Price risk perceptions and adoption of management strategies by smallholder rice farmers in Mbeya region, Tanzania

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Abstract: One of the main risks that tend to affect the profitability and well-being of smallholder rice farmers in Tanzania is volatile rice prices. Improving the capacity of farmers to manage price risks is essential to increase rural incomes. This article applies descriptive statistics, exploratory factor analysis, and probit model to examine price risk management strategies of smallholders rice farmers, and factors affecting their use. Results have shown that most rice farmers prefer to manage price risk through spot market strategies, even though forward contracts perform better. The factors that significantly affected the adoption of the risk management tools were farm income, technological intensity, income diversification activities, access to market information, and storage facilities. Findings suggest that policies aimed at establishing and promoting commodity-derivative markets, improving market information systems, supporting the construction of warehouse facilities in rural areas, and improving access to credit for farmers could enhance farmers’ ability to manage price risks. Governments can also set up price guarantee schemes to help farmers cope with the loss of income resulting from catastrophic events or major market disruptions.

Subjects: Agricultural Development; Agricultural Economics; Rural Development

Keywords: Price risk; perception; management strategy; smallholder; Tanzania; rice

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PUBLIC INTEREST STATEMENT

One of the main risks facing the agricultural sector is the increasing volatility of commodity prices. Farmers can use different instruments to manage the risk of price fluctuations, including forward contracts, futures, and options markets. However, the use of these hedging strategies among smallholder farmers in developing countries is minimal. The reasons are based on the characteristics of farmers and their low level of commercialization. In this context, an understanding of the behavior of smallholder farmers in managing the price risk inherent in their activity is crucial for the development of appropriate policies to support agricultural marketing.
1. Introduction
Agricultural production has unique characteristics compared to other economic activities. One of the most striking is the extent and nature of the risks and uncertainties to which it is exposed, which have a direct impact on production costs and the profitability of producers and of all agents that integrate the production chain (Pochara, 2012). The risk of production is linked to external factors such as climate, plant diseases, insect attacks, which affect production (Broll et al., 2013). Market risk is related to the producer’s inability to predict input prices as well as the selling prices of agricultural products (Harčaríková, 2018). Most of these risks are unknown to smallholder farmers before the farming season, but are anticipated based on their perceptions and past experiences.

The prices of agricultural products are very volatile. These prices are often lower just after the harvest period and higher before the harvest period and depend on aggregate supply and demand (Franken et al., 2012). However, the producer cannot predict in advance the exact level of these prices or adjust the time of sale, mainly because of the many other factors involved (exchange rate, taxes, storage, etc.) (Sirisupluxana & Bunyasiri, 2018). Besides that, high price fluctuations also provide opportunities for traders to manipulate price information at the farm level. This results in the transmission of prices from the consumer market to farmers tend to be asymmetrical in the sense that if there is an increase in prices at the consumer level, the price increase is not passed on to farmers wholly and quickly, on the contrary, if there is a price decline (Seck et al., 2010).

Different instruments can be used by farmers to manage the risk of adverse fluctuations in the prices of agricultural products. Among the most commonly used strategies are forward contracts and futures or options markets (Broll et al., 2013). Through the negotiation of these contracts, agents can fix, at present, the price of the asset for a future date, reducing their exposure to unwanted fluctuations in these quotes, and ensuring profitability to the activity (Broll et al., 2013; Carrer et al., 2019). These operations are called hedging. However, despite their potential, the use of these strategies in developing countries remains limited.

In the United Republic of Tanzania, rice is the second most important crop, mainly grown by farmers as a cash crop for local and regional markets (URT, 2017a). The country also ranks second within Easters, Central, and Southern Africa in terms of rice production and consumption after Madagascar (USDA, 2019). Rice is accounting for about 19.5% of the country’s annual cereal production (URT, 2017b), of which smallholder farmers produce around 90 percent under continuous flooding with average farm size and yield of 1.3 hectares and 2.5tonnes/ha, respectively. The crop has a per capita consumption of 25 kg per year, accounting for around 9 percent of the nation’s calorie intake (RCTs, 2015). In terms of trade, rice is the most traded crop than any other food crop in Tanzania, around 42 percent of all rice produced is marketed, of which majority of farmers sell unhusked rice to traders and millers (Nkuba et al., 2016). Rice-based production activities offer employment to between 1.5 to 2 million people countrywide (RCTs, 2015).

