Managing risks for operational efficiency of smallholder farmers: a pathway for resilience and sustainable agro-food system in Nigeria

By

Sunday S. Akpan[1]* and Mfon N. U. Akpan[2]
[1*2]Department of Insurance and Risk Management, University of Uyo, Uyo
Correspondence: sundaysakpan@uniuyo.edu.ng
+2348032196839

Abstract

The reality that risk is present in every operation involving humans across the world necessitates a rethink on how smallholder farmers can be strengthened for resiliency and sustainability of agro-food system in Nigeria without appropriate risk management. No doubt, farming is risky; smallholder farmers live with risk and make decisions affecting their operations daily. As they may find it difficult to access formal indemnity-based risk management options, there is need to explore alternatives strategies for managing these risks. This study is thus conducted to investigate the risks in smallholder farming and appropriate management strategies for use by smallholder farmers in Nigeria. A qualitative research approach was adopted using systematic literature review (SLR) technique. We followed Cervantes-Godoy, Kimura and Antón's smallholder risk management model. Findings revealed that risks affecting smallholder farmers globally do not differ as they come basically from non-agricultural events (e.g., health problem); shocks in production, market, institutional, personal, financial and legal operations none of which are exclusive to any particular country, Nigeria inclusive. A number of risk management (Ex ante) and risk coping (Ex post) instruments and strategies considered to be effective and efficient were found to include among others, crop and plot diversification, inter-cropping practices, family-intra-community charity, liquid asset (crop) and buffer stock, avoidance, social network, diversification (both on-and off-the-farm), agricultural credit, contract farming, and most interesting index-insurance services. We have proposed a risk management matrix for smallholder farmers to use in selecting the most appropriate strategy for handling risk in their business.

Key words: Risks, Risk management, insurance, index-insurance, Smallholder farmer, agro-food system

Department of Insurance and Risk Management, University of Uyo, Uyo
Corresponding Author: sundaysakpan@uniuyo.edu.ng

Introduction

You are at risk if there is a possibility of harm or loss to you, your family, your employees, or your property. Weather, pricing, government rules, accidents, and disease are all examples of risk factors that might have an impact on your farm's operations. Risk is defined as something that can create a loss for your farm or an issue for you or your workers; or something that can prevent you from reaching your goals. Farming is always fraught with risk. Every day, farmers make decisions that influence their operations. Many of the elements that influence their judgments cannot be foreseen with 100% precision; this is risk. Kahan (2008) cited a number of cases that depict risk faced by farmers in managing their farm as a business. Such cases are weather conditions change; prices at the time of harvest could drop; hired labour may not be available at peak times; machinery and equipment could break down when most needed; draught animals might die; and government policy can change overnight. These risks are ubiquitous and they also affect smallholder farmers. While farmers have always faced risk, farming has grown increasingly risky as a result of market liberalization and globalization.

Smallholder farmers are particularly susceptible. Even for home food consumption, a casual approach to farming is no longer practical. Farmers must improve their professional abilities not just in fundamental production but also in farm business management. Risk management abilities are among these. Skilled farmers and other business people generally avoid risky situations unless there is a chance of profit. Larger earnings are typically associated with higher risks. These risky but possibly rewarding circumstances must be handled with extreme caution. Good risk management is identifying possible problems and working to mitigate their negative consequences. It is not sufficient to just respond to unfavorable occurrences after they occur; this is not appropriate risk management. Farmers must create more profit and become more competitive in order to succeed. They must comprehend the farming environment and be proficient at-risk management. Better agricultural prospects emerge as a result of more effective risk management.

There can be little doubt that farming has become riskier as farmers have become more commercial. According to Hardaker, Lien, Anderson, and Huirne (2015), risk is prevalent and complicated in farming, particularly in agricultural production. Regardless of the scale, farming

operations are characterized by a wide range of yields, volatile output and input prices, and rapid changes in farming technology. These factors influence the variation in profitability of a farm from season to season and from year to year (Dunn, 2002). Risk sources and severity levels might vary depending on agricultural methods, geographic location, meteorological conditions, supportive government policies, and farm type. Risk is a serious problem in developing nations, since farmers have little knowledge to foresee factors such as farm input costs, output pricing, and weather conditions that may affect farms in the future (Nyikal & Kosura, 2005; Pannell, Malcolm & Kingwell, 2000) The types and intensity of dangers that farmers confront vary by location. Incorporating and comprehending the consequences of risk at the farm level will aid policymakers in developing suitable solutions to assist farmers in surviving the multiple hazards they face (Aditto, Gan, & Nartea, 2012).

In retrospect, smallholder farmers must understand risk and have risk management abilities in order to effectively foresee issues and mitigate their effect. It may be true that without addressing the inherent risks in smallholder farming, achieving resilience and a sustainable agro-food system in Nigeria would be difficult, if not impossible. Although, there are myriads of literature in risk management in agriculture as a whole, and particularly in smallholder farming, it appears unclear if smallholder farmers have an adequate grasp of the inherent risks in their operations, as well as what acceptable risk management solutions are available for smallholder farmers to use. A systematic review and synthesis of these literature to bring to one-fold risks that are peculiar to smallholder farming and measures that can be applied to manage the risks is considered necessary based on the need for a comprehensive knowledge and ease of accessibility of such knowledge for application. This paper therefore is an attempt to identify the various risks inherent in smallholder farming and how to mitigate them. Specific objectives of the study are to:

i. Identify all possible risks in smallholder farming;
ii. Identify all possible risk management options available for smallholder farmers;
iii. Develop and proposed a risk management matrix or framework for smallholder farmers.

