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Impact of Irrigation on Poverty Reduction in Rwanda

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Abstract

In Rwanda, the major constraints to agriculture include population pressure coupled with the dominance of traditional practices and low application of modern inputs like improved seeds and fertilizers. This study examined the impact of irrigation practices on poverty reduction in Rusizi district, western Rwanda. The authors employed a sample of 100 respondents selected from 7,925 members of four cooperatives growing rice at Bugarama wetland. The participants were selected by using purposive and random sampling techniques. This study adopted a comparative descriptive design which used questionnaires and interviews for data collection. The collected data were analyzed by using SPSS version 21.0. The results indicated that there was a high degree of positive correlation between irrigation and poverty reduction where Karl Pearson coefficient of correlation (r) was 10.986. This implies that irrigation contributed to the poverty reduction positively and at high level and the raise of income positively affected farmers' livelihood. The study also highlighted existing challenges of practicing irrigation and way forward to ensure poverty reduction at large scale. The findings of this study will be important to different stakeholders with provision of information on the impact of irrigation in increasing food security and poverty reduction in general.

Keywords

Agriculture Practice, Irrigation, Poverty Reduction, Rice Production, Rusizi District, Rwanda

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1. Introduction

Irrigated agriculture has expanded enormously over the past five decades in the world resulting from a revolution in irrigation development which has increased from less than 100 million ha in 1950 to more than 275 million ha in 2000 [1, 2]. Most of the expansion in irrigated area during the period has taken place in developing countries and, nearly 100 million ha in China and India constitute more than one third of the total irrigated land globally [3, 4]. Massive expansion in the irrigated area in the 1950s and 1960s in Asia is considered to be the backbone for the success of the Asian Green Revolution in the 1970s and thereafter [2-4].

Despite significant contribution of irrigated agriculture to increasing food production and to the overall socio-economic development, irrigation has come under increasing criticism over the past decade for several reasons [4, 5]. These include for example socio-economic inequity, social disruptions and environmental changes that are attributed to irrigation development and reservoir construction [4]. Expansion in African surface irrigation water supplies with construction of new dams and canals, has been accompanied by substantial increases in groundwater extractions while these irrigation developments have provided substantial benefits for increased food production, food security, labor price, they have also imposed significant costs on African society like Ethiopia [5].

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As Rwanda's agriculture is mostly rain-fed, production is exposed to climatic variation and unreliable rainfall. As such, irrigation presents a mechanism to intensify Rwanda's agricultural production [6, 7]. Irrigation investments have enormous potential to improve the lives of smallholder farmers who otherwise depend on rain-fed agriculture, through improving yields, increasing cultivation in the dry season, and reducing risk [6-8]. However, the hillside irrigation requires massive infrastructure investment, and only 1% of arable land is irrigated. Operation and maintenance costs of this class of systems are also high, and sustainability of investment will require a shift from staple crop to high-value export crop production [7, 8].

Despite various constraints under record in Rwanda such as demographic explosion, pressure on arable land and natural calamities due to change in climatic conditions, some efforts are in action like birth control, protection of the environment as well as agricultural development plans [9, 10]. These can be useful since Rwanda is characterized by a predominantly agricultural economy where more efforts are oriented and focused on increasing and improving agricultural productivity. Hence, irrigation can generally be considered as an effective way of increasing agricultural production in Rwanda [7, 8].

The practice of irrigation allows farmers to grow varieties of crops in sequence on the same field within a year and the succeeding crop is planted only after the preceding crop has been harvested. Thus, irrigation increases volume of output obtained from a given field [9-11]. This expresses that the use of irrigation is one of the spectrums of technologies available to increase agricultural production and there is an observable income gap between users and non-users of irrigation [12]. The improvement in agricultural production determines the rate of economic development and reduction of poverty in the country [13]. This has been recognized by the government of Rwanda and then irrigation has been adopted countrywide. The researcher, therefore, based on the above and chose to analyze the impact of irrigation on poverty reduction in Rusizi district, western Rwanda.

