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RESEARCH ARTICLE

ASSESSMENT OF FARMERS CHALLENGES WITH RICE PRODUCTIVITY IN SELECTED IRRIGATION SCHEMES, WESTERN KENYA

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ABSTRACT

This research was conducted in three rice irrigation schemes in Western Kenya namely; Ahero, West Kano and Bunyala in August 2011. The main objective of the study was to evaluate socio- economic challenges facing rice growing farmers; and to developed strategies to assist households improve their economic status, household food security and water management for irrigation. The research sample was computed at 200 households, data was collected using a questionnaire, observation and analysed by statistical package for social science (SPSS) version 11. The major findings indicate over 90% of respondents are permanent residents in the schemes and 57% are male- headed, whereas 41% are female –headed. Over 93% of the households rely on rice production as their main source of income. Most farmers in AIS (95%) and WKIS (86%) grow rice on less than seven acres of land, most of which is allocated by National Irrigation Board. Results from the study indicate over 76% of own the land under rice production. In terms of crop variety, 56% of farmers in Ahero prefer IR2793 as compared to 50% of farmers in Bunyala. In West Kano 59% of the farmers rank Basmati 317 variety highly. In the absence of IR2793 rice variety, farmers prefer to cultivate Basmati 317. Their reasons for preferring respective rice varieties is due to long experience in cultivation and lack of awareness on new improved rice varieties. Based on these results, it is observed the three irrigation schemes reveal a vicious cycle of poverty. The farmers living conditions are characterized by low purchasing power, high rice crop production costs, low levels of education of women and overcrowded households. The study recommends an improvement in the use of modern technology in rice production for improved socio- economic status of these households in western Kenya.

INTRODUCTION

The demand for rice in Kenya continues to soar as more people show progressive changes in their eating habits, coupled with urbanization. Rice is currently the third most important cereal crop after maize and wheat. Most of the rice in Kenya is grown in irrigation schemes established by the Government, which include Mwea in central Kenya, three irrigation schemes (Ahero, West Kano and Bunyala) in western Kenya. On the other hand, a smaller quantity of rice is produced along major river valleys, located in the coast and lake basin regions. About 80% of rice in Kenya is grown under continuous flooding as is typified in gravity operated Mwea irrigation scheme, and in the three western Kenya irrigation schemes that are pumps operated (JICA, 1988). The paddy system of rice production requires a lot of water and production is often affected by water scarcity in times of drought (Gessel, 1982), as was the case in 2009. The present water management in the irrigation schemes creates a regular flow of water in the larger canals and intermittent rotational flows in smaller canals. As a result, the rice farmers and their families who stay in specified villages within the irrigation schemes depend on the irrigation system as the main source to supply them with water for all agricultural and domestic purposes. The System of Rice Intensification (SRI) that involves intermittent wetting and drying of paddies as well as specific soil and agronomic management practices is an alternative system that can be considered to increase crop water productivity (Ceesay, 2002). SRI offers an opportunity to improve food security through increased water productivity of rice, increased smallholder farmers' income and reduce the national rice import bill (Mati, 2010). Moreover SRI makes use of assets already available to rice farmers (Dobermann, 2004). SRI was introduced at Mwea irrigation scheme in August 2009 (Mati, 2010) and to date, very few people know

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about SRI in Kenya. This study intends to establish rice production process and challenges facing farmers and how they can be resolved to improve food security and economic development. We will consider SRI and compare it with other rice varieties in terms of costs and input savings that may accrue to farmers.

Research Objectives

The objectives of the research was to evaluate socio-economic challenges facing rice growing farmers; and to developed strategies to assist households improve their economic status, household food security and water management for irrigation.

Research Area

The research was carried out in three rice irrigation schemes in Western Kenya namely; Ahero, West Kano and Bunyala. These are managed by the Kenya National Irrigation Board (NIB). The rice schemes receive rainfall pattern of western Kenya region that is characterized by bimodal rainy season and isolated heavy storms due to the influence of Lake Victoria. Annual temperatures range from 22.1 ^{0}C in June to 23.5 ^{0}C in March. The average annual rainfall is approximately 1175 mm. The irrigated fields in the three schemes are underlain by deep black cotton soils with very high clay content that swell or shrink and crack accordingly when they are hydrated or dried (Figure 1). Ahero Irrigation Scheme (AIS) is located in Kano Plains, close to Lake Victoria, in Kisumu County and draws water from river Nyando using pumps. AIS was commissioned in 1969 and supports approximately 520 farmers on a net irrigated area of 840 ha. West Kano Irrigation Scheme (WKRIS) is also located in Kano Plains, on the shores of Lake Victoria in Kisumu County and draws water from Lake Victoria using pumps. The scheme was commissioned in 1975 and supports approximately 550 farmers on a net irrigated area of 900 ha. Bunyala Irrigation Scheme (BIS) is located in Budalangi division, Busia County. The scheme is located along old course of river Nzoia on the shores of Lake Victoria and draws water from river Nzoia using pumps. The scheme was commissioned in 1968 and supports approximately 300 farmers on an irrigated area of approximately 500 ha.