The marketing of rice, although it seems less exposed to risks than horticultural products that are easily damaged or quickly decomposed, it is also exposed to the variation in the price paid to the producer (Ngailo et al., 2016). Price fluctuation occurs due to an imbalance between the amount of rice demand and supply, especially after successive harvests of high production (Seck et al., 2010). In general, rice farmers tend to continue to sell their produce during the main harvest even though prices were relatively low at the time. This is due to urgency of needs such as paying for production inputs borrowed during the production season, meeting daily needs, and capital for the next cropping season.

Supporting rice farmers towards better management of these risks makes it possible to increase the resilience of their farms and minimize their impacts, particularly from an economic and social point of view. Indeed, the risk of rice price variations can be minimized through better planning of the marketing activities and the adoption of protection strategies. However, with a few exceptions,
the use of formal methods of analysis and protection against price risks has been little observed (Capitani & Mattos, 2017; Pochara, 2012; Sirisupluxana & Bunyasiri, 2018; World Bank, 2014). In this context, studying the perceptions and responses of smallholders to price risk is essential for the formulation of appropriate policies and strategies to minimize the impacts of price fluctuations. In addition, this is also important to study as farmers’ response to price risk can affect resource allocation and ultimately affect rice supply.

Numerous studies have examined how farmers should behave under risk and uncertainties (Hayran & Gül, 2015; Asravor, 2018; Ahmad et al., 2019; Fahad et al., 2018), however less empirical studies have been conducted on price risk perception and management strategies of farmers (Aditto et al., 2012; Bishu et al., 2016; Le & Cheong, 2010). Regarding farmers’ adoption of price risk management techniques, studies have identified two groups of variables to explain the use of price risk management instruments (Moschini & Hennessy, 2001; Velandia et al., 2009; Broll et al., 2013; Harčaríková, 2018; Sirisupluxana & Bunyasiri, 2018; Carrer et al., 2019). The first is based on the characteristics of the producer, such as education, experience in the activity, age, if a member of a cooperative, participation in training, degree to which he keeps himself informed of the market, level of knowledge of derivative products, preferences relating to the business management model and aspects of its behavior, such as excessive confidence in administrative management and the risk attitude. The second group includes the characteristics of the farm and the business, in particular: the size of the production, the income from the specific activity, the income from other activities, the financial leverage, the diversification of production, the existence of rural insurance and participation in government price protection programs. However, the effect of these variables differs in magnitude and direction in different places with different livelihoods. Besides, the fact that none of these studies is being carried out in Tanzania creates the need to undertake this study.

2. Material and methods

2.1. Study area and data collection

The study was conducted in Mbeya, located in the southern part of Tanzania mainland. The region was selected as a study area because it is among the most rice-producing regions, accounting for over 17.8 percent of total rice production in Tanzania (URT, 2017a). Mbeya is also located along the highway connecting Tanzania, Zambia, and Malawi; this means that rice from this area can be easily transported to other domestic markets and nearby countries as export products. To this end, three wards of the Mbarali District in Mbeya region were selected for the study (see Figure 1).

The study involved farmers who produced rice in the 2017/2018 crop season, these farmers were randomly selected from a list of names available to the extension officers. Both probability and non-probability sampling were employed. Under probability sampling, the simple random sampling method was used to select 205 rice farmers in the Mbarali District whereby non-probabilistic was used to select key informants. Questionnaires were administered (between February and April 2019), designed to describe and explain the use of price risk management tools among rice farmers in the study area. Questions about the farmers’ profile regarding risk and demographic variables were also included. Additionally, representatives of traders, farmer organizations, warehouse owners, brokers, millers, and financial agents were interviewed to understand the marketing systems and to identify the perception of these agents regarding the use or not of price protection mechanisms by farmers. Qualitative variables were treated through classification, interpretation, and grouping of information.

