the sampled farmers (N=200) are WTP at least Ush 15,000/acre per season as user fees; and these constitute the first category of farmers defined as "adequate WTP" (ADWTP).

The second category is composed of the rest of the farmers (42% of the sample) whose WTP is inadequate to cover the costs; and this is referred to as the "inadequate WTP" (INADWTP) category. Table 2 shows that a typical rice-growing household at DRIS is male-headed (94% of the sample) and of medium size (7.3 people).

However, a significantly higher proportion of households in the ADWTP category are male-headed (98.3%) than their cohorts in the INADWTP category (88.1%); and the average household size in the ADWTP category (8.1 people) is higher than in the INADWTP category (6.3 people). The average age of the head of a typical rice-growing household at DRIS is estimated at 42.2 years and does not differ between the two categories; but the education of the household head (estimated at 7.3 years of schooling for the entire sample sample) is significantly higher among households

Table 2. Selected socioeconomic characteristics of sampled rice-growing households at DRIS.

Variables	Entire sample (N=200)	ADWTP (N=116)	INADWTP (N=84)	Chi-square/ t-value
Percentage of male headed households	94	98.3 [a]	88.1[b]	8.953
Age(years) of household head	42.2	43.3[a](1.211)	40.4[a](1.680)	1.420
Number of years of formal education of household head	7.3	8.5[a](0.283)	5.6[b](0.377)	6.270
Household size	7.3	8.1[a](0.309)	6.3[b](0.377)	3.587
Total area of land owned at DRIS	2.7	3.3[a](0.242)	2.0[b](0.162)	4.195
Practical experience (years) in rice farming under irrigation	13	15.8[a](0.855)	9.3[b](0.853)	5.163
Percentage of households trained in soil/water conservation/rice growing	58	76.7 [a]	32.1 [b]	39.75
Percentage of households accessing extension services on rice	53.5	61.2[a]	42.9[b]	6.594
Percentage of households who had access to credit in the past two years	29.5	36.2 [a]	20.2 [b]	5.974
Percentage of households with at least one member involved in off-farm activities	29.5	27.6 [a]	32.1 [a]	0.486
Distance from the household to the nearest rice market	1.5	1.5[a](0.425)	1.6[a](0.389)	-1.446
Percentage of households with a positive attitude towards payment for irrigation water	85.5	90.5 [a]	78.6 [b]	5.608
Rice output (Kgs/household) per season	683.9	792.63[a]	533.75[b]	2.721
Rice yield (Kg/Acre) per season	740.9	748.37[a]	730.58[a]	0.330
Rice Net-Income (Ushs/household) per season	1,071,800	1,254,300[a]	819,830[b]	2.704
Rice Net-Income (Ushs/Acre) per season	1,184,400	1,225,600[a]	1,127,500[a]	0.843

Numbers in parentheses are standard errors. Different superscripts (a, b) reflect statistically significant differences in variable between the farmers categories; while same superscripts signify no difference. The 3[rd] column labeled ADWTP presents summary statistics for households with adequate WTP (WTP ≥ Ush 15,000/acre per season); while the 4[th] column labeled INADWTP presents summary statistics for households with inadequate WTP (WTP < Ush 15,000/acre per season).

in the ADWTP category (8.5 years) than their cohorts in the INADWTP category (5.6 years).

Households in the ADWTP category are also endowed with bigger farmland at DRIS (3.3 acres) and longer practical experience in irrigated rice farming (15.8 years) than those in the INADWTP category (estimated at 2 acres and 9.3 years, respectively). Furthermore, significantly higher percentages of households in the ADWTP category had prior to the contingent valuation survey accessed training in rice growing and soil and water conservation (76.7%), rice-related extension services (61.2%) and credit (36.2%) than their cohorts in the INADWTP category, for which the corresponding percentages were 32.1, 42.9 and 20.2%, respectively.

