Selcuk Journal of Agriculture and Food Sciences

https://dergipark.org.tr/tr/pub/selcukjafsci

Research Article

(2025) 39(2), 434-445 DOI:10.15316/SJAFS.2025.036 e-ISSN: 2458-8377 Selcuk J Agr Food Sci

Risk Assessment in Paddy Rice Cultivation: The Case of Gihanga, Burundi

Thierry Keringingo[1,*], Zuhal Karakayacı[1]

[1]Selçuk University, Faculty of Agriculture, Department of Agricultural Economics, Konya, Turkiye

HIGHLIGHTS

- Gihanga is located in the Imbo plain, which has rice growing potential.
- Rice is a profitable and easily marketable crop in study area.
- This study revealed that rice farms in Gihanga face various risks that require sustainable strategies.
- The classification of risks according to their severity values was developed using the Kine-Finney method and the results showed the existence of many risks with a severity value above 400.

Abstract

This study was carried out in the Imbo plain of the Gihanga region in Burundi. The primary objective of this research is to analyze the main risks associated with rice production. To achieve the study's objectives, face-to-face surveys were conducted using the KoboCollect application. Once the surveys were completed, a statistical analysis was carried out using SPSS 25, and the Fine-Kinney method has been used to assess the severity of the identified risks. The results reveal that rice cultivation is predominant in Gihanga, with an average production of 3,878.95 kg per enterprise and per year. The average area allocated for rice cultivation was 1.4 hectares. The risks observed in the examined farms, with severity values exceeding 400, include drought, lack of agricultural insurance, plant diseases, inadequate irrigation infrastructure, and limited access to quality inputs. Major challenges identified include difficulties in accessing financial resources, insufficient agricultural oversight, and poor water management. On the other hand, in Imbo, it was found that the semi-intensive production system of small farms neither weakened nor strengthened their competitive advantage. It is imperative to consider agricultural risks when making production decisions, and the formulation of policies aimed at developing the rice sector is strongly recommended.

Keywords: Risk analysis; Fine-Kinney method; agricultural enterprises

1. Introduction

The economy of Burundi is primarily based on agriculture, with the agricultural sector contributing approximately 40% to the Gross Domestic Product (GDP), employing 84% of the working population, and providing 95% of the food supply (Katungi et al. 2021). The average land ownership per household is 0.27 ha, which is well below the 0.90 ha considered the minimum for economic viability (IFAD 2022).

Agricultural productivity in Burundi is hindered by several challenges, including pest outbreaks and crop diseases (Okonya et al. 2019), droughts and occasional floods (Nyairo et al. 2020), limited liquidity for inputs

Citation: Keringingo T, Karakayacı Z (2025). Risk assessment in paddy rice cultivation: The case of Gihanga, Burundi. *Selcuk Journal of Agriculture and Food Sciences*, 39(2), 434-445. https://doi.org/10.15316/SJAFS.2025.036

***Correspondence:** thiekera@gmail.com

Received date: 22/02/2025

Accepted date: 20/06/2025

(such as fertilizers, plant protection products, productive seeds, and planting materials), land fragmentation (Mpozi et al. 2020), inefficient utilization of available water resources (Bisekwa et al. 2020), lack of liquidity and credit opportunities among small-scale farmers, and limited access to research and extension services (Ndagijimana 2021). Despite these challenges, most regions of the country have climatic conditions suitable for agriculture (Kessler et al. 2021).

Agriculture is particularly vulnerable to risks, many of which stem from climatic hazards. Agricultural risks impose a significant burden globally (Hazell et al. 2010). For instance, (Paridaens et al. 2012) showed that water scarcity and erosion due to heavy rainfall affect 22% and 14% of agricultural land, respectively, in the northern provinces of Burundi. Farmers are perceived as risky borrowers, which limits their access to credit, increases the cost of interest, and results in a clear impact by trapping farmers in a vicious cycle of low productivity and poverty (Hazell et al. 2010). Land degradation and climate change affect approximately one-third of the world's land area, leading to negative consequences for the income and food security of the agricultural population (Mirzabaev 2016). Agricultural risks are categorized in various ways by different researchers. A commonly used classification divides agricultural risks into two main groups: operational risks and financial risks (Hardaker et al. 2004). Agricultural risks can be examined in five primary areas: production, marketing, financial, legal, and social risks (Laurence et al. 2013). According to a literature review, rice production involves different sources of risk, including technological risks, political risks, economic risks, production risks, marketing risks, human or personal risks and financial risks.

In the study, a risk analysis was conducted on rice-producing agricultural enterprises in the Gihanga district, and an effort was made to partially fill the knowledge gap on this topic. The research results have guided subsequent studies on risks in the area, providing important data that can help rice producers make decisions under risky conditions, assist farmers in determining risk management strategies, and provide decision-makers with crucial information for their use.

2. Materials and Methods

The data for the study were obtained through face-to-face surveys with rice-producing agricultural enterprise owners in Gihanga. The survey form was incorporated into the KoBoCollect application to facilitate data collection and entry. In this study, the sample size was calculated according to the following formula based on the proportion of the main population, using an uncluttered simple random sampling method (Oğuz and Karakayacı 2017).

$$\mathbf{n} = \frac{\mathrm{Np}\ (1 - \mathrm{P})}{(\mathrm{N} - 1)\sigma_{px}^2\ p(1-p)} \tag{1}$$

In the formula,
n: Sample size
N: Number of enterprises in the population
$\boldsymbol{\sigma_{px}^2}$**:** The variance of the proportion and
p: 0,5.

