ROLE OF CROP INSURANCE IN THE PRODUCTION OF RICE IN RWANDA: CASE STUDY OF DUHUZIMBARAGA KILIMBI-MACUBA COOPERATIVE, NYAMASHEKE DISTRICT.

Authors: [1]UYISENGA Samuel[*], Prof. Fidèle NIYITANGA(PhD), Dr. Celestin BIGIRIMANA (PhD)
Corresponding authors: **uyisamuel2020@gmail.com**; **Tel:** (+250) 785 874 512
Master of Rural Development and Agriculture Economics, Science in Agribusiness of the University of Rwanda "UR"

ABSTRACT:
The study focused on the role of crop insurance in the production of rice in Rwanda: a case study of Duhuzimbaraga Kilimbi-Macuba Cooperative, Nyamasheke District. The specific objectives were to examine the extent to which do farmers from rice cooperatives responds to agricultural crop insurance; to determine the advantage of rice crop insurance to famers; and to evaluate the effects of different coverage and subsidy levels on inputs use, certainty equivalents, indemnity payments and premiums; and production of rice in Rwanda. The study used qualitative and quantitative approaches. Targeted population was 472 farmers, while the sample size was 170 smallholder rice farmers from Duhuzimbaraga Kilimbi-Macuba rice cooperative. Data were collected using questionnaire and interview. Data were analysed using SPSS IBM 23.0 version with descriptive statistical methods. Findings stated that there's significant and positive moderate correlation among Indemnity-based insurance and Production of Rice as Pearson correlation confirmed (r= .413** with p-value of 0.000 < 0.01); however out of taken into consideration different factors which have an effect on Production of Rice on farmers, only Indemnity-based insurance in crop insurance has a great robust effect of 41.3% for Production of Rice on farmers in Nyamasheke District. Findings additionally revealed that there is a huge and moderate correlation between Index-based insurance and Production of Rice on farmers, with (r=.291**; p-value of 0.000 <0.01); this shows that, out of the taken into consideration various factors that influence Production of Rice on farmers, only Index-based insurance in crop insurance has a massive and vigorous effect of 29.1% of Production of Rice on farmers in Nyamasheke District. Generally, the outcomes confirmed that there is significant and positive strong correlation between Crop Insurance and Production of Rice on farmers in Nyamasheke District as Pearson correlation confirmed (r= .550** with p-value of 0.000 < 0.01); this designates that out of consideration other elements affecting production of rice, crop insurance has an extensive and strong effect of 55.0% for Production of Rice on farmers in Nyamasheke District.
Key Words: *crop insurance, production of rice, cooperative, Advantages*

1. Introduction

Rice in Eastern African countries is also emerging as an important staple crop by exception of South Sudan which produces insignificant quantities of rice, all of the Rwanda's fellow EAC member countries which are Kenya, Tanzania, Uganda, and Burundi consume, produce and trade large quantities of the commodity. By recognizing the strategic importance of rice all those EAC countries have adopted rice development strategies with multiple objectives of raising production or productivity, attaining self-sufficiency by reducing imports and expanding exports. Successful implementation of these rice development strategies requires not only an understanding of the constraints faced within domestic rice value chains but also how domestic value chains are integrated regionally or globally through trade and affected by trade flows. Rwanda has two rice cropping seasons per annum, rice planted in June/July is harvested in

October/December (Season A), while rice planted in December/January is harvested in May/June (season B).

Rice is the foremost commodity grown in Rwanda with a rice area estimated at 17000 hectares (NISR, 2015), attributing to the rapid rise in rice production in the past decade, the country has not yet achieved self-sufficiency. Rwanda annually imports an average of 26,736 tons of milled rice. Rice growing conditions are favorable in Rwanda, with farmers constantly achieving yields of around 5.8 tons per hectare, outperforming those in neighboring countries such as Burundi, Uganda, Tanzania (2.5 tons per Hectare), and Kenya (4.5 tons per hectare) (FOASTAT, 2016).

To spread the rice value chain development initiatives the Ministry of Agriculture and Animal Resources (MINAGRI) launched the National Rice Development Strategy (NRDS) (2011-2018) in 2011. National Rice Development Strategy (NRDS) was aimed at achieving self-sufficiency in rice production by 2018, and substantially raising the competitiveness of Rwanda rice in local and regional markets (MINAGRI, 2013). In most parts of Rwanda, it is difficult for rice farmers to access sufficient amounts of good quality rice seeds on time for the season which limits productivity due to the absence of efficient public seed production and distribution networks in the country; the intensive mono-cropping of rice has gradually built up the pressure of pests and diseases to alarming levels in several marshlands; lack or inadequate knowledge on the appropriate control measures against pests and diseases amongst farmers is a major impediment in raising productivity levels.

The safety measures and standards of the availability and use of pesticides are not properly regulated leading to pollution of drinking water and raising health risks for farmers and farm families in marshlands. Natural disaster that impacts agricultural production adversely affects the livelihood of farmers' households and where the majority are small-scale subsistence farmers living in a rural area and such loss impacts their income. Climate change is the big risk that Rwandan rice farmers face which changes the precipitation patterns and leads to more uncertainty in Rwandan rice agriculture (Mahul and Stutley, 2010).

