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Effect of Market Factors on Rice Profitability in Rwanda

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Abstract: ***Rice is regarded as an important crop generating income for smallholder farmers in Rwanda. Despite the importance of rice, no studies have been carried out to investigate the determinants affecting the profitability of the crop. This study was conducted with the aim of investigating the determinants of profitability of rice production among smallholder farmers in Rwanda. A multi stage sampling technique was used to select respondents. The data collected included both primary and secondary data. The primary data were collected from 200 rice farmers by use of structured questionnaire containing both open-ended and closed questions. Multiple Linear regression analysis was used to determine factors influencing profitability of rice. The regression model found that the market factors with a significant positive effect on rice farming profitability were: marketed quantity and selling price. On the other hand, the cost of transportation had a significant, but negative influence on rice farming profitability. The benefit-cost ratio (BCR) was 1.22, meaning that rice production is profitable for smallholder farmers (BCR>1). This benefit Cost ratio means that for every one USD invested in the rice farming, a small holder farmer earns 1.2 USD. Though this BCR is positive, the level of profit is low and can be improved to benefit smallholder farmers in rice farming. The study recommends the following: introduction of labour saving technologies in rice farming, such as mechanisation; to continue investing in the establishment of different infrastructures in rural areas; support farmers in establishing well-functioning markets in order to ensure favorable prices for farmers; farmers are advised to implement good agricultural practices, which would result in increased production, thus leading to increased surplus for the market.***

Keywords: Profitability analysis, linear regression, Smallholder farmers, Muhanga District, Rwanda

1. Introduction

Rice (Oryza) is one of the most important staple food in the world, ranking second after maize, both in global production level and area under cultivation. It is the predominant source of nourishment each day for more than 1.6 billion people around the world, thus making up to 16.5% of global caloric intake. The Asia continent is far the leading rice producer and consumer, with over 90 percent of the world's rice produced and consumed in the Asia-Pacific Region (FAO, 2016). India, China, Indonesia, Bangladesh, Thailand, Vietnam, Burma, Philippines, Cambodia and Pakistan are the top ten rice producers in the world. China, Philippines and Indonesia are also the largest rice importing countries worldwide while India, Thailand and Vietnam are the three principal rice exporting countries in the world (FAO, 2016). Though rice production is a profitable business in Asia, the level of profitability differs from one country to another, mainly due to the paddy prices, paddy yields, area cultivated and the magnitude of costs of production observed in each country.

Focusing on the cost of producing rice, it is more expensive to produce rice in countries like China, Philippines and Indonesia compared to countries such as Vietnam, Thailand and India.

Vietnam has the least cost of production with an average of 277.2 USD per kilogram, Thailand and India follow with 374.7 USD per kilogram and 376.5 USD per kilogram respectively.

Among the importing countries, the Philippines had the lowest cost at 526.8 USD per kilogram, Indonesia had the highest cost, at 666.4 USD per kilogram, followed by China 597.3 USD per kilogram. These results clearly point out the cost efficiency of the exporting countries relative to that of the importing countries (Bordey FH. e*t al*, 2016). The observed high costs of production in importing countries like Philippines and Indonesia translate into high farm gate prices (764.1 USD in Philippines and 933.9 USD, compared to exporting countries like Thailand and Vietnam, where the price obtained per kilogram is less than 466.9 USD .The average rice yields in irrigated rice schemes are 7.4 tons per ha, 7.3 tons per ha, 6.8 tons per ha, 5.8 tons per ha,5.4 tons per ha, and 4.7 tons per ha in Vietnam, China, Indonesia, Thailand, Philippines and India, respectively. Therefore, Thailand rice production is the most profitable because of its relatively low cost of production, moderate gross revenue, and bigger area cultivated. India and Vietnam despite their high yields and productions, record the lowest gross revenue in Asia due their very low paddy prices compared to other leading rice producers. The Philippines is consistently second to the last in all income aspects listed above, due to low rice yields associated with high production cost, which reduces the profits made by rice farmers (Bordey FH. e*t al*, 2016).

The market price has a significant effect on the estimated gross revenue and net profit. A study on the competitiveness of Philippine rice in Asia estimated market prices and gross revenues in 6 leading rice producing countries. This study revealed that countries with the highest market price were also countries with the largest gross revenues per hectare. Because of high yield and high production of paddy price, China got the highest gross revenue per hectare, amounting to almost US$ 6,500 per hectare, followed by Indonesia at USD 5,700. India had the lowest gross revenue per hectare. Vietnam, in spite of the highest rice yield of more than 20 tons per ha, ranked third in gross revenue because its paddy

price is much cheaper; less than half of the price in China and Indonesia.