2. Methodology

2.1. Description of the Study Area

Rusizi is a district located in the western Rwanda. The district is divided into 18 sectors namely: Bugarama, Butare, Bweyeye, Gikundamvura, Gashonga, Giheke, Gihundwe, Gitambi, Kamembe, Muganza, Mururu, Nkanka, Nkombo, Nkungu, Nyakabuye, Nyakarenzo, Nzahaha, Rwimbogo. The district is composed by 89 cells and 595 villages and borders with the Republic of Burundi in the south, and the Democratic Republic of Congo in the west [14].

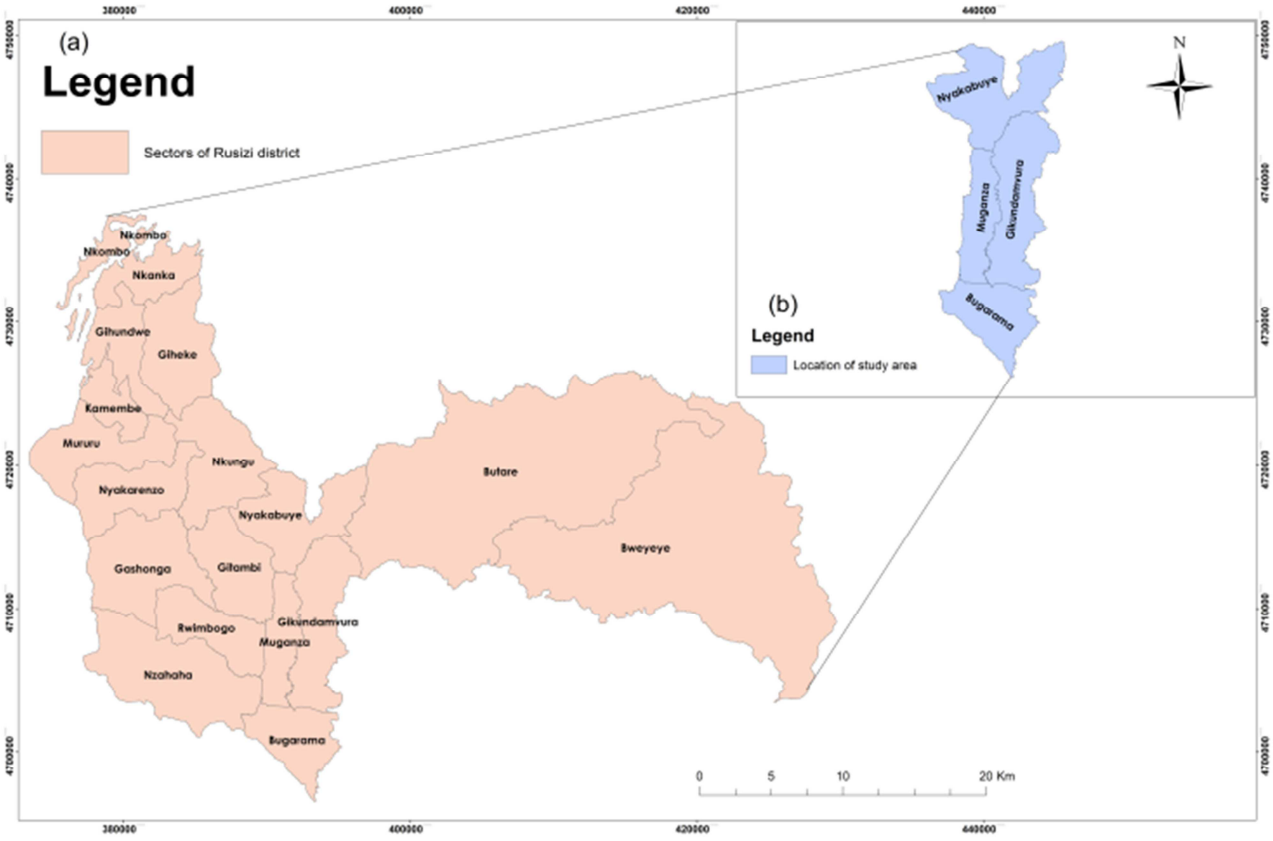

Figure 1. Map indicating (a) sectors of Rusizi district and (b) location of study area.