Currently, rice production in the three schemes is mainly *Sindano* (IR2793) variety and each farmer is licensed to cultivate 1.6 ha of irrigated rice in four fields, each of 0.4ha. Some of the major challenges that the three irrigation schemes face are; lack of cost-effective water supply system (pumping vs. gravity), lack of water storage to guarantee adequate supply during the dry spell, slow adoption of participatory irrigation management by the farming community, combating of water-borne and other related diseases, ensuring environmental stability and lack of clean drinking water, among others.

METHODS AND MATERIALS

The research used a household questionnaire survey instruments for the three rice irrigation schemes. The survey instrument was administered in twenty to thirty minutes, depending on the patterns, speed and comprehension and clarity of responses. The questionnaire was field-tested in Ahero Irrigation scheme by the enumerators and subsequently revised to eliminate problems in language comprehension. A total of six enumerators were used in the surveys and were distributed equally in the three irrigation schemes. All the six enumerators had prior experience in household survey and were fluent and literate in the local language as well as English. The project researchers facilitated one day training for the six enumerators prior to the survey.

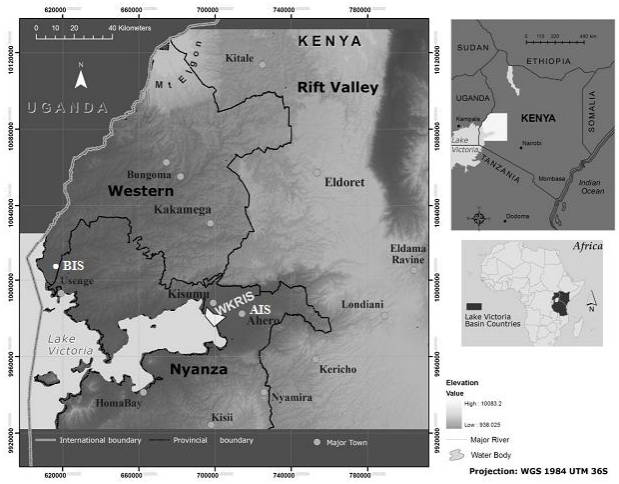

Figure 1: Location of the three irrigation schemes under study in the western part of Kenya

The target population of rice farmers in Ahero, West Kano and Bunyala irrigations schemes is 1380 and therefore Equation 1 for finite population was used to compute the sample size.

$$n = \frac{Z^2.p.q.N}{e^2(N-1)+Z^2.p.q} \quad \text{..... (Equation 1)}$$

Where n is size of sample, Z is standard variate at a given confidence level, p is sample proportion, q = (1-p), N is the size of population and e is acceptable error (the precision). Using Equation 1 with N=1380, e = 0.02, Z=1.96 (as per table of area under normal curve for the given confidence level of 95%), the p value is assumed to be equal to the precision p=0.02 and q = 0.98, the sample population n is computed as 166.

The computed sample size was proportionally distributed to each scheme based on respective individual scheme population of 530, 550 and 300, giving the individual sample sizes of: Ahero (64), West Kano (66) and Bunyala (36). This values were scaled up to Ahero (80), West Kano (80) and Bunyala (40) giving a total of 200 rice farmers to reduce sampling errors and improve the quality of data collected. The respective farmer registers with known number of farmers was used to select the sample using systematic sampling with the start being randomly selected. This resulted in a 95% confidence level and at least 2% precision. The probability of selection in the three cases was proportional to the population. In the selected households, the interviewers ascertained that the respondent was an adult and was willing to be interviewed. In cases where no adults were present, the team moved to the next closest house and conducted interviews following the

same procedure. Upon completion of the interviews in the field, the filled questionnaires were brought to Ahero where an experienced person was hired to enter data using SPSS version 11 software and supervised by the research team. This program was also used for data analysis. Frequency tables were used to discern tendencies, and cross tabulations were used to compare sub-groups.