2.2. Theoretical framework

The most common theories of risk perceptions and management strategies are protection motivation theory (PMT), risk compensation/risk homeostasis theory, situated rationality theory (SRT), habituated action theory (HAT), social action theory (SAT) and social control theory (SCT). However, in this study, we assume that anticipated risk influences the management strategies adopted by
smallholder farmers, hence the protection motivation theory (PMT) is adopted by this study. According to PMT theory, individuals are more likely to protect themselves when they anticipate negative consequences, have the desire to avoid them and are able to take preventive measures. Thus, motivation for risk management increases not only when there is cause for concern but also the tools and skills to take preventive measures (Mulilis & Lippa, 1990; Rogers, 1983).

The study is also guided by transaction costs and neoclassical random utility models for the individual. As described by Franken et al. (2012) and Carrer et al. (2019), a rational farmer will choose a risk management strategy when the expected utility of adopting that strategy is higher than the utility of adopting another strategy $a_j$, i.e. $U_{a_i} > U_{a_j}$, where and $a_j$ are risk management strategies (see Table 3). Consecutively, a farmer will choose a price risk management strategy that helps to minimize transaction cost as compared to higher cost strategies.

2.3. Estimation method
Three estimation methods were applied in this study. The first was the use of descriptive statistics such as the mean and standard deviation to determine the most important risk sources and risk management strategies according to the perceptions of rice farmers (Bishu et al., 2016). A five-point Likert scale was used to obtain this information from respondents. The Likert scale has been widely used in economics to collect information on feelings and attitudes perceptions (Likert, 1932). It ranks the responses on a scale and therefore helps a researcher to order them. The responses were
subjected to a reliability test to check whether they were consistent in the measurement of perception using Cronbach’s alpha (Cronbach, 1951). Cronbach (1951) defined Cronbach’s alpha as:

\[ \alpha = \frac{Kc}{{V + (K - 1)c}} \]  

(1)

Where \( K \) is the items to be summated, \( c \) is the average of all covariance’s between the items across the sample, is the average variance of each item and 1 is a constant.

The second step was to perform exploratory factor analysis to identify the effective risk management strategies. Exploratory factor analysis helped factor scores. Factor were assessed with eigenvalues greater than 1 using varimax rotation. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett test of Sphericity were used to check whether the scale was appropriate for factor analysis.

The final step was to identify the factors that determine the adoption of price risk management strategies using respondents direct scores as dependent. The Probit model was used. This model was selected taking into account the possibility that the risk management strategies are not mutually exclusive and that it was possible to use several strategies simultaneously (binary outcomes) (Wooldridge, 2010).

In deciding whether or not to adopt such strategy, it can be assumed that the producer considers the marginal advantages and disadvantages of using risk management strategies. Since the parameters of this decision are not generally observable, for each producer, a latent variable, can be defined as:

\[ y_i^* = X'\beta + \mu_i \]  

(2)

Where \( X' \) denotes a set of explanatory variables which affects outcome variables, represents the vector of unknown parameters that are to be estimated and is the randomized error. The observed pattern of adopting risk management strategies can be described by a dummy variable \( y \) such that \( y_i = 1 \) if producer utilizes risk management strategies and \( y_i = 0 \) if producer does not adopt such strategies. The observed values of \( y \) are related to \( y^* \) as follows:

\[ y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \]  

(3)

and,

\[ Pr(y_i = 1) = Pr(y_i^* > 0) = Pr(\mu_i > -X'\beta) = 1 - F(-X'\beta) = F(X'\beta) \]  

(4)

Where \( F \) is a cumulative distribution function for \( \mu \), and asymmetric distribution is assumed. Using maximum likelihood procedures, parameter estimates are obtained (Greene, 1993).

