



Open access Journal

**International Journal of Emerging Trends in Science and Technology**IC Value: 76.89 (Index Copernicus) Impact Factor: 4.849 DOI: <https://dx.doi.org/10.18535/ijetst/v5i3.03>

## Adoption and Intensification Factors of Rice in Rwanda: A Case of Kirehe District

Author

**Gasana Emmanuel**

PhD Scholar, Open University of Tanzania and lecturer at the University of Kibungo

### Abstract

Ministry of Agriculture and animal resources (MINAGRI) has revamped and rendered several marshlands to farmers for rice cultivation, through a number of high profile agricultural development projects, throughout Rwanda. Kirehe District counts among areas that have been included in this momentum. This study sought to inquire into factors underlying the adoption and intensification rice in Kirehe District. The main objective of this research was to explore the factors that led to the adoption and intensification of rice in Kirehe District. The study was designed as a descriptive cross-sectional investigation and used a sample of 492 respondents, selected through purposive sampling procedure. Data collection used observation, questionnaires and interviews. Data analysis used descriptive statistics and Factor analysis for quantitative data and content analysis for qualitative data. The Principle Component Analysis methodology has been used as Factor analysis. Findings of the study revealed that three factors underlying rice adoption in Kirehe are shift from poor produce, cash insecurity; the quest of intensive farming employment and marshlands exploitation opportunities. Also CPA revealed factors underlying rice intensification in Kirehe District: chemical inputs access to credit; seeds varieties; size of land. The study also observed effects of rice adoption and intensification including infrastructure development, access to social services and improved living standards. Research findings helped conclude that the set of three factors regarding rice farming adoption can be applied elsewhere in Rwanda to exploit local opportunities. They helped conclude again that the set of four factors fostering rice intensification: labor, land, seeds, and chemical inputs can be applied elsewhere in Rwanda to boost local intensification.

**Keywords:** Adoption, intensification, rice, factors.

### 1 Introduction

#### 1.1 Background to the Problem

Rice has been gathered, consumed, and cultivated by women and men worldwide for more than 10,000 years - longer than any other crop. It is the most important food crop for about half of the human race. Global production of rice has risen steadily from around 200 million metric tons (MT) of un-milled rice in 1960, to over 678 million MT in 2009. Today rice represents 29% of the total output of grain crops worldwide <sup>[14]</sup>. More than 3.5 billion people depend on rice for more than 20% of their daily calorie intake. Annual rice consumption can be very high, exceeding 100Kg per capita in many Asian

countries and in some African countries as well <sup>[33]</sup>. Over 90% of the world's total rice crop is produced in South and East Asia. In the area and production, China is the leading country in the world. Africa accounts for 3% of global production. The major limiting factor for the growth of rice is not climate, but water supply. Rice is the only major crop that can be grown in the standing water in vast areas of flat, low-lying tropical soils and is uniquely adapted for growth in submerged conditions. Rice is grown in the tropical and subtropical regions of most continents. It is cultivated under widely differing conditions because of the great cultivar diversity <sup>[14]</sup>.

The adoption of rice as other crops in Rwanda requires that farmers are organized themselves in order to get - major inputs and production technologies to meet their needs<sup>[36]</sup>. Normally these farmers are organized into cooperatives so that they can obtain government support. The Cooperatives were initiated by Ministry of Agriculture and Animal Resources, through the Rwandan government for development of agriculture. The Rwandan government has opted for the adoption to strengthen the implementation of its strategic plan through Ministry of Agriculture. The popularization of large scale rice was done and continues to do so in all rice growing areas of the country. The system of rice intensification allows producers to increase productivity and quality of production.

In many developing countries, agriculture is still an important source of employment. Rwanda's economy is mainly based on agriculture. In 2012, about 93 percent of the economically active population was employed in agriculture and many of the farmers had an average size of less than one hectare of arable land per household. Despite efforts by the government to encourage people to focus on agriculture, it remains by far the main source of employment. Agriculture currently accounts for about 42 percent of GDP in real terms<sup>[33]</sup>. Agriculture is the largest sector in the economy of Rwanda in terms of contribution to GDP, employment and foreign exchange earnings. The contribution of agriculture to economic growth is even greater when strong multiplier effects are taken into account. Agriculture also contributes significantly to the national and more than 90 percent of food self-sufficiency<sup>[33]</sup>.

Rural incomes are derived primarily from the sale of food crops, livestock and crops. Unfortunately, it is clear that over the past two decades, agricultural production was insufficient to meet the needs of the growing population and inducing food insecurity and rising levels of poverty especially in rural areas it is difficult to find the non-agricultural labor<sup>[35]</sup>. It is in this case that the government of Rwanda by the Ministry of

Agriculture opted for the adoption of rice production as an important component of the agricultural sector in Rwanda that has a strong potential to stimulate economic growth<sup>[35]</sup>

Rice was first introduced in Rwanda in 1950 at Bugarama region, Western province of Rwanda. According<sup>[34]</sup>, the wide scale adoption of rice started in 1967 following the trials conducted by Chinese and Taiwan missions at Kabuye, Gasabo districts. Also in 1967, significant progress was made and resulted in the development of several rice schemes across the country. Since then, rice has become one of the main food crops in Rwanda<sup>[35]</sup>. Chinese cooperation has contributed to the development of a number of rice growing areas at Bugarama (Rusizi district), Kabuye (Kigali) and Mukunguli (Muhanga district). By 1972 China developed rice schemes at Rwamagana and managing through the SOPRORIZ (Society of Rice Production), took over management of all rice growing areas mentioned above<sup>[32]</sup>

In Rwanda, rice is mainly growth in the marshes. They are very favorable for the growth of this crop. In some marshes, rice is the only crop that grows well and has better performance compared to other cereals<sup>[29]</sup>. The adoption of rice was given a higher priority and the government seeks to increase its productivity factors by improving the flooded marshes that are suitable for this crop. It was also observed that rice is able to give very high over 7tonnes per hectare per cycle growth returns; which is well above the yield of all other crops than can be planted in marshes. Therefore, the adoption of rice production is considered as the most profitable and offers a viable of poor rural farm family resources in Rwanda<sup>[27]</sup>.

