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THE ROLE OF TRADITIONAL FARM RISK MANAGEMENT STRATEGIES ON REDUCING CREDIT RISK IN TANZANIA AGRICULTURAL LENDING

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Abstract: *Agricultural financing enhances food security, job creation, a transition from subsistence to commercial farming, and strengthens the overall economy. However, due to unfavorable weather and market conditions there is limited financing directed towards agriculture especially in developing countries. Despite smallholder farmers' high adoption rate of tradition risk management strategies to minimizing these risks, little has been done to examine its moderating role on the relationship between agricultural risks and credit risk. This study examines the role of farm business risk management strategies on minimizing the influences of production and market risk on smallholder farmers loan repayment capacity. The quantitative study used pooled cross-sectional data from a Tanzanian commercial bank from 2019 to 2021, covering 1,277 farmers from different administrative regions. Using binary interaction effect logistic regression analysis model, the study's results indicate that irrigation, mechanization, and off-farm diversification significantly minimizes the effects of production and market risk amongst smallholder farmers in Tanzania, an indication that traditional risk management strategies are effective tools amongst smallholder farmers. On the contrary, on-farm diversification strengthens the influence of production and markets risk on loan repayment amongst the smallholder farmers in Tanzania, the results that can be influenced by a number of factors, including poor diversification knowledge among smallholder farmers. In light of these findings, the study recommends that policymakers and other development partners to develop agricultural infrastructure and provide more extension agents that can educate smallholder farmers on the best practices on traditional risk management strategies.*

Keywords: *credit risk, traditional risk management, smallholder farmers*
(JEL code: Q14)

INTRODUCTION

Around 1.2 billion people globally live in poverty, with roughly 75% residing in rural areas and dependent on farming for their livelihoods. In recognition of this challenge, boosting agricultural investment in developing countries is a central pillar of the new Sustainable Development Goals (SDGs) (Soria et al., 2019). By 2050, the industry will require at least US$80 billion annually (Chepwambok et al., 2021; World Bank, 2019). This snapshot reflects that agriculture's future is tied to significant investment. However, a major hurdle exists: unfavorable weather and market conditions, identified by rural households in low-income countries as critical threats to productivity, income and overall resilience. In response to these challenges, there is limited financing directed towards agriculture.

Agricultural sector is dominated by the smallholder farmers with the estimation that they hold 75% of agricultural land and contribute at least 80% of the world's food production (Adamopoulos & Restuccia, 2014). In the context of Tanzania, the situation is not different where by Tanzania sample census of agriculture 2019/20 indicates that most of the Tanzanians engaged in Agriculture are smallholder farmers who grow a wide variety of annual and perennial crops, cash crops and a wide variety of fruits and vegetables. According to the report, smallholder farmers have a strong dominance in all the categories of crops (URT, 2021).

Smallholder farmers in developing countries are vulnerable to production risks and market risks (Ali et al., 2020), however, the majority lack access to institutional risk management tools such as crop insurance, and thereby rely on traditional measures (Birthal et al., 2021). Despite efforts to encourage adoption of agricultural insurance to mitigate production risks, studies still indicate there is poor adoption. Factors such as liquidity constraints, discount rates, basis risk,

and trust issues contribute to the low demand for insurance among smallholder farmers (Ali et al., 2020).

A study by Knapp et al. (2021), enlightens on the role of traditional risk management strategies on mitigating the effects of productions and market risks and they find both substitutive and complementary relationship of the use of these strategies especially in Europe. Scholars have documented a wide use of traditional risk management by smallholder farmers ranging from on-farm diversification, irrigation, off-farm diversification, and mechanization, indicating their significance on improving farm yield (Birthal et al., 2021; Chigunhah et al., 2020; de Roest et al., 2018; Jena & Tanti, 2023). Limited by the shortcomings of individual traditional strategies separately, which often cover a narrow range of risks, risk-averse smallholder farmers typically adopt a portfolio of strategies to address the diverse threats they face (Akhtar et al., 2021).