As mentioned in the introduction of this paper, the factors that determine the adoption of risk management strategies generally evolve the characteristics of the producer and his business. In this sense, fourteen variables were constructed to explain the decision on whether or not to use price risk management strategies: age, education level, family size, farm size, farming experience, risk attitude, access to support services (credit & extension), marketing experience, access to storage and transport infrastructure, membership in farmers organization, risk attitude, farmers gross revenue, income from non-farm activity, and degree of technology intensity in the production system.

3. Result and discussion

3.1. Socio-economic characteristics of sampled respondents
The socio-economic characteristics of rice farmers are presented in Table 1 below. Among 105 farmers, around 41.9% of respondents (86 farmers) adopted several price risk management
strategies, and almost 58.1% (119 farmers) did not use any risk management strategy. Farmers who adopted price risk management strategies were slightly younger and had more years of formal schooling than those who had not used any of the spot marketing strategies or forward contracts. Besides, adopters of the strategies had more sources of income, more sources of marketing information, and high participation in farmer groups and networks than non-strategy users.

In terms of the characteristics of farm enterprises, farmers who managed price risk had a much larger far size, a higher production, and their resources mainly financed most of their production and investment costs. These farmers also had a high technological intensity in the production system. As for gross revenue, there was a considerable difference in production revenue for both groups of farmers.

3.2. Farmers’ perceptions of risk sources and risk management strategies

3.2.1. Sources of risk
Table 2 summarizes the results of the most important perceived sources of price risk for rice farmers. The findings show that unexpected seasonal variations in demand, unexpected variability in yields at input prices, insufficient storage facilities, farmers’ inability to reach markets due to distance and infrastructure problems, lack of market information and skills to negotiate better trading terms were the most important and relevant sources of price risk. The standard deviations of the risk sources were less than one, which indicates that these risk sources obtained a high level of consensus among the rice farmers in the study area.

The results presented in Table 1 further imply that, the uncertainty of changes in demand, variability in yields, and changes in prices of substitutes have become a growing concern among smallholder farmers. This may be due to irregular weather and climate changes, variability in input prices, and changes in tastes and preferences of urban consumers. On the other hand, poor transportation infrastructure and inadequate storage facilities continue to hamper market access and better smallholder integration in the market. Consequently, informal credit agreements with buyers or input providers where farmers agree to repay by harvest rather than cash prevents many farmers from choosing profitable markets. The results are in line with the findings by (Harčariková, 2018) and (Mlanzi, 2016) who indicated that the effects of market based sources of risk are critical for smallholder farmers and therefore deter producers from making the investments needed to increase productivity and production.

3.2.2. Price risk management strategies
Farmers’ behavior concerning price risk management strategies was analyzed based on the perception of one alternative over the other. The mean relevances attributed by farmers to risk management strategy are presented in Table 3. Financial and marketing strategies were considered more important managerial responses to price risks in the region.

3.2.2.1. Spot market strategies. Among the spot marketing strategies adopted by the rice farmers, spreading sales over several periods, choosing varieties with low price variability and/or growing different varieties, cost and volume controls, collective storage and marketing, contractual relationship with established buyers, storing farm produce until the prices are higher, and diversifying sources of income (investing off-farm or cultivating more than one crop) were ranked the most important strategies with mean ranging from 4.79 to 3. Nearly 70 percent of adopters reported using these strategies to cope with price fluctuations. Having diversified crops, livestock, or other enterprises’ represents a vital management measure because it reduces dependence on a single product or activity. However, the lack of farm and non-farm resources can affect the diversification performance of smallholder farmers.
The strategy of obtaining market information before deciding to sell was also considered ‘important’ by farmers. Farmers who unable to obtain market information would prefer to sell to village collectors at the farm gate. Providing them with marketing information (i.e., price, quantity to sell, where to sell, or types of possible contractual arrangements) will give them more bargaining power and reduce their uncertainty when making trade deals with buyers. This finding supports
Table 2. Farmers’ perception of sources of price risk