RESULTS AND DISCUSSIONS

Demography and socio-economic characteristics of respondents

All respondents interviewed in Ahero (AIS) and Bunyala (BIS) irrigation schemes are permanent residents in the schemes. In West Kano, 86.3% respondents are permanent residents while the rest have stayed in the scheme for between six months (2.5%) and 5 years. On average, 57% of the households in AIS are male headed and 41% are female headed. In West Kano (WKIS) and BIS, more households (66.2% and 70%, respectively) are male-headed while 33.8% and 30% respectively are female headed. In AIS, 73.8% of the household heads and 72.5% of the households in both WKIS and BIS have attained primary and secondary education. Less than 27% of the respondents in all the schemes have attained technical/college training or university education. From the results gender disparities exist in the level of education attained by household heads. In all the three irrigation schemes, more female household heads have attained primary education compared to their male counterparts whom have attained post secondary education.

The level of education of the household head is a key factor that inhibits the ability to acquire knowledge and skills on agricultural production and basic water and sanitation hygiene. The education level of the household head influences the vulnerability of the household to water and sanitation related diseases, especially considering that most of the irrigation schemes are located in areas that easily floods thus attract disease causing vectors. More than 55% of the households surveyed in the three irrigation schemes are composed of between five and nine household members. In WKIS and BIS, 25% of the households surveyed, respectively, have between 10 and 14 household members, whereas in AIS 16.2% of the households surveyed have a similar number of household members. Among the dependants, more of the households surveyed have up to nine children (80% in AIS, 66.2% in WKIS and 72.5% in BIS).

Livelihood Strategies of the Respondents

Table 1 shows over 93% of all the households in the three irrigation schemes primarily depend on rice production as the main source of income. While all households in Bunyala derive their main income from rice farming, households in AIS and WKIS supplement their income by exploiting wage labour opportunities (1.2% and 2.5%, respectively), craftsmanship (5% in AIS) and fishing (1.2% in WKIS). These income sources contribute minimal compared to rice production. From these livelihood activities, households earn varying income levels annually. In AIS, about 91.3% of the households surveyed generate Kshs. 30,000–119,000 annually, mainly from rice production. A high proportion of households in WKIS (70%) and BIS (52.5%) earn a similar amount of income annually. It is evident from the findings that some households (47.5%) surveyed in BIS generate lower income levels (less than Kshs. 30,000 annually) from the livelihood activities they engage in. However, it is important to note low number of households in WKIS (17.5%) and AIS (5%) generate more than Kshs 120,000 annually.

In addition to the main sources of income, most households surveyed have invested in productive assets (Table 2) that enable them to diversify income options, cushion (form of insurance) themselves against shocks associated with reduced yields or losses of rice production, supplement household dietary and nutritional needs and assist in meeting family needs such as education, social obligations (marriages) and investments. These results reveal that poultry is a major contributor to household livelihoods in the three schemes.

Rice Production and its challenges

Land ownership and land use characteristics

Majority of farmers in AIS (95%) and WKIS (86.2%) grow rice on less than seven acres of land, most of which is allocated by NIB. In BIS 50% of the respondents cultivated three to five acres of land allocated by the NIB, and less than 8% rent land for rice production. About 8% and 11.9% of farmers in BIS and AIS, respectively, rent less than three acres of land for rice growing. In WKIS, 16.3% of the respondents rent up to seven acres of land for rice cultivation. Most households surveyed in AIS (95%) and WKIS (86.2%) cultivate less than 5 acres of land allocated by NIB. In BIS 50% of the households surveyed grow rice on less than five acres of land allocated by NIB. A high proportion of farmers in WKIS (16.3%) rent land under rice production, compared to AIS (11.2%) and BIS (7.5%) (Table 3). Half of the respondents in the three irrigation schemes have practiced farming for about 20-40 years, with one third cultivating rice for 30-40 years. About 60% of the farmers in AIS have participated in 1-2 meetings or demonstrations on rice production in the previous year compared to 27.5% in WKIS and 25% in BIS. These results imply farmers may be using old techniques in growing rice, thus there is need to create awareness on current and most productive rice farming technology.