2. Statement of the problem

The government of Rwanda has even implemented insurance programs (crop insurance), especially for the agriculture of rice, chili, fresh beans, potatoes, and maize. During this study, the focus is made on rice as it is a crucial commodity and a major source of livelihood for many small-scale farmers, to promote agricultural development and, food security, and to mitigate risk against crop yield loss due to pests and diseases outbreak, excessive rainfall and floods or extreme drought due to climate change.

Despite the efforts made by Government in rice crop insurance, farmers still fail to repay their loans due to crop failure and poor harvest adding more difficulties to a sector already prone to high financing risks.

However, this survey research was chosen due to the facts of an explanatory analytical study on the study of advantages of crop insurance on the production of rice in Rwanda with a case study of the Nyamasheke District, by answering the following questions: To What extent do farmers from rice cooperatives respond to crop insurance? What are the advantages of rice crop insurance to farmers? What are the effects of different coverage and subsidy levels on input use, certainty equivalents, indemnity payments, and premiums?

3. Objectives of the study

This study aimed to assess the role of crop insurance in the production of rice in Rwanda. case study of Duhuzimbaraga Kilimbi-Macuba Cooperative, Nyamasheke District. The Specific Objectives were:

[1] To examine the extent to which do farmers from rice cooperatives responds to agricultural crop insurance.
[2] To determine the advantage of rice crop insurance to famers

[3] To evaluate the effects of different coverage and subsidy levels on inputs use, certainty equivalents, indemnity payments and premiums; and production of rice in Rwanda

4. Research Hypotheses

This study verified three alternative hypotheses as follows:

H1: There is significant and positive perceptions of farmers from rice cooperatives on agricultural crop insurance;

H2: There is significant advantage of rice crop insurance to famers;

H3: There are significant and positive effects of different coverage and subsidy levels on inputs use, certainty equivalents, indemnity payments and premiums; and production of rice in Rwanda

5. Operational Definitions of Key Concepts

Crop insurance

Crop insurance is purchased by agricultural producers, including farmers, ranchers and others to protect against either the loss of their crops due to natural disasters, or the loss of revenue due to declines in the prices of agricultural commodities. There are two major types of crop insurance: multiple peril crop insurance (MPCI) and crop-hail insurance (Hardaker *et al.,* 2004).

Agricultural insurance is an insurance that is basically specific to agriculture like crops and livestock. According to Nnadi *et al.,* (2013) agricultural insurance provide cover against financial losses and helps farmers to cope with income shocks and manage them efficiently. It reduces the impacts of the risks faced by farmers by compensating them for the losses faced and helping them to invest much money in agriculture projects for increasing their income (Nahvi *et al.,* 2014).

Production of rice

Rice production in India is an important part of the national economy. India is the world's second-largest producer of rice, and the largest exporter of rice in the world.

Cooperative

A cooperative is "an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned enterprise". Cooperatives are democratically owned by their members, with each member having one vote in electing the board of directors (Hardaker *et al.,* 2004).

The Nature of Risk

Meaning of Risk

Risk can be defined as the probability or threat of damage, injury, loss or any undesirable event caused by internal or external vulnerabilities which can be avoided by taking preventive actions (Business Dictionary, 2018).

In other words, risk can be defined as result of the probability of an undesirable event occurring and the assessment of expected harm resulting from the event. According to Hardaker *et al.* (2004), risk in finance is defined as the possibility of variation in actual returns on an investment from an expected return, even when those returns are positive outcomes, while risk in agriculture is defined as a situation where the probability of an event is known but the actual value of the occurrence of the event is unknown.

Types of risks

Risks can be categorised into different categories like the risk that affect business such as market and environmental risks like natural disasters. Hazards such as natural disasters often lead to a major decline or even a total loss of food production for consumption and income where it can be categorized into individual/ household risks community or group risks and regional risks.

In agriculture the greater concern of risks is on the community level of risk while the impact is

experienced most severely at household level. According to Abebe and Bogale, (2014) these risks can be categorized according to the degree of correlation across household, the severity of the losses that are sustained and how frequently they occur.

Risk in Agriculture

Agricultural production faces many risks that are including production risks, prices risk, and resources risks that can makes yield and income unpredictable to farmers. That major risks in Agriculture are production, marketing, financial, institutional and human risks (FAO, 2008) where production risks may be caused by unpredictable weather such drought, floods or by outbreaks of pests or diseases. Financial risks may be caused by uncertainty about future interest rates and farmer's ability to generate oncome for loan repayment. So, the high interest rates on loans may reduce smallholders' ability to repay loans.

Impact of Risks on Agriculture

The impact of risks affects poor farmers especially in developing countries like Rwanda. Risk is prevalent in agriculture and affects different aspects of it like production, profitability, consumption and food Security.

Effects of risks on agricultural production

According to FAO (2008) Farming is dependent on biological process that re susceptible to weather, pest and diseases while drought, floods and hail can cause losses in yield and farmer's income which affect the sustainability of agricultural businesses.

Mullera *et al.,* (2011) assessed the climate change risks on agriculture in Africa and projected that climate change weaken agricultural production further, especially for the majority of smallholder farmers in developing African countries, who depend on rain-fed agriculture and have low adaptive capacity and that decline in production affect the food security.