During the contingent valuation survey, respondents were asked for their opinion about compelling farmers to pay for the maintenance of the irrigation scheme at DRIS. Majority (85.5%) had a positive attitude towards payment of user fees, but the proportion of such households was significantly higher in the ADWTP (90.5%) than in the INADWTP (78.6%) category. 30% of the sampled households had at least one household member engaged in off-farm activity as their main occupation but the proportion of such households did not differ significantly between the two categories. The distance from the home of the sampled households to the nearest market where they sell rice was estimated at 1.5 km but this also did not differ between the ADWTP (1.5 km) and INADWTP (1.6 km) categories

Recent studies conducted at DRIS show that the availability of irrigation water has a positive and significant impact on rice yield and income which in turn significantly affects household contribution of labor to the cleaning of irrigation and drainage channels (Nakano and Otsuka, 2011;

Table 3. Determinants of farmers' WTP user fees at DRIS.

Variable	Coefficient	Robust standard errors	T-Value
Constant	7.762	0.271	28.65
ln Education of household head	0.397***	0.059	6.76
ln Household size	0.083	0.092	0.90
ln Total area of land owned at DRIS	0.250***	0.059	4.22
ln Practical experience (years) in rice farming under irrigation	0.156**	0.071	2.22
ln Distance from the household to the nearest rice market	-0.444*	0.251	-1.77
Training in soil/water conservation/rice growing	0.361***	0.115	3.15
Access to extension services on rice	0.140	0.114	1.23
Access to Credit	0.214**	0.086	2.49
Involvement in Off-farm Income Activity	0.002	0.093	0.02
Positive Attitude towards payment of user fees	0.126	0.121	1.05
Proximity to Irrigation Water Source	0.076	0.059	1.27
Number of observations		200	
Adjusted R-Squared		0.51	
Prob>F		0.0000	
F(11, 188)		26.37	
Breusch-Pagan test for heteroskedasticity Prob> chi2		0.0487	
Mean VIF		1.62	

*,**,***,Significance at the 10, 5 and 1% levels, respectively.

Nakano et al., 2013). This study also gathered data on rice production and marketing by the sampled households in the first cropping season of 2012. The results show an average rice yield of 741kg/acre per season (1.83 mt/ha per season) for the entire study sample (N=200), which does not significantly differ between the ADWTP (748.4 kg/acre) and INADWTP (730.6 kg/acre) categories. This seems to suggest that the availability of irrigation water did not differ significantly across the sampled households in the first season of 2012, likely because as noted by Nakano and Otsuka (2011), rainfall and water supply at the scheme are abundant in the first cropping season and farmers occasionally suffer from flooding, although water supply is scarce in the second season. The average net income from an acre of rice (measured by gross margin) was estimated at Ushs 1,184,400 (USD 474) per season; and this as well did not significantly differ between the ADWTP (Ush 1,225,600/acre) and INADWTP (Ush 1,127,500/acre) categories.

However, the average net income per household in the first season of 2012 (estimated at Ush 1,071,800 for the entire sample) was significantly higher among households in the ADWTP category (Ush 1,254,300) than their cohorts in the INADWTP category (Ush 819,830). This is attributed to the fact that households in the ADWTP category are endowed with bigger land at DRIS (3.3 acres) than their cohorts in the INADWTP category (2 acres), which enables the former to earn higher rice income. Therefore, larger farmers earn more income from rice and as a result have better willingness and ability to pay user fees than smaller farmers. This corroborates the findings of Nakano and Otsuka (2011); and supports the notion that private benefits conferred by plot size are the prime motivation for participation in collective irrigation water management (White and Runge, 1994), because farmers with larger plots enjoy greater income benefits from abundant water supply, hence the greater incentive to pay user fees.

The descriptive results discussed above suggest a significant relationship between socio-economic characteristics of rice-growing households at DRIS and their WTP user fees. These relationships are examined further using regression analysis; and the results are summarized in Table 3. The adjusted coefficient of determination (Adjusted R-Squared) value of 0.51 means that 51% of the variation in farmers' WTP user fees is explained by the variables included in the regression model. The regression results show statistically significant relationships between farmers' WTP user fees and formal education of the household head; farm size; practical experience in irrigated rice farming; participation in training related rice growing in general or soil and water conservation and irrigation water management in particular; and access to credit and markets. In this study, access to credit and participation in training are treated as exogenous despite being choice variables to the respondents. This is because they are pre-determined in the sense that they both happened in the past, well before the respondents were asked to respond to the bids on user fees; in the same way that education is treated as pre-determined and exogenous yet the respondent made the choice of the level at which to end schooling.