The number of rice producers registered with the Imbo Rice Development Company (SRDI) is 9,826, and the survey was conducted with a 10% margin of error and a 95% confidence level to determine the number of enterprises to be surveyed. According to the formula mentioned above, the total sample size was calculated as 95 enterprises. In the formula, the value of p, which represents the probability of the event occurring, is set as 0.5 for risk-taking enterprises, while q, representing the probability of the event not occurring, is also set as 0.5 for risk-averse enterprises. Both values were taken as 0.5.

In examining the risk attitudes of producers in the study area, they were classified into three categories: risk-taker, risk-averse, and risk-neutral. To determine which group the producers belonged to, the reference gamble and preference scale methods were employed. The risk attitudes of the producers were identified based on the choices they made among the options presented (Holloway 1979). The classification of producers

into specific risk attitude groups was determined by following the steps outlined below (Holloway 1979). First, the producer was informed that they would receive a reward based on a certain probability. In the initial step, the producer was presented with a guaranteed reward alternative that was smaller than the probabilistic reward. The producer was then asked to choose between the two options. If the producer chose the probabilistic reward, the value of the guaranteed alternative was increased. This process was repeated until the producer became indifferent between the two options. Next, the probability value in the first step was increased, and the procedure was repeated. As a result, a graph was constructed with the horizontal axis representing the indifference points and the vertical axis representing the probabilities (Preference Curve). In the third step, the results obtained were plotted on this graph to determine the risk attitudes. In the study, the shape of the preference scale curve, which illustrates the risk attitudes of farmers using the reference gamble method, is presented below (Holloway 1979).

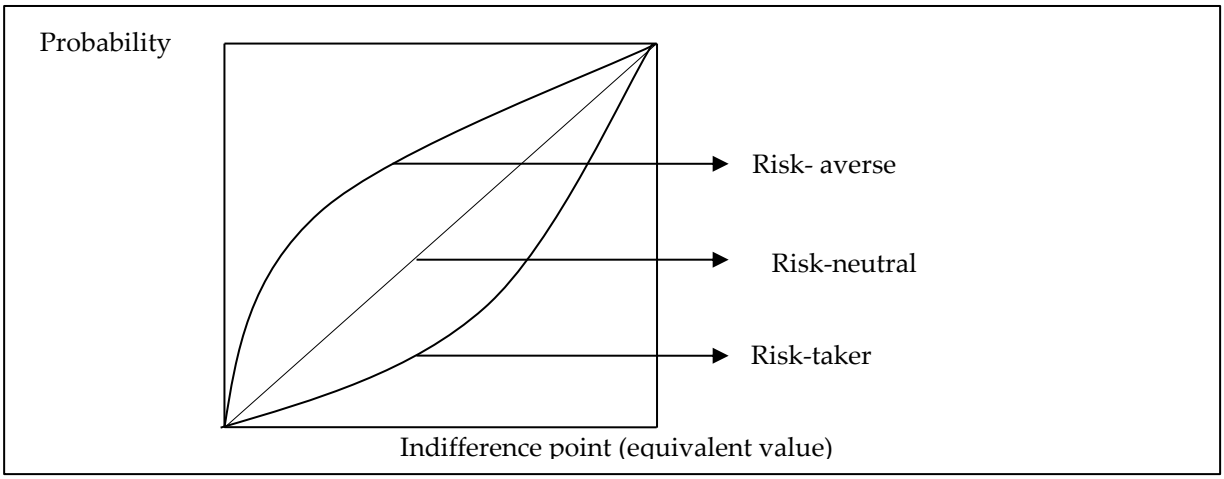

Figure 1. Preference Curve

The risk behaviors of business managers were categorized into three groups (risk-taker, risk-averse, and risk-neutral) using reference gambling and preference scales. However, it was assumed that being risk-neutral means not taking risks, so the business managers who were risk-neutral were also considered as part of the risk-averse group (Holloway 1979; Ceyhan et al. 1997). In this study, two groups were used: risk-taker and risk-averse. Additionally, the businesses examined in the study were divided into two large groups based on the size of the enterprises in Group I and Group II.

In the research area, factors considered as social, economic, and ecological risks were incorporated into the survey. Each factor was rated using a five-point Likert scale, and respondents were asked to evaluate the impact of these factors on the production process. The average of the responses provided by rice producers was calculated to generate risk scores, and the perceived levels of risk factors were determined. To systematically process and integrate the collected data, a database was created for the relevant surveys. For the evaluation and analysis of the data, the SPSS 25 statistical software program was utilized.

In this study, the Fine-Kinney method was applied to assess the risks associated with agricultural production in the examined enterprises. The Fine-Kinney method evaluates risks based on the factors of probability, frequency, and severity, and these values are multiplied to obtain a risk score. The parameters for probability, frequency, and potential outcomes have been explained. The severity of the damage caused to humans, businesses, or the environment in the event of risk occurrence is calculated. The following calculations were made to assess the risks that may be encountered in the enterprises examined in the study (Erzurumluoğlu et al. 2015).

The risk value is calculated as follows:

$$\text{Risk Value} = I \times F \times D \quad (2)$$

Where:

I = Probability (a value between 0.2 and 10)

F = Frequency (a value between 0.5 and 10)

D = Degree of Impact (the severity of damage or harm that the risk event would cause to humans, the workplace, or the environment if it occurs).

Table 1. Fine-Kinney method/decision and action based on risk level.