### **1.2 Statement of the problem**

Since the 1980s, Rwanda is suffering from a structurally deficit situation, resulting mainly from an inadequate management of natural resources, an overexploitation of land without restitution of nutrients removed by crops or leached by erosion, and from self-subsistence farming strategies consisting in use of inefficient traditional

technologies characterized by lack of professionalism. This situation has resulted in the fact that the country has not been able to meet the food needs of the population from national production and resorted to commercial imports and mainly to food aid. To reverse this trend, the country has embarked on a strategy of intensification, in which emphasis is put on a certain number of strategic food crops: rice, maize, sorghum, potato and beans. The priority given to the rice production is justified by the following reasons:

Despite of the experienced increase in rice production, the country currently imports about 30 percent of rice from the countries such as Tanzania, India, Vietnam, Pakistan and Thailand<sup>[26]</sup>. There is an urgent need to improve productivity of the harvest. Also rice produced in Rwanda is rarely sold in rural markets, while most of urban markets sell mostly imported rice. This is mainly because the rice grown locally suffers from higher ruptures during processing<sup>[35]</sup>.

### 1.3 Objectives

#### 1.3.1 General objective

The general objective of this study is to assess the adoption and intensification factors of rice in Kirehe district.

## 3 Research Results

### 3.1 Respondents Demographic Characteristics

Table 1 : Demographics of respondent

Characteristic	Attributes	Frequency	Percentage
Gender	Male	285	58.0
	Female	207	42.0
Age	Over twenty five	187	38.0
	Under twenty five	305	62.0
Level of Education	Primary school	197	40.0
	Read and write	138	28.0
	Secondary School	118	24.0
	University	39	8.0
Farm Size	Between half and One	187	38.0
	Between one and two	39	8.0
	Under half hectare	266	54.0
Total Sample Size		492	100

Source: *Field Data, 2016*

Table 10 shows that the sample was mostly composed up by females 58% against 42% of males. This is true since the majority of Rwanda's people engaged in agriculture is reported to be

#### 1.3.2 Specific objectives

- i. To determine the level of adoption and intensification of rice in Kirehe District
- ii. To determine the level of rice production in Kirehe District
- iii. To identify factors of rice adoption and intensification in the study area

## 2. Research Methodology

This study used both probability and non-probability methods for selecting samples. Sample size is determined by two broad categories of techniques: probability (random) sampling and non-probability sampling. Probability sampling is ideal if generalizability of results is important for your study<sup>[5]</sup>. To estimate closely how the sample approximates the population two parameters are necessary: margin of error and confidence interval. The margin of error indicates the range of values that can result in error when you use a sample to estimate the population. The risk of being wrong within the margin of error is known as confidence level<sup>[2]</sup>.

mostly that of women. It also shows that people under 25 years old constituted the quintessence of surveyed people with 62% whereas the people aged over 25 years accounted for 38%. This also

is a reality since the youth constitute 53% of all people according to the third integrated households living conditions survey. Other notable aspects is the fact that people who can read and write and who have primary school level constitute the considerable majority with 62%, those who has secondary schools account for 24% and the rest, University or High Institutions amounts for 8%. This translates to the fact that, farming is almost practiced by low-level educated people. Finally, concerning the possession of land, the majority, 54% possess land which is less or

equal to a half hectare, those who possess a land ranging between half hectare and one hectare amount for 38% and the rest, i.e 8% is made up by people whose land possession exceeds one hectare.

### 3.2 Level of awareness about rice crop cultivation

This study examined the level of information availability about the rice crop among respondents. The findings of this study are summarized in the figure 1.

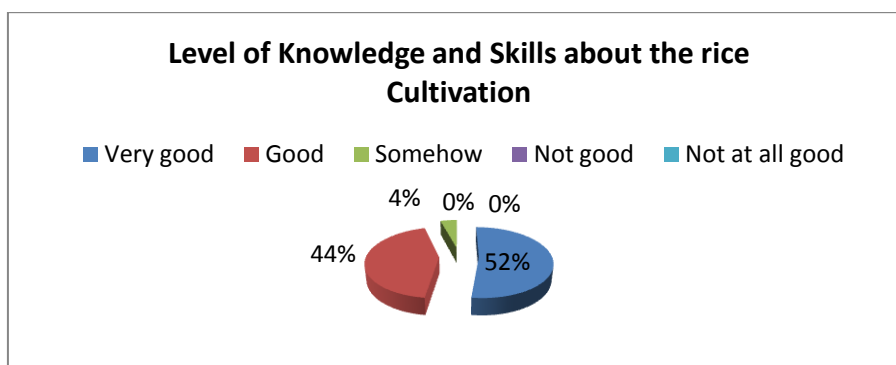


Figure 1: Level of knowledge and skills about the rice cultivation

**Source: Field data, 2016**

Figure 1 illustrates the fact that knowledge and skills about rice cultivation is well distributed among respondents. About 52% and 44% have very good and good knowledge and skills about rice cultivation. However, 4% have somehow good knowledge and skills and they require support from those who are knowledgeable. That

is why they are grouped into cooperative so that they can help each other and they look for agronomists to support them.