| Source of risk                                      | Mean | SD  | Rank |
|----------------------------------------------------|------|-----|------|
| Seasonal changes in demand                         | 4.07 | 0.92| 1    |
| Unexpected variability in yields                   | 3.82 | 0.88| 3    |
| Insufficient storage facilities                     | 3.93 | 0.95| 2    |
| Lack of market information                         | 3.52 | 0.93| 6    |
| Inadequate infrastructure                          | 3.67 | 0.86| 4    |
| Lack of marketing skills to negotiate better terms | 3.48 | 0.98| 7    |
| Debt situation with buyers or input providers      | 3.34 | 1.03| 9    |
| Cost and variability of fuel prices                | 2.93 | 1.14| 11   |
| Small farm size                                    | 3.64 | 0.99| 5    |
| Variability in input prices                        | 3.36 | 0.96| 8    |
| Lack of agricultural support payments              | 3.05 | 1.10| 10   |

Source: Field Survey, 2019.

Note: SD: standard deviation
Cronbach’s Alpha = 0.846

(Magesa et al., 2014) and (Mmbando et al., 2015), who argued that timely access to marketing information helps smallholder farmers to make informed sales decisions.

On the other hand, the importance attributed by rice farmers on cost control/management may be associated with the crop year in which the research was carried out. The price paid to the farmers for rice in the 2017/2018 crop was relatively low for most of the year, which showed the importance of reducing costs so that the margin of farmers’ income is guaranteed.

After ranking, the factor analysis was performed. Five with eigenvalues greater than 1 were identified based on the 14 risk management variables. For the first component, the study reported high loadings on choosing rice varieties with lower price variability, integrating crops with animals, and growing more than one crop, hence described as “Diversification strategy”. Component two loaded highly on cost and volume controls, and debt reduction strategies; thus it was referred to as “Financial management strategy”. Component three had high loadings on gathering market information, storing products until the price is higher, spreading sales over several periods, and contractual relationship with buyers, hence named “Market network strategy”. Component four was named “Management and optimization strategy” because it loaded highly on collective storage and marketing, and optimizing the use of resources. Component five was interpreted as an “off-farm strategy” because it loaded highly on investing off-farm as a strategy to overcome household liquidity constraints, especially at harvest time. The results (see Table 3) generally show that marketing, financial and diversification strategies were perceived by farmers as essential strategies to adopt in the mitigation of all price risk sources. These results mostly agree with those of Addito et al. (2012), Bishu et al. (2016), and Asravor (2018).
| Risk Strategy | Mean | SD  | Rank | Effective price risk management strategies | Cronbach’s α | KMO |
|---------------|------|-----|------|-------------------------------------------|--------------|-----|
|               |      |     |      | Divers. | Financial Mgt. | Market network | Mgt. & optimization | Off-farm |
| Storage of products until the price is higher | 3.79 | 1.45 | 7     | 0.31 | 0.35 | 0.73 | 0.39 | 0.28 | 0.92 | 0.91 |
| Gather market information before deciding to sell | 4.69 | 0.55 | 2     | 0.18 | 0.34 | 0.79 | 0.42 | -0.11 | 0.92 | 0.90 |
| Spread sales over several periods | 4.79 | 0.67 | 1     | 0.36 | 0.45 | 0.81 | 0.37 | 0.12 | 0.92 | 0.92 |
| Cost and volume controls | 4.46 | 0.86 | 4     | 0.13 | 0.61 | 0.12 | 0.35 | -0.03 | 0.92 | 0.86 |
| Reduce debts, especially with informal lenders | 2.80 | 1.53 | 13    | 0.18 | 0.68 | 0.32 | 0.49 | -0.26 | 0.92 | 0.83 |
| Collective storage and marketing | 4.12 | 1.03 | 5     | -0.02 | 0.24 | 0.46 | 0.75 | 0.15 | 0.92 | 0.92 |
| Contractual relationship with processors and established buyers | 3.96 | 1.21 | 6     | -0.14 | 0.17 | 0.82 | 0.43 | -0.23 | 0.92 | 0.87 |