Rank	Risk Value	Decision	Action
1	R < 20	Acceptable Risk	Immediate action may not be required
2	20 < R < 70	Definite Risk	Should be included in the action plan
3	70 < R < 200	Significant Risk	Should be carefully monitored and addressed in the annual action plan
4	200 < R < 400	High Risk	Should be addressed in a short-term action plan
5	R > 400	Very High Risk	Work should be halted, and immediate measures should be taken

In the examined enterprises, after determining the probability, frequency, and severity (impact) of natural, economic, and social risks, the risk value was calculated based on the Fine-Kinney formula. Accordingly, the action plan was implemented in the order of the risk values presented in Table 1.

3. Results and Discussion

3.1. Rice Production

In this section of the study, the results obtained from the survey conducted in the Gihanga district of Bubanza province are presented. Table 2 shows the product inventory and cultivated areas.

Table 2. Annual crops production pattern (ha)

Farm Groups		Group I		Group II		Enterprise Average		Total
Risk Attitudes		Risk-Taker	Risk-Averse	Risk-Taker	Risk-Averse	Risk-Taker	Risk-Averse	Grand Total
Rice	Ha	0.75	0.75	0.67	0.77	0.71	0.76	1.47
	%	12.3	14.2	17	12.9	14.2	13.5	14
Maize	Ha	0.7	0.67	0.71	0.84	0.71	0.76	1.46
	%	11.5	12.7	18.1	14.1	14.1	13.4	14
Sweet potato	Ha	0.58	0.42	0.96	0.78	0.77	0.6	1.37
	%	9.51	7.97	24.4	13.1	15.4	10.7	14
Soybean	Ha	0.82	0.73	0.82	0.82	0.82	0.78	1.6
	%	13.4	13.9	20.9	13.8	16.4	13.8	16
Cowpea	Ha	0.75	0.71	0	0.9	0.38	0.81	1.18
	%	12.3	13.5	0	15.1	7.48	14.3	10
Dry Beans	Ha	0.5	0.61	0.77	0.85	0.64	0.73	1.37
	%	8.2	11.6	19.6	14.3	12.7	13	14
Peanut	Ha	0.5	0.5	0	0	0.25	0.25	0.5
	%	8.2	9.49	0	0	4.99	4.45	4.4
Cassava	Ha	0.5	0	0	0	0.25	0	0.25
	%	8.2	0	0	0	4.99	0	2.1
Fallow	Ha	1	0.88	0	1	0.5	0.94	1.44
	%	16.4	14.4	0	16.4	8.2	15.4	12
Total	Ha	6.1	5.27	3.93	5.96	5.02	5.62	10.6
	%	100	100	100	100	100	100	100

In this study two large groups were distinguished based on the size of the companies, group I whose surface area is less than or equal to 2.5 ha and group II with a surface area greater than 2.5 ha. The second based on behaviors in the face of risks (risk taker and risk averse) has been also analyzed. In the study area, rice, which occupies 1.47 ha per farm, is the dominant crop. According to the results of a study conducted by (Gahiro 2011) in Burundi, rice farms in the Imbo region were divided into two zones: Zone 1 and Zone 2. The average size of rice fields ranged between 1.25 ha and 1.60 ha, and the average area covered by rice was quite similar to that confirmed by this study. The Imbo plain includes two major groups of rice farms: the first group consists of farms with areas ranging from 0.2 to 0.8 ha, while the second group comprises farms in Zone 3 with large areas averaging 1.67 ha. In the study area, rice continues to be the most widely cultivated crop for various reasons, the most important of which are listed in Figure 2.

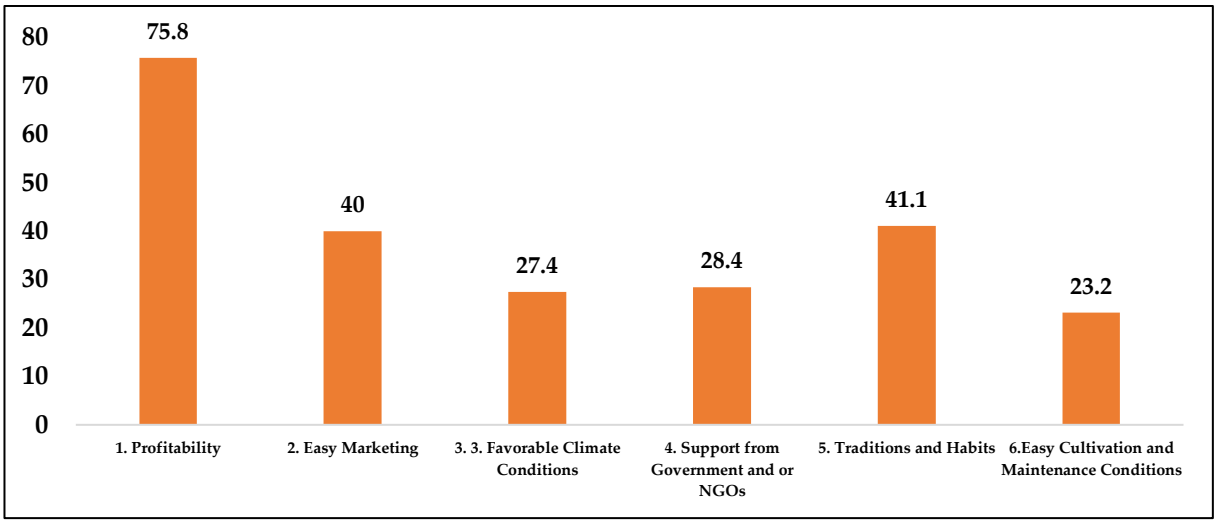

Figure 2. Reason for rice cultivation in the examined enterprises

This figure likely illustrates the percentage or score distribution of different factors that contribute to the prevalence of rice production in the study area. The factors include profitability, ease of marketing, favorable climate conditions, support from government and NGOs, traditions and habits, and ease of cultivation and maintenance. The main factor that drives producers in the study area to choose rice cultivation is the profitability of rice farming, with 75.8% of producers stating that rice is highly profitable. Although rice is a new crop in Burundi, it is based on traditional practices and customs. The second factor that inspired producers to focus their efforts on this crop is that 41.1% of participants were influenced by these traditional, non-mechanized practices. In studies conducted by (Edward et al. 2022) in Ghana and (Yohana and Yan 2021) in Tanzania, the main reasons driving them to cultivate rice and its profitability were identified. Data on the amount of rice produced and sold, as well as the sale price, are presented in Table 3.