### 3.3 Source of information about the rice cultivation

The study investigated the source of information about the rice cultivation

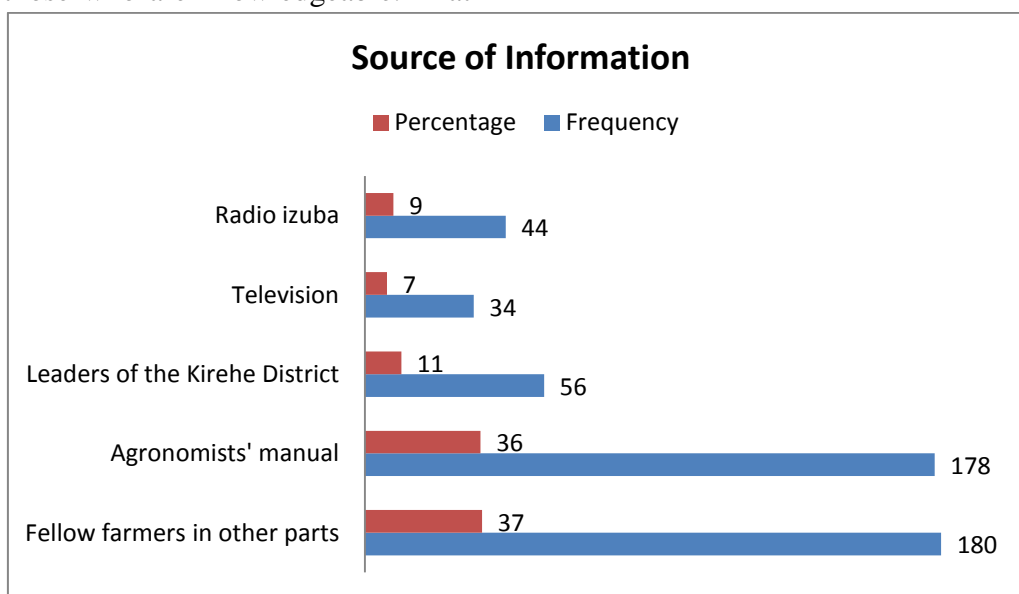


Figure 2: Source of Information (N = 492)

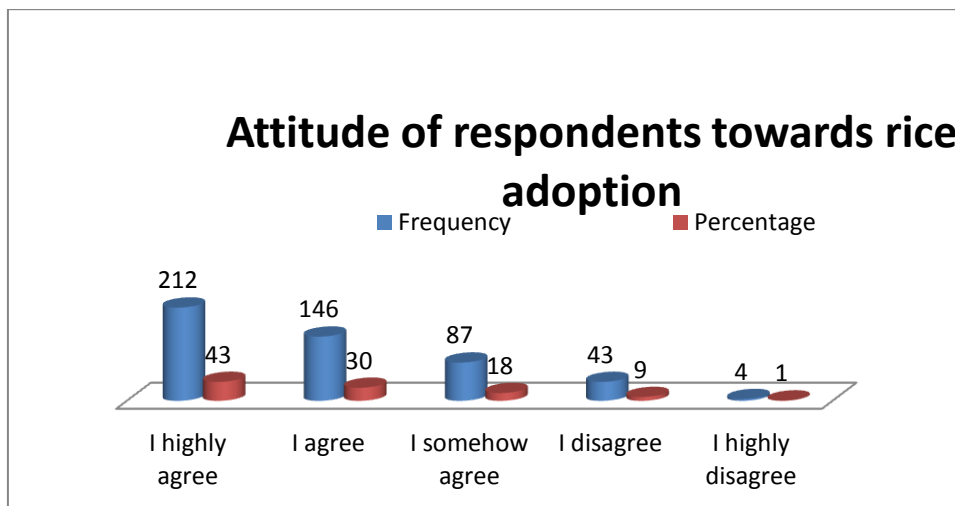
**Source: Field data, 2016**

Majority 37% get information from fellow farmers in other parts and other 36% get information from agronomists provided training manuals.

**3.4 Attitude towards rice cultivation**

The study explored the attitude of respondents towards rice adoption. Majority of respondents had positive attitude towards rice cultivation

**Figure: whether respondents support rice adoption (N = 492)**



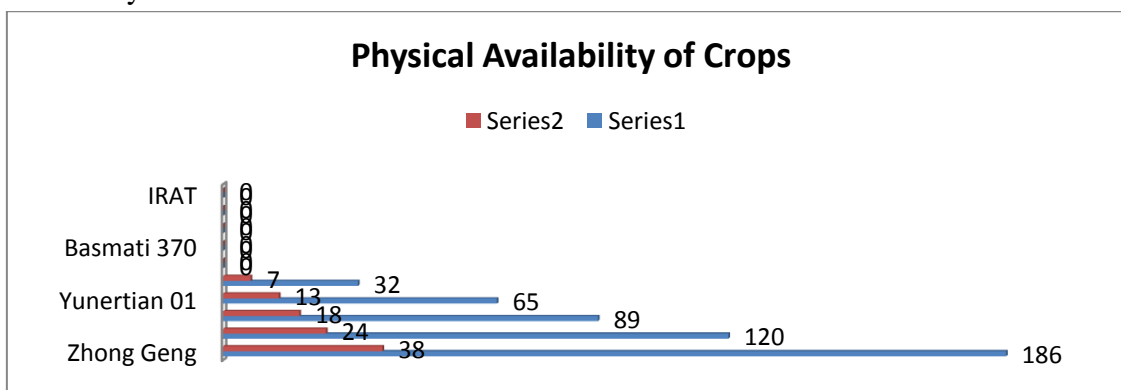
**Figure 3: Attitude of respondents towards rice adoption (N = 492)**

**Source: Field data, 2016**

Majority of farmers have positive attitudes towards rice production. About 43% and 30% highly agreed and agreed respectively on rice adoption. This shows a good attitude towards rice adoption in the study area.

**3.5 Physical availability of the rice crop**

The study also inquired whether rice crop varieties were available in the study areas. Findings from the field revealed that they were available.



**Figure 4: Source of Information (N = 492)**

**Source: Field data, 2016**

Findings from figure 4 shows that 38% of respondents cultivate the varieties called Zhong Geng as compared to other varieties.