Given the multiple adoption of traditional risk management strategies by smallholder farmers, it is to the knowledge of the researcher that little is known on the influence of the traditional risk management strategies on buffering farm business production and marketing risks influence on the repayment capacity of a smallholder farmer. Therefore, the aim of this study is to examine the influence of the traditional risk management strategies (irrigation, on-farm diversification, off-farm diversification and mechanization) on production risks and market risks association with farmer's repayment capacity.

MATERIALS AND METHODS

The study is based on a database from a Tanzanian commercial bank of smallholder farmers who obtained loans in years 2019, 2020, and 2021. The study utilized pooled cross-sectional data and a farmer as a unit of analysis. The commercial bank categorised farmers into two major groups: farmers who have repaid their loans and the farmers who have defaulted their loans. The commercial bank uses the BCBS definition on default event which states that for risk-weighting purposes under the standardized approach, the default exposure is defined as one that is past due for more than 90 days (BCBS, 2017). Other essential data for the study are temperature and rainfall (sourced from the Tanzania Meteorological Agency - TMA), information on diseases/pests and policy (obtained from the Ministry of Agriculture), and price volatility (sourced from the Ministry of Industry and Trade). Given the volatility of the macroeconomic variables during the study period and the collinearity among the macroeconomic variables, the study used regional GDP growth rate (obtained from the Bank of Tanzania - BoT) as the macroeconomic indicator.

Analysis model

Given that the dependent variable in this study can only assume values of either 0 or 1, it adheres to the Bernoulli distribution.

$$f(y_i|x_i) = P_i^{y_i}(1-P_i)^{1-y_i} \quad \ldots\ldots 1$$

Where y={0,1}, the P= probability function

Both Non-linear Least Squares (NLS) and Maximum Likelihood (ML) models are proficient in estimating binary models. The prevalent approach involves Maximum Likelihood, wherein the parameters are determined to maximise the log-likelihood function.

$$Log\ L(x_i;\theta) = \sum_{i=1}^{N}\big((Y_i\ LogP_i + (1-Y_i)Log(1-P_i)\big) \quad \ldots\ldots 2$$

Given the specific nature of the study, where loan data exhibit a distribution with a considerably fatter tail compared to the normal distribution, the application of the probit model is hindered due to its reliance on normally distributed data. The independent variables include farm business risks, macroeconomic factors, and the risk management strategies adopted by the farmer. Additionally, various socio-economic control variables related to the farmer, as documented by different scholars, were incorporated into the model, as they are known to influence and control the relationship of the stated variables above.

The logit model was applied in this study, utilising a dummy dependent variable representing the loan repayment capacity.

$$Prob(x) = \frac{e^{x'\beta}}{1+e^{x'\beta}} = \Lambda(x'\beta) \quad \ldots\ldots 3$$

$\Lambda(.)$ indicates the logistic cumulative distribution

The estimation model is formulated based on the maximum likelihood function for estimating binary models, as presented below.

$$Log\ L(x_i;\theta) = \sum_{i=1}^{N}\big((Y_i\ log\ P_i + (1-Y_i)Log\ (1-P_i)\ )\big) \quad \ldots\ldots 4$$

But $P_i = F(x_i'\beta)$ 5

$$P_i = F(\beta_0 + \beta_a A_t + \beta_b B_{it} + \beta_c C_{it} + \varepsilon_i) \quad \ldots\ldots 6$$

$$Log\ L(x_i;\theta) = \sum_{i=1}^{N}\big((Y_i\ LogF(x_i'\beta) + (1-Y_i)Log(1-F(x_i'\beta))\big) \quad \ldots\ldots 7$$

Where $P_i = Probability\ of\ loan\ repayment;$

Y_i : *Loan repayment capacity*

Moreover, F(.) is the cumulative density function.