2.0 Literature review

2.1 An overview of Smallholder farming

Smallholder farmers face a range of shocks and challenges beyond their control that can have a drastic impact on their incomes and livelihoods. These include unexpected non-agricultural events, such as health problems, and agricultural events, such as market and price fluctuations or pest and disease infestations. Climate change is a key driver behind agricultural shocks. More frequent extreme weather events and an increase in the incidence of pests and diseases are increasing financial losses for farmers in developing countries. As of 2016 for instance, the CGAP (2016, cited in GSMA, 2020), within the "Afro-Asia" region, statistics shows that 61%, 31%, and 72% of crops were destroyed by weather while 32%, 26%, and 38% of the crops were destroyed by pests at least once in the past five years in places like Mozambique, Pakistan and Tanzania respectively. Statistics further show that these types of shocks and risks cannot be properly managed by formal insurance since such mechanism covers only 3% of smallholder farmers in Sub-Saharan Africa compared to 33% in developed climes like Latin America and 22% of Asian smallholder farmers.

Globally, it is reported that "Insurance services in developing countries can struggle to offer safety nets for such shocks. Globally, less than 20 per cent of smallholder farmers have any form of agricultural insurance, and across Sub-Saharan Africa, this figure is less than three per cent" (GSMA, 2020 p.5). Alluding to this fact, Smallholder farmers, like every other business person in the informal sector, often times seems to think that their risks can only be managed by an insurance mechanism. And since they hardly can afford the associated cost of insurance, they shy away and give risk management a lip service. Lest they forgot, there are many options available for them to manage risk in smallholder farming to ensure efficient and sustainable operation.

2.2 Risk management in Smallholder farming

Risk management is an important aspect of life in general yet it is often given the back space in discussions and deliberations by scholars and policy makers. In the opinion of Kahan (2008), the primary activity for management of every entity including smallholder farm management is decision-making. Farmers must make decisions early in the cropping season about which crops to sow and what seeding rates and fertilizer amounts to employ. For perennial crops and cattle, yields

and prices will not be known for several months, if not years. Farmers are rarely assured of the consequence of their actions. This is most often the case when the decision is straightforward and there is only one possible consequence. For instance, if farmers opt to take out short-term loans, they are aware of the consequences: banks would charge them interest at a predetermined rate. Farmers in this scenario are fully aware of the implications of their actions.

However, in the majority of cases, the outcome of a decision cannot be anticipated since there are several alternative outcomes. Farmers frequently discover that their decisions are less than flawless as a result of changes that occur between the time the decision is made and the time the decision's outcome is completed. It is possible that the outcomes are contingent on the actions of others and on future circumstances beyond the farmer's control. Farmers must have the required knowledge to make informed decisions on many aspects of their farming operations: Prices of inputs, outputs, and yields, as well as other technical information area necessity. Farmers frequently have an intuitive sense of how their crops will perform in dry, ordinary, and rainy seasons. Some may keep a formal record of the yearly rainfall in the area surrounding their farm, while others may rely on their memory and observe the pattern over time. Before deciding on a farming schedule for the season, some farmers may have an intuition about the chances of a dry or rainy year. Often, farmers consider the prospective ramifications of their decision to plant and develop their crops before making their decision.

Occasionally, the risk is so negligible that it is overlooked. This is especially true when a long history of a consistent link exists between the decisions made and the outcomes. For instance, if a farmer has a long-standing, good working relationship with his or her hired labor force and the situation has remained stable, there is little possibility of labor being unavailable when needed. At times, the risk may be quite high, and the farmer must exercise caution. For instance, being the first farmer to embrace a new seed or animal type may expose you to a number of risks, each of which may result in either loss or gain. Before opting to implement the new technology, the farmer should conduct research and have an understanding of the hazards and their magnitude. Decisions are often easier to make when there is little or no danger.

The bigger the risk and the more complex the situation, the more difficult it is to make an informed choice. It is good to realize that farmers do not always choose to undertake anything. Refusing to

select or make a certain choice is a decision in and of itself, with associated results and repercussions. Thus, it is critical for the farmer to understand risk and how it affects his agricultural operation. This empowers the farmer to exert greater control over the variables affecting the home, farming, and livelihood systems.

2.2 Smallholder farmers' decision-making and risk

As a result of the uncertainty of the future, farmers must devise techniques to manage risk and protect themselves from the mistakes they make today. The goal of risk management is to minimize the likelihood of a "bad" event. Farmers that want to minimize their exposure to risk should take a different approach. For example, they need to identify the probable risks; realize the various outcomes; decide on different tactics; examine the ramifications of each conceivable outcome; and evaluate the profits that may be gained. Figure 2.1 depicts the actions farmers should take to mitigate risk. Risk tolerance and estimation among farmers varies widely. They use a variety of criteria to make their selections. Farmer risk tolerance varies widely among farms. When it comes to assessing danger, farmers frequently rely on their gut instincts rather than data provided by experts.

A farmer's willingness to tolerate a minor profit or loss is linked to his or her attitude toward risk. In the long run, a loss of say, N300,000 per year is unlikely to have a substantial impact on or even put an end to a big commercial farmer's operations. However, a small-scale farmer with a poor income is unlikely to be able to bear such a financial burden. As a result, the farmer would be less inclined to take the risk of losing so much money.