As the objective of the study was to assess the impact of irrigation in reducing poverty among people, the authors chose the Bugarama swamp located in Rusizi district as the study area. The swamp is located (Figure 1) in four sectors (Bugarama, Muganza, Nyakabuye and Gikundamvura) of Rusizi district.

2.2. Types and Sources of Data

The authors mainly consisted of using secondary data related to the harvested rice, irrigated land, names and members of cooperative growing rice in Bugarama swamp. These datasets were ranging from 2015 to 2019. In order to assess rice growers' perception on the extent to which irrigation contributed to reducing poverty among them, the study employed a structured questionnaire.

The informants were selected from four (4) cooperatives namely: Koperative Ejo Heza Muhinzi w'Umuceri (KEHMU), Koperative Imbanzabigwi Muhinzi w'Umuceri w'I NYAKABUYE (KOIMUNYA), Koperative Jyambere Muhinzi w'Umuceri (KOJMU) and Cooperative de la Production Rizicole de Kizura (COPRORIKI) growing rice in Bugarama swamp in Rusizi district. Their total members are 7,925 from whom a sample was estimated by using the Yamen's formula [15] as follow.

$$n = \frac{N}{1+N(e)2} \quad (1)$$

Where n is the sample size, N is the stands for the target population/population size of the study e: is the level of precision equals to (10%).

$$n = \frac{7,900}{1+7,925(0.1)^2} = \frac{7,925}{1+7,925\ (0.01)} n = 99.98 = 100 \quad (2)$$

Thereafter, in order to ensure that each cooperative was represented, the authors calculated the informants per cooperative by using the proportionate sampling method [16, 17] as follows:

$$\text{ni} = \frac{Ni*n}{\text{N}} \quad (3)$$

Where ni is the sample size proportion to be determined, Ni is the population proportion in each cooperative, n is the sample size calculated in equation 2 and N is the total population considered by the study.

Table 1. Study population and sample size.

Cooperative	Total members	Sample size
KEHMU	2,217	28
KOIMUNYA	2,338	29
KOJMU	1,408	18
COPRORIKI	1,962	25
Total	7,925	100

2.3. Data Analysis

The analysis on the produced rice was completed by using the Microsoft Excel. The quantitative data from the questionnaires were analyzed by using descriptive statistics which include frequencies, percentages, mean, and standard deviation. To test the relationship between the dependent and independent variables, the Spearman correlation coefficient was used in the Statistical Packages for Social Sciences (SPSS). Also, the authors analyzed and edited quantitative data by using SPSS whereby frequencies were adequately established. Descriptive statistics and Chi-square were used as analysis techniques.

3. Results and Discussion

3.1. Record on Rice Production Under Irrigation

Table 2. Cooperatives' cultivated and irrigated land 2015-2019.

Cooperative	Cultivated and irrigated land	Agricultural seasons covered
KEHMU	402.5	A and B
KOIMUNYA	383	A and B
KOJMU	300	A and B
COPRORIKI	297	A and B

The results in Table 2 indicated that the four cooperatives growing rice in Bugarama wetland have occupied varied land. KEHMU occupies the largest cultivated and irrigated land of 402.5 hectares while COPRORIKI occupies the smallest land area of 297 hectares. However, it was noted that all four considered cooperatives growing rice in the study area are working during both agricultural seasons A and B.

Table 3. Produced rice in both growing seasons from 2015 to 2019.

№	Cooperative	2015	2016	2017	2018	2019
1	KEHMU	3,446	3,447	6,894	13,787	27,574
2	KOIMUNYA	2,917	2,919	5,838	11,674	23,348

№	Cooperative	2015	2016	2017	2018	2019
3	KOJMU	2,667	2,670	5,340	10,677	21,354
4	COPRORIKI	1,832	1,836	3,672	7,340	14,680
5	Total	12,877	10,872	21,744	43,478	86,956

The results on the produced rice under irrigation practice at Bugarama wetland (Table 3) showed that the lowest production of 10,872 tons was recorded in 2016 mainly by COPRORIKI which registered an annual production of 1,836 tons of rice.