Where:

$\beta_a, \beta_b\ and\ \beta_c$ are coefficients of independent variables,

A_t are farm idiosyncratic variables

B_{it} are production and market variables

C_{it} It is a macroeconomic variable (GDP)

The study utilises interaction effect logistic regression to examine the moderating influence of various conventional farm risk management strategies adopted by farmers in addressing both production and market risks on their repayment capacity. In logistic regression with predictors X_1 and X_2, an interaction model is defined by interpreting the effect of variable X_1 contingent on the value of variable X_2 and vice versa. The fundamental interaction effect model involves a predictor variable obtained by multiplying the two regular predictors. The estimation model is derived from the maximum likelihood function for estimating binary models, as depicted in equations 4, 5,

and 7. Equation seven is subsequently adjusted to encompass the interaction effect.

$$P_i = F(\beta_0 + \beta_a A_t + \beta_b B_{it} + \beta_c C_{it} + \beta_d X_1 X_2 + \varepsilon_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{8}$$

Where:

X_1X_2 is the interaction term.

Therefore, the study utilised interaction effect logistic regression to explore whether a substantial difference exists in the effect of market variables on the repayment capacity between farmers involved in post-harvest processing and those who are not. Furthermore, the study applied an interaction effect logistic regression model to evaluate the influence of traditional farm business risk management strategies on the repayment capacity of farmers facing production and market risks.

Table 1. Measurement of variables

	Independent variable	
1	Loan Repayment Status	Binary variable denoting whether the farmer successfully repaid a term loan. (1 = Loan repaid, 0 = Default)
	Control variables (Idiosyncratic factors of the farmer)	
2	Gender	The Binary variable indicates female and male ownership, with male ownership as the reference group.
3	Age	Number of years
4	Farm Size	The number of acres owned by a farmer
5	Farmer's experience	The number of years in cultivating a specific crop.
6	Family size	Number of individuals living in the farm household.
	Farm business risks	
7	PVOL (Price Volatility)	The annual coefficient of variation is obtained from the monthly average price of a specific crop in the region where a farmer cultivated the crop. Adopted from the studies by Kobzar et al., 2004; Huchet-bourdon, 2011). $CV = \frac{\sigma}{\bar{X}}$ CV = Coefficient of variation σ = Standard deviation
8	RAINVOL (Rain variability)	The annual standard deviation of the monthly average rainfall in millimetres for the district where a farmer cultivated the crop. Adopted from the studies by (Mwaura and Okoboi, 2014; Harkness et al., 2023). $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(P_i - \bar{P})^2}$ σ = Standard deviation N = Number of months P_i = Average rainfall in the ith month. $\bar{P}$ = Mean rainfall in a given year

9	TEMPVOL (Temperature variability)	The annual standard deviation of the monthly average temperature in degrees Celsius for the district where a farmer cultivated the crop. Adopted from the study by (Mwaura and Okoboi, 2014; Harkness et al., 2023) $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(P_i - \bar{P})^2}$ σ = Standard deviation N = Number of months P_i = Average temperature in the ith month. $\bar{P}$ = Mean temperature in a given year
10	Diseases	Binary variable indicating the occurrence of acute diseases or pests affecting the crop for which the farmer secured a loan in a particular district during a specific year. The occurrence of diseases/pests is set as a reference.
11	Policy	Binary variable indicating the imposition of an export ban on the crop for which the farmer secured a loan during a specific year. The presence of an export ban is a reference.
	Macroeconomic variable	
12	ln_GDPR	Natural logarithm of Gross Domestic Product Growth Rate in the region where a farmer cultivated the crop.
	Risk management strategies	
13	Post-harvest processing	Binary variable indicating whether the farmer engages in post-harvest crop value addition. Post-harvest processing serves as a reference.
14	Irrigation	Binary variable indicating whether the farmer is practising irrigation. Irrigation sets as a reference.
15	Mechanisation	Binary variable indicating whether the farmer does not use a hand hoe as a major tool in agricultural activities. Mechanical tools other than the hand hoe sets are used as a reference group.
16	On-farm diversification	Binary variable indicating whether the farm engages in mixed farming or not. Farmers engaging in mixed farming serve as a reference group.
17	Off-farm income	The Binary variable indicates whether the farm engages in other income-generating. Farmers engaging in other income-generating activities are set as a reference group.