**3.6 Size of Land allocated to Rice production per person**

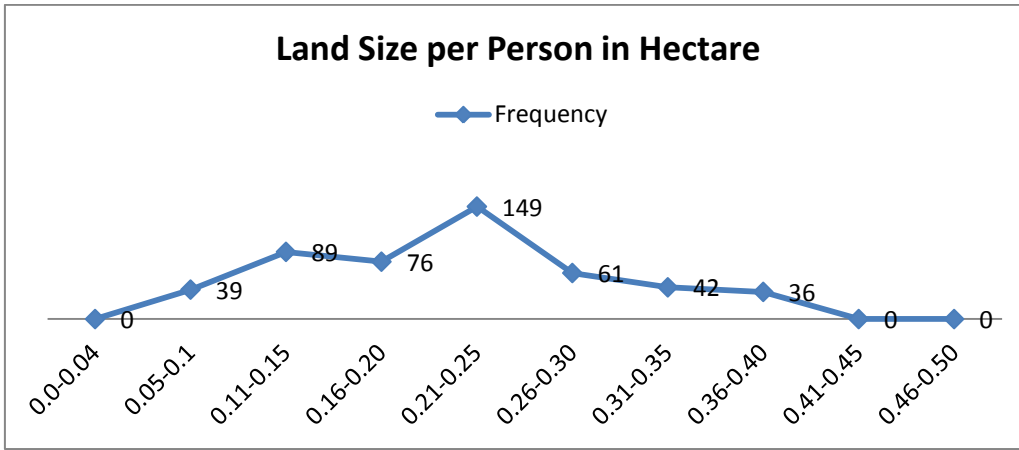


Figure 5: whether respondents support rice adoption (N = 492)

Source: Field data, 2016

Findings show that most famers have the land size allocated to rice cultivation which is around 2 hectares per person.

3.7 Level of rice intensification

3.7.1 Availability of Extension services

The study was interested to know whether the extension services were available to the farmers. Findings of the study revealed that in most cases extension services were available

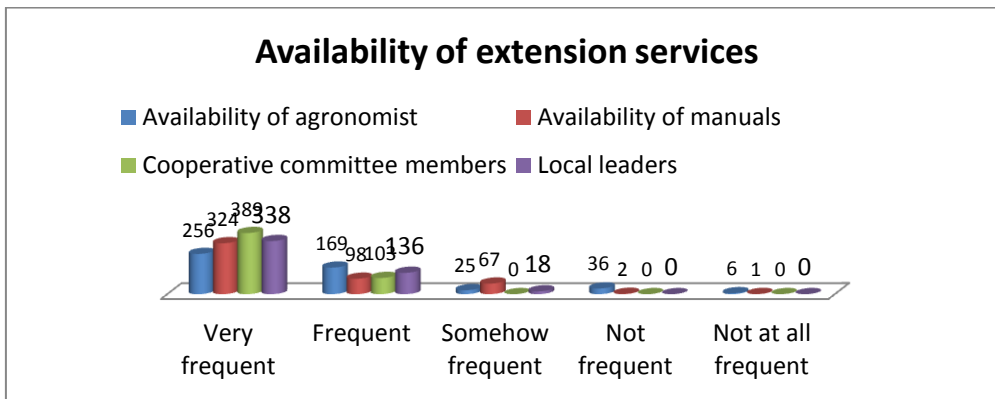


Figure 6: whether respondents support rice adoption (N = 492)

Source: Field data, 2016

The findings show that for most farmers, extension services such as agronomists, manuals, cooperative and assistance from local leaders are given very frequently or frequently.

3.7.2 Number of rice farmers

The number of rice farmers has been increasing over time as an indicator of intensification. At the beginning there were few rice farmers, but with time and sensitization the number of rice farmers has been growing as illustrated in figure below.

Figure: increase in number of rice farmers (N = 492)

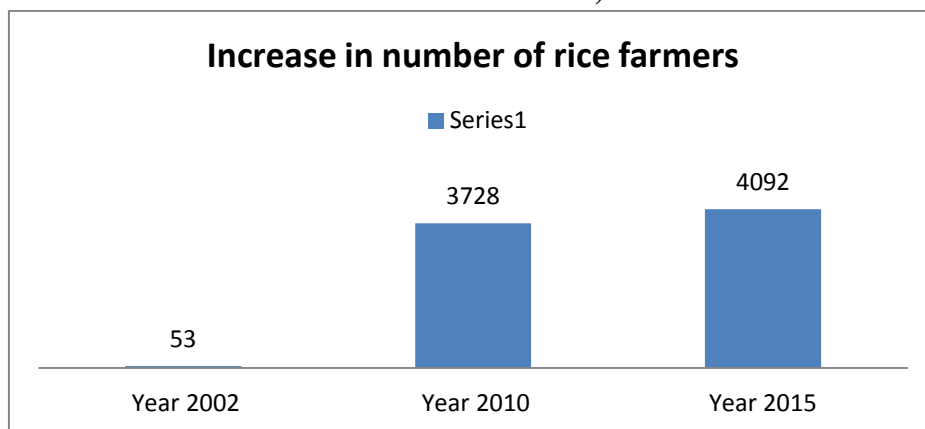


Figure 8: Increase in number of rice farmers (N = 492)