The climate change in the big challenge faced by the agricultural sector which is struggling to cope with a rising for food and renewable energy. Unmanaged risks can result in a cycle of shock which makes farming very risky, for example, the outbreak of diseases can lead to huge losses, followed by high prices. Risk also affects the adoption of technology.

Impacts of agricultural risks on farm profitability

In developing countries, agriculture is a source of income and food security for many people with the main objective of increasing his farm income. Farmers are mainly concerned with income variability and income stability is not necessarily brought by price stabilization (De Janvry and Sadoulet, 1995).

High level of profits is sometimes associated with high level of risks it requires importantly the management of risks effectively. The appropriate risk management is more effective and better farming opportunities obtained when farmers have clear understanding on their farming environment and aware of potential problems and have ability to know how their effects can be decreased.

In most developing countries low farm profitability is a big problem because it affects the country food security as many countries' population depend on agriculture. According to Aung (2011); and Kuku et al., (2011) low farm profitability limits the supply of food and because of that low farm income rural households have limited access to food utilization.

Effects of agricultural risk on household consumption

Agricultural risks affect the decision of farm production, strategies of risk management, and a long-term investment and access to financial services that influence household consumption. Some agricultural shocks like droughts and floods which may lead to food price hikes can have a considerable effect on household food accessibility and affecting the stability of food security.

In developing countries most of the poor households can be affected by the rise of price of food commodity where most poor households' food makes up a large share of their total expenditure where poor households tend to spend a large share of their income on food. If the unfavorable events like droughts, floods and outbreaks of disease can cause the reduction in

farm income. When farmers have access to credit, transitory income shocks can be smoothed away by savings and borrowings, and have no effect on household consumption patterns. Households can make income-generating choices that may produce the highest expected value and use after-shock mechanisms such as insurance and credit to achieve the desired consumption smoothing.

Effects of agricultural risks on food security
According to FAO (2016) Agricultural risks and uncertainties disrupt farm production and food security. The agricultural risks are the one of the major poverty causes, where poor households which are basically depend on the agricultural production when they faced with these agricultural risks, they being trapped in poverty cycle that is difficult to escape. UN (2015) reported that the eradication of extreme poverty

and hunger is the first goal of the sustainable development goals. Agricultural production is the very crucial for achieving food security (Godfray *et al.,* 2010). According to FAO (2015) increasing investments in the agricultural sector are needed to boost food security and production and also to restrain the harmful effects of climate change.

Management of Risk
According to Hubbard (2009) make a definition of risk management as the identification, assessment and prioritization of risk, followed by the economical and coordinated application of resources to monitor reduce and control the probability of undesirable occurrences. Its main objective is to ensure that uncertainty doesn't deviate from the goals settled for any kind of business.
Risk management consist of two ways which are the following the first is to anticipate an undesirable event that can be occur and taking some preventive measures, if possible, to reduce the chances of that event to occur. The second is that it requires to take action to reduce the adverse impact should the occur and may involve a cost to ensure that farmer can effectively manage the farm risk. It is extremely important for farmers to

identify the sources of agricultural risks in order to be able to choose the appropriate risk management strategy. Factors such as age, farm size and attitude to risk determine farmers' choice of risk management strategies, also different farming system, the size of the farm and its income differentiate the responses of farmers.

Risk management through insurance
Insurance is an effective tool that can be used in risks management. If a specific risk is identified and quantified, a farmer can seek insurance cover for the farm against potential shocks where the insurance company assess the nature of risks and count the premiums on those risks, basically understanding how insurance works and how farmers are compensated is important in risk management and the adoption of crop insurance.

Definition of insurance
According to Anderson & Brown (2005) make a definition of insurance like a signed agreement between two parties where one party (the insured) agrees to pay a predetermined payment called the premium to the other party (the insurer). The insurer agrees to pay a claim or benefit to the insured upon the occurrence of specified loss. Insurance does not reduce the probability of an event occurring, but it decreases the effect of the

event on the financial status of the enterprise (Danso-Abbeam *et al*., 2014).

Agricultural insurance
Agricultural insurance is an insurance that is basically specific to agriculture like crops and livestock. According to Nnadi *et al.,* (2013) agricultural insurance provide cover against financial losses and helps farmers to cope with income shocks and manage them efficiently. It

reduces the impacts of the risks faced by farmers by compensating them for the losses faced and helping them to invest much money in agriculture projects for increasing their income (Nahvi *et al.,* 2014).

Agricultural insurance is divided into crop insurance and livestock insurance where livestock insurance may be purchased by farmers to protect their livestock against the risks like sickness, death and accident. This study basically focusses on crop insurance. Crop insurance can be classified into two main groups, indemnity-based and index-based insurance. Indemnity-based insurance focuses on the actual loss incurred by a farmer and ensures that claim repayments are paid to the loss and involves careful inspection of damage to ensure corresponding indemnity calculation (Ellis, 2016). While index-based uses triggers to determine the actual crop loss. Triggers can be made by either using data on rainfall amounts or crop yield data (Cole *et al.,* 2012).