However, the agricultural years of 2018 and 2019 revealed increased rice production compared to previous years of 2015, 2016 and 2017. In 2018, the production reached 43,478 tons and KEHMU harvested the highest rice production of 13,787 tons. In 2019, the production almost doubled compared to 2018 and reached 86,956 tons and the KOIMUNYA harvested the highest record of 23,348 tons of rice.

3.2. Farmers' Perception on the Role of Irrigation

3.2.1. Demographic Characteristics of Respondents

The findings in Figure 2 indicated that 3% of respondents were aged 25 years, 21% of respondents were on the range of 25-30 years, 45% of respondents were on the range of 30-40 years and 29% of respondents were aged 40-50 years and 2% were aged 50 years and above.

Table 4. Gender of respondents.

Gender	Frequency	Percentage
Male	52	52
Female	48	48
Total	100	100

As shown in Table 4, it was found that 52% of cooperative members growing rice in Bugarama wetland are male and 48 percent of them are females. With regard to education level among respondents, the findings from the study are recorded in Figure 3.

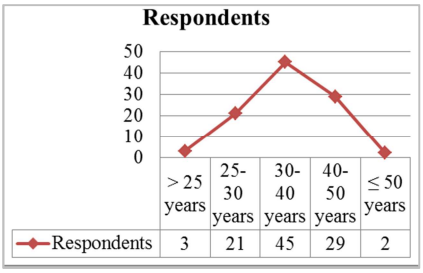

Figure 2. Age of respondents.

The findings indicated that 3% of respondents were illiterate, 17% of respondents attended primary, 60% of respondents attended secondary level and 20% of respondents reached University level. The findings showed that majority of respondents have basic education in order to be able to implement the irrigation as agriculture practice in Rusizi district and all respondents provided the real information and concerned with the specific objective of the study due to their schooling level.

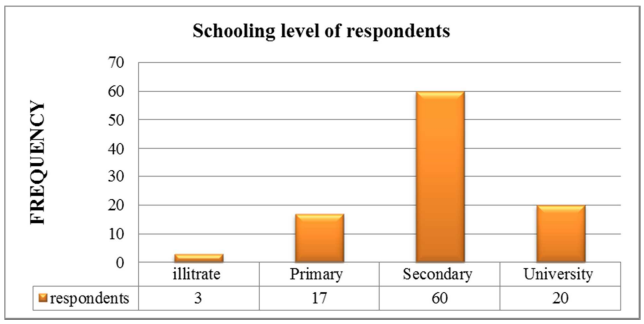

Figure 3. Schooling level of the respondents.

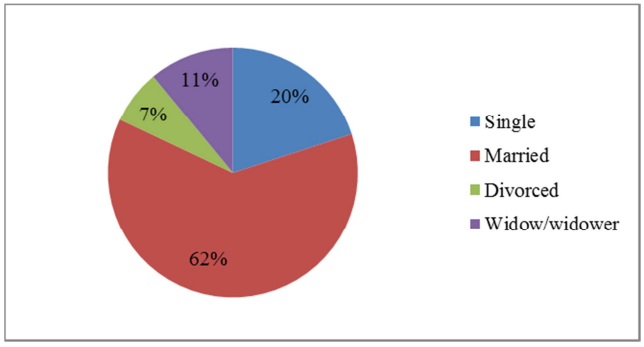

Figure 4. Marital status of respondents.

As shown in Figure 4, 62% of respondents were married, 7% of respondents were divorced, 11% of respondents were window/widowers and the 20% respondents were single.

3.2.2. Participants Irrigation Experience

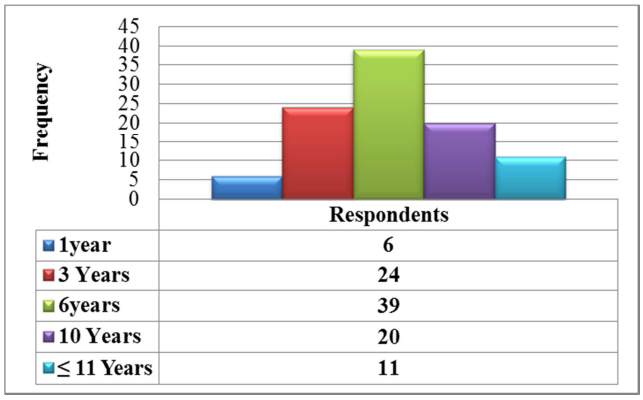

Figure 5. Respondents irrigation experience.