Land tenure in the irrigation schemes

In the three irrigation schemes, 86.2%, 77.5% and 92.5% of the respondents in AIS, WKIS and BIS, respectively, own the land under rice production. Less than 4% of respondents in all the irrigation schemes rent the land cultivated, while about 1% in WKIS lease the land used to grow rice. Production costs vary across the three irrigation scheme. The total proportion of farmers who rent land for rice production is; 3.8%, 12.5% and 2.5% in AIS, WKIS, and BIS respectively; and spend Kshs 10,000 to Kshs 15,000 annually. About 8.8% and 2.5% of the respondents in AIS and WKIS, respectively, spend Kshs 15,001 to Kshs 20,000 annually, whereas only 2.5% of farmers in BIS spend over Kshs 25,000 annually to rent land for rice production. Similarly, the cost of irrigation water fee for all rice production in AIS and BIS ranges between Kshs 3,001-3,500 per acre of land cultivated. The paid water fee to NIB mainly covers the operation and maintenance costs of the irrigation infrastructure. In WKIS, majority of farmers

Table 1: Household income sources and average annual incomes

Variables	Category	Distribution per scheme (%)		
		Ahero	West Kano	Bunyala
Main income sources	Fishing	-	1.2	-
	Craftsman	5.0	-	
	Wage labour opportunities	1.2	2.5	
	Farming	93.8	96.2	100.0
Average annual household income (Kshs)	Less than 30,000	3.8	12.5	47.5
	30,000 - 59,000	57.5	30.0	40.0
	60,000 - 119,000	33.8	40.0	12.5
	More than 120,000	5.0	17.5	-

Table 2: Distribution of domestic livestock types owned by households in the three irrigation

	Numbers of animals owned	Cattle	Goats	Sheep	Chicken/Ducks	Other
Ahero	1 – 4	42.5	18.8	16.2	22.5	0
	5 – 9	22.5	17.5	13.8	8.8	
	10 – 14	11.2	1.2	10.0	30.0	
	15 – 19	6.2	0	0	6.2	
	20 – 24	3.8			7.5	
	>25	0			1.2	
	0	13.8	62.5	60	23.8	
	Total	100	100	100	100	
West Kano	1 – 4	35.0	30.0	18.8	28.8	36.2
	5 – 9	20.0	15.0	0	13.8	5.0
	10 – 14	3.8	6.2		20.0	0
	15 – 19	6.2	0		8.8	
	20 – 24	2.5		2.5	1.2	
	25 – 29	5.0		0	0	
	0	27.5	48.8	78.7	27.4	58.8
	Total	100	100	100	100	100
Bunyala	1 – 4	40.0	17.5	2.5	15.0	12.5
	5 – 9	20.0	2.5	12.5	32.5	0
	10 – 14	2.5	0	0	17.5	
	15 – 19	2.5			7.5	
	20 – 24	0			10.0	
	0	35	80	85	27.5	87.5
	Total	100	100	100	100	100

Table 3: Land use characteristics and rice production

	Land Area (Acres)	Irrigated land allocated by NIB	Irrigated land rented	Total area under rice farming	Area under rice production last season
			Frequency (%)		
Ahero	None	0	88.8	5.0	7.5
	0.1 - 2.9	33.8	11.2	36.2	38.8
	3 - 4.9	61.2	0	50.0	47.5
	5 - 6.9	3.8	0	7.5	5.0
	7 – 10	1.2	0	1.3	1.2
West Kano	None	0	83.8	0	0
	0.1 - 2.9	46.2	10.0	45.0	48.8
	3 - 4.9	40.0	3.8	45.0	45.0
	5 - 6.9	13.8	2.5	7.5	3.8
	7 – 10	0	0	2.5	2.4
Bunyala	None	50.0	92.5	0	0
	0.1 - 2.9	0	7.5	47.5	50.0
	3 - 4.9	50.0	0	50.0	47.5
	5 - 6.9	0	0	2.5	2.5

(82.5%) spent about Kshs 3501- 4000; 15% spent Kshs 3001-3500; and 2.4% of farmers spend less than Kshs 3,000 on irrigation water fee. The high water fee cost in WKIS compared to both AIS and BIS is because there is double pumping at the inlet from Lake Victoria and outlet as drainage to the wetland. Enquiry was done on the age at which rice seedlings are transplanted and the seedling density per spot in the three irrigation schemes. Majority of farmers (92.5%, 65% and 97.5%) in AIS, WKIS and BIS respectively transplant seedlings from the nursery at 21-23 days old. Only in WKIS did we identify farmers (15%) who transplant at 18-20 days old. Between 2.5% (BIS) and 6.25% (AIS and WKIS) of the respondents transplant seedlings from the nursery at 24-26 days. A small proportion of farmers in WKIS (8.8%) transplant seedlings after 27-30 days and about 5% transplant seedlings when they are more than 30 days old. On number of seedlings per hill (density), majority of respondents 80% in BIS indicated three; while 77% in AIS and 47% in WKIS indicated two. Fifteen per cent in AIS indicated three and twenty per cent in BIS indicated two. There is a great variation in WKIS whereby 11% show one; 10% show 1-2; 18% show 2-3 and 11% show 3. These results show disparities in the number of seedling transplanted at each spot in the field, thus there is need to educate farmers on the optimum density per spot to enhance productivity.