Table 3. Rice production in the surveyed enterprises

Rice Production	N	Minimum	Maximum	Mean	Std. Deviation
Quantity of Rice Produced (Kg/year)	95	1500	8000	3878.95	1088.420
Quantity of Rice Sold per year	95	250	6000	3660.53	1143.271
Rice Price per year (USD/Kg)	95	0.68	1.27	1.10	259.589
Rice Yield (kg/Ha)	95	1000	5000	3546.32	955.589

* 1 US Dollar = 2922.5 BIF (08/02//2025).

The average quantity of rice produced per surveyed enterprise was found to be 3,878.95 kg, with the highest amount being 8,000 kg and the lowest quantity being 1,500 kg. According to Table 3, it was determined that not all of the produced quantity was sold, with the average annual amount sold being 3,660.53 kg. Based on the survey results, the average price was calculated at $1.10/kg. The remaining quantity of rice, 218.42 kg (27.3

kg/person/year), was consumed on the farms. The average yield was determined to be 3,546.32 kg/ha. Indeed, the production techniques applied, the costs incurred in production, and the results obtained indicate that rice growers in Imbo are more productive (over 5 tons/ha) and competitive than farmers in swamp areas (Gahiro 2011). It was also noted that the average annual national rice consumption is 8.5 kg per person, which is lower than the amount consumed in the surveyed farms.

3.2. Risk Factors in the Examined Enterprises

As mentioned in the general introduction of this study, rice cultivation faces risks in various categories. Detailed informations are presented in Figure 3.

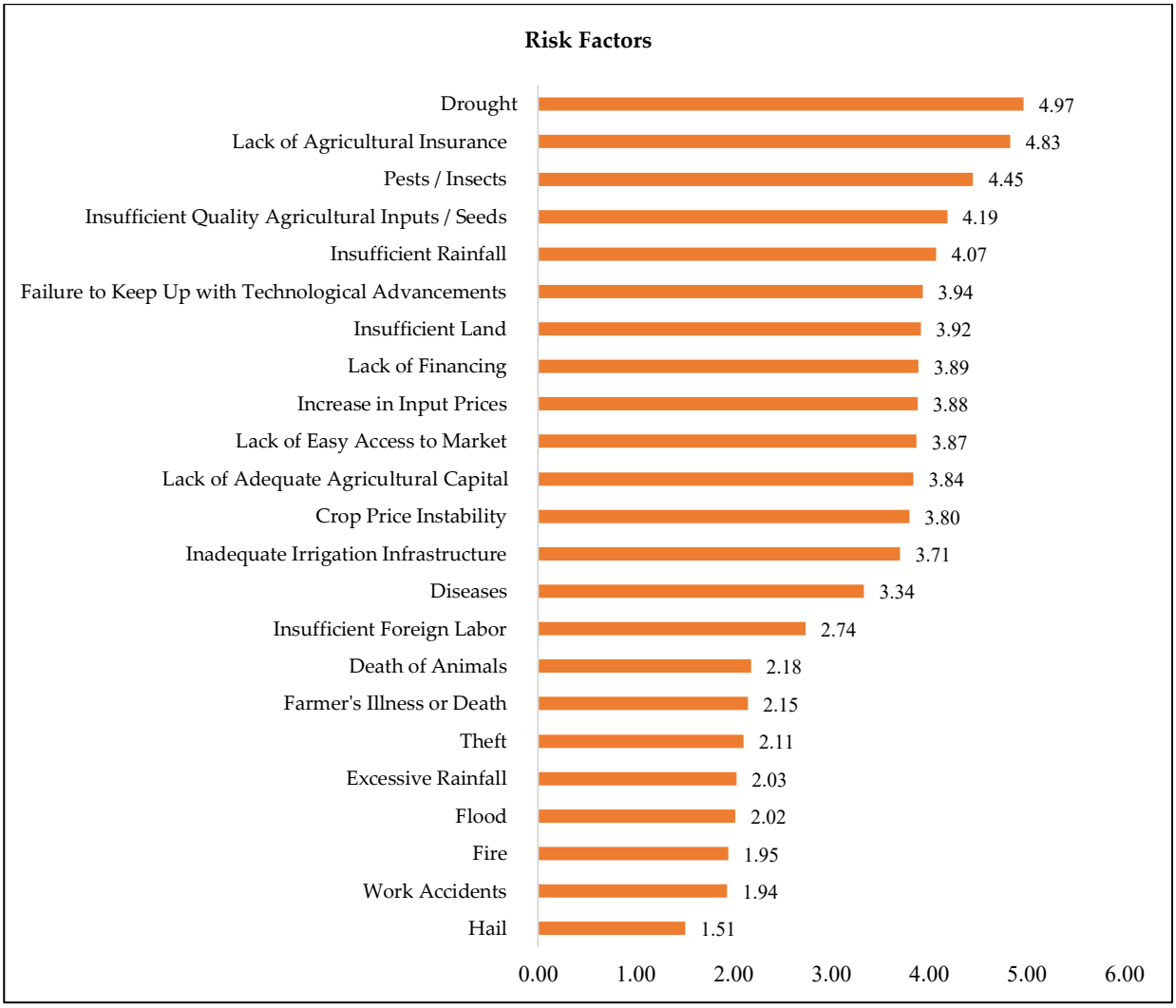

Figure 3. Potential risk factors encountered in the surveyed enterprises

Rice-growing farms face environmental, financial, human, and institutional risks. Despite the presence of water in the region, drought is indicated as the primary major risk. Risks such as the lack of agricultural insurance, plant diseases, insufficient quality of seeds and other inputs, and inadequate rainfall have scored above 4 on the Likert scale. According to (Wabi et al. 2021), irregular and decreasing rainfall is the greatest concern for irrigated rice producers.