According to the Season B, 2020 Seasonal Agricultural Survey results conducted by National Institute of Statistics of Rwanda in 2020 season B paddy rice cultivated area was estimated at 15 077 ha a considerable decrease of 17% compared to 2019 season B. Paddy rice production was 64 279 MT with a decrease of 11 % from season the 2019 season B. The average paddy rice yield was 4 264 Kilograms per hectare. According to the farmer type the average paddy rice yield was 3 704 kilograms per hectare for small-scale farmers and 4,276 Kilograms per hectare for Large-scale farmers (NISR SAS, 2020).

Agricultural Insurance in Rwanda

The Ministry of Agriculture and Animal Resources (MINAGRI) launched the National Agriculture Insurance Scheme (NAIS) that was take place on 23rd April 2019 an event held in Nyanza District in the Southern of Rwanda. This was to mitigate the risks and losses incurred by farmers due to unpredictable natural disasters, pests and diseases that affect their livestock and crops.

The dubbed Tekana Urishingiwe Muhinzi Mworozi meaning Smallholder farmer feel safe you are insured, where the scheme subsidized up to 40% by the government of Rwanda, was to enable farmers to easily access financial services and ensure flow of credit to agriculture sector. As stated by the Minister of MINAGRI the National Agriculture Insurance scheme is in line with the government's intention to improve the livelihoods of citizens through capacity building and providing support in their respective professions in order to eradicate poverty, thus growing the country's economy.

6. Conceptual Framework

The conceptual framework defines the link between crop insurance as independent variable, and the dependent variable as production of rice.

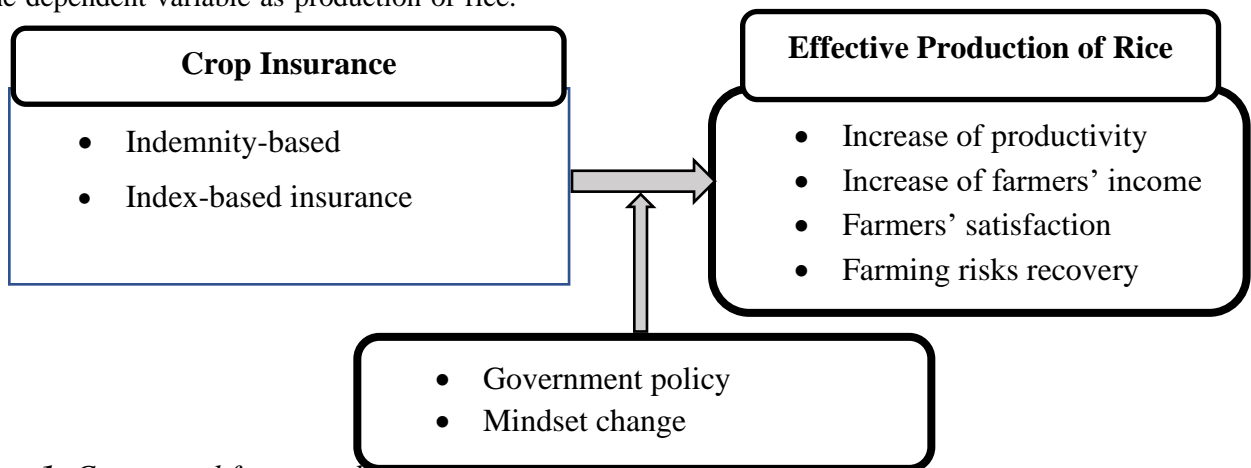The conceptual framework is shown in determine 1 as follows.

Figure 1: Conceptual framework;
Source*: Researcher conceptualization (March, 2022)*

7. Materials and Methods

The methodology used the mixed methods comprising qualitative and quantitative research designs adopted in this study. The targeted population was 472 farmers that cultivate rice in Kilimbi marshland located in the Nyamasheke district. The sample size of 170 was selected randomly from smallholder rice farmers from the Duhuzimbaraga Kilimbi-Macuba rice cooperative located in the Nyamasheke district.

Data collection techniques of the study are questionnaire; interview, and documentation research techniques. The study used SPSS IBM version 23.0 as software for analysis. The descriptive statistical method was adapted to describe the frequency, and percentages of data collected.

8. Findings and Discussions of the Results

Data were collected through questionnaires addressed to 170 respondents, and a document review especially the progress of reports on this project in previous years ago. Data obtained were analyzed quantitatively using computer software of SPSS IBM version 23.0.

Socio-Demographic Characteristics of Respondents

This sub-part identifies sectors, cells where the respondents are located, gender, age, education level, marital status, occupation, renting, and experience of respondents in crop insurance especially in production of rice in Nyamasheke District. Find the below tables in this section are detailing the results from the survey with respondents in Nyamasheke District.

Table 1: Respondents distribution by Sector

Sectors	Frequency	Percent
Karambi	9	5.3
Kirimbi	75	44.1
Macuba	86	50.6
Total	**170**	**100.0**

Source: *Primary data from field (2022)*

Findings in Table 1 illustrate the respondents' distribution by sector in Nyamasheke District. The results confirmed that majority of respondents were coming from Macuba Sector. This is justified by 86 or (i.e.; 50.6%) of respondents who confirmed that they live at Macuba sector, followed by 75 or (i.e., 44.1%) from Kirimbi sector while only 9 or (i.e., 5.3%) of respondents live at Karambi sector in Nyamasheke District.