Table 4: Respondents' preferred rice variety

		Distribution (%)					
	Rice variety	Rank 1	Rank 2	Rank 3	Purchased	Own	Preferred
Ahero	IR2793-80-1	56.3	35.0	6.3	55.0	1.3	81.3
	Basmati 370	40.0	38.8	15.0	35.0	3.8	16.3
West Kano	ITA 310	2.5	22.5	21.3	2.5	2.5	1.3
	IR2793-80-1	21.2	35.0	18.8	62.5	1.3	35.0
	Basmati 370	58.8	26.2	15.0	27.5	5.0	42.5
	ITA 310	20.0	31.2	26.2	2.5	1.3	20.0
Bunyala	IR2793-80-1	50.0	47.5	10.0	87.5	1.3	87.5
	Basmati 370	22.5	27.5	10.0	5.0	2.5	12.5
	ITA 310	0	5.0	22.5	1.3	1.3	0
	BW 196	27.5	20.0	7.5	0.0	1.3	0

Cost of Rice Production and Preferred Variety

In AIS, 56.3% of farmers prefer IR2793-80-1 compared to 50% farmers BIS. In WKIS, 58.8% of the farmers rank Basmati 370 variety highly (58.8%). In the absence of the IR2793-80-1 rice variety, farmers in AIS would cultivate Basmati 317; whereas farmers in WKIS and BIS would replace their highly ranked varieties with IR2793-80-1 and BW 196, respectively. In terms of overall preference of rice variety; 81.3% in AIS and 87.5% in BIS prefer IR2793-80-1 rice variety, while 42.5% in WKIS prefer Basmati 370 varieties. The reasons for preference of respective varieties are due to long experiences/cultivation and lack of awareness on new improved rice varieties. Farmers indicated that they purchased rice seeds from NIB. The results show a positive relationship between the farmers' preferred variety and the proportions purchased (Table 4). The cost of producing rice in the three irrigation schemes involve field operations and activities like; preparing the nursery bed, land preparation, transplanting seedlings, applying top dressing fertilizers on established rice crop, spraying, irrigating, weeding, cutting, heaping, staking or drying rice, threshing, packaging and transportation. Most households surveyed use both hired and family labour (Table5 and Plate 1). Transport costs are higher than all other rice production activities particularly in AIS and BIS.

a): land levelling

(b): sowed nursery

c): transplanting

(d): hand weeding

(e): irrigation event

(f): bird scaring

(g): threshing

(h): a busy harvesting day

Plates 1: Various activities during the growing season for rice in the three irrigation schemes

Data shows 80% of the farmers in all the three irrigation schemes purchase fertilizer for both planting and top dressing, except in WKIS where only 7% of the respondents use fertilizer to plant rice. The quantity of fertilizer used varies in the three irrigation schemes as shown in Table 6. In AIS, farmers use almost an equal proportion of fertilizer for planting and top dressing at a cost of Kshs 1680-1710. In WKIS, farmers use more fertilizer for planting (60.7 kg) than topdressing (47.9 kg) at between Ksh 2135 and Ksh 4670, respectively. This can be explained by the variety grown (Basmati 370). Only 2% of the respondents in AIS and WKIS use farm manure. As the crop matures, farmers in all the three irrigation schemes purchase sisal twine and chemicals at approximately Kshs 1105 in WKIS; compared to Kshs 480 in BIS and Kshs 102 in AIS. This can be explained by the fact that dealers sell chemicals directly to farmers in WKIS whereas farmers purchase chemicals through NIB in both AIS and BIS.