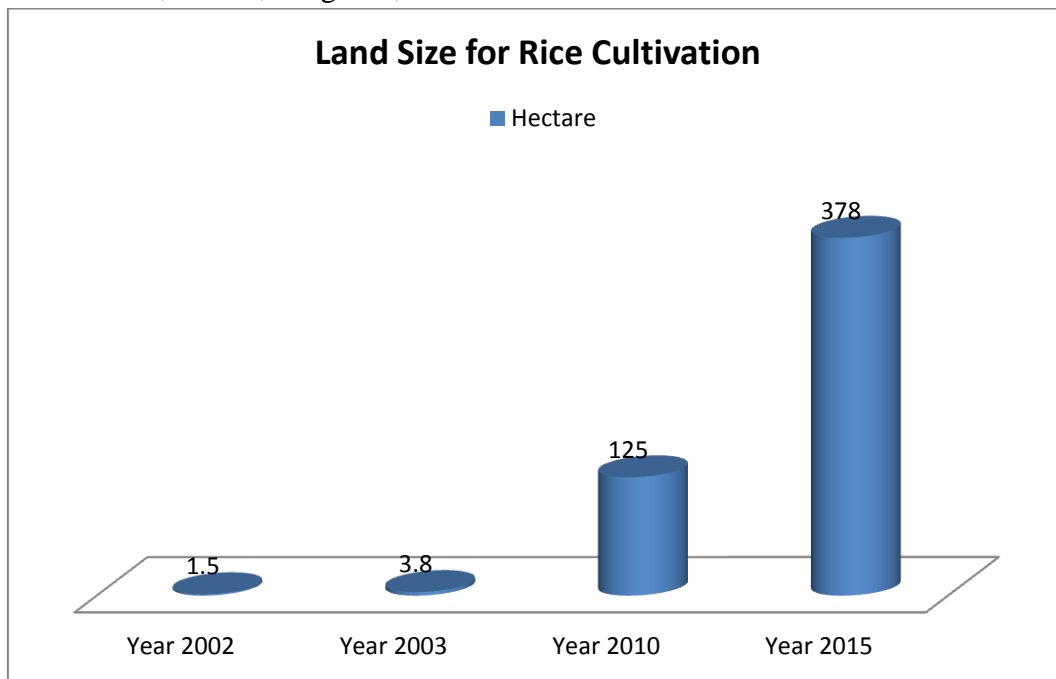
**Source: Field data, 2016**

In the study area, rice farmers have been increasing over the years, from 53 farmers in 2002 to 4092 farmers in 2015.

**3.7.3 Size of the rice cultivated land**

The size of the rice cultivated land has been increasing over time. The rice culture has replaced the cultivation of beans, maize, sorghum, sweet

potatoes and vegetables that were cultivated in the marshland before the arrival of the rice. This replacement took place as a result of the combined efforts of the farmers, cooperatives, Ministry of Agriculture and animal resources supported projects. The following is the summary of how the rice cultivated land has been growing over time.



**Figure 9:** Land size for rice cultivation (N = 492)

**Source: Field data, 2016**

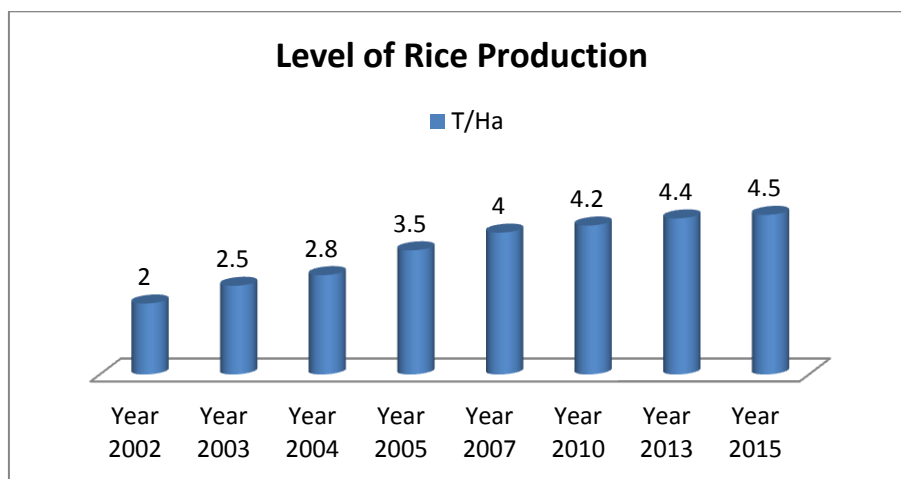
The figure 9 shows that land size for rice cultivation in the area has been widening from 15 hectares in 2002 to 378 hectares in 2015.

**3.8 Level of Rice Production**

**3.8.1 Trend in rice production in Kirehe district**

The study investigated the level of rice production by considering the yield or output per hectare. The study findings showed that the level of rice production has been increasing over time. The following is the diagram showing the increase in the level of rice production.

**Figure: Level of Rice Production (N = 492)**



**Figure 10:** Level of Rice Production (N = 492)



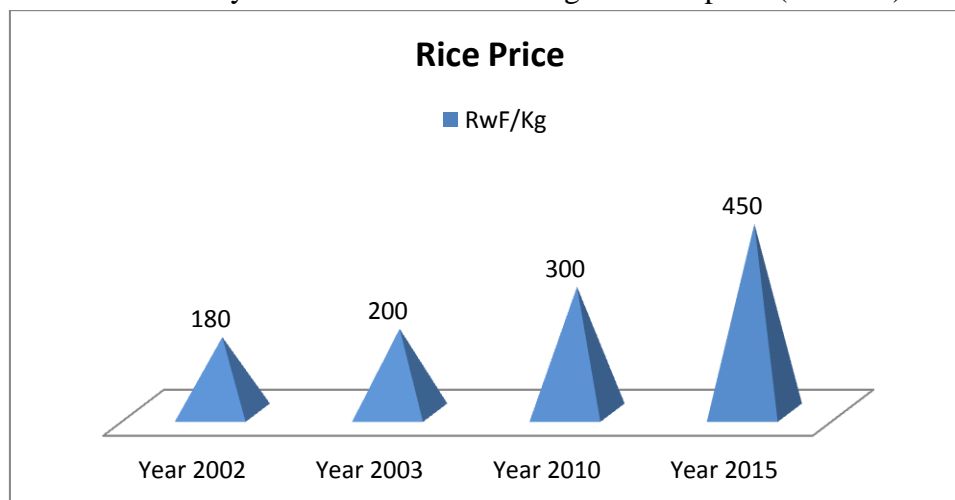
**Source: Field data, 2016**

This figure 10 shows that the level of rice production has been improving from 2 Tons per hectare in 2002 to 4.5 Tons in the year 2015.