Indeed, the lack of modern technologies, insufficient arable land, inadequate financing, high input prices, difficulty accessing markets, insufficient agricultural capital, lack of infrastructure, and various diseases are risks that threaten farmers and have received scores between 3 and 4 on the Likert scale. This situation has been validated in the study "Confronting Risks in Agriculture" by (Hardaker et al. 2004), which demonstrated that, in addition to market risks such as rising fertilizer prices and falling rice prices, financial risks like

increased interest rates, human risks like negligence leading to yield loss, and institutional risks such as changes in agricultural policies are also frequently encountered. This finding was also observed in the research conducted by (Nto et al. 2014) to assess risk management practices in rice production in Abia State. In that study, the main causes of financial risk in rice production included interest rates and the inability of rice farmers to access credit. Lastly, risks such as foreign labor shortages, animal deaths, theft, excessive rainfall, flooding, forest fires, workplace accidents, and hail were less frequently identified as threats to enterprises with scores below 3.

Rice producers have listed some strategies they can implement to reduce the risks mentioned above, and the most important of these are announced in Figure 4.

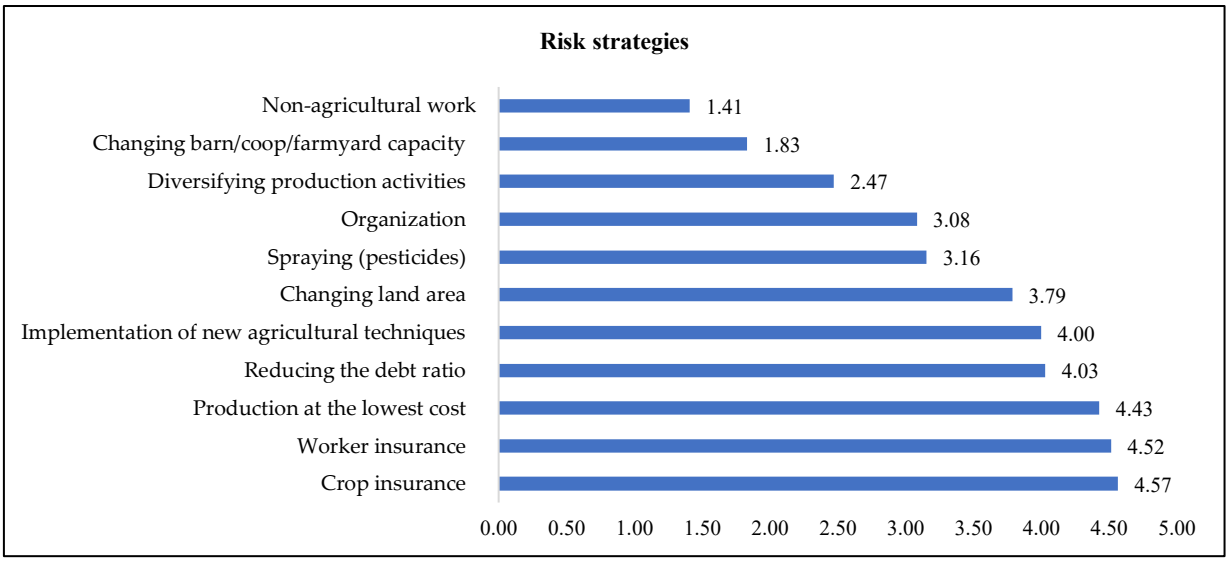

Figure 4. Risk strategies that can be applied in rice cultivation.

It has been determined that the most significant dimension of the risk strategy is agricultural insurance, with a score of 4.57. In the study area, no actual cases of agricultural insurance have been encountered. Similarly, worker insurance has been identified as another risk strategy with a score of 4.52. The transfer of risk to third parties such as futures markets, insurance companies, and financial investors is one of the important risk strategies discussed by (Näther and Theuvsen 2012). Producers have highlighted the risk associated with the strategy of reducing input usage levels and production costs (4.43). Although many input and fertilizer suppliers can offer credit to producers, they often hesitate due to the variable risks associated with producers (Hazell et al. 2010; Levine and Reinhard 2007).

Reducing production costs and the level of inputs will increase producers' profits. In fact, this is called cost minimization, and it is the primary goal of a rational producer. It has been suggested as a strategy to reduce debt levels and the associated financial risks (4.03). The adoption and implementation of new agricultural techniques have also been considered a risky strategy with a score of 4 on the Likert scale. Land capital is essential in agriculture, and in this context, land consolidation has been strongly desired as a risk strategy (3.79). In fact, the most well-known method for dealing with diseases and pests is agricultural pesticide application, and this same strategy has emerged with a score of 3.16. Another risk strategy considered important by producers is the establishment of cooperatives and the diversification of agricultural products, with scores of 3.08 and 2.47, respectively. According to (Kremen et al. 2012), product diversification can support climate adaptation, resilience, and food security.