Rice is currently an important staple food in African countries, and this is mostly due to the rapid urbanization and changing consumer preferences. Rice is largely subsistence crop in West Africa where most of the continent's rice is produced, with a total area of 5.5 million hectares allocated to rice cultivation. Nigeria accounts for 50% of this area, 27% in Guinea and Mali, the rest is largely in Ghana, Senegal and Benin (OECD & FAO, 2016).

In East African countries rice is commonly a cash crop for farmers. Tanzania is by far the leading country in rice production with 2,621,034 MT produced in 2014, followed by Uganda, Kenya and Rwanda with 237,000 MT; 136,000 MT and 111,604 MT produced in the same year, respectively (FAOSTAT, 2015). According to different studies, this crop is believed to be profitable in the region. For instance, a report on the rice value chain in Tanzania showed that rice is profitable for smallholder farmers adopting improved technology, in Kilombero district and Mbeya region, with a gross margin of US$ 394 and USD 643 per hectare, respectively (FAO, 2015). Analysis of rice value chain in Tanzania found that rice was a profitable business for farmers under both irrigation and rain-fed systems (Nkuba *et al.,* 2016). The same study suggested that farmers could improve their profits by increasing rice yields and selling at competitive prices. Rice farming is also documented as profitable for Rwandan smallholder farmers. Barayandema, Manzi & Umuhoza (2017) carried out a rice value chain analysis in Rwanda, focusing on the Southern province. Under this study, they estimated the gains made by farmers out of rice farming for short and long grain varieties. They found that both rice varieties were profitable for rice farmers, with a gross profit of approximately US$ 0.1 per kilo, for short and long grain varieties. They also revealed that rice profits were mainly depending on the market price of rice and production cost. This means that increasing the market price would increase profits made by smallholder farmers.

The current study analyses the market factors leading to rice profitability as well as estimating the profits made by small scale farmers in Muhanga district.

2. Materials and Methods

2.1 Study area

The present study was carried out in Muhanga District, Southern Province, in Rwanda. This district is located in 50 kilometers (km) from Kigali city, Rwandan capital. Figure 1 shows the map of Rwanda, with Muhanga circled in green colour. This district is bordered by Gakenke District to the north, Kamonyi District to the east, Ruhango District to the south, Karongi District to the southwest and Ngororero District to the west. The district has an estimated population of 319,141, with 49 per being male and 51 per cent female (NISR, 2012). The main economic activity is agriculture by 78.5% of the population while 76.9% of households also kept livestock. The main crops include beans, rice, sweet potatoes, cassava, maize, banana, soybeans, and potatoes (Muhanga district, 2013).

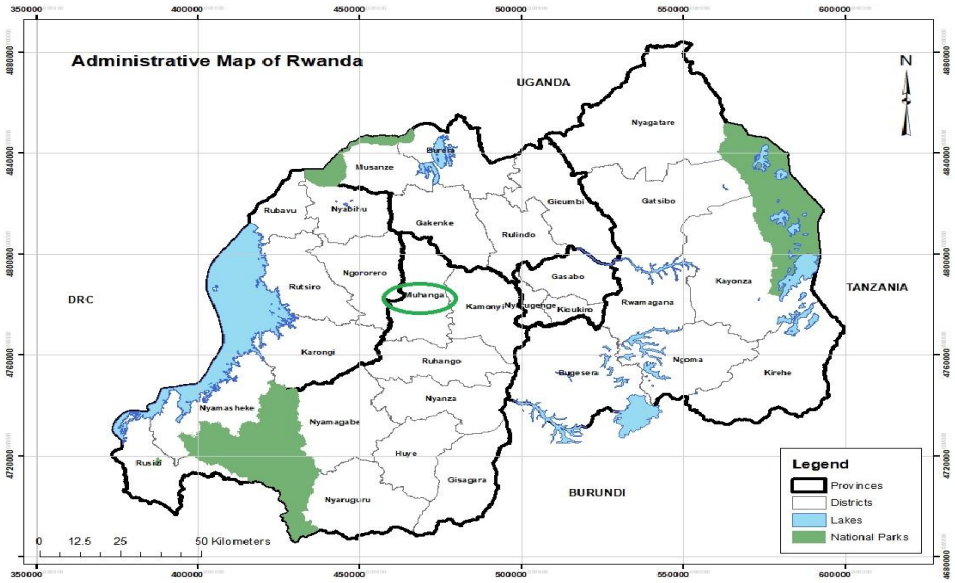

Figure 1: Rwanda administrative map showing the study area (Muhanga district)

Target Population

To investigate market factors determining rice farming profitability among rice farmers, and estimate profits made by farmers, the study considered two rice farming cooperatives in Muhanga district, as indicated in table 1. The two cooperatives comprise 754 rice growers (Table 1).