**3.8.2 Trends in prices of rice in the market**

The price has been changing over time. The price of rice is better than other products in the market.

Figure: Rice price (N = 492)



**Figure 11:** Rice Price (N = 492)

**Source: Field data, 2016**

This figure 11 shows that the rice price has been increasing from 180 RwF/Kg in 2002 to 450 RwF/Kg in 2015.

**3.9 Analysis of factors influencing rice adoption and intensification****3.9.1 Factor analysis**

The raw data collected from the survey was used as data for Factor Analysis and after the extraction procedures; the results have been tabulated. The goal of this section is to answer the first -research questions of this study, namely:

What are important factors for rice adoption in Kirehe District?

What are the important factors for rice intensification in Kirehe District?

In order to answer these above research questions, the results of the factor analyses are presented and interpreted accordingly.

**4 Discussion****4.0 Introduction****4.1 Discussion on Level of Adoption and Intensification**

This study found that farmers in Kirehe district adopted farming as a diffusion from Rwamagana district. This confirms the accounts given by

Gatore district report (2001) which stated that Farmers from Rwabutazi swamp, Kirehe district and Gatore sector, have procured seeds from Rwamagana in 2000 and tried rice home. From there, the swamps rounding Gatore sector were shared out among people by local leaders in the order of leaders of Kirehe district aiming to reduce poverty hunger in Gatore sector and its neighboring sectors. At the same time the people started to cultivate different crops such as sorghum, maize, beans, slowly by slowly the people started to think how to introduce a new crop where 2001 small group of the people introduced rice cultivation in their field , but a large number of them advanced their ideas refusing that suggestion. Since 2003, Kirehe district implemented a law of introducing rice growing in the whole swamp of Gatore sector but many constraints affected rice cultivation, including: the use of traditional, that lack of adequate seeds. The lack of market, the attack of various diseases, and appearance of some destructives predators such as birds, flies... were also common<sup>[19]</sup>.

The study also found that farmers who have adopted rice plantation use their associations to get support from the central government, local



authorities through projects and extension services. This finding confirmed the account given RSSP (2010) which described that the rice farmers organized themselves and have created cooperative namely COPRIKI, in order to solve different problems. This cooperative started to search support until, it got support from Rural Sector Support Project (RSSP), Strategic Plan for the Transformation of Agriculture-Phase (PAPST), which contributed in giving support of giving technicians (agronomists) and helping rice farmers to build the office and storage facilities, and ISAR (Institut des Sciences Agronomiques du Rwanda: National Agriculture Research Institute) for giving different rice varieties (RSSP, 2010).

Also the findings of this study about level of adoption and intensification are in line with the definition of adoption given by Yapa and Mayfield (1978) who stated that the adoption of an entrepreneurial innovation by an individual requires the satisfaction of at least three conditions: the availability of sufficient information, the existence of a favorable attitude towards the innovation, and the physical availability of the innovation. This study revealed that these conditions were present in the study area. The knowledge and skills about rice farming were very good, the information was available through different channels and different rice varieties were available in the study area.

The study also showed that the number of farmers adopting rice has been increasing over time. This is in line with the explanations given by<sup>[32]</sup> who stated that the rate of adoption refers to the percentage of farmers who have adopted a given technology and that the intensity of adoption refers to the level of adoption of a given technology, the number of hectares planted with improved seed (also tested as the percentage of each farmer planted to improved seed) or the amount of input applied per hectare will be referred to as the intensity of adoption of the respective technologies. All these factors were well observed in the study area.

The findings about the level of adoption have also helped to answer to the questions raised by<sup>[48]</sup>: what decision making path ways do individuals follow when considering whether or not to adopt an innovation? Which sources of information are important? What are the differences among people who adopt innovations quickly or slowly? How do the characteristics of innovations affect the rate of adoption? How do the potential users communicate among themselves about these innovations? Who plays the importance role of opinion leader in this communication process? And how does an innovation diffuse through a society over time? This study showed the pathways used by individuals in Kirehe district when they decided to adopt the rice production, the sources of information they used as information was spreading from Rwamagana through different channels; trends of adoption and communication system used through cooperatives and associations.

#### **4.2 Rice production**

This study found that the rice production has been increasing in the study area. This increase in rice production is in line with the development of agriculture in the different areas. Rice production in Kirehe district has been influenced by adoption of high yield varieties. Also the price of rice on the market has influenced the rice production.

These findings confirm the findings by<sup>[15]</sup> who argued that improved varieties have contributed to rice improvement in different countries. Also these findings confirm the green revolution and rice cropping which advocated for improved seed of high yielding varieties of rice and increased input in order to increase the output<sup>[39]</sup>.

#### **4.3 Factors affecting adoption and intensification**

Adoption factors of rice in Kirehe District: The PCA results confirmed three factors: shift from poor produce, cater for cash insecurity, quest of intensive farming employment as main factors for adoption of rice. Rice intensification in Kirehe District is influenced by four major factors. These

include Chemical inputs, seeds variability, labor, and land size.

The intensification of rice has been explored using 9 variables relating to inputs factors (chemical inputs, seeds varieties, and labor); endowment factors (size of land, climate and utilities); institutional inputs (personal skills, extensions services, and access to credit) and only four factors were found more significant.