(Continued)
Table 3. (Continued)

| Risk Strategy | Mean | SD  | Rank | Effective price management strategies | Cronbach’s α | KMO |
|---------------|------|-----|------|---------------------------------------|--------------|-----|
| Divers.       | 3.65 | 1.15| 9    | 3.06                                 | 0.36         | 0.79 |
| Financial Mgt.| 3.06 | 1.32| 11   | 4.62                                 | 0.63         | 0.72 |
| Market network| 3.06 | 1.11| 13   | 2.99                                 | 0.63         | 0.72 |
| Off-farm      | 3.06 | 1.41| 15   | 2.28                                 | 0.59         | 0.72 |
| Cronbach’s α  | 0.06 | 1.15| 9    | 3.65                                 | 0.19         | 0.79 |
| KMO           | 0.79 | 0.36| 0.72 | 0.72                                 | 0.06         | 0.79 |

Mean effective price management strategies include: effective strategies: 3.65; poor strategies: 2.28. Source: Field Survey (2019).
Table 4. Parameter estimates of the Probit model for factors affecting utilization of price risk management strategies

| Independent variable                  | Diversification | Financial Management | Off-farm income | Market network | Management & optimization |
|---------------------------------------|-----------------|----------------------|-----------------|----------------|---------------------------|
| Constant                              | -0.536 (0.005)**| -0.129 (0.467)      | -0.191 (0.505)  | -0.348 (0.016)**| -0.085 (0.562)           |
| Age                                   | 0.179 (0.040)** | 0.092 (0.301)       | -0.036 (0.029)**| 0.007 (0.818)  | 0.032 (0.135)            |
| Education level                       | -0.012 (0.138)  | 0.013 (0.687)       | -0.005 (0.438)  | 0.031 (0.019)** | 0.173 (0.001)**          |
| Farm size                             | -0.072 (0.386)  | 0.131 (0.217)       | -0.039 (0.240)  | 0.587 (0.503)  | -0.012 (0.988)           |
| Family size                           | 0.094 (0.272)   | -0.360 (0.568)      | 0.001 (0.071)*  | -0.025 (0.240) | -0.193 (0.453)           |
| Farming experience                    | 0.481 (0.057)*  | 0.063 (0.179)       | 0.054 (0.196)   | 0.257 (0.043)**| 0.022 (0.014)**          |
| Storage & transport infrastructure    | -0.035 (0.689)  | 0.047 (0.259)       | 0.018 (0.946)   | 0.466 (0.005)**| 0.034 (0.257)            |
| Membership in farmers organization    | 0.049 (0.088)*  | 0.193 (0.019)**     | 0.135 (0.034)** | 0.015 (0.001)**| -0.016 (0.194)           |
| Off-farm income                       | 0.101 (0.154)   | -0.129 (0.814)      | -0.004 (0.303)  | 0.171 (0.069)*  | -0.023 (0.111)           |
| Market distance                       | -0.122 (0.253)  | 0.005 (0.328)       | -0.032 (0.257)  | 0.141 (0.035)**| 0.078 (0.203)            |
| Degree of technological intensity     | 0.339 (0.056)*  | 0.147 (0.393)       | 0.039 (0.170)   | 0.056 (0.310)  | 0.432 (0.002)**          |
| Risk aversion behaviors               | 0.082 (0.003)** | 0.172 (0.001)**     | 0.044 (0.305)   | 0.959 (0.237)  | -0.031 (0.476)           |
| Access to extension services          | 0.031 (0.001)** | 0.105 (0.021)**     | 0.359 (0.156)   | 0.294 (0.451)  | 0.063 (0.008)**          |
| Access to credit                      | 0.165 (0.225)   | -0.045 (0.032)**    | 0.327 (0.003)** | -0.031 (0.697) | 0.326 (0.577)            |
| Access to market information          | 0.058 (0.936)   | 0.339 (0.171)       | -0.057 (0.254)  | 0.279 (0.001)**| 0.105 (0.165)            |
| Farm income                           | 0.032 (0.048)** | 0.082 (0.165)       | 0.093 (0.007)** | -0.192 (0.244) | 0.058 (0.232)            |
| Pseudo R²                             | 0.652           | 0.294               | 0.383           | 0.451          | 0.237                     |
| F-statistics                          | 61.43***        | 20.72***            | 26.44***        | 37.31***       | 12.54***                 |
| Number of observation                 | 205             | 205                 | 205             | 205            | 205                       |