Table 1: Target population and sample size

No	Name of Cooperative	Study population	Sample Size
1	Rugeramigozi rice cooperative	441	117
2	KIABR	313	83
Total		**754**	**200**

Sample size and sampling techniques

A sample is a group in research representing a big population from which information is obtained. The sample is obtained from the population of interest, and is always smaller than the population. Collecting data and information from a determined sample is a better option because the researcher can rarely have enough time and other required resources to access all members of the population.

The following formula was used to determine the sample size (Kothari, 2004):

$$n = \frac{Z^2 \times P \times Q \times N}{D^2(N-1) + Z^2 \times P \times Q}$$

Where n= sample size,
N= size of population (number of household),
Z= coefficient normal distribution,
Q= probability of failure,
D = margin error and
P= probability of success.
For Kothari, the margin error or level of significance varies between 5 % and 10 %. The study used a margin error of 5 % (0.05), confidence level.

The probability of success is p=0.5, and Z^2 is 1.645 according to probability tables.

The total population under study was 754 people.

$n = \frac{1.645^2 \times 0.5 \times 0.5 \times 754}{0.05^2(754-1)+1.645^2 \times 0.5 \times 0.5}$ = 199.6 respondents (approximately 200 respondents)

Using the above mentioned formula by Kothari (2004), and given the population under this study, a sample of 200 small scale rice farmers was used for the purpose of this study.

The sample size per cooperative was computed using proportionate sampling and the sample size of each cooperative was determined as follows:

$$n_x = \frac{Nx * n}{N}$$

Where:

- n_x is the sample size of Cooperative x
- Nx is the population size for Cooperative x
- N is total population size and
- n is total sample size

The number of farmers that were interviewed from each cooperative was:

a) Cooperative 1 (Rugeramigozi cooperative):

$$n_x = \frac{Nx * n}{N}$$

$$n_x = \frac{441 * 200}{754} = 117 \text{ farmers}$$

b) Cooperative 2:

$$n_x = \frac{Nx * n}{N}$$

$$n_x = \frac{313 * 200}{754} = 83 \text{ farmers}$$

Finally, simple random sampling was used to select respondents.

Research Instruments and methods

Structured questionnaire was used to collect the quantitative and qualitative data required. The questionnaire contained information related to production costs and market factors. The questionnaire contained both open ended and close-ended questions.

Measurement of variables

Rice profitability was taken as the dependent variable and other factors as independent variables as described below (Table 2).

Market based factors

- **Selling price of rice**: This is a continuous variable which is assumed that higher prices are more likely to give profit to farmers and then influence good investments in production.
- **Access to market information:** This variable was measured as a dummy variable, taking 1 if the rice farmer had access to market information and 0 in case he did not receive market information. This factor is hypothesised to influence rice profitability positively, as having market information lead to increased profitability.
- **Distance to market:** When there is access to market, smallholders are motivated to produce more. The closer to the market, the lower the transport cost incurred by the farmers. The distance to market was measured by the time taken in walking for a single trip. This is a continuous variable and it is hypothesized to affect rice farming profitability.
- **Marketed quantity:** The quantity of rice supplied to the market is considered to greatly influence rice profitability. It was measured as a dummy variable, estimated in tons.
- **Transport cost:** Transport cost was measured in Rwandan francs and is a continuous variable. The transport cost included the cost from farm to the market, loading and offloading costs. It is assumed that this cost would negatively affect profits made from rice selling.
- **Total quantity produced:** This was measure as a continuous variable, estimated in tons per hectare. The total quantity of produced would influence rice profitability in a positive way, because the higher the production, the higher the opportunity of getting a surplus for the market. The greater the amount of rice produced, the greater will be the sale and hence the revenue, which have positive impact on the livelihoods of farmers.
- **Rice farming experience** was measured by the number of years in rice farming. Experienced farmers were assumed to have tried out a number of production technologies such as spacing, improved variety, early planting and fertilizer application.