The regression results imply that a one percent increment in education of the household head, land endowment and practical experience in irrigated rice farming increases farmers' WTP user fees by 0.4, 0.25 and 0.16% respectively; while a 1% reduction in distance to the rice market increases WTP by 0.44%. A switch from having "no access" to "access" to credit and training (in rice growing, soil and water conservation and irrigation management) is associated with a 43.5% ($e^{0.361}$) and 23.8% ($e^{0.214}$) increase, respectively in the geometric mean of farmers' WTP user fees.

These findings imply that more educated farmers have higher WTP irrigation fees, likely because higher education is associated with better understanding of the benefits of adequate supply of irrigation water in agricultural production. Education is also believed to increase farmers' ability to obtain, analyze and assimilate information that helps them to make prudent decisions related to the management of their farming enterprises.

Also, education is a good proxy for off-farm income because it enables agricultural households to pursuit alternative income opportunities outside agriculture (e.g.,salary or business), which increases their ability and WTP irrigation fees. These results are consistent with the findings Adepoju and Omonona (2009); Mezgebo et al. (2013); Ogunniyi et al. (2011); Wendimu and Bekele (2011) who found a positive relationship between formal education and WTP.

However, Nakano and Otsuka (2011) found education attainment to be negatively correlated with household contribution of labor towards the collective maintenance of DRIS, because of the higher opportunity cost of labor associated with non-farm income among more educated households. This renders more educated households less keen to contribute labor to collective action than their less educated cohorts. The implication of these findings is that the impact of education attainment on participation in irrigation water management plays out differently depending on whether the users are required to contribute labor or money to ensure the supply of irrigation water.

The positive relationship between farm size and WTP is likely because farmers with larger land endowment also cultivate larger rice plots at DRIS and earn higher income from rice when the supply of irrigation water is adequate. These findings are consistent with those of Mezgebo et al. (2013); Ulimwengu and Sanyal (2011); and Nakano and Otsuka (2011); and illustrate the prime importance of private benefits conferred by farm size in collective irrigation water management (White and Runge, 1994). Also, given that rice production is the most important income source for over 80% of the households at DRIS (Sserunkuuma et al., 2009), farm size is a good proxy for household income, which enhances ability and WTP user fees. The positive correlation between practical experience in rice farming under irrigation and WTP is likely because farmers with longer experience are more familiar with the benefits of adequate supply of irrigation water enjoyed when DRIS was properly maintained and have also observed the decline in rice output through the years as the scheme deteriorated. This enables them to better appreciate the importance of their contribution towards improved water supply, hence the higher WTP. This result is consistent with Addis (2010); Kassahun (2009); and Latinopoulos (2001).

Access to credit and training related to rice growing in general or soil and water conservation and irrigation water management in particular are associated with higher WTP of user fees, likely because training tends to increase farmers' awareness of the dangers of unabated siltation of the irrigation channels and appreciation of their role in abating these dangers through payment of user fees, as well as appreciation of the ensuing benefits.

This finding is consistent with Calatrava and Sayadi (2005) who found that farmers who attended agricultural training courses had significantly higher WTP for water in tropical fruit production in South Eastern Spain. The positive relationship between access to credit and WTP is likely because credit enables cash constrained farmers to earn more income from agribusiness and other micro-enterprises, (Zeller, 2000), which enhances their ability and WTP user fees. The need to earn money to pay back the acquired credit also likely contributed to the higher WTP bids among farmers who accessed credit, with the hope that this will lead to increased rice output and income to enable them to pay back the credit.

This result corroborates the findings of Addis (2010) and Illukpitiya and Gopalakrishnan (2004). Distance to the rice market and WTP are negatively correlated because farmers closer to the markets incur less transaction costs and earn more from their rice compared to those further away and are, thus, willing and able to pay more to ensure adequate supply of irrigation water.

This finding is consistent with Ulimwengu and Sanyal (2011) who found a negative impact of travel distance on the WTP for agricultural services. The rest of the explanatory variables (household size, access to extension services, involvement in off-farm activities, having a positive attitude towards payment of user fees and proximity to the irrigation water source) have positive but statistically insignificant relationships with WTP user fees. This is likely because of the way these variables were captured in the contingent valuation survey, which doesn't reflect their true impact on WTP.