Table 2: Respondents distribution by cell

Cells	Frequency	Percent
Cyimpindu	23	13.5
Gatare	6	3.5
Gitwe	5	2.9
Kabuga	3	1.8
Karengera	6	3.5
Muhororo	47	27.6
Mutongo	21	12.4
Nyakabingo	1	.6
Rugari	57	33.5

	Frequency	Percent
Vugangoma	1	.6
Total	**170**	**100.0**

Source: *Primary data from field (2022)*

Findings indicated on Table 2 presents respondents participation by cells where majority of respondents come from at Rugari cell followed by those from Mutongo cell while on third there are respondents from Cyimpindu cell as mentioned in table above. Nyamasheke District is one of the rural districts of Rwanda where the main activities are the agriculture, this district is taken as a new comer in rice agriculture of after Rusizi district especially in Bugarama marshland. The irrigation schemes located in Nyamasheke district are Nyagahembe, Mugonero, Kibati, Kirimbi, and Kamiranzovu, shangi and Bushenge. All those irrigation scheme or marshland rice farmers are grouped into different cooperatives.

Table 3: Respondents distribution by Gender

	Frequency	Percent
Female	67	39.4
Male	103	60.6
Total	170	100.0

Source: *Primary data from field (2022)*

Concerning gender, 67 or (i.e., 39.4%) of respondents were females, while 103 or (i.e., 60.6%) of respondents were males who are working with crop insurance in the production of rice in Duhuzimbaraga Kilimbi-Macuba Cooperatives, at Nyamasheke District.

Table 4: Respondents distribution by Ages

Ages	Frequency	Percent
28-38 years	42	24.7
39-48	47	27.6
49-58	53	31.2
59-68	26	15.3
69 and above	2	1.2
Total	170	100

Source: *Primary data from field (2022)*

Table 4 illustrates the respondents' distribution by ages in Duhuzimbaraga Kilimbi-Macuba Cooperatives, at Nyamasheke District. Concerning to ages of respondents, the findings confirmed that majority of 53 or (i.e., 31.2%) of respondents have age between 49-58 years followed by 47 or 27.6% of respondents who have age between 39-48years, while on third rank, there are 42 or 24.7% of respondents who have ages between 28-38years. Only 15.3% of respondents have age between 59-68years while last, are 1.2% respondents who have 69 years and above.

Table 5: Distribution of respondents by Education level

Education level	Frequency	Percent
Illiteracy	1	.6
Primary	169	99.4
Total	170	100.0

Source: *Primary data from field (2022)*

Concerning education level of participants in this study with farmers of Duhuzimbaraga Kilimbi-Macuba Cooperative, Nyamasheke District, 99.4% of respondents have complete primary level and only 0.6% respondent is illiterate. To have respondents' farmers who know to read and write help us to obtain quality data provided in their own without intermediate of other people out of this survey. All 100.0% respondents have confirmed that their occupation is farming activity in Nyamasheke District.

Table 6: Respondents distribution by experience in farming

	Frequency	Percent
1-5 years	37	21.8
6-10 years	84	49.5
11-15 years	49	28.7
Total	170	100

Source: *Primary data from field (2022)*

Experiences of respondents shown by 21.8% of respondents have experience from 1-5 years in farming; 49.5% of respondents have experience between 6-10 years; while 28.7% of respondents have experience between 11-15 years. The respondents have enough experience in farming activity, so, the data provided should be having quality that help us to achieve our study objectives.

Descriptive analysis

The study used inferential statistics to make judgments of the opportunity that an observed difference amongst companies is a reliable one or one that could have passed off with the aid of hazard in this have a observe. for that reason, the usage of inferential records makes inferences from information to greater preferred conditions; the examiner use descriptive statistics certainly to provide an explanation for what's happening in our facts. on this phase, the examiner illustrated findings on correlation coefficient matrix and a couple of linear regression analysis among mobile banking services and customer satisfaction.

Findings on Correlation Coefficient Matrix

In records, correlation or dependence is any statistical relationship, whether or no longer causal or now not, among random variables or bivariate records. A correlation matrix is a table displaying correlation coefficients among variables. A correlation matrix is used to summarize information, as effort proper into a greater advanced assessment, and as a diagnostic for advanced analyses. In this observe, findings in Table present correlation matrix among the variables.

Table 7: Correlation Coefficient matrix

		Indemnity-based insurance	Index-based insurance	Crop Insurance	Production of Rice
Indemnity-based insurance	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	170			
Index-based insurance	Pearson Correlation	.609**	1		
	Sig. (2-tailed)	.000			
	N	170	170		
Crop Insurance	Pearson Correlation	.857**	.863**	1	
	Sig. (2-tailed)	.000	.000		
	N	170	170	170	
Production of Rice	Pearson Correlation	**.413****	**.291****	**.550****	1
	Sig. (2-tailed)	.000	.000	.000	
	N	170	170	170	170

**. Correlation is significant at the 0.01 level (2-tailed).

Findings in Table 7 stated that there's significant and positive moderate correlation among Indemnity-based insurance and Production of Rice as Pearson correlation confirmed (r= .413** with p-value of 0.000 < 0.01); however out of taken into consideration different factors which have an effect on Production of Rice on farmers, only Indemnity-based insurance in crop insurance has a great robust effect of 41.3% for Production of Rice on farmers in Nyamasheke District.