Source:Authors Review of Literature

RESULT AND DISCUSSION

Descriptive statistics

Mechanisation and repayment status

This study employed the degree of mechanisation of agricultural tools in the production process to measure a smallholder farmer's mechanisation level. Table 3.1 (below) reveals that smallholder farmers who employed hand hoes successfully repaid 70.14 per cent of agricultural loans. In comparison, 97.06 per cent of agricultural loans were repaid by smallholder farmers utilising mechanised agricultural production tools. This suggests a positive association between the level of mechanisation and loan repayment. Mechanisation, in addition to increasing efficiency, can serve as a risk management tool owing to various benefits, including timely farm preparation and planting, improved handling of produce during harvesting, enhanced quality, and consequently better market prices.

Table 2. Challenges Faced by CBOs in Rural Development

Loan Repayment Status	Mechanisation		
	Hand Hoe	Mechanised	**Total**
Default	229	15	**244**
	29.86%	2.94%	**19.11%**
Loan Repaid	538	495	**1033**
	70.14%	**97.06%**	**80.89%**
Total	767	510	**1277**

Source:Commercial Bank Data (2022)

Irrigation and repayment status

The descriptive findings highlight that 82.20 per cent of smallholder farmers engaged in irrigation farming successfully repaid their loans, compared to 79.77 per cent of those who did not practice irrigation farming, as illustrated in Table 3.2. Although the two groups differ relatively slightly, irrigating smallholder farmers still exhibit a higher repayment rate than their counterparts. This marginal distinction indicates the positive association between irrigation and loan repayment. Irrigation is crucial in optimising yields, particularly in mitigating the impact of unfavourable weather conditions, including erratic rainfall and temperature variations that can affect precipitation levels in an area. This descriptive insight aligns with the perspectives of other scholars, including (Terry and Ogg, 2017; Birthal et al., 2021; Koide et al., 2021; Vo et al., 2021), emphasising the significance of irrigation in agricultural practices.

Table 3. Irrigation and Repayment Status

Loan Repayment Status	Use of an irrigation system or not		
	No irrigation	Irrigation	**Total**
Default	139	105	**244**
	20.23%	17.80%	**19.11%**
Loan Repaid	548	485	**1033**
	79.77%	**82.20%**	**80.89%**
Total	687	590	**1277**

Source:Commercial Bank Data (2022)

On-farm diversification and repayment status

In Table 3.3, 79.22 per cent of smallholder farmers practising mixed farming successfully repaid their loans, contrasting with the 86.33 per cent repayment rate among smallholder farmers who did not engage in mixed farming. The results indicate that, despite the benefits of mixed farming, which include the potential to stabilise income by addressing various production and marketing risks, smallholder farmers practising mono-cropping have a better repayment rate than smallholder farmers who practice mixed farming. The results display the superiority of economies of scale over the economies of scope philosophies.

Table 4. On-farm Diversification and Repayment Status

Repayment Status	**On-farm diversification**		
	No On-Farm diversification	On Farm diversification	**Total**
Default	41	203	**244**
	13.67%	20.78%	**19.11%**
Loan Repaid	259	774	**1033**
	86.33%	**79.22%**	
Total	300	977	**1277**

Source:Commercial Bank Data (2022)

Off-farm diversification and repayment status

The descriptive findings of this study reveal that 93.57 per cent of smallholder farmers who secured loans from banks and had additional sources of income beyond agriculture successfully repaid their loans. In contrast, only 68.85 per cent of smallholder farmers relying solely on agricultural projects could repay their loans, as displayed in Table 3.4. As anticipated, having multiple income sources implies diversifying investments beyond agricultural production. This approach enables smallholder farmers to establish income streams that correlate negatively with the agricultural sector. Consequently, the failure of the agricultural sector may not impact the alternative income sources in the same manner, contributing to the over-

all stability of a smallholder farmer's income. This ability to diversify income sources is reflected in a smallholder farmer's capacity to meet debt obligations even when the agricultural sector underperforms. Aligning with the principle emphasised by Markowitz (1952) that rational investors seek to minimise risk, smallholder farmers are expected to develop additional investment options that collectively reduce overall risk. Not all production periods and farm activities occupy the smallholder farmer's time, so farmers can enhance productivity by engaging in other non-farm economic activities.