On the interval of weeding the rice crop, over 70% of households in the three irrigation schemes indicate at least twice, though the proportions increase from AIS (70%); WKIS (86%) and BIS (95%). In WKIS and BIS, 53.2% and 55.0%, respectively weed their rice crop after 10-14 days. A significant section of the households surveyed in BIS (32.5%) weed after 20-24 days, while in WKIS, only 11% of the households weed after the same period. Enquiries made on

Table 5: Labour costs per acre of irrigated rice paddy

Activity	Distribution (%)								
	Hired labour					Family labour			
	Number		Unit cost	Gender		Number		Gender	
	People	Days	(Ksh)	Male	Female	People	Days	Male	Female
Ahero									
Nursery Bed	1.0	1.0	132.8	0.2	0.5	3.0	2.7	1.3	1.6
Land preparation	3.4	2.2	189.4	1.0	2.4	2.1	2.8	1.0	1.2
Transplanting	6.7	1.5	124.8	3.8	3.6	2.1	0.9	1.1	1.1
Top dressing fertilizers	0.7	0.4	203.3	0.5	0.1	0.9	0.8	0.8	0.2
Spraying	1.1	1.9	228.4	0.8	0.2	0.5	3.5	0.5	0.1
Irrigating	0.9	49.3	173.6	0.5	0.6	0.6	1.0	0.5	0.1
Weeding	5.1	2.4	168.6	1.1	3.3	2.2	1.9	1.1	1.1
Cutting	5.9	1.0	146.6	3.0	1.7	0.7	0.3	0.5	0.2
Heaping/Staking/drying	8.7	1.0	200.0	0.5	7.4	0.9	0.3	0.4	0.5
Threshing	8.7	1.0	201.3	0.4	7.8	0.8	0.3	0.4	0.5
Transport cost	-	-	1,045.0	-	-	-	-	-	-
West Kano									
Nursery Bed	2.9	3.4	279.0	2.3	0.4	1.7	3.4	0.7	0.9
Land preparation	5.7	5.6	304.9	3.1	2.4	1.8	5.5	0.7	1.1
Transplanting	15.1	1.1	183.2	4.8	7.8	1.4	1.3	0.5	0.9
Top dressing fertilizers	1.1	1.0	222.1	1.0	0.0	0.7	0.6	0.4	0.3
Spraying	1.2	1.3	340.4	1.1	0.0	0.7	0.5	0.4	0.3
Irrigating	1.2	3.9	320.5	0.9	0.2	1.0	1.0	0.7	0.4
Weeding	4.4	2.8	432.8	0.5	3.4	1.2	2.8	0.4	1.0
Cutting	4.4	1.0	336.7	4.3	0.1	0.8	0.5	0.4	0.3
Heaping/Staking/drying	7.2	1.0	161.2	0.9	6.1	1.4	0.9	0.4	1.0
Threshing	8.0	1.0	152.8	0.9	6.3	1.4	1.0	0.4	1.0
Transport cost	2.3	1.0	105.6	2.3	0.0	1.6	1.0	0.8	0.8
Bunyala									
Nursery Bed	1.5	2.2	196.0	0.4	1.1	1.5	2.9	0.8	0.7
Land preparation	6.6	6.0	225.0	5.1	1.1	3.4	0.5	0.5	7.2
Transplanting	7.2	3.6	3.6	237.5	0.2	1.2	2.6	0.5	0.7
Top dressing fertilizers	0.7	1.3	177.1	0.7	0.2	0.4	0.7	0.2	0.1
Spraying	1.0	1.9	203.8	1.0	0.0	0.0	-	-	-
Irrigating	1.0	8.5	20.0	0.9	0.0	0.8	-	0.5	0.3
Weeding	4.2	6.0	173.1	0.1	4.0	1.1	3.7	0.5	0.6
Cutting	4.1	3.2	267.1	3.9	0.0	0.0	-	-	-
Heaping/drying/threshing	7.1	3.4	172.0	0.0	7.1	0.9	2.7	0.1	0.8
Transport cost	2.6	1.2	286.6	-	-	-	-	2.6	0.1
Others	1.9	2.8	-	1.9	0.0	0.6	1.6	0.6	-

Table 6: Source and cost of inputs for rice cultivation per acre

Activities	Input use		Source	Quantity/units	Unit cost	Total cost (Ksh/acre)
	Yes	No				
Ahero						
Seeds	80	0	Purchased	27 Kg	72.7	1755.6
Fertilizers (planting)	80	0		49.4 Kg	34.2	1710.6
Fertilizers (topdressing)	80	0		48.8 Kg	33.4	1676.5
Farm manure	2	78	Self	-	-	-
Stakes	80	0		5 Pieces	87.5	460
Sisal twine	80	0	Purchased	4.4 Pieces	45.5	114
Others (chemicals)	13	67		2.8 Kg	35.9	102.3
West Kano						
Seeds	80	0	Purchased	25.8 Kg	93.6	2382.5
Fertilizers (planting)	7	73		60.7 Kg	1535.7	2135.7
Fertilizers (topdressing)	80	0		47.9 Kg	1543.9	4666.2
Farm manure	2	78	Self	-	-	--
Stakes	6	74		338.7 Pieces	18.3	1800
Sisal twine	3	77	Purchased	3.6 Pieces	88.6	242.9
Others (chemicals)	17	67		125.2 g/Litre	6.6	1104.4
Bunyala						
Seeds	40	0	Self	25 Kg	90.7	2266.3
Fertilizers(planting)	40	0	Purchased	2 Kg	1750	3500
Fertilizers(topdressing)	40	0		47.9 Kg	1543.9	4666.2
Stakes	3	37	Self	338.7 Pieces	18.3	1800
Sisal twine	3	37	Purchased	3.6 Pieces	88.6	242.9
Others (chemicals)	40	0		400 g/Litres	1.2	480