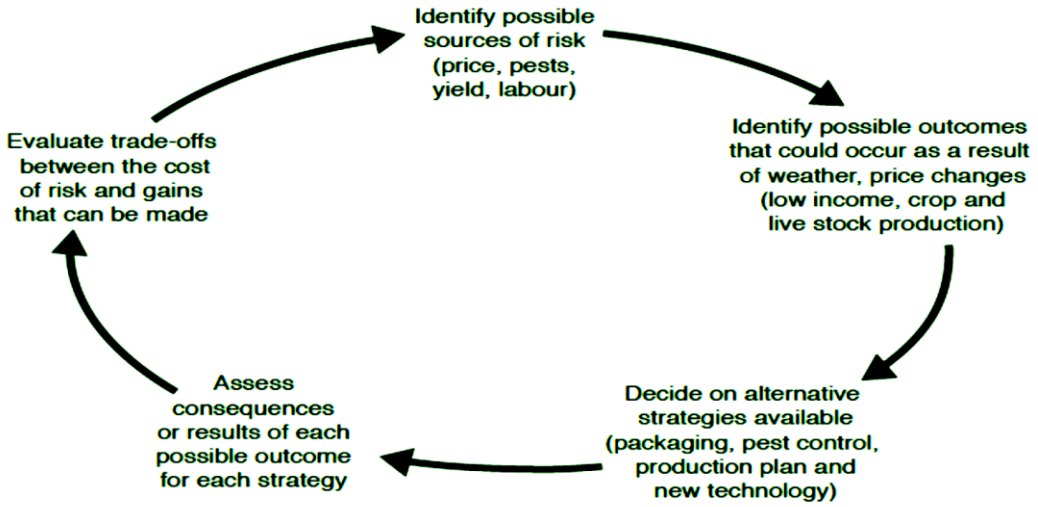

Figure 2.1: Process of Smallholder risk management decision making process
Adapted from Kahan (2008)

2.3 Smallholder Farmers' Attitudes towards Risk

The three categories of farmers include those who are risk-neutral, those who accept risks, and those who avoid them. In order to minimize their exposure to danger, risk-averse farmers aim to do as little as possible. With a predisposition for less hazardous sources of income, they are more likely to be cautious persons. It is common for them to give up some revenue in order to minimize the risk of low income and losses. A risk averter is not someone who refuses to take any risks. To compensate for this, the risk-averse farmer will want more money than they would typically get if there was no danger.

Risk-takers are businesspeople who aren't afraid to try new, riskier ventures. Risk-takers, as opposed to risk-averse people, pick the option that has a probability of a better end, even if it means accepting a worse one. Farmer risk-takers are more likely to incur the risk of making earnings rather than protecting oneself from possible losses when confronted with the alternative Even Nevertheless, farmers who are willing to take risks are nonetheless driven by the potential reward. It's a middle ground between those who are risk-averse and those who are risk-takers. Farmers and those who give assistance can benefit from understanding the farmers' attitudes about risk. As a result, individuals have a better understanding of the factors influencing their risk management choices. Despite the fact that most farmers are risk-averse, this is not a permanent state of mind.

Several factors have a role. As a result, a farmer may be risk-averse in one context and risk-taker in another, depending on the circumstances.

3.0 Methodological Framework

The method adopted in this paper is qualitative research method which relies on systematic literature review (SLR). This method was recommended for any study conducted based on qualitative research paradigm by Borrego, Foster, & Froyd (2014). Empirically, this method was employed by Shi, Ding, Zuo, & Zillante (2016) and lately by Abdelmegid, González, Poshdar, O'Sullivan, et al (2020). In his opinion, Shi, et al. (2016) said SLR provides a well-recognized method for investigating literature and justifying outcomes in a comprehensive, transparent, and replicable manner. It consists of three phases namely literature search, literature analysis and synthesis discussion of findings as shown in Figure 3.1.