Findings additionally revealed that there is a huge and moderate correlation between Index-based insurance and Production of Rice on farmers, with (r=.291**; p-value of 0.000 <0.01); this shows that, out of the taken into consideration various factors that influence Production of Rice on farmers, only Index-based insurance in crop insurance has a massive and vigorous effect of 29.1% of Production of Rice on farmers in Nyamasheke District.

Generally, the outcomes confirmed that there is significant and positive strong correlation between Crop Insurance and Production of Rice on farmers in Nyamasheke District as Pearson correlation confirmed (r= .550** with p-value of 0.000 < 0.01); this designates that out of consideration other elements affecting production of rice, crop insurance has an extensive and strong effect of 55.0% for Production of Rice on farmers in Nyamasheke District.

Multiple Linear Regression Analysis

This segment helps to confirm and take a look at studies hypotheses. The models had been as X= independent variable is crop insurance which has two indicators: x1: Indemnity-based insurance, x2: Index-based insurance; while dependent variable is production of rice for farmers. Based on those variables, the following functions were set: $Y= f(X)$, therefore, $Y= \beta_0+\beta_1 x_1+\beta_2 x_2+\varepsilon$.

Table 7: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.416[a]	.173	.163	20.68418	1.395

a. Predictors: (Constant), Index-based insurance, Indemnity-based
b. Dependent Variable: Production of Rice

Adjusted R^2 is a corrected goodness of fit measure for linear models. It identifies the percentage of variance in the target field that is explained by the inputs. This attempts to correct for this overestimation. It might decrease if a specific effect does not improve the model. Adjusted R-squared is calculated by dividing the residual mean square error by the total mean square error. Findings in Table 7 show model summary of regression analysis on the independent variables and production of rice because the structured variable. The adjusted R-Square is used to compensate for extra variables within the version. In this case, the adjusted R-square value tells us that our model accounts for

0.163 of variance in the scores of respectable models.

Findings showed the value of R.= .416ᵃ that's categorized as excessive courting. The observe provided also R-square .173; which means that the percentage of production of rice is defined by

way of the unbiased variable indicated through crop insurance represented by x1: Indemnity-based insurance, x2: Index-based insurance. This indicates that the model is big, and fine robust, as the independent variable incredibly explains the dependent variable.

Table 8: ANOVAᵃ

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14922.702	2	7461.351	17.440	.000ᵇ
	Residual	71448.475	167	427.835		
	Total	86371.177	169			

a. Dependent Variable: Production of Rice

b. Predictors: (Constant), Index-based insurance, Indemnity-based

The evaluation of variance is a partitioning of the total variance in a fixed of records into some of thing parts, in order that the relative contributions of identifiable sources of variant to the total variation in measured responses may be determined. From this partition, suitable F-tests may be derived to permit differences between sets of method to be assessed. Accordingly, ANOVA is a bio statistical technique for figuring out whether a distinction exists among the way of three or more impartial populations. The one-manner ANOVA parametric take a look at result

in either accepting or rejecting this null hypothesis. In this situation, from the ANOVA table 8, stage of vigorous mode or f-test is 17.440 that is fantastic with p-value is 0.000ᵇ that is much less than 0.01, set as widespread significance tiers. According to the findings, the study has retained and accepted alternative hypothesis (H3) which stated that There are significant and positive effects of different coverage and subsidy levels on inputs use, certainty equivalents, indemnity payments and premiums; and production of rice in Rwanda

Table 9: Correlation Coefficientsᵃ

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	65.959	10.318		6.393	.000
	Indemnity-based insurance	2.519	.597	.374	4.220	.000
	Index-based insurance	.433	.612	.063	.707	.000

a. Dependent Variable: Production of Rice

The regression coefficients are the estimates of the unknown population parameters and describe the relationship between a predictor variable and the response. In linear regression, coefficients are the values that multiply the predictor values. As the models had been as X= independent variable which is crop insurance that has two indicators comprising x1: Indemnity-based insurance, x2: Index-based insurance; while dependent variable which is production of rice for farmers. Based on those variables, the functions were set as Y= f(X),

therefore, $Y= \beta_0+\beta_1 x_1+\beta_2 x_2+\varepsilon$. That means Y= 65.959+2.519x1+.433x2+10.318. Therefore, the results from Table 4.33 indicated that Indemnity-based insurance has positive and significant effect on Production of Rice for farmers as (β_1=2.519, t= 4.220; p-value= .000 which less than significant standards of 1%). Findings show that Index-based insurance has positive and significant effect on production of rice for farmers as (β_2= .433, t= .707 and p-value= .000 which is less than standard significant of 1%).

9. Conclusion

The crop insurance has effectively absorbed production risk and has given impetus to crop specialization. It has also influenced the use of high-value inputs, which in turn has contributed towards enhancing returns from farming. Even though there was effort made by Government of Rwanda in rice crop insurance, findings showed that farmers are still failed to repay their loans due to crop failure and poor harvest adding more difficulties to a sector already prone to high financing risks.