Table 7: Rice production and utilization

Quantity (Kg)	Distribution (%)					
	Total harvested			Total sold		
	Ahero	West Kano	Bunyala	Ahero	West Kano	Bunyala
1 – 1500	16.2	26.2	20.0	18.8	42.5	22.5
1501 – 2500	16.2	36.2	22.5	15.0	27.6	20.0
2501 – 3500	18.8	16.2	30	17.8	12.5	35
3501 – 4500	7.5	11.5	17.5	8.8	6.2	12.5
4501 – 5500	10.0	1.2	2.5	9.0	2.5	10.0
5501 – 6500	8.8	2.5	7.5	12.4	3.8	-
6501 – 7500	7.5	2.5	-	10	1.2	-
7501 – 8500	6.2	1.2	-	1.2	-	-
8501 – 9500	3.8	-	-	2.5	-	-
9501 – 10500	2.5	-	-	2.2	1.2	-
Over 10500	2.5	2.5	-	2.3	2.5	-

Table 8: Problems encountered in rice production

Problems	Distribution (%)		
	Ahero	West Kano	Bunyala
Access to loan	53.8	13.8	7.5
Diseases/pest	81.3	92.5	95.0
High cost of fertilizers	72.5	11.3	92.5
Inadequate grain storage facility	3.8	3.8	37.5
Inadequate irrigation water supply	21.3	53.8	85.0
Lack of quality seeds	20.0	23.8	5.0
Low rice prices	45.0	35.0	75.0
Poor drainage	0	8.8	55
Others	37.5	70.0	85.0

methods of weeding revealed that, over 80% use manual hand pulling while 16% use herbicides in WKIS. The significant difference can be attributed to scarcity of labour. Ninety nine per cent (99%) of respondents in BIS and AIS draw water for irrigation from the NIB canal/river whereas in WKIS (95%) use water from Lake Victoria. Farmers in the three irrigation schemes attain varied rice yield levels. However, a higher percentage of farmers in WKIS (78.6%) and BIS (72.5%) realize yields not exceeding 3,500 kg, compared to 51.2% of farmers in AIS who harvest the same quantity of rice. In a similar trend, respondents in the irrigation schemes indicate that they sell varying proportions of their harvest to generate income to meet household needs (Table 7). In BIS, however, production levels are comparatively low with no farmers realizing more than 6,500kg of rice. This may be due to irrigation water scarcity, poor drainage and high incidence of pests and diseases experienced. Over 90% of respondents in all the three irrigation schemes surveyed retain up to 500 kg of the rice produced for domestic use. This implies that most of the rice produced by farmers in the three irrigation schemes is for sale; with a paltry amount of rice produced for domestic consumption. The results show, rice is not a basic food for most of the respondents, thus rice is sold to purchase staple food (maize). The price of one kilogram of rice offered to farmers in the three irrigations schemes varies as follows; AIS (60%) and WKIS (65%) sell their rice for between Kshs 37-44 per Kg. In BIS 40% of the farmers interviewed sell the rice produce for Kshs 29-36 while 52.5% sell rice for Kshs

Table 9: Incentives for enhancing irrigation water use efficiency in rice production