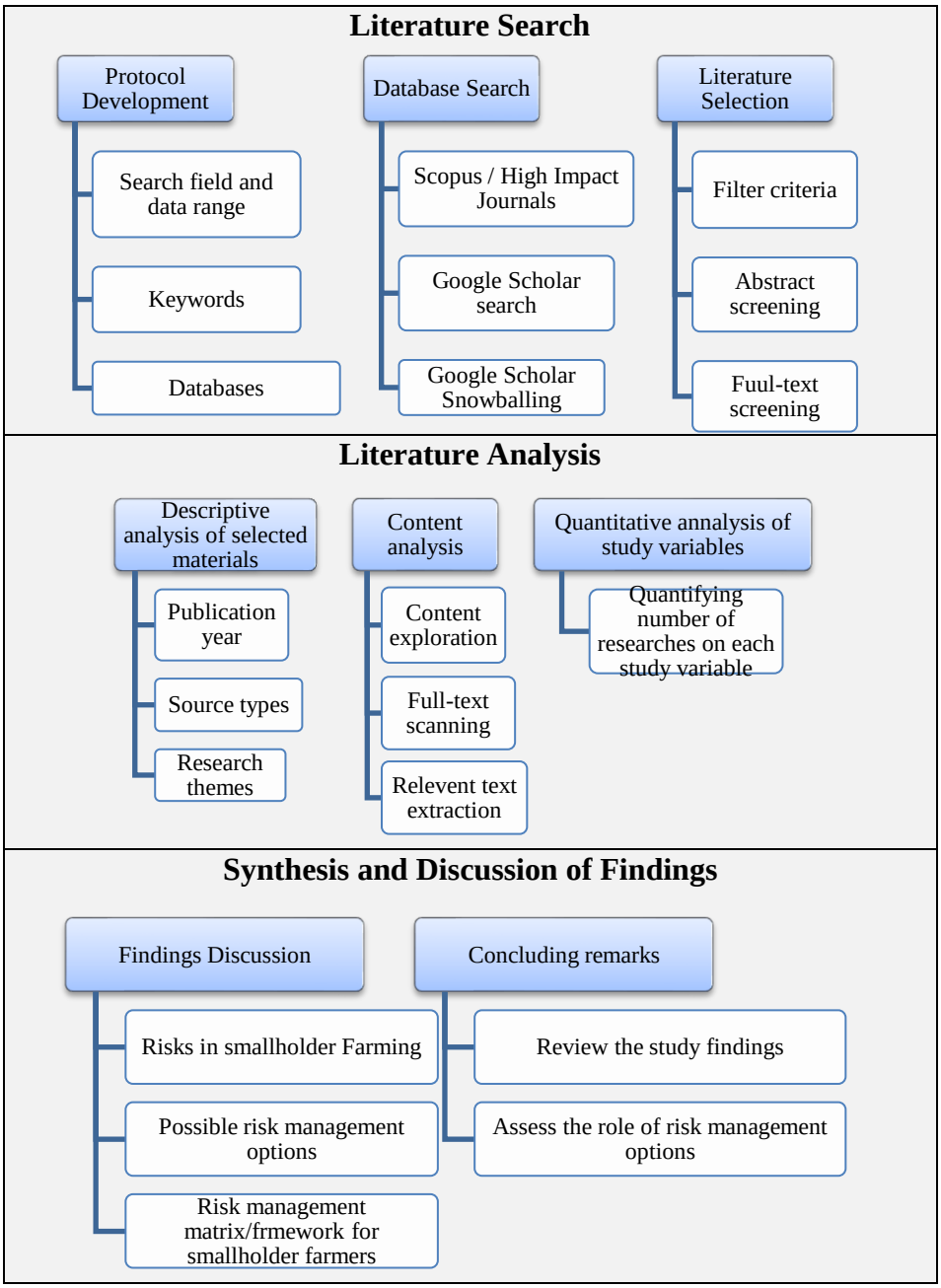

Figure 3.1: Research Design

3.1. Literature search: In the first phase, literature was extensively searched to identify the most pertinent studies to the research questions cum objectives. This phase involved three major activities, including protocol development, database search, and literature selection. Protocol development or search protocol embodied the planning document of the SLR. It included a detailed description of the key elements of SLR such as the research questions, relevant databases, keywords, and inclusion/exclusion criteria, based on the recommendations by Borrego, Foster, &

Froyd (2014). Google Scholar was selected as the main database to search for scholarly papers. This database is known to cover most of the leading journals and conferences in this field of study. Dissertations and theses were also essential for inclusion in the SLR process (Borrego et al., 2014). The search fields included the title, abstract, and keywords. The publication date criteria were set to the period after 2000. The main reason to set this search period is to ensure wider coverage of scholarly studies in the twentieth century.

3.2 Literature Analysis: In this phase the selected literature were analyzed extensively to describe their attributes and content. The methods applied were descriptive and content analysis. The descriptive analysis summarized the nature of the documents regarding their publication years, sources, authors, and research themes. The content analysis conducted provided an in-depth exploration of the documents

3.3 Synthesis and discussion of findings: The third phase aimed at addressing the research questions cum objectives based on the findings of the literature analysis. The details of each phase are discussed in the following sections

4.0 Findings and Discussion

4.1 Risks faced by Smallholder farmers

From the SLR conducted, farmers regardless of the scale, face myriads of risks that are classified under five categories. As reveal by a number of studies the risks faced by smallholder farmers are classified into six categories with the most being production risks, followed by market risks, next by institutional risks, followed by financial and lastly by personal risks then the legal risk. Previous reviews highlight the extent to which agricultural studies focus on risk, for example, 29% of studies that used farm-scale models in the European Union between 2007 and 2015 included risk or stochasticity (Reidsma et al., 2018). Our results, however, also confirmed the earlier findings by Komarek, De Pinto, & Smith (2020) which was that studies have overwhelmingly clustered around production risks, followed by market risks. Our study has added one more category of risk – legal risk to Komarek's et al (2020) risk categories. This finding is incongruent with that of Huet, Adam, Giller and Descheemaeker (2020) which places human risk as the second most important risk for farmers. This is quite interpreting in the sense that while literatures focus more on market risk, less literature is devoted to human risk which is quantitatively of equal if not more important than

market risk. The next risk most studied in literature is institutional risks, followed by financial and lastly by personal risks. For simplicity, we adapt the Komarek's et al (2020) Venn diagram presentation and their positions and arguments on the five categories of farm risks for ease of discussion. These categories (as adapted) are presented in Figure 4.1.