However, the development of livestock farming and the expansion of non-agricultural activities are among the risk strategies that scored less than 2. Studies conducted by Mishra and Morehart (2002) and Nartea et al. (2003) in New Zealand, as well as by Mishra and Morehart (2001) and Davis and Patrick (1999) in the United States, have emphasized the importance of agricultural and non-agricultural investments in reducing risks. For many African farmers, these coping strategies are informal and rely on family and community structures,

such as food sharing, internal and external migration, money transfers, child labor, in-kind loans, or sending children to live with their parents (Heltberg and Siegel 2008). Typically, farms do not follow a single coping strategy during these difficult times; instead, they use various strategies to maximize their chances of survival (Heltberg and Siegel 2008).

3.3. Risk Assessment in the Surveyed Enterprises Using the Fine-Kinney Method

In this section, the Fine-Kinney method was used to assess the risks faced by the surveyed farms. The Fine-Kinney method is a systematic approach to risk evaluation that considers three main factors: the probability of occurrence, the severity of consequences, and the frequency of exposure. By analyzing these factors, the method helps prioritize risks and identify the most critical areas requiring intervention. In the surveyed farms, the Fine-Kinney method was used to classify risks. By grouping the risks using this method, their priority order was determined, and measures were taken according to their level of importance. Each risk was individually evaluated according to the Fine-Kinney method, and their risk levels were identified as presented in Table 4.

Table 4. Fine-Kinney method in rice cultivation

Risk Factors	Probability Scale	Frequency Scale	Impact/Damage	Risk Value	Risk Status
Lack of agricultural insurance	9.70	9.66	98.21	9197.52	Very High Risk
Drought	9.40	9.29	88.79	7753.19	
Pests / Insects	6.82	6.97	54.88	2609.56	
Insufficient rainfall	5.92	5.66	31.85	1067.13	
Insufficient quality agricultural inputs / seeds	5.32	5.24	31.27	871.47	
Lack of easy access to market	4.76	4.79	25.44	579.77	
Failure to keep up with technological advancements	4.32	4.29	22.17	411.40	
Increase in input prices	4.44	4.18	20.74	384.49	High Risk
Crop price instability	4.29	4.17	20.34	364.08	
Lack of financing	4.32	4.36	18.98	356.95	
Insufficient land	3.95	3.85	19.06	290.29	
Lack of adequate agricultural capital	3.94	3.83	16.92	255.16	
Inadequate irrigation infrastructure	3.58	3.60	16.48	212.70	
Diseases	3.39	3.45	13.66	160.14	Significant Risk
Insufficient foreign labor	2.84	2.78	10.39	81.90	
Theft	2.40	2.81	10.24	69.09	Definite Risk
Death of animals	1.41	2.09	5.41	15.93	Acceptable Risk
Excessive rainfall	1.34	1.65	4.14	9.18	
Flood	0.92	1.60	4.40	6.48	
Farmer's illness or death	0.89	1.33	3.38	4.01	
Work accidents	0.74	1.33	3.13	3.06	
Fire	0.68	1.17	3.13	2.50	
Hail	0.45	0.88	2.41	0.96	

The probability, frequency, and severity values of the risks are calculated using the Fine-Kinney method. Risks are categorized into different groups, such as natural, economic, and social risks. According to the data in Table 4, the risk values range from 0.96 to 9197.52.

In the study area, the most significant natural risks are drought, plant diseases, and insufficient rainfall. Risks originating from production techniques are also among the most notable. These include the lack of quality inputs, the underdevelopment of traditional agricultural practices, and the absence of modern irrigation infrastructure. However, agricultural insurance is not yet implemented in the soils of Burundi, which creates a significant disadvantage for agriculture.

Among the major risks, economic risks such as problems accessing distribution markets, high input prices, price instability in markets, insufficient financing, and inadequate agricultural capital have also emerged. In this study, social risks are classified as the least significant risks, with examples including work accidents and animal deaths.

Several studies have explored the multiple risk factors that influence agricultural productivity and sustainability across different African regions. For instance, Manzamasso (2021) conducted a study titled "The Effects of Price Variations, Weather Conditions, and Policy Changes on Maize and Rice Cultivation in Togo," which provided valuable insights into the systemic challenges faced by farmers. The study identified key constraints impacting agricultural productivity in Togo, including political implications, climate variability, and the fluctuations in market prices and policy shifts. These findings underscore the need for integrated risk management approaches that take into account both environmental and institutional dimensions in agricultural planning and decision-making.

In fact, these risk values are divided into five major categories based on their severity: Very High Risk, High Risk, Important Risk, Certain Risk, and Acceptable Risk. The most detailed information regarding Fine-Kinney analyses is explained in Table 5.

Table 5. Fine-Kinney method applied to rice in the surveyed farms

Risk Value	Risk Factors	Action
R<20	• Death of animals, • Excessive rainfall, • Flood, • Farmer's illness or death, • Work accidents, • Fire, • Hail	Immediate action may not be required.
20<R< 70	• Theft	Should be included in the action plan.
70 <R<200	• Diseases, • Insufficient foreign labor	Should be closely monitored and addressed in the annual action plan.
200 <R<400	• Increase in input prices, • Crop price instability, • Lack of financing, • Insufficient land, • Lack of adequate agricultural capital, • Inadequate irrigation infrastructure	Should be addressed in the short-term action plan.
R>400	• Lack of agricultural insurance, • Drought, • Pests / Insects, • Insufficient rainfall, • Insufficient quality agricultural inputs /Seed • Lack of easy access to market, • Inadequate irrigation infrastructure	Work should be paused, and immediate measures should be taken.