Source: Field Survey (2019)
Notes: *, **, *** Statistically significant at 10, 5, and 1 per cent, respectively. Probability values in parenthesis
3.2.2.2. Hedging strategies. Apart from the spot market strategies, the study also wanted to know if rice farmers use any of the hedging strategies (forward contracts or agricultural futures markets). Only 12.2 percent of interviewed farmers used short term forward contracts with established buyers for the marketing of their products. This suggests that the use of price hedging strategies in Tanzania is still under development and is not popular among smallholder farmers. The few farmers who use short-term forward contracts in marketing are those who have long experience in the field, produce on a large scale, and well connected, in addition to having a higher level of education. It was also noted that many farmers enter into informal contracts with buyers to sell products at fixed prices to pay for loans taken out during the farming season.

Apart from the above, the study also identified that most of the Tanzanian farmers are not aware about the existence of Tanzania Mercantile Exchange PLC, this is because the process its implementation is still ongoing, since it was established in 2014. In this process, it is essential to emphasize the actors' importance to create mechanisms to disseminate information and education on the benefit of using commodity exchange markets for farmers and other actors in the supply chain.

3.3. Factors affecting utilization of risk management strategies by rice farmers

Table 4 presents the results obtained from the estimation of the Probit model. Of the fifteen explanatory variables used in the model, market network strategy was perceived as more important by farmers who have access to off-farm income, market information, and storage facilities; have farming experience; who are member of farmer organisations; and their farms are far from the markets. On the other hand, it was found that elder farmers were less involved in the off-farm strategy. However, due to past experiences, older farmers with farming experiences are more likely to use diversification to minimize the possible effects of price fluctuations in future.

The study also found that the larger the scale of production and hence the income of the farmers, the greater the likelihood of using certain price risk protection mechanisms. For example, the higher the household income, the more likely it is to diversify or invest off-farm. This means that, higher income farmers have a lower propensity to financial risk, they do not need to resort to third-party resources to finance their farming activities. Therefore they do not obligated to sell immediately after harvest due to cash needs. In contrast, farmers who had access to credit and exhibited risk-averse behaviours perceived the “financial management strategy” as relevant than farmers who did not have access to credit and exhibited low-risk behaviour. These results are similar to those obtained by Makus et al. (1990), Carrer et al. (2019), and Sirisupluxana and Bunyasiri (2018).

Concerning the variable membership in farmers’ organizations, the results obtained was contrary to expected. As seen in most of the articles on the subject, it is expected that a producer who already in farmers’ organizations will use collective interventions to ensure risk protection “management and optimization strategy”. However, the results pointed to an inverse relationship. The situation can be explained by the fact that Tanzania experienced a period of restructuring farmers’ cooperatives, whereby in the past, the cooperatives were strong as the government was using them to facilitate the allocation of agricultural credit, supplying machinery and the purchase of farmers produce. But because of the failure experience in most of the cooperatives, currently, even if the farmer is linked to an association, he/she prefers to do several activities, such as marketing at farm gate, local markets or agricultural fairs, because he/she considers the process of affiliation to the association as bureaucratic and not economically viable.