The results in Figure 5 revealed that 39 respondents have 6 years of experience, 24 respondents counted 3 years, 20 respondents have 10 years of practicing irrigation which means that the majority of respondents knew full information of irrigation and its challenges in agriculture activities.

Table 5. Irrigation in Rusizi district.

Statement	Attributes	Frequency	Percent
Have you heard of irrigation program?	Yes	100	100.0
	No	0	0.0
	Total	100	100.0
Do you implement irrigation on your land?	Yes	100	100.0
	No	0	0.0
	Total	100	100.0
Which types of crops do you grow in your plot?	Rice	52	52.00
	Wheat	21	21.00
	Irish potatoes	18	22.00
	Beans	9	9.00
	Total	100	100.0
Do you think irrigation is the favorable choice for your crop production?	Yes	90	90.00
	No	10	10.00
	Total	100	100.0
Where has it been easy to implement the irrigation? (Conducive area for irrigation)	Uphill	16	16.00
	Valley	84	84.00
	Total	100	100.0

The results in Table 5 showed that 100% of respondents confirm without doubt that they are aware of irrigation program. Also, the results in Table 4 indicated that 100% of respondents participate in activities put forward by irrigation program since they are all beneficiaries of the program. In addition, as shown in Table 5, it was noted that only 9.00% of the sampled population indicated that beans is the selected crop, 52% selected rice, 21% selected wheat while 18% indicated that Irish potatoes is the main crop in their area.

According to [18, 19], the priority food crops in Rwanda include wheat, rice, Irish potato, cassava, soybeans and beans. The results of this study (Table 5) revealed that 90% of the respondents said that the selected crops were adapted to their soil and agro-climatic zone while 10% of the respondents indicated that the selected crop was not compatible. The latter low percentage of respondents stands for farmers who resisted and were still clinging to some of their traditional crops which were not prioritized or grown as mono-crop in the area and respect all agricultural program for social economic development.

3.3. Benefits of Practicing Irrigation Among Farmers

Table 6. Rice growers' economic capacity before implementing irrigation.

Statement	Attributes	Frequency	Percent
Land possession size before implementation of irrigation	[0.1- 0.3] ha	14	14
	[0.3- 0.5] (ha)	55	55
	[0.5-1] (ha)	18	18
	[1-2](ha)	10	10
	More than 2 ha	3	3
	Total	100	100.0
Negative factors influencing farm productivity before irrigation program	Shortage of land	60	76.92
	Lack of tenure security	28	35.89
	Fragmentation of land	75	96.15
	Poor quality of land	73	93.58
Was the production enough to feed the family?	Yes	14	14
	No	86	86
	Total	100	100.0
Could you get food crop surplus for sale?	Yes	23	23
	No	77	77
	Total	100	100.0

The results of the study as shown in Table 6 indicated that 14% respondents owned a piece of land of 0.1-0.3 ha before irrigation, 55% owned a land between 0.3-0.5ha, 18% owned 0.5-1ha of land, and 10% owned between 0.1-2 ha of land and lastly 3% owned a land more than 2ha.

Moreover, the results as shown in Table 6, as by 96.15% of respondents indicated that land fragmentation is the main factor influencing negatively farm productivity. Accordingly, as highlighted by 86% of respondents, the undersized units of land influence their productivity while 14% echoed that their

farm productivity is influenced by lack of tenure security (Table 6). As confirmed by 77% of respondents in Table 6, there was insufficient production before the introduction of the program which explains why 77% of respondents agreed that there was no food crop surplus for sale to market.

Table 7. Farmers' economic capacity after practicing irrigation.