	Action and incentives	Distribution (%)			
		Rank 1	Rank 2	Rank 3	Rank 4
Ahero	Water scheduling equipment	27.5	7.5	7.5	13.8
	Efficient irrigation equipment	0	8.8	0	3.8
	Training	7.5	20.0	2.5	32.8
	Information on new crops	0	0	27.5	2.5
	Information on new markets	15.0	30.0	0	7.5
	Water pricing	22.5	26.2	28.8	10.0
	Compliance with regulations	0	0	2.5	12.2
	Water meters			0	15.0
	Others	27.5	7.5		2.5
West Kano	Water Scheduling equipment	7.5	13.8	5.0	10.0
	Efficient irrigation equipment	43.8	5.0	16.2	20.0
	Training	11.2	42.2	23.8	16.2
	Information on new crops	8.8	15.0	20.0	12.5
	Information on new markets	3.8	8.8	10.0	12.5
	Water pricing	3.8	5.0	10.0	13.8
	Compliance with regulations	0	3.8	12.5	6.2
	Water meters		6.2	0	6.2
	Others	5.0	1.2	2.5	0
Bunyala	Water Scheduling equipment	2.5	2.5	15.0	20.0
	Efficient irrigation equipment	7.5	52.5	25.0	7.5
	Training	72.5	27.5	0	0
	Information on new crops	0	5.0	12.5	7.5
	Information on new markets		0	2.5	22.5
	Water pricing		2.5	10.0	17.5
	Compliance with regulations		2.5	27.5	20.0
	Water meters		0	2.5	5.0
	Others	17.5	7.5	5.0	0

37-44 per Kg. It is only in AIS and WKIS that a small proportions of farmers sell their rice for Kshs 45-52 per kg (20% and 18.8%, respectively) and Ksh 53-60 per Kg (3.8% in both schemes). These results imply farmers receive very low prices for their produce which in turn has negative impacts on their annual income and livelihoods. The variations in production levels in the three irrigation schemes and the selling prices of rice produced have negative implications on their returns on investment for farmers and household incomes.

The respondents were asked to identify problems they encountered in rice production and to rank in order of importance. The results shown in Table 8 indicate the following; in AIS diseases and pests, high cost of fertilizers, access to loans and credit as well as low prices of rice produced are the most critical problems facing farmers. In WKIS, diseases and pests, inadequate irrigation water and low prices of rice produced are the most critical problems. In BIS, disease and pest infestation, high cost of fertilizers, inadequate irrigation water, low prices for rice produced and poor drainage are ranked critical problems. On overall pest and disease control; high costs of fertilizers and irregular water supply are the major problem facing rice farmers in western Kenya. These results imply farmers are faced with many rice production problems that should be addressed by stakeholders in order to reduce costs of production, improve prices of produce and provide incentives for farmers to produce rice as a cash crop and food crop. In order to improve rice production and enhance efficient water use in the three irrigation schemes, respondents identified the following incentives as shown on Table 9. Households in AIS prefer the installation of water scheduling equipment (27.5%), water pricing (22.5%) and information on new markets (15.0%). In WKIS, farmers rank efficient irrigation equipment (43.8%) as the most important intervention, followed by training (11.2%). Training of farmers is a key intervention proposed by farmers in BIS (72.5%). Installation of an efficient irrigation equipment ranks second (52.5%) and compliance with regulations was ranked third. A major challenge for intervention is change of attitude from the norm of rice growing to the new SRI technology for rice farmers. Data obtained from model sample farms will assist to have farmers adopt new technology which will increase rice yield per acre and reduce per unit water use, improve household income and improve livelihoods thus reducing poverty.

Conclusion

The findings from the study indicate that the inhabitants of western Kenya rice schemes have limited sources of livelihoods and most rely on rice farming. However, most of them attain low yield levels which reduce their living standards in terms of housing, education facilities, health facilities and infrastructure in general. Those in the rice producing zone need to be encouraged to practice commercial rice farming. This can be achieved by accessing credit facilities, availing loaning facilities (soft loans) and initiating community based organizations to increase their bargaining power with financial institutions. The western Kenya rice irrigation schemes (AIS, WKIS and BIS) are pump-fed; this has a negative impact on the farmer since it elevates the production costs due to pumping cost of irrigation water. There is need to explore gravity water sources to cut down on the production cost and improve on the farmer's income. This could be facilitated through the construction of dams upstream and gravity intake works and conveyance to offer continuous water supply to the schemes. Rice farmers should be encouragement to form cooperative societies that will enable them access credit facilities at low interest rates as compared to the banking sector. Such societies are better placed in accessing inputs and reliable markets that offer competitive prices due to their strong bargaining power. The study

recommends that farmers be trained and exposed to emerging technologies in rice farming practices such as system of rice intensification (SRI) that involves intermittent wetting and drying of paddies as well as specific soil and agronomic management practices. If appropriately applied SRI could help cut down on rice production costs by reducing wastage of water. The national irrigation board needs to empower farmers by disseminating new technology through farmers' field schools and continuous demonstration.

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