CONCLUSIONS AND RECOMMENDATIONS

This study analyzed farmers' WTP user fees and the determinants of WTP at DRIS, which is currently undergoing rehabilitation by the government of Uganda (GOU) and is due to revert to farmers who are expected to manage and maintain it through payment of user fees and contribution of labor to collective action. The study was motivated by the need to determine how much farmers are willing to contribute towards the maintenance costs; and to use this information to guide the setting of appropriate user fees.

The study found that while farmers are on average WTP Ush 20,000/acre per season as user fees, Ush 15,000/acre per season is actually needed to cover maintenance and operation costs as per DRIS' work plan for 2013/2014. The higher WTP notwithstanding, the study recommends charging Ush 15,000/acre per season, which not only generates sufficient revenue to cover the costs, but also lies below the average WTP, implying that several farmers would willingly pay this amount without coercion.

However, because the WTP for some farmers (42% of the study sample) is below Ush 15,000 (for some it is as low as Ush 1,000), there is need for continued sensitization of farmers on the importance of their contribution towards the cost of supplying water to ensure farmer buy-in. This has to go hand in hand with provision of incentives for voluntary payment as well as strong enforcement of penalties against non-payment of the user fees among those with low WTP. Available literature shows a history of poor enforcement of penalties against uncooperative farmers at DRIS, leading to incessant shortfalls in the collection of user fees (only 40% of irrigation fees being collected on average) and inadequate contribution of labor towards collective maintenance of the irrigation and drainage channels.

Fujiie et al. (2005) recommends incentivizing community leaders who mobilize farmers for collective action and collect the user fees as a way of reversing the shortfalls. An incentive such as a monetary reward for chairpersons and counselors based on the number of farmers from their respective blocks who pay user fees promptly and participate in the cleaning of the channels could help to improve the performance of those leaders in collection of user fees and mobilization farmers for collective action. Another strategy for addressing the shortfalls is to switch from the current self-enforcement mechanisms to private third-party agencies to enforce compliance with the existing bylaw. The regression results show statistically significant relationships between farmers' WTP user fees and formal education of the household head; farm size; practical experience in irrigated rice farming; participation in training related rice growing in general or soil and water conservation and irrigation water management in particular; and access to credit and markets. These results imply that in addition to provision of incentives for voluntary payment and enforcement of penalties against non-payment of user fees, appropriate interventions related to these factors influencing farmers' WTP are necessary. For example, the positive relationship between WTP and participation in training in soil and water conservation, rice growing or irrigation water management implies that intensifying training in these areas is important to increase farmer awareness of the dangers of unabated siltation of the irrigation channels and appreciation of the importance of their contribution towards the cost of de-silting to ensure adequate supply of irrigation water. Interventions that promote farmers' access to affordable credit are also recommended, based on the positive and significant relationship between having acquired credit and WTP. These may include establishment of an agricultural bank or risk-sharing guarantee schemes to motivate financial institutions with a rural branch network to provide credit to farmers at more affordable rates. In light of the findings of a positive correlation between farmers' WTP user fees and market access, there is need to invest in increasing farmers' access to rice markets to reduce transaction costs and enable farmers to receive better returns to rice production; which will in turn enhance their ability and WTP user fees.

The positive relationship between farm size and WTP implies that development of a land rental or lease market at DRIS would enable interested farmers to expand the sizes of their rice farms; which will in turn increase their income and ability to pay as well as WTP user fees.

While this study shows that education attainment enhances farmers' willingness to contribute money towards maintenance of the irrigation scheme, available literature shows that education emasculates willingness to participate in irrigation water management when farmers are required to contribute labor.

Therefore, switching from the current practice of compelling all farmers to contribute both money and labor to the alternative involving giving them the option of contributing larger amounts of either labor or money (in lieu of the other) depending on the opportunity cost of their labor in other income generating activities may help to reduce the shortfalls in user fee collection and labor contribution towards collective maintenance of the irrigation system at DRIS.

Conflicts of Interest

The authors have not declared any conflict of interest.

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