These findings are in line with the claims by<sup>[48]</sup> who stated that there are generally four categories of factors conditioning rice adoption worldwide. These include socio-economic, ecosystems, technical and institutional, and government policies. Looking at the findings of this study, it can be argued that socio-economic factors such as cash insecurity, ecosystems factors such as quest for full employment and technical factors such as shift cultivation have influenced rice adoption in Kirehe district, in Rwanda. Contrary to previous findings, Institutional factors regarding mainly varieties improvement research centers, endowed with required scientific capacity in order to perform breeding as described by Walter and Alwang (2015), certification and release of worked out improved varieties, were not significantly influencing adoption of rice in Kirehe district. This is because the adoption in Kirehe district was a bottom up approach where technology precedes research, and people were the ones taking initiatives to request for the adoption of rice. The institutional factors came later after the rice has already been adopted.

Concerning the intensification of rice in Kirehe district, the findings of this study are in line with the findings by RAB (2014) which used the Conditional Logit Model (CLM) and explored attributes and farm household characteristics influencing the farmers' choice among different alternatives and revealed that a majority of rice farmers had adopted improved varieties and showed that the prices of seeds and of paddy and the yield are variety-specific attributes that significantly influence the farmers' choice of an improved rice variety and also that farm size,

labor availability within a farm household, and access to financial facilities significantly influence farmers' decisions to adopt improved rice varieties. In the same way, this study found that land size, labor, seeds and chemical availability are the major determinants of rice intensification in the study area.

#### **4.4 Effects of Rice adoption and intensification**

This study found that there are several positive effects of rice adoption in the study area. These findings confirm findings by<sup>[21]</sup> who observed that the evolution of crops contributed greatly to socio-economic development for the people of Kirehe district in general and Gatore sector particularly whereby farmers are able of providing necessary school material for their children from primary school and the development of agriculture in Kirehe district thus, has contributed to the increasing of subscribed people for medical insurance locally known as "Mutuelle de santé". Also due to agriculture development the housing conditions in the sector have been improved. This is done either modernizing their existing houses or constructing new ones or rehabilitating their houses. The findings of this study are also in line with Crop Intensification Program (CIP) which started in 2007 increased the use of inputs for priority crops i.e. fertilizer and improved seeds and promoted land consolidation as a part of the green revolution. Irrigation master plan under scrutiny; soil erosion control; marshland development program (more land being reclaimed for cultivation), animal breeding and nutrition strategies being reviewed; one cow program distributing heifers to poor households (target is 668,763 heifers by 2017), food security strategy led to a significant increase in production of main food security crops under the crop intensification program.

The rice intensification observed in the study area is also in line with the System of Rice Intensification (SRI) as described by Uphoff (2008) who showed that SRI has helped to spread rice in countries such as Madagascar, China, Cambodia, and others. This system originated

from Madagascar and it spread throughout other countries. The system is based on reducing the cost of land, seeds, fertilizers, and other agricultural inputs in order to raise production. In the same way, this study has observed that factors such as land, labor, seeds and chemicals play important role in rice intensification.

## 5 Conclusion and Recommendations

### 5.1 Conclusion

This study was interested in investigating the factors influencing adoption and intensification of Rice in Rwanda using the case of Kirehe district. The study used classical capitalist and Marxist theories of production and population growth to explain the phenomenon of rice adoption and intensification in Rwanda. Using these perspectives it was observed that in Rwanda there is high population growth and production of rice is one of the solutions to ensure food security in the country.

The findings showed that in Kirehe district there is a good level of rice adoption and intensification, increasing rice production, and factors influencing rice adoption and intensification have been identified and effects of rice adoption and intensification have been described. The study found that rice adoption in Kirehe district in Rwanda is influenced by socio-economic factors such as cash insecurity, ecological factors such full employment regardless of the seasons and technical factors shift cultivation to adopt more productive varieties. The study also observed land size, labor, seeds availability and chemicals availability are factors leading to intensification in the study area.

From the above findings of this study, it can be concluded farmers in Kirehe district have decided to adopt rice cultivation and cultivation of rice has been intensified in different areas. This rice adoption and intensification have been possible because the farmers saw opportunities in rice production as a way of changing their lives. The opportunity was to change the culture of poor produce and move into culture of more lucrative

produces. These opportunities were later coupled by the government efforts and other stakeholders to change the dreams of farmers into reality. Furthermore, availability of agricultural inputs such as land, labor, fertilizers, and seeds and credits has helped more farmers to adopt the rice cultivation and to improve their production. The rice adoption and intensification has helped the whole district to be transformed, the infrastructure such as roads and electricity, high living standards, and savings have improved considerably in the study area. Rice adoption and intensification have given momentum to socio-economic development and have empowered farmers to come out of poverty.

### 5.2 Recommendations

This study which has explored factors for adoption and intensification of rice in Kirehe district in Rwanda emphasizes the following general recommendations:

1. The Local Government Authorities should raise awareness of farmers in the area who have resisted rice cultivation in order to help them acquire knowledge and skills about rice cultivation and become self-reliant and empowered.
2. The Ministry of Agriculture and Animal Resources should provide more projects and financial support to farmers by introducing high yielding seeds varieties and chemicals in the area and providing extension services and amenities to help farmers improve rice production and gain more income from the market.
3. Rice farmers should improve their management capacities through their cooperatives to negotiate good deals in their transactions and to markets their products. This can help them improve their living standards and to support the country.
4. Research Institutes in the country should intensify their work in agricultural research to assess products that are more

suitable in the land in Rwanda and to help farmers in their farming methods to improve rice production.

5. The Government of Rwanda should facilitate the innovation and technological advancement in relation to irrigation, land use and land management in order to improve the technological basis of the country so that farmers may move from hand hoes to tractors and other modern farming methods. These can facilitate labor inputs which one of the factor in rice intensification.

### Recommendation for further studies

The study also suggests the following recommendations for further studies

1. A study may be conduct to assess the factors influencing non-adoption of rice by farmers in the area of the study.
2. A study may be conducted to investigate whether rice can be cultivated in other areas apart from marshlands where currently rice is cultivated.
3. Researches can be conducted to find a variety of rice which can produce yield thrice a year rather than the current varieties which give yield twice a year.