Table 2: Categorization of explanatory variables

Variable	Unit or Coding system	Typology	Expected signs
Market based factors			
Transportation costs	Frws	Continuous	Negative
Selling price of rice	Frws	Continuous	Positive
Access to market information	1 if access, otherwise 0	Dummy	Positive

Storage cost	Frws	Continuous	Negative
Marketed quantity	Kilograms	Continuous	Positive
Post-harvest handling cost (threshing, winnowing, materials)	Frws	Continuous	Negative

Data collection

Data collection was conducted from selected rice producers through a structured questionnaire which included both closed and open-ended questions. Pre-testing of the questionnaire was conducted by interviewing selected rice farmers who were not part of the actual survey. After incorporating the lessons learned from the pre-test, the questionnaire was administered to sampled rice farmers through the use of face to face personal interviews, for full data collection.

Data analysis

The study adopted both the qualitative and quantitative analysis in order to achieve the objective of the study. The study used both descriptive statistics and econometric model in order to analyse collected data. Descriptive statistics included means, percentages, standard deviation and frequencies. A multiple linear regression model was used to analyse factors affecting rice profitability. The profitability analysis was conducted using the Gross margin and benefit cost ratio. The descriptive statistics were run in SPSS version 16 while the empirical models were run in STATA version 13.

Application of Multiple regression model

The following multiple linear regression model was used to analyze how selected factors affect rice farming profitability:

$Y= \beta 0 + \beta 1\ X1 + u$

Where;

Y= Profit

Bo=Constant

B1=Coefficients to be estimated

X_1 = market factors

U=error term

Profitability of rice farming

The enterprise budgeting technique that will be used to determine the level of rice profitability is given by:

GM = TR –TVC

Where:

GM= Gross margin for the farmer in Rwf per hectare

TR= Total revenue from the sale of rice by the farmer in Rwf per hectare

TVC = Total Variable Cost incurred by the farmer in Rwf per hectare

BCR= Gross margin/input cost

3. Results and Discussion

This section presents the findings of the study. It describes the socio demographic profile of interviewed farmers, followed by market based factors that influence profitability of rice farming. It also presents the cost benefits analysis conducted on rice farming in the study area.

Socio-demographic profile of the respondents

Table 3: Demographic characteristics of rice producers

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	198	49.18	12.37	19	85
Farming experience	200	8.24	1.70	2	9
Farm Size (Ha)	195	1.07	0.48	0.02	2.56
Average land under rice production (ares)	200	8.41	3.84	2	23
Family members	200	4.83	1.87	1	10

Market based factors affecting rice profitability

The marketed quantity and selling price of rice had a statistically significant positive effect on rice farming profitability, at 5 per cent level of significance (Table 3). On the other hand, transportation cost had a significant negative impact on rice farming profitability, in the area of study. The quantity of marketed rice has a significant positive influence on rice profitability, meaning that the more the sales, the more the farmer is able to make high profits.

The selling price of rice was found to be strongly related to profits made by farmers. This is consistent with Nwike & Ugwumba (2015), Muhammad, Mehmood, Abdur & Sarfaraz, (2015). The selling price has a strong positive effect with rice farming profitability.

As assumed at the beginning of this study, transportation cost had a significant negative influence on rice profitability. Similarly, Igboji, Anozie & Nneji, (2015) in their study of socio-economic factors and profitability of rice production among small scale Farmers in Ebonyi State, Nigeria, indicate that high costs of transportation are associated with low rice farming profits. Though the effect of post-harvest handling cost is not significant, its coefficient is negative. This implies that it negatively influences profitability.