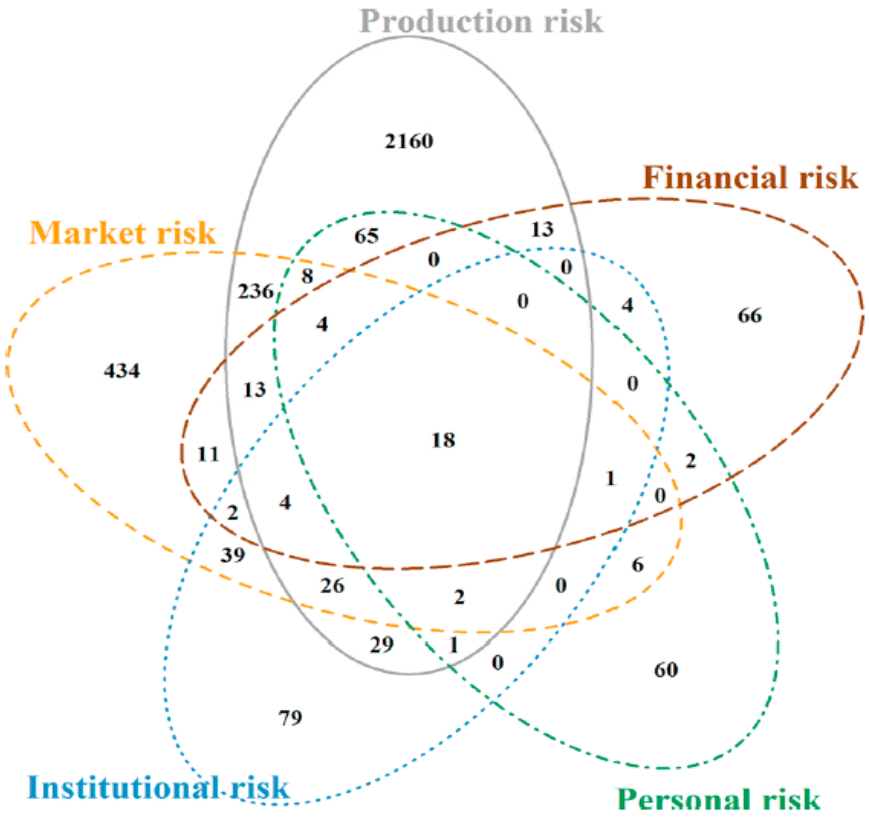

Figure 4.1: Venn diagram for distribution of the number of studies across five types of risks in Farming. Data from authors' literature search

4.1.1 Production risks. These risks arise from the unpredictability of crops and animal growth processes, with common sources of these risks being weather and climate (temperature and precipitation) as well as pests and illnesses. Other variables that restrict or reduce yields are also production concerns, such as high levels of heavy metals in soils or high soil salinity.

4.1.2 Market risks: These are primarily concerned with pricing, cost, and market access uncertainties. Weather shocks and their influence on yields, energy price shocks, and uneven access to information all contribute to market volatility. International trade, liberalization, and protectionism are additional sources of market risk, as they can expand or restrict market access

across different geographical scales. Farmers' decision-making is influenced by the presence of different hazards, such as weather unpredictability, price spikes, or decreased market access (Holden and Shiferaw, 2004; Harvey et al., 2014; Lazzaroni and Wagner, 2016).

4.1.3 Institutional risks: These risks are associated with unanticipated changes in agriculture-related laws and regulations (Harwood et al., 1999), which are influenced by formal or informal institutions. Government, as a formal entity, may introduce risks through unforeseen policy and regulatory changes, elements over which farmers have little influence. Institutional risk can also come from informal institutions, such as unforeseen changes in the behavior of informal trade partners, rural producer associations, or societal norms, all of which have an influence on agriculture. Farmers are becoming increasingly reliant on and tied to institutions, particularly as agricultural output becomes more market-oriented.

4.1.4 Personal risks: These are unique to an individual and pertain to issues with human health or interpersonal interactions that influence the farm or farm household. Personal risk factors include agricultural machinery injuries, disease-related mortality or sickness of family members, pesticide-related adverse human health impacts, and disease transmission between animals and people (Antle and Pingali, 1994; Lopes Soares and Firpo de Souza Porto, 2009; Masuku and Sithole, 2009; Arana et al., 2010; Tukana and Gummow, 2017). For farmers, health concerns are a significant cause of income volatility and stress (Dercon et al., 2005). Farmers frequently deal with the entwined nature of personal and institutional risks; for example, divorce or the death of a spouse might result in the takeover of land or cattle as a result of institutional risks imposed by customary rules (Meinzen-Dick et al., 2014). The terms "personal," "human," and "idiosyncratic" all pertain to the same sort of "personal" hazards that we discussed.

4.1.5: Financial risks: These risks relate to the risks connected with the farm's financing structure and is defined as the increased volatility of the farm's operational cash flow as a result of the fixed financial commitments associated with credit utilization (Gabriel and Baker, 1980; de Mey et al., 2016). Financial risk may be attributed to a variety of factors, including changes in interest rates or loan availability, as well as changes in credit conditions.

4.1.6 Legal risks: Smallholder farmers are subject to a slew of legal ramifications. When a farmer breaches a written or verbal contract, for example, legal responsibility may result. Farmers

are subject to both state and federal legislation. Those who don't abide by the terms of the agreement might be held responsible for damages. Criminal culpability may also apply in environmental law cases. Customers, staff, or anybody on the farm land, either with or without authorization, who are hurt may bring a case against the farmer. A person who is harmed by a farmer's products can bring a lawsuit against the farmer. Finally, the farmer may be held accountable if agricultural operations, whether on or off the farm, cause harm to a third party or a neighbor.

However, the focus on production risk is understandable given that productivity in agriculture is closely connected to biological processes and can be studied in relatively controlled experiments. These experiments permit a better understanding of cause and effect. For example, the analysis of long-term agronomic trials can help identify how weather variability affects crop yield stability. The focus on market risks is also reasonable. Markets, prices, and price volatility are at the center of theories and models developed in agricultural economics. Researchers have recognized the importance of risks beyond production risks (such as market prices), but the rate of increase in studies on multiple risks was less than the rate of increase in studies on single types of risk over the past two decades

As was observed by Komarek's et al (2020), the literature has focused less on institutional, personal, and financial risks, compared with production and market risks. The focus on production and market risks may also be related to the greater availability of open access data on weather and prices (Woodard, 2016; Coble et al., 2018). This focus has in turn shaped the methods available to study risk. Only a limited number of studies examined personal risk. One example cited in Komarek's et al (2020) was Zhen et al. (2005) who reported survey results from 270 farmers that implied cropping systems on the North China Plain are economically viable. These farmers also reported the overuse and inappropriate handling of mineral fertilizer and pesticides, resulting in 20% of farmers reporting headaches and fatigue. These health problems are a concern for human welfare and may affect agricultural production through reduced work productivity. Quantifying these human health problems is a challenge, but identifying the risk is an important first step in quantifying the cost of the risk.