When considering the risks examined in Gihanga, the risks that show the highest risk level, i.e., those with a risk level above 400, are classified as intolerable risks. These are risks that require decision-making in production activities and necessitate urgent action. Among these risks are the lack of agricultural insurance,

drought, pests/insects, insufficient rainfall, low-quality agricultural inputs/seeds, lack of easy market access, and inadequate irrigation infrastructure. Although it may not be possible to completely eliminate these risks, it is possible to minimize the damages through certain measures. These are risk factors that must definitely be taken into account.

The second risk group includes risks with a level between 200 and 400, such as increases in input prices, instability in product prices, lack of financing, insufficient land availability, inadequate agricultural capital, and insufficient irrigation infrastructure. These risks are considered to have a slightly lower negative impact, and it is ideal to address them by integrating them into a short-term action plan. Key risks evaluated in this group include inadequate agricultural capital, lack of financing, indebtedness, absence of crop insurance, and fluctuations in crop yields ranging between 200 and 400.

In their book titled "Coping with Risk in Agriculture", Hardaker et al. (2004) highlighted the prevalence of various types of risks commonly faced by farmers. These include market risks, such as rising fertilizer prices and falling paddy rice prices; financial risks, like increasing interest rates; human risks, such as negligence leading to yield losses; and institutional risks, including changes in agricultural policies. Their analysis underscores the complexity and interconnectivity of risk factors in the agricultural sector, emphasizing the need for comprehensive risk management strategies.

There are risks that should be included in the annual action plan, carefully monitored, and addressed. These are in the third group, with a risk level between 70 and 200, which includes issues such as human diseases and a shortage of foreign labor. Theft, with a risk value between 20 and 70, represents the fourth group and is inevitably included in the risk control action plan. Finally, the fifth group includes risks such as animal death, heavy rainfall, flooding, farmer illness or death, work accidents, fires, and hail, all with a risk level below 20, which fall under the normal risk group. These risks do not significantly affect production decisions. Despite the mild climate, fires are less frequent due to the scarcity of forests and shrubs, and the sparser vegetation. Almost all of the region is suitable for agriculture, and although rainfall is insufficient, there are numerous rivers with weak irrigation systems. Since intensive agriculture is practiced in the region and there are few animals, animal deaths are not considered a major risk affecting agricultural activities. Agriculture is primarily manual and non-mechanized, involving hoeing, so accidents arising from agricultural activities are less frequent. Although these risks are less significant, measures should still be taken to eliminate them.

According to the Norwegian report VKM (2013), titled *"Risk Assessment of Mycotoxins in Cereals in Norway,"* it has been established that cereals can be contaminated by fungi producing mycotoxins, which are toxic secondary metabolites. These mycotoxins present in cereals may pose risks to both human and animal health. Prolonged ingestion of mycotoxins found in Norwegian cereals can lead to, among other effects, a reduction in immune responses, impaired growth, and reproductive dysfunction. The study also found that rice crops are vulnerable to this fungal disease. The risk assessment should encompass the fungi and toxins present in cereals and cereal-based products available in the Norwegian market.

Gihanga is a warm region located in the Imbo plain, where natural risks are prevalent due to climate change and the shortening of the rainy season. It is also an area with fertile yet dry soils. Burundian agriculture, in general, faces issues related to the lack of quality inputs, including problems with technology and mechanization of activities. The increase in input prices (seeds, fertilizers, pesticides, diesel, oil), the underpricing of agricultural products, and market imbalances are risks that discourage rice producers. These risks stem from the lack of information regarding the calculation of production costs and the absence of direct market access.

To successfully strengthen marketing strategies, it is recommended that sales be distributed throughout the year, direct sales without intermediaries be implemented, forward contracts be made, pricing be set for the future, and joining cooperatives and producer organizations that could facilitate market access. Farmers are unable to access credit due to the lack of repayment possibilities and are also faced with high bank interest rates. The simplest strategies applied against financial risks include: obtaining insurance against financial

losses, organizing investments, planning expenses, reducing debt, limiting credit, and selling assets that can be converted into cash.

4. Conclusions

In conclusion, the agricultural sector holds a critically important place in the economies of underdeveloped countries. However, due to its dependence on natural conditions, agriculture is a high-risk sector. Therefore, identifying risk factors and corresponding risk strategies, especially for key crops with significant production shares, is crucial for the development of the agricultural sector.

This study focused on determining risk factors and strategies for rice, one of the most widely produced crops in the Gihanga region of Burundi. Although rice cultivation is profitable, the Fine-Kinney method revealed that this crop faces various risks requiring immediate decisions and actions, as risk levels were found to exceed 400. These risks include the lack of agricultural insurance, drought, pests/insects, insufficient rainfall, low-quality agricultural inputs/seeds, lack of easy market access, and inadequate irrigation infrastructure. The study's results highlighted those strategies such as agricultural insurance, reducing production costs, adopting new farming techniques, land consolidation, and crop diversification can provide sustainable and long-term solutions for rice farming enterprises.

In this context, it is recommended to examine and adapt practices from other countries that align with the local infrastructure, and to reform national agricultural policies accordingly. By implementing these measures, the agricultural sector in Gihanga and similar regions can become more resilient, sustainable, and economically viable.

Author Contributions: All authors contributed equally to all stages of the preparation of this manuscript. Similarly, all authors approved the final version of the manuscripts.

F**unding:** This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest regarding the publication of this manuscript.