Table 4: Market based factors affecting rice profitability

Rice profitability	Coef.	Std. Err.	T	P>|t|
Access to market information	-0.004	0.085	-0.040	0.97
Quantity of rice supplied to the market	0.766	0.097	7.880	0.000*
Post-harvest handling cost	-0.113	0.100	-1.140	0.26
Selling price of rice	0.03	0.010	3.68	0.000*
Transportation cost	-0.000	0.000	-2.360	0.02*
Storage cost	-0.004	0.015	-0.260	0.79
_cons	-0.025	4.392	-0.010	1.00

Number of Obs = 200, F (35, 92) =4.10; Prob > F = 0.0000; R-squared = 0.6092; Adj R-squared = 0.461; Root MSE = 0.3679* Significant at 5 % percent level of significance

Profitability of rice production

In the assessment of profitability of rice farming, the Cost-benefit analysis (CBA) was employed. The net profit was based on certain number of estimates like production, farm output per hectare, farm gate price and total investment cost spent in the production. The average rice production was 4,000 Kg/ha which was low compared to the target of 7 tons per hectare by 2018 (Ministry of Agriculture and Animal Resources [MINAGRI], 2013) while the mean area under rice production was 0.21 hectares in the study area (Table 5). The total cost investment needed in rice production including fixed cost (cost of land renting) and variables cost as indicated in (table 5). The total investment cost was USD 951 per hectare which is very high for small holder farmers.

The total revenue for the rice farmer was USD 1,160 per hectare. Based on cost benefits analysis the net profit was USD 209/ha in the farming season of 2017A.

The net present value (NPV) in 20 years' project duration was computed, based on two different discount factors of 12% and 18.5% respectively. NPV is USD 1,561 in 20 years of the investment period discounted to 12% discount factor and NPV of USD 1,093discounted to 18.5% discount factor. The benefit-cost ratio (BCR) analysis showed that BCR was 1.22, meaning that rice production is profitable for smallholder farmers (BCR>1). The benefit-cost ratio means that for every one USD invested in rice farming, a small holder farmer earns 1.2 USD.

Table 5: Profitability analysis from rice production

	Variable cost	Unit	Cost per hectare
A	Seed	USD	8.54
	Fertilizer: NPK	USD	111.12
	Fertiliser: UREA	USD	38.49
	Fungicide	USD	16.04
	Insecticide	USD	5.34
	Nursery	USD	69.49
	Ploughing	USD	102.61
	Field cleaning	USD	55.56
	Sowing	USD	42.74
	Fertiliser application	USD	6.41
	Fungicide and insecticide application	USD	6.41
	Weeding	USD	138.92
	Waving birds	USD	90.83
	Cleaning of water channels/canals	USD	24.57
	Irrigation	USD	21.37
	Harvesting	USD	21.37
	Threshing	USD	36.33
	Winnowing	USD	18.18
	Drying	USD	16.04
	Transport	USD	35.28
	Sheeting materials	USD	42.75
	Total variable cost	USD	**908.39**
B	**Fixed costs**		
	Land tax	USD	16.03
	Material for land preparation	USD	5.34
	Packaging sacs	USD	23.61
	Total fixed cost	USD	**44.98**
C	**Total cost**	USD	**953.37**
	Yield	Kg/Ha	4000
	Selling price	USD/Kg	0.29
	Total revenues	USD	1162.63
	Total cost of production	USD	**953.37**
	Gross margin	USD	209.26
	Cost of producing 1 kg	USD	0.23
	Margin per Kg	USD	0.06
	Benefit Cost Ratio		1.22
	Net Present Value at 12%	USD	1565.14
	Net Present Value at 18.5% Frw	USD	1094.17

4. Conclusion and Recommendations

From this study, it is concluded that market factors that significantly affect rice farming profitability in the study area are marketed quantity (+), selling price (+), transportation cost (-). Findings of the study also revealed that rice farmers in Rugeramigozi marshland make profit, though there's room to improve the profits made. Understanding market factors contributing to rice farming profitability is critical, as it gives a base of designing the right interventions aimed at improving farm profitability.

Further research needs to be done to assess how other factors, such as institutional and socio factors affect rice farming profitability.

Based on the research findings of following recommendations were drawn:

- The Rwanda Agriculture Board needs to continue advising farmers to implement good agricultural practices, which would increase rice production, leading to increased surplus for the market;
- The Ministry of Agriculture should identify and put in place financial instruments to increase the access to loans for agricultural production;
- The Ministry of Agriculture is recommended to invest and introduce affordable and adapted labor saving technologies, such as mechanisation in rice farming activities, from land preparation to post-harvest activities. This would increase efficient and lead to reduced labour costs;
- The Ministry of agriculture, the Rwanda cooperative agency and the rice federation need to continue investing in capacity building of farmers in the whole rice value chain. This would result in strong cooperatives which allow farmers to benefit from the economies of scale. Strong cooperatives would allow farmers to sell their produce together, giving them more bargaining power and cutting down the individual cost of transport to markets.

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