4.2 Risk management strategies of Smallholder farmers

Managing risks for operational efficiency of smallholder farmers can be daunting tasks as these crops of farmers would have to take some very important decisions (Zhang, Ju, & Zhan, 2019)). From literature, we found that for smallholder farmers to be able to manage their farm risks, they would have to take the following decisions prior to deciding which strategy to adopt. In other words, whatever strategy is adopted to manage risk is a condition consequent upon these decisions:

i. their decisions on production and consumption (including which crops and livestock products to produce and in which proportions);
ii. the allocation of household labour (diversifying income sources);
iii. the management of household assets;
iv. the use of informal institutional arrangements (e.g. community risk-sharing);
v. the use of insurance, credit or other market mechanisms;
vi. the uptake of government programmes (including safety nets).

A key point is that these decisions are inter-related, and specific decisions and outcomes are likely to vary according to a country's structural and institutional characteristics, as well as its general level of development (Romer Løvendal and Knowles, 2005). Numerous strategies exist to help smallholder farmers to avoid, transfer, share, spread, and/or take risks (Drollette, 2009; Ullah, Shivakoti, Zulfiqar, & Kamran, 2016). The selection of a specific tool hinges upon individual circumstances and farmers' willingness to bear risks (Singh, 2010). The literature points towards the existence of numerous tools and options for reducing risks, At the most general level there are two approaches to deal with risk: *ex ante risk management* and *ex post risk coping*. Risk can be dealt through different types of agents or institutions such as the farm/household, the market, and the government. OECD (2009) presents a framework for an efficient management of risk across different actors

4.2.1 Ex ante strategies

These are measures taken to avoid, transfer or reduce risks or exposure to risk and are long-term in nature, (Lekprichakul, 2009). These strategies are as follows.

Avoiding risk*:* Though this is not usually the best way to manage risk as it can lead to a poverty trap (World Bank, 2001), but given the poverty conditions under which most smallholder farmers

live, it is ideal for them to avoid some specific activities that involve more risk although such activities frequently could bring more income gains.

Household size: The formation of households is by itself an important risk-sharing strategy. Single-person households are rare in rural areas of developing countries. It is common to observe high fertility rates in rural areas, and households often span several generations. Large households allow for economies of scale in food preparation, risk sharing in food production, and care in case of sickness.

Diversification of economic activities: Different activities in both the farm and non-farm sectors are frequently taken up as a strategy to reduce total income risk through diversification by engaging in non-farm businesses and off-farm wage labour. This strategy allows to a certain extent, farmers to adopt riskier high-return crops (Lanjouw and Lanjouw, 2001). Diversification strategy can take many forms such as; (i) income diversification; (ii) inter-cropping where farmers produce in the same plot more than one single crop; (iii) the mixed farms where crop and livestock production activities are combined; (iv) spatial plot diversification; and (v) crop diversification. These activities are a common means to reduce the risk of crop failure due to adverse weather events, crop pest or insect attacks.

***Savings and asset accumulation*:** This strategy is used as a mean to smooth consumption as optimal response to borrowing constraints. This is done by saving in good times in anticipation of bad times. This is usually done in the form of assets and buffer stocks since formal savings mechanism is less likely to be available for smallholder farmers.

***Technology and agricultural investment*:** The application of fertilizer and use of historical rainfall distributions to know and manage weather-linked consumption shocks (Dercon & Christiaensen, 2011).

Sharecropping and other production relationships: Sharecropping is an agricultural production system in which farmland is supplied by a landowner through leasing, license, or the like to a tenant who farms the land, in return for a portion (e.g., 50%) of the crop harvested. Sharecropping has been used for a long time as a risk sharing strategy (Cervantes-Godoy, Kimura & Antón, 2013)

Informal risk-sharing institutions: The use of informal risk-sharing arrangements such as savings clubs, also known as Rotating Credit and Savings Associations (ROSCAs) or Accumulating Savings and Credit Associations (ASCAs) where group members come together once a week and deposit a certain amount of money, the total collected amount is then given immediately to one member of the group until all members get their own.

Market strategies: Such as futures market used to deal with price risks are mostly formal mechanisms and usually less available to smallholders in developing countries.

Contract farming: Is one of the alternative options to stabilize farmers' income by offering assistance to small farmers in gaining early market access and reducing market price shocks (Sriboonchitta, & Wiboonpoongse, 2008). The significance of this strategy for the smallholder farming community is the reduction of risk to a to a minimal level by predetermined prices other than market price (Ahsan, 2011; Iqbal, Abbas, Naqvi et al., 2020) as well as diminishing of uncertainty for beneficiaries (Akhtar, Abbas, Kassem, Bagadeem, et.al., 2021).

Insurance policies*:** In underdeveloped nations (and a few wealthy countries), traditional public agricultural insurance plans like crop insurance, livestock insurance, farm assets and property insurance, and fishery insurance amongst others that are largely indemnity-based have been mainly ineffective. Incomplete data and large transaction costs have been shown to be destabilizing, and there are no cheap fixes. Although subsidized insurance has been introduced in numerous OECD nations as a means of providing disaster relief, it has not completely replaced ad hoc payments and frequently covers non-catastrophic risks (OECD, 2011). As a matter of fact, this type of insurance is unaffordable for most smallholder farmers worldwide (Carter, de Janvry, Sadoulet, & Sarris, 2017). A more recent and expanding body of study examine alternate, and ***technically non-indemnity-based, insurance arrangements known as **indexed insurance** for smallholder farmers and their potential to minimize risk exposure.