Findings stated that farmers from rice cooperatives respond to agricultural crop insurance knew crop insurance through insurance companies' mobilization as confirmed by 34.7% ;20.6% confirmed that they knew crop insurance through state institutions. The 28.7% stated that they preferred insurance that provides indemnity payments based on crop cutting index for losses. The 94.7% confirmed that there is great impact of crop insurance on farm productivity technical efficiency and innovation. The findings helped as to retain first hypothesis (Ho1) stated that There is high extent to which formers from rice cooperatives responds to agricultural crop insurance. Findings revealed that there are great advantages of rice crop insurance to the famers as stated by 45.9% confirmed that with rice crop insurance, there is an access to credit for farmers.

29.4% stated that with rice crop insurance, they have anincrease of income. Findings also helped to retain second research hypothesis (Ho2) stated that there is significant advantage of rice crop insurance to the famers. In this situation, from the ANOVA table, stage of vigorous mode or f-test is 17.440 that is fantastic with p-value is 0.000^b that is much less than 0.01, set as widespread significance tiers.

Because of this, the study has rejected null hypothesis (Ho) stated that there is no significant and positive relationship between crop insurance and production of rice; because the findings indicated a substantial and wonderful courting between the variables, and for that reason, the study has retained and accepted alternative hypothesis said that the independent variable (crop insurance) have significantly and positively effect on production of rice.

Based on the findings above, the problem of the study was solved, research questions were answered, research objective were achieved and research hypotheses were all verified and all retained, where we may say that there is significant role of crop insurance in the production of rice in Rwanda especially Duhuzimbaraga Kilimbi-Macuba Cooperative, Nyamasheke District.

10. Recommendations

The following recommendations could be better to put them in action in order to improve crop insurance for stimulating the production of rice in Rwanda

To the Farmers

(1) For improving the production, farmers together with government should set up land reforms which are the first and predominant point. Those including the use of Machines, tractors, and implements do land reforms to increase rice production.

(2) Water is an essential need for planting crops, and by the management of water, you can enhance the production. Water management is the best way to improve production. Using the sprinkler irrigation system, you can increase the output by up to 50%.

(3) According to farming scientists, about 5% of crops destroyed by insects, pests, and diseases. Most of the farmers are oblivious of the use of medicines and insecticides developed in recent years. Improving the production of the crops, yields must use these medicines.

(4) In order to take risk management to the next level and instil confidence among farmers, we recommend a full implementation of the policy scenarios suiting the duality aspect of farmers in Rwanda.

To insurance Company and Government

Agriculture insurance is a critical tool to help farmers mitigate risk, but expanding access to it is no small challenge; so, they should respect agreement made with farmers because sometimes farmers are claiming about not receiving indemnities. The agencies implementing crop

insurance expressed that lack of staff, lack of coordination among them and hinderance to their routine functions were the major constraints, as stated by local government officials in Nyamasheke District; however, there is a need of enhancing campaign awareness to the farmers in

Suggestion to further Researchers

Rice production however is a highly risky venture in a disaster-prone Philippines. Output declines were observed in the recent years mostly due to natural disasters. Moreover, majority of the rice farms in the region are small farm holders who are more vulnerable to crop damages and diseases. Crop insurance is viewed as a risk management tool that can stabilize farmer's income and consumption after experiencing perils hence a promising strategy to reduce

the use of crop insurance to stimulate and strengthen the harvest especially Rice production in Rwanda. Government should play a role of being intermediate between farmers and insurance agency in order to avoid conflict between those both parties.

poverty. With the substantial amount of public funds, it is important to know whether its services bring positive impacts to small-scale farmers. Considering the findings obtained in this study, the suggestions for further studies inform the phenomenon of crop insurance in Rwanda to strengthen rice crop production in Rwanda. Therefore, the researcher opens the doors to further researchers to cover what this study did not cover.

REFERENCES

[1] Abebe, T.H. and A. Bogale (2014). Willingness to pay for rainfall-based insurance by smallholder farmers in central rift valley of Ethiopia: The case of Dugda and mieso woredas. *Asia pacific journal of energy and environment* 1(2): 121-155.

[2] Adams, A.1995. Banking and finance Series investment, Kluwer Law international London. *Net Journal of Agricultural Science*, 1(1):1-9.

[3] Adger W., Agrawala, M., Mirza, C., conde, K., O'brien, J., Pulhin,R. Pulwarty, B. and K.Takahashi (2007). Assement of adaptation practices, opinions, constraints and capacity;

[4] Anderson, J. and Brown R. (2005). *Risk insurance*

[5] Aung, N. (2011). *Agricultural efficiency of rice farmers in Myanmar; a case study of selected areas IDE discussion paper* No. 306.2011.09

[6] Besley, T. (1995). Savings, credit and insurance. In J. Behrman and T.N. Srinivasan (Eds.), Handbook of development economics volume 3, Amsterdam: North-Holland.

[7] Business Dictionary (2018). What is risk? Available at http://www.businessdictionary.com/ [accessed 24 June 27, 2022].

[8] Brown, W. and C. Churchill (1999). Providing Insurance to Low-income household's part I: A primer on insurance

principles and products. *USAID-microenterprise best practices (MBP) Product*, pp.91.