References

Edward O, Prince A, Akwasi M and Henry D (2022). Rice price volatility and transmission: Implications for food security in Ghana. https://doi.org/10.1080/23322039.2022.2085605

Gahiro L (2011). Competitivite des filieres rizicoles burundaises : Le Riz De L'imbo Et Le Riz Des Marais https://theses.hal.science/tel-00854623v1/document

Hardaker BJ, Huirne RBM, Anderson JR, Lien G (2004). Coping Risk in Agriculture. Second Edition. Oxfordshire: CABI Publishing, ISBN:0851998313, United Kingdom, p.332.

Hazell P, Anderson J, Balzer N, Clemmensen AH, Hess U, Rispolli F (2010). The potential for scale and sustainability in weather index insurance for agricultural and rural livelihoods. IFAD and WFP, Rome, p. 153.

Heltberg R, Siegel P (2008). Climate change: Challenges for social protection in Africa. Paper for conference on social protection for the poorest in Africa. Washington DC: World Bank.

Holloway C (1979). Decision making under uncertainty: models and choices, Prentice-Hall, Inc., englewood Cliffs, New Jersey.

IFAD (2022). Republic of Burundi: Country Strategic Opportunities Programme (2022–2027); International Fund for Agricultural Development: Rome, Italy.

Katungi E, Nduwarigira E, Ntukamazina N, Niragira S, Mutua M, Kalemera S, Onyango P, Nchanji E, Fungo R, Birachi E, Rubyogo JC, Bruchara RA (2020). Food security and common bean productivity: impacts of

improved technology adoption among smallholder farmers in Burundi; Pan-Africa Bean Research Alliance (PABRA): Nairobi, Kenya.

Kessler A, Reemst L, Beun M, Slingerland E, Pol L, de Winne R (2021). Mobilizing farmers to stop land degradation: A different discourse from Burundi. *Land Degrad & Development* 32, 3403–3414. https://onlinelibrary.wiley.com/doi/10.1002/ldr.3763

Kremen C, Iles A, Bacon C (2012). Diversified farming systems: An agroecological, systems-based alternative to modern industrial agriculture. *Ecology and Society* 17(4): 44.

Laurence C, Gene G, Steve I, Doug J, Rod S (2013). Introduction to risk management: Understanding agricultural risks, 2nd Ed., Extension Risk Management Education and Risk Management Agency, United State Department of Agriculture.

Manzamasso H. (2021). Impacts of price, weather and policy changes on maize and rice farming in Togo. *African Journal of Economic and Management Studies* (2021) 12 (3): 357–380. https://doi.org/10.1108/AJEMS-09-2020-0427 .

Mirzabaev A (2016). Land degradation and sustainable land management innovations in Central Asia. Springer, Cham. https://link.springer.com/chapter/10.1007/978-3-319-25718-1_13

Mpozi BB, Mizero M, Egesa AO, Nguezet PMD, Vanlauwe B, Ndimanya P, Lebailly P (2020). Land access in the development of horticultural crops in East Africa. A case study of passion fruit in Burundi, Kenya, and Rwanda. *Sustainability* 12, 3041. https://www.mdpi.com/2071-1050/12/7/3041

Näther, Theuvsen L (2012). Risk management im Pferdebetrieb: Leitfaden für Pferdebetriebe: So behalten Sie die Risiken im Griff.

Ndagijimana M (2021). Coping with risk and climate change in farming: Exploring an index-based crop insurance in Burundi. Ph.D. Thesis, Wageningen University and Research: Wageningen, The Netherlands.

Nto P, Mbanasor JA, Osuala AE (2014). Evaluation of risk management practices in rice production in Abia State, Nigeria. *American Journal of Experimental Agriculture* 4(3), 263-274.

Nyairo R, Machimura T, Matsui TA (2020). Combined analysis of sociological and farm management factors affecting household livelihood vulnerability to climate change in rural Burundi. *Sustainability* 12(10), 4296. https://www.mdpi.com/2071-1050/12/10/4296

Oğuz C, Karakayacı Z (2017). Tarım Ekonomisinde Araştırma ve Örnekleme Metodolojisi, Selçuk Üniversitesi Ziraat Fakültesi Tarım Ekonomisi Bölümü Yüksek Lisans Ders Kitabı 1.Basım.

Okonya JS, Ocimati W, Nduwayezu A, Kantungeko D, Niko N, Blomme G, Legg JP, Kroschel J (2019) Farmer reported pest and disease impacts on root, tuber, and banana crops and livelihoods in Rwanda and Burundi. *Sustainability* 11(6), 1592. https://www.mdpi.com/1660-4601/16/3/400

Paridaens AM, Belotti L, Régi S, Mahwane J, Zoem JP (2012). Analyse des données secondaires de la sécurité animentaire, vulnérabilité et nutrition au Burundi. Burundi. Retrieved from https://documents.wfp.org/stellent/groups/public/documents/wfp253438.pdf.

VKM, (2013). Risk assessment of mycotoxins in cereal grain in Norway. https://vkm.no/download/18.2994e95b15cc545071615a36/1510054265635/Risk%20assessment%20of%20mycotoxins%20in%20cereal%20grain%20in%20Norway.pdf

Wabi M, Vanhove W, Idohou R, Hounkpèvi A, Kakaï R L, Damme P (2021). Characterization of spatio-temporal trends in longterm rainfall of three weather stations in Benin: Implications for Agricultural Decision Making. https://orcid.org/0000-0003-1854-7306

Yohana J, Yan Y (2021). Price risk perceptions and adoption of management strategies by smallholder rice farmers in Mbeya region, Tanzania. https://www.tandfonline.com/doi/full/10.1080/23311932.2021.1919370.