Furthermore, the education level of rice farmers, access to extension services, farming experience and degree of technological intensity (measured by the adoption of improved varieties and mechanization) had a significant and positive influence on the utilization of “management and optimization” strategy. It can be understood that the level of education plays a vital role in the life of farmers regarding the interpretation of information inherent in production and marketing.
Thus, with an increase in the level of education, it would be possible for farmers to choose a better marketing channel, to be able to negotiate higher prices and better contractual terms. Besides, the higher the technology intensity, the more it helps farmers to optimize the use of resources and therefore less impacted by price risks. These results are in line with those of Velandia et al. (2009), Pochara (2012), Tarekegn et al. (2017), and Asravor (2018).

Finally, access to marketing information was also related to the probability of adopting price risk protection mechanisms, as shown by the positive and significant parameter of variable ‘market information’. Household marketing decisions are based on price, supply, and demand information. Access to these pieces of information influences bargaining skills, sales volume, and selling prices. Poorly informed farmers may not be able to adopt risk protection mechanisms, leading to inefficient production and marketing decisions. The findings are in line with Kisoka-Lwayo and Ajuruchkwu (2012), Achandi and Mujawamariya (2016), Capitani and Mattos (2017), and Asravor (2018), who argued that uninformed farmer is willing to accept whichever price is offered by the buyer who comes to the village. Furthermore, access to warehousing facilities helps farmers manage price risk by storing and selling during periods when prices are reasonably higher.

4. Conclusions and recommendations
This study aimed to examine price risk perceptions and identify the factors that lead rice farmers in Mbeya region to adopt price risk management strategies. According to the findings, rice farmers in Tanzania consider seasonal changes in demand, unexpected variability in yield and input prices, inadequate storage facilities, and lack of market information as main price risk sources. Furthermore, the findings show that many rice farmers in Tanzania do not use price risk management strategies in marketing. Most of the time, the farmers’ objective is to sell all the products in a single time to avoid the storage as most of them do not have the ideal conditions to store the product for subsequent sale. One of the strategies used to manage price risks was to create bonds of friendship with individual buyers through mutual trust generated overtime in the marketing process. Other strategies were; spreading sales over several periods, storing farm produce until the prices are higher, collective storage and marketing, cultivating different varieties, obtaining market information before deciding to sell, selecting varieties with low price variability, cost control, contractual relationship with buyers, and diversifying sources of income.

On the other hand, the use of agricultural commodity exchange as a price risk management strategy has not been realised and is little known to rice farmers despite the existence of the Tanzania Mercantile Exchange PLC. Short-term forward agreements were the only strategies used by farmers to market rice as a form of price hedging strategy. In most cases, rice farmers have entered into formal and informal sales agreements with suppliers of credit inputs, millers, and large-scale trading companies.

Empirical results suggested that farmers with higher production revenues, higher technology intensity in the production system, higher education level, alternative sources of income, access to market information, and storage facilities were more likely to adopt price risk protection mechanisms. In this regard, we recommend empowering farmers by creating policy and legal frameworks that improve their ability to manage price risks. Some of the policy measures to achieve these outcomes include promoting the use of commodity exchange through warehouse receipt system, improving market information systems, supporting the construction of storage facilities, improving access to credit for farmers, training farmers in entrepreneurship, business management, and marketing. Governments can also put in place a social safety net program (price guarantee schemes) to help farmers cope with income losses resulting from catastrophic events or major market disruptions.

Finally, it is noteworthy that this study presents an innovative concept for this product segment. Despite the importance of price risk management in the agricultural sector and the observed
fluctuations in rice prices in Tanzania, no other study was found to identify farmers’ behavior regarding the price risks inherent in their activities and factors influencing the adoption of price risk management strategies for Tanzanian rice farmers.

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Disclosure statement
The authors declare that they have no competing interests.

Declarations
Ethics approval and consent to participate
• All the ethical procedure was followed during data collection, analysis, and presentation

Availability of data and materials
• The data that support the findings of this study are available from the corresponding author upon reasonable request.

Authors’ contributions
• This work was carried out in collaboration with all authors. Author YJM designed the study, wrote the protocol, performed the survey and managed literature, performed the statistical analysis, and wrote the first draft of the manuscript. Author YY verified the analytical methods and supervised precisely the whole work. All authors read and approved the final manuscript.

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