For losses caused by weather and catastrophic occurrences, index insurance pays out payments based on a pre-determined index, such as the amount of rainfall. It protects a specified area rather than a single farm from a certain hazard (Hess, & Ha zell, 2016). An index insurance policy does not need individual claims to be evaluated, allowing for a faster and more objective method of settling claims. Payouts are made automatically when an index crosses a predefined threshold. Smallholder farmers have generally had two options for index insurance:

i. ***Area-yield index (AYII):*** Area-yield index insurance services are similar to indemnity-based services, with assessments made at one farm against a predetermined index for a given area. Characteristically, AYII is low in set-up costs, risk of moral hazard and adverse selection, basis risk and actuarial difficulty; slow in claim settlement and has a medium operational cost.

ii. ***Weather index insurance (WII)***. With weather index insurance, payouts are based on the occurrence of a specific weather event over a specified period in a defined area. For WII, set-up costs, basis risk and actuarial difficulty are high; operational cost and risk of moral hazard and adverse selection are low; while claim settlement is fast (GSMA, 2020).

4.2.2 Ex post strategies

These are measures taken after the shocks to mitigate or insulate the welfare impacts of the shocks and are usually short-term survival adjustment (Lekprichakul, 2009). The various strategies include:

Sale of assets: Smallholders accumulate savings and assets in the form of livestock or grain reserves rather than liquid financial saving in order to safeguard against economic shocks.

Labour supply**:** Labour supply choices are dynamic and may change in response to shocks. To safeguard consumption levels in the face of a negative shock, previously economically inactive farmers may choose to join the labour market, and previously active farmers may choose to increase and / or change the nature of labour supplied, for example from a family farm to casual wage labour to keep the farm afloat (Porter, 2012).

Reduction in consumption: Income and consumption smoothing attempts by farmers are rarely perfect; expenditures often decline in the face of economic shocks and if for instance, farmers are unable to manage agricultural shocks, they can enter into long-term contracts, such as debt and bonded labour for continuous farming.

Support networks: A set of *ex post* risk-coping mechanisms utilizes the social networks to transfer from unaffected farmers to affected farmers to help smooth out consumption in the face of income shocks from agriculture. This is important in the context of migration and remittances that saves

as insurance against income shocks (Yang & Choi, 2007).These networks are frequently purposively put in place by households as part of their *ex ante* risk management.

***Migration*:** This may be a risk-coping mechanism after the incidence of a shock. While the link from an economic shock to out-migration may seem direct, it is frequently less evident than expected (Yang, 2008).

***Agricultural credit*:** Smallholder farmers can also use agricultural credit to manage their risk associated with financial loss. Agricultural credit has been found to have a significant impact on farmer's production, income, and food security, particularly for those who are vulnerable to heavy rains, thunder storms, pest and insect attacks, and other natural hazards (Ayaz, Anwar, Sial, & Hussain, 2011; Akhtar, Li, Nazir, Razzaq, Ullah et al., 2019)

4.3 Risk Management matrix for smallholder farmers

To choose from these myriads of techniques, smallholder farmer must first determine which risks have high or low frequencies, and which have high or low severity using the risk management matrix presented in Figure 4.2.

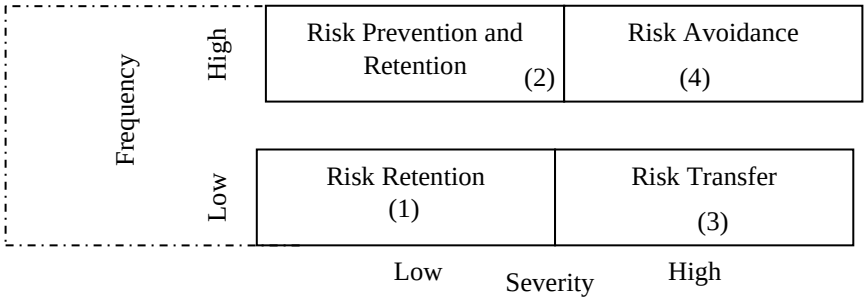

Figure 4.2: Risk Management Matrix for Smallholder Farmers

For risks that have low severity and low frequency, the smallholder farmer can choose to retain the risk. For risk that has low frequency and high frequency, they may choose to either retain or prevent it. If the risk is high in severity and low in frequency, the most appropriate strategy is to transfer such risk. Finally, where a risk is high in both severity and frequency, it would be most appropriate to avoid such risk. These decisions must be taken based on the risk preference of the smallholder farmer.

5.0 Concluding Remarks

Farmers deal with a broad range of risks, with production and market risk being mostly researched on than financial, legal or personal or human. Our study examines the trajectory of the literature on the types of risks faced by smallholder farmers. The strategy to manage the risk and the framework to choose which strategy best suit the risk faced. We have argued that unexpected events continue to effect farmers and we know that farmers manage multiple risks jointly. We employed a SLR methodology which involves searching literature, analyzing same and making findings and discussing the findings. Our results show that smallholder farmer face risk in production, marketing. Also, institutional, financial, personal and legal risks also affect smallholder farmer. There is study has also revealed several ex-ante and ex post strategies that can be adopted in managing these risks. We have proposed a risk management matrix for use in the selection of the most appropriate risk management strategy by smallholder farmers. Based on our review, we can say that the types of risk that researchers have studied reflect the importance of different risks faced by smallholder farmers and there is need for them to explore the non-indemnity-based vis-à-vis the non-probabilistic methods and strategies of managing risk to manage their exposures for their operational efficiency. This way we can grasp a pathway for resilience and sustainable Agro-food system in Nigeria.