Table 5. Off-farm Diversification and Repayment Status

Repayment Status	Off-farm diversification		
	No Off-farm diversification	Off-farm diversification	Total
Default	204	40	244
	31.15%	6.43%	19.11%
Loan Repaid	451	582	1033
	68.85%	93.57%	80.89%
Total	655	622	1277

Source:Commercial Bank Data (2022)

Influence of Traditional Risk Management Strategies on Reducing Loan Repayment Risk

Risk management is an important aspect of any business, given the inherent nature of the impossibility of forecasting future income with certainty. Different strategies can be adopted to mitigate, transfer, accept or minimise the risk related to a business. Given the setting and nature of the agricultural business projects, especially those owned by smallholder farmers, the adoption of risk management strategies is primarily traditional as opposed to modern strategies such as insurance. Thus, the following sections examine the association between traditional risk management strategies that smallholder farmers adopt and the risks they face in their business projects.

Influence of irrigation on reducing production risks

The interactive logistic regression model results, showcased in Table 3.5, indicate that irrigation weakens the association between price volatility and repayment status. However, the relationship is not significant. This result implies that irrigation minimises the influence of price volatility risk on reducing the likelihood of smallholder farmers' loan repayment capacity. The result supports that irrigation improves the crop yield of a smallholder farmer in both quantity and quality. The improvements can create a competitive advantage for a smallholder farmer. The advantages come with the ability of smallholder farmers to offer superior produce in the market and supply the produce when the supply is low because of their ability to produce throughout the year. Given all these factors, a smallholder gets the advantage of fetching a better price in the market and an improved position on loan repayment.

Further, the results indicate that irrigation significantly weakens the association between rainfall variability risk and repayment status ($p<0.05$). These results indicate that irrigation weakens the ability of rainfall variability to lower the likelihood of the loan repayment capacity of the smallholder farmer. This condition means irrigation supplements the production process when the weather is not conducive to water supply from rainfall. It allows the farmer to have more production cycles in the year. Further, it enables the farmer to evade the pig cycle, a phenomenon whereby a farmer falls victim to producing in large quantities when every farmer is producing, which leads to a loss of the power to control the supply. According to Birthal et al. (2021) Irrigation can enhance crop yields and offer protection against severe climatic shocks, including droughts, thus shielding farm income variability across production periods. Further, according to Koide et al. (2021), irrigation can improve weed control and increase yield, doubling the profitability. Similarly, irrigation weakens the association between temperature variability risk and repayment status. However, the relationship is not significant. The results indicate that irrigation can lower temperature variability risk and reduce the likelihood of a smallholder farmer's repayment status. Irrigation can also regulate the soil temperature and improve the soil condition for the belowground biodiversity of numerous taxa at the field scale, thus improving ecological functioning.

Influence of mechanisation on reducing farm business risks

The results of the interaction logistic model, as presented in Table 3.5 above, indicate that mechanisation weakens the association between temperature variability risk and loan repayment status ($p<0.1$). These results suggest that mechanisation minimises the influence of temperature variability risk on reducing the likelihood of smallholder farmers' loan repayment capacity. Given its ability to plough deep and turn the soil upside down, mechanisation improves soil aeration, a crucial aspect of soil ecology. Improved soil ecology recovers soil fertility, which improves farmers' productivity and sustainability. Generally, mechanisation can enhance crop yield quality through proper handling pre- and post-harvesting. These findings are supported by other scholars, such as Van den Berg et al. (2007), Sanaullah et al. (2021) Mingzi et al. (2022), and Jena and Tanti (2023).

The results suggest that mechanisation strengthens the association between price volatility and loan repayment capacity. However, the relationships were not significant. This means that mechanisation enhances the ability of price volatility risk to reduce the likelihood of loan repayment, thereby weakening their loan repayment capacity. Given the nature of smallholder farm size, attaining economies of scale, given that the small average farm size is poor, leads to inefficient use of mechanical tools. As the average farm size of a Tanzanian smallholder farm is 2.1 ha (Rapsomanikis, 2015; URT, 2021b), It is apparent that it is difficult to reap the benefits of mechanisation by attaining the economies of scale, given the level of tools invested. On the other side, Chavas et al. (2015) describe how technological changes, including mechanisation, can alter the sensitivity of aggregate farm crop supply to external shocks, influencing the variability of food prices. As Alston et al. (2012) emphasised, innovation and technological changes in agriculture profoundly affect the structure of agricultural production, markets, and trade. Technological changes can alter the size and significance of food price volatility by affecting the sensitivity of aggregate farm supply to external shocks and changing the price elasticity

of supply or demand. In essence, technological changes have the potential to influence food price variability and, consequently, the repayment capacity of farmers.