Response	Frequency	Percentage
Land increase after irrigation		
2 to 3 acre	62	62
4 to 6 are	32	32
7 are and above	6	6
Total	100	100.0
Plot productivity after irrigation		
It has increased	78	100.0
It has not increased	0.0	0.0
Total	78	100.0
Yield increase after irrigation		
Twice	20	20
Thrice	66	66
Four times	4	4
Five times	10	10
Total	100	100.0
Sufficiency of production after irrigation		
Yes	100	100
No	0	0
Total	100	100.0
Availability of food crop surplus as irrigation resultant		
Yes	81	81
No	19	19
Total	100	100.0
Improvement of livelihood through income		
Off-farm jobs created	21	26.9
New assets acquired	71	91.0
Opening saving account	63	80.7
Children education	45	57.69
Health insurance	67	85.89

The study of the research in Table 7 revealed that the cultivated land has been increased after irrigation implementation. This was highlighted by 62% of respondents that their land increased between 2 and 3 are, 32%% stated that their land increased between 4 and 6 acre while 6% indicated that their land has been increased above 7 acre after irrigation.

According to the responses above, all respondents (100%) affirmed that the productivity of their cultivable lands increased as a result of irrigation program. Surely, that increase varied from plot to plot depending on individual land location, farmer's knowledge in farming practice, land characteristics. Additionally, based on the results in Table 7, 20% and 66% of respondents revealed that they had an increase in yield two and three times, respectively whereas 14% of respondents indicated that yield from selected crops increased about four and five times, respectively.

Furthermore, with regard to the increase of income from the sale of food crop surplus improved the livelihood of their families, 80.7% of respondents said that they were able to open savings accounts in Savings and Credits Cooperatives (SACCOs). The amount of money deposited on their savings accounts ranged from 30,000 to 500,000 RWF, 91.0% acquired new assets such as cattle, plots, TV screens, motorbikes, etc., while 26.9% created off-farm jobs like shop-keeping, shoe retailing, taxi-motorcycling. In addition, 85.89% of respondents indicated that the increase of financial capacity allowed them to pay health insurance while 57.69% were able to finance primary and secondary school of their children's education.

3.4. Relationship Between Irrigation and Poverty Reduction

Table 8. Correlation of variables.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	10.986[a]	1	.001		
Continuity Correction[b]	2.311	1	.128		
Likelihood Ratio	5.168	1	.023		
Fisher's Exact Test				.083	.083
Linear-by-Linear Association	11.000	1	.001		
N of Valid Cases[b]	100				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .08.
b. Computed only for a 2x2 table.

As indicated in Table 8, the Chi-square calculated was 10.986a while chi-square tabulated is 3.841. Since Chi-square calculated is greater than Chi-square tabulated, the research rejected null hypothesis. Therefore, there was a relationship between irrigation and poverty reduction situation of farmers in Rusizi district.

The decision can also be made according to the P-value; in this research, P-value is 0.001. Since P-value is less than alpha (0.05), the null hypothesis was rejected and the research accepted alternative hypothesis. This also means that there was a significant relationship between irrigation program and poverty reduction situation of farmers in Rusizi

district. The relationship has been confirmed also by the respondents where they showed the extent to which irrigation program contributed to the poverty reduction situation of farmers in Rusizi district.

4. Conclusion

The purpose of this study was to examine the impact of agriculture practices on poverty reduction with case of irrigation program at Bugarama wetland in Rusizi district. The target population of this study was 7,925 members of KEHMU, KOIMUNYA, KOJMU and COPRORIKI cooperative growing rice in the wetland. The authors employed a sampled of 100 respondents calculated from the above total cooperative members. The participants were selected by using purposive and random sampling techniques. This study adopted a comparative descriptive design which used questionnaires and interviews for data collection. The quantitative data used first checked to find out blank entries to be filtered out and the remaining data were analyzed by using SPSS version 21.0. The results of the study indicated that there was a high degree of positive correlation between irrigation and poverty reduction where Karl Pearson coefficient of correlation (r) was 10.986. This implies that irrigation contributed positively to the poverty reduction at high level and the raise of income positively affected farmers' livelihood. The authors believe that the findings of this study will be important to different stakeholders with provision of information on the impact of irrigation in increasing food security and poverty reduction in general.

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