### Acknowledgements

I would like to thank my supervisors, Prof. Deus Ngaruko and Dr James Kisoza, for giving me an opportunity to work with them and for their scholarly guidance in spite of their busy schedule. Their insight, perpetual encouragement, and guidance during the design and preparation of the thesis will remain for me a source of inspiration.

This academic work would not have been completed without the support and contribution of many individuals to whom I wish to extend my heartfelt gratitude. I convey my profound thanks to the farmers' members of COPRIKI for their solicitude providing objective information that made the masterpiece of this work.

This page cannot honor me allowing enumerating all persons from whom I have harvest and gather various material and moral support. Namely thanks go straight to the following personalities: the Coordinator of OUT, Ngoma Branch; the Mayor of Kirehe District; the Executive Secretary of Gatore Sector; my wife and my children; everyone who contributed to this work.

### References

1. Adegbola and Sadjinou (2003) Farmers' adoption of improved rice technology in Niamey, Rive Droite Area, Niger Republic. *World J Agric Sci* 3(4):530–536
2. Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2002). *Statistics for Business an Economics* . Cincinnati : South-Western .
3. Baily Joseph (2012): *Methods of Social Research*. New York, 3<sup>rd</sup> Edition
4. Bartholomew, J. D., & Knott, M. (1999). *Latent Variable Models and Factor Analysis*. London : Arnold Publishing.
5. Bhattacharjee, A. (2012). *Social Science Research: Principles, Methods, and Practices*. Florida: University of South Florida.
6. Bockel, L., & Touchemoulin, O. (2011). *The Kirehe Community-based Watershed Management Project in Rwanda: Carbon Balance Appraisal With the EX - ACT tool*. FAO: Rome .
7. Brauche, P. E., & Azam, M. S. (2004). Factorial Invariance of the Occupational Work Ethic Inventory. *Vocational Education Research* , 29 (2).
8. Cattell, R. B. (1978). *The Scientific Use of Factor Analysis in Behavioral and Life Sciences* New York : Plenum.
9. Chemonics International Inc. (2009). *Staple Foods Value Chain Analysis: Contry Report - Rwanda* . USAID.
10. Christenson, C. (1982). The Methodology of Positive Accounting. *Accounting Review* , 58 (1), 1 - 22.

11. CIMMYT Economics Program . (1993). *The Adoption of Agricultural Technology: A Guide for Survey Design* . Mexico, D.F.: CIMMYT.
12. Derrahi, K. (2014). *An Integrated and Participatory Approach to Sustainable Watershed Management: A Showcase of 9 Participatory Management Models from Rwanda*. MINAGRI; IFAD; PROCASUR.
13. Edet UJ, Borating OT (2008) Improved rice variety adoption and its welfare impact on rural farming households in Akwa Ibom, State of Nageria. *J New Seeds* 9(2). Harworth Press, pp 157–160
14. EUCORD. (2012). *Rice Sector in East Africa* . Common Fund for Commodities.
15. Evenson, R. E., & Gollin, D. (2003). *Crop Variety Improvement and its Effect on Productivity: The Impact of International Agricultural Research* . Cambridge : CABI Publishing .
16. F.A.O (2010): Enabling self sufficiency and competitiveness of Rwanda rice.
17. Feder G, Just R, Zilberman D (1981) Adoption of agricultural innovations in developing countries: a survey. World Bank Staff working paper no. 444. The World Bank, Washington, DC
18. Filmer and Pritchett (1999) The Effect of Household wealth on Educational Attainment : Evidence from 35 countries.
19. Gatore sector report (2011): Monograph of Kirehe district: Community Profile of Gatore sector.
20. Grigg B. (1991). An operational Model for Evaluation of Agricultural Sustainability
21. Habiyaremye Augustin (2012): The Tourism revenue of akagera National Park to finance the activities of socio-economic development of Kayonza district.
22. Highman, A. (1986). The Audited Self - Administered Questionnaire. *Journal of Marketing* (20), 155 - 159.
23. Hirsh (2009): The Making of Americans- democracy and our schools
24. Horgan, F. (2011) Review of principles for sustainable pest management in rice, UK
25. ICRAF. (2010). *Rwanda Irrigation Master Plan* . Nairobi: ICRAF.
26. IFAD . (2008). *Kirehe Community-based Watershed Management Project: Project Design Design Report*. IFAD.
27. Jagwe, J. N., Okoboi, G., Hakizimana, P., Tuyisinge, J., & Rucibigango, M. (2003).
28. Kaiser, H. F. (1974). An Index of Factorial Simplicity. *Psychometrika* (39), 120 - 138.
29. Karthiresan, A. (2010). *Mapping of Poverty Reduction Strategy Papers: Sector Strategies and Policies Related to Rice Development in Rwanda* . Rome: IFAD.
30. Khiev, B (1999) Farmers’s pest management and rice production practices in Cambodia, Phnom Penh
31. Kleinbaum, D. G., & Klein, M. (2010). *Logistic Regression: A Self-Learning Text* (Third ed.). New York: Springer.
32. Koschat, M. A., & Swayne, D. F. (1991). A Weighted Proscrusters Criteria. *Psychometrika* , 56 (2), 229 - 239.
33. Michael Morris (2008): Promoting sustainable pro-poor growth in Rwanda agriculture
34. MINAGRI. (2010) Strategic Plan for the Transformation of Agriculture in Rwanda- Phase II (PSTA)- Final Report
35. MINAGRI. (2013). *National Rice Development Strategy (2011 - 2018), Revised, August, 2013*. Kigali: GoR.
36. MINALOC (2002): National Strategy Paper on Strengthening Good Governance of Poverty Reduction in Rwanda. Kigali: Ministry of Local Government.