Similarly, the results indicate that mechanisation strengthens the association between pests/diseases and repayment status. Nonetheless, the relationship was not significant. The results indicate that mechanisation strengthens the likelihood of pests/ diseases reducing smallholder farmers' loan repayment status. Given that most smallholder farmers practice economies of scale, Takeshima et al. (2020) state that mechanisation can raise or lower the economies of scope (EOS) depending on the differences or similarities in agroecological conditions in the selected crop.

Table 6. Influence of traditional risk management on the association of farm business risk and repayment status

	Irrigation	Off-farm diversification	On-farm diversification	Mechanisation
Price Volatility	-3.015	0.164	-1.52	3.48
	(4.412)	(2.808)	(5.315)	(3.563)
Rainfall Variability	-0.029**	-0.007	0.047**	-0.014
	(0.012)	(0.013)	(0.022)	(0.019)
Temperature Variability	-1.074	-0.454	1.922	-2.082*
	(1.247)	(1.006)	(1.618)	(1.217)
Export ban (Policy)		-0.635	1.646	
		(1.012)	(1.514)	
Diseases/Pests		0.085	12.158	0.996
		(1.022)	(957.486)	(1.307)

Source: Commercial Bank Data Analysis Stata Results (2022)

Influence of off-farm income on reducing farm business risks

The interaction logistic regression model results, as presented in Table 3.5, suggest that off-farm income weakens the association of farm risk related to rainfall variability, temperature variability and policy related to the export ban on repayment status. The results infer that off-farm income weakens the likelihood of rainfall variability; temperature variability and policy related to export bans to reduce smallholder farmers' loan repayment capacity. As discussed earlier, farmers diversifying into non-farm-related economic activities offer several benefits. Firstly, the smallholder farmer creates the ability to efficiently use his/her time after agricultural working time, as well as the time when there is minimum agricultural work, given that the majority of smallholder farmers use rainfed farming system. Secondly, when properly executed, off-farm diversification offers a cushion on income when the agricultural projects face challenges related to rainfall variability risk, temperature variability risk and risk related to the export ban. Income raised from economic activities with a negative or zero relationship with the crop risks can be used to cover the smallholder farmers' losses and loan instalments. However, the success of the off-farm depends much on the selection of the portfolio and the nature of the association of the farm and off-farm business.

Contrary to the study expectations, off-farm income strengthens the association between price volatility and the smallholder farmers' repayment status and diseases/pests and the farmers' repayment status. However, the associations were not significant. It is imperative for farmers to carefully select off-farm income activities to ensure a negative or uncorrelated relationship with farm income. Opting for activities positively correlated with farm business can exacerbate the risks linked to price volatility, diseases, and pests.

In line with these findings, other scholars propose a nuanced relationship between off-farm income and the risks faced by farmers during production and marketing. Beck et al. (2019) observe that farm households respond to low coffee prices by increasing adult wage labour within the household. Similarly, Jin et al. (2021) suggest that smallholder rubber farmers shift family labour from farms to off-farm employment in the face of declining rubber prices. Additionally, Key et al. (2017) assert that farm income exhibits greater volatility than off-farm income. Consequently, farmers strategically diversifying their business portfolio with zero or negatively correlated business lines may effectively offset the impacts of farm business risks. In contrast with the findings, A. Ullah et al. (2018) highlight that farmers' involvement in off-farm income negatively impacts their technical efficiency, reducing overall income.