[9] Cole, S., Bastian, G., Vyasl S., Carina, W. and D. Stein (2012). The effectiveness of index-based micro-insurance in helping smallholders manage weather-related risks. Systematic review.

[10] De Janvry, A. and E. Sadoulet (1995). Quantitative development policy Analysis. Baltimore: Johns Hopkins University press. Available at http://caoye.lzu.edu.cn/upload/news/N20141 106111536.pdf [accessed on 14 June 27, 2022]

[11] Danso-Abbeam, G., Addai, K. and D.Ehiakpor (2014). Willingness to pay for farm insurance by small holder cocoa farmers in Ghana. *Journal of social science for policy implications*, 2(1): 163-183.

[12] Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development studies*, 35(1): 1-38.

[13] Ellis, E. (2016). Framers willinmgess to pay for crop insurance: Evidence from Eastern Ghana, Department of Agricultural Economics McGill University, Montreal: 110 Quebec, Canada.

[14] Food and Agriculture Organization (FAO). (2008). Managing risk in farming. Available at; http: www.fao.org/uploads/media/3-

Managingriskinternlores.pdf[accssed 06 June 27, 2022]

[15] Food and Agricultural Organization (FAO). (2015). Surge in climate -related disasters poses growing threat to food security, Available at: http:// www.fao.or.new/story/en/item/345727/icode / [accessed 03 June 27, 2022].

[16] Food and Agriculture Organization (FAO). (2016). Agriculture and Food insecurity Risk Management in Africa.

[17] Faostat, F. (2016). Agriculture organization of the United Nations statistics division. *Economic and Social Development Department, Rome, Italy. Available online: http://faostat3. fao. org/home/E (accessed on 24 Mars 2022)*.

[18] Godfray, H.C., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir,J.F., Pretty, J., Robinson, S., Thomas, S.M. and C.Toulmin (2010). Food security: The challenge of feeding 9 Billion people. Science, 327(5967): 812-818. Available at; www.sciencemag.org[16 May 2022].

[19] Ghins, L., & Pauw, K. (2017). The impact of policy and the market environment on production and wholesale trade incentives for rice in Rwanda. *Agricultural Development Economics Working Paper* 18-02. Rome.

[20] Hardaker, J,B., Huirne, R.B., Anderson, J.R and G.Lien (2004). Coping with risk in agriculture (second edition), CAB International, New York.

[21] Hubbard, D. (2009). The failure of risk management: why it's broken and how to fix it. John wiley & sons.p.46.

[22] Kakinda-Mbaga, F. M. (1990). Introduction to social research. *Unpublished manuscript*.

[23] Korir, L.K.(2011). Risk management among agricultural households and the role of off-farm investemnts in Uasin Gishu county, Kenya. M.sc, Egerton University, Kenya.

[24] Mahul, O., & Stutley, C. J. (2010). *Government support to agricultural insurance: challenges and options for developing countries*. World Bank Publications.

[25] MINAGRI. (2004). Plan stratégique pour la transformation de l'agriculture au Rwanda*,* Kigali, Rwanda

[26] Mohanty, S., Wassmann, R., Nelson, A., Moya, P., & Jagadish, S. V. K. (2013). Rice and climate change: significance for food security and vulnerability. *International Rice Research Institute*, *14*, 1-14.

[27] Mullera, C., Cramera, William, L., Harea, B. and H. Lotze-Campena (2011). Climate change risks for African agriculture. PNAS 108(11)4313-4315.

[28] Nahvi, A., Kohansal, M., Ghorbani, M. and N. Shahnoushi (2014). Factors affecting rice farmers to participate in agricultural insurance. *Journal of applied science and Agriculture*, 9(4): 1525-1529.

[29] Nelson, G.C., Rosegrant, J., Koo, R., Robertson, T., Sulser, T., Zhu, C., Ringler, S., Msangi, A., Palazzo, M., Batka, M., Magalhaes, R., Valmonte Santos, M., Ewing and D.Lee (2009). Climate change: Impact on agriculture and costs of adaptation. Food Policy report#19. IFPRI, Washington, DC.

[30] NISR (2011) integrated household living conditions survey. *EICV3 thematic report agricultural.* Kigali, Rwanda.

[31] NISR. 2014. Seasonal Agricultural Survey 2014. Kigali, Rwanda.

[32] NISR. 2015a.Seasonal Agricultural Survey 2015.Kigali, Rwanda.

[33] Nnadi, F.N., Chikaire, J., Echetama, A.J., Ihenacho, A.R., Umunnakwe, C.P. and O.C. Utazi (2013) Agricultural insurance: A strategic tool for Climate cgange adaptation in the agricultural sector.

[34] Pasaribu, S. M. (2010). Developing rice farm insurance in Indonesia. Agriculture and Agricultural Science Procedia 1, 33 – 41. International Conference on Agricultural Risk and Food Security 2010.

[35] REMA (2015). Rwanda state of Environment and outlook Report 2015. Kigali, Rwanda.

[36] Thorburn, C. (2015). The rise and demise of integrated pest management in rice in Indonesia. Insects 6(2), 381–408.

[37] United Nations (UN). (2015). Sustainable Development. Available at; https://sustainabledevelopment.un.org [accessed 18 May 2022].