Influence of on-farm diversification on reducing farm business risks

The findings from the interaction logistic regression model, presented in Table 3.5, reveal that on-farm diversification weakens the association between price volatility and repayment status. However, the association is not significant. According to the concept of diversification elucidated by Markowitz (1952), a rational farmer, akin to a prudent investor, is anticipated to select crops that maximise returns while minimising price volatility risk to an optimal level. In a set of crops with equivalent price volatility levels, a rational farmer is expected to opt for a mix of crops that yield higher returns under the same level of price volatility risk. This strategic selection involves the selection of varieties with shorter life cycles, a mix of crops that complement each other's performance in the market, and a mixture of domestic and export market-dependent.

The study further found that on-farm diversification strengthens the association between temperature variability risk and repayment status. However, the relationship was not significant. This contradicts the study's expectation that on-farm diversification will weaken the relationship. The results can be due to smallholder farmers' limited ability to create crop portfolios that follow the principles of portfolio selection suggested by the Markowitz theory of portfolio selection. Smallholder farmers should select crops with zero or negative correlations regarding their sensitivity to temperature variability risk. If the crops selected have a positive association with temperature variability, the risk impacts will be magnified. Contrary to this study, Khan et al. (2022)Farmers who have observed significant climate changes, such as decreased precipitation and increased average temperatures, have adopted various risk management strategies, including crop diversification, despite the paucity of literature to gauge their impact.

Further, the results in Table 3.5 indicate that on-farm diversification strengthens the association between crop export bans and repayment status. However, the relationship was not significant. This suggests that farmers cultivating multiple crops are less likely to repay their loans than farmers who do not practice mixed or intercropping when facing crop export bans. This can result from a lack of proper knowledge of diversification techniques for most smallholder farmers. The success of crop diversification requires well-articulated knowledge; otherwise, the benefits may not be fully realised, as evidenced by a study conducted by Quiroz and Valdés (1995). The study found that unskilled farmers producing a few state-protected crops were adversely affected during trade policy reforms due to a lack of diversification into other crops.

Adopting innovative agricultural practices (SAP) and emphasising ecological and environmentally friendly approaches underscores the significance of on-farm diversification. On the contrary, in this study, on-farm diversification strengthens the association between diseases/pests' risks and repayment status. However, the relationship was not significant. On-farm diversification has the potential to reduce crop disease frequency and severity by minimising pathogen inoculum and creating less favourable microclimates for pathogen development. However, the principles of portfolio selection that do not complement the manifestation of diseases/pests from one crop to another crop in the portfolio are crucial. Given the poor availability of extension services among smallholder farmers in rural Africa and their poor education level, it is unlikely that smallholder farmers will create a portfolio that observes the Markowitz principles of portfolio selection, which creates an area for future evaluation.

Contrary to expectations, on-farm diversification significantly strengthens the association between rainfall variability and loan repayment ($p<0.05$). This may be attributed to many farmers practising on-farm diversification, as mentioned earlier, having limited knowledge and poor access to agricultural extension services. Forming a crop portfolio mostly depends on generational inherited habits and treads on the influence of climate change and other significant and continuously changing factors. The rainfall pattern has drastically changed, requiring innovative strategies to formulate a crop portfolio to minimise the risks associated with rainfall volatility compared to the ancient ways of creating a crop portfolio. As in corporate business, creating a business portfolio requires a knowledgeable team; the agricultural extension agents should be involved in creating a smallholder farmer's portfolio that will improve and accommodate the ever-changing environment.

CONCLUSION

This study utilized econometric analysis to assess the role of traditional risk management strategies on reduction of loan repayment risk at the farm level. The analysis involved the use of secondary data from a commercial bank. Results indicates that farmers' practicing irrigation, mechanization, and off-farm diversification are more likely to pay their loans while facing production and market risks. However, farmers practicing irrigation are more likely to minimize risk related to rainfall variability, temperature variability, and price volatility. On the other hand, farmers practicing mechanization are more likely are more likely to minimize risks related to temperature variability and rainfall variability, although the later relationship was not significant. Further, smallholder farmers who practice off-farm diversification minimizes the risk related to rainfall variability, temperature variability and export ban, however the influence was not significant. Lastly the study indicated that on-farm diversification does not have a significant influence on minimizing the influence of production and market risks amongst the smallholder.

In light of these findings, the study recommends that policymakers to improve and develop, irrigation systems, improve the availability and affordability of farm machinery and technology as well as the availability of extension agents.

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