References

Abdelmegid, M. A., González, V. A., Poshdar, M., O'Sullivan, M., Walker, C. G., & Ying, F. (2020). *Barriers to adopting simulation modelling in construction industry. Automation in Construction, 111, 103046.* doi: 10.1016/j.autcon.2019.103046

Aditto, S., Gan, C., & Nartea, G. V. (2012). Sources of risk and risk management strategies: the case of smallholder farmers in a developing economy. *Risk Management-Current Issues and Challenges*, 449-475.

Ahsan, D. A. (2011). Farmers' motivations, risk perceptions and risk management strategies in a developing economy: Bangladesh experience. *Journal of Risk Research, 14*(3), 325-349.

Ahsan, D. A. (2011). Farmers' motivations, risk perceptions and risk management strategies in a developing economy: Bangladesh experience. *Journal of Risk Research, 14*(3), 325-349.

Akhtar, S., Abbas, A., Kassem, H. S., Bagadeem, S., Ullah, R., & Alotaibi, B. A. (2021). Sustainable Crop Production, the Concurrent Adoption of Contract Farming, and Managing Risks through Income Diversification. *Agronomy, 11*(5), 973.

Akhtar, S., Li, G. C., Nazir, A., Razzaq, A., Ullah, R., Faisal, M., ... & Raza, M. H. (2019). Maize production under risk: The simultaneous adoption of off-farm income diversification and agricultural credit to manage risk. *Journal of integrative agriculture, 18*(2), 460-470.

Ayaz, S., Anwar, S., Sial, M. H., & Hussain, Z. (2011). Role of agricultural credit on production efficiency of farming sector in Pakistan–a data envelopment analysis. *Pak. j. life soc. Sci*, *9*(1), 38-44.

Borrego, M., Foster, M. J., & Froyd, J. E. (2014). Systematic literature reviews in engineering education and other developing interdisciplinary fields. *Journal of Engineering Education*, *103*(1), 45-76.

Carter, M., de Janvry, A., Sadoulet, E., & Sarris, A. (2017). Index insurance for developing country agriculture: a reassessment. *Annual Review of Resource Economics*, *9*, 421-438.

Cervantes-Godoy, D., S. Kimura and J. Antón (2013), Smallholder Risk Management in Developing Countries, *OECD Food, Agriculture and Fisheries Papers*, No. 61, OECD Publishing, Paris. http://dx.doi.org/10.1787/5k452k28wljl-en

Dercon, S., & Christiaensen, L. (2011). Consumption risk, technology adoption and poverty traps: Evidence from Ethiopia. *Journal of development economics*, *96*(2), 159-173.

Drollette, S. A. (2009). Managing Production Risk in Agriculture; AG/ECON/2009-03RM; Department of Applied Economics Utah State University: Logan, UT, USA

Dunn, J. W. (2002). *Farm-level risk analysis for Kansas farmers*. Doctoral Thesis: Kansas State University.

Hardaker, J. B., Lien, G., Anderson, J. R., & Huirne, R. B. (2015). *Coping with risk in agriculture: Applied decision analysis*. Cabi.

Iqbal, M. A., Abbas, A., Naqvi, S. A. A., Rizwan, M., Samie, A., & Ahmed, U. I. (2020). Drivers of farm households' perceived risk sources and factors affecting uptake of mitigation strategies in punjab Pakistan: Implications for sustainable agriculture. *Sustainability*, *12*(23), 9895.

Kahan, D. (2008). *Managing risk in farming*. Food and agriculture organization of the United Nations.

Kammar, S. K., & Bhagat, R. (2009). Constraints experienced by farmers in adopting risk and uncertainty management strategies in rainfed agriculture. *Pusa AgriScience*, *32*, 70-74.

Komarek, A. M., De Pinto, A., & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. *Agricultural Systems*, *178*, 102738.

Komarek, A. M., De Pinto, A., & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. *Agricultural Systems*, *178*, 102738.

Lekprichakul, T. (2009). Ex ante and ex post risk coping strategies: How do subsistence farmers in southern and eastern province of Zambia cope?. *Research Institute for Humanity and Nature, Kyoto, Japan*.

Nyikal, R. A., & Kosura, W. O. (2005). Risk preference and optimal enterprise combinations in Kahuro division of Murang'a district, Kenya. *Agricultural Economics*, *32*(2), 131-140.

Pannell, D. J., Malcolm, B., & Kingwell, R. S. (2000). Are we risking too much? Perspectives on risk in farm modelling. *Agricultural Economics*, *23*(1), 69-78.

Porter, C. (2012). Shocks, consumption and income diversification in rural Ethiopia. *Journal of Development Studies*, *48*(9), 1209-1222.

Richard Asravor, (2018) "Smallholder farmers' risk perceptions and risk management responses: Evidence from the semi-arid region of Ghana", African Journal of Economic and Management. https://doi.org/10.1108/AJEMS-10-2017-0250

Schaffnit-Chatterjee, C., Schneider, S., Peter, M., & Mayer, T. (2011). Mitigating climate change through agriculture. *Deutsche Bank Research*.

Shi, Q., Ding, X., Zuo, J., & Zillante, G. (2016). Mobile Internet based construction supply chain management: A critical review. *Automation in Construction*, *72*, 143-154.

Singh, G. (2010). Crop Insurance in India; IIMA Working Paper WP2010-06-01; Indian Institute of Management Ahmedabad: Ahmadabad, India.

Sriboonchitta, S. & Wiboonpoongse, A. (2008). Overview of Contract Farming in Thailand: Lessons Learned; ADB Institute Discussion paper No. 112; Asian Development Bank Institute: Tokyo, Japan.

Ullah, R., Shivakoti, G. P., Zulfiqar, F., & Kamran, M. A. (2016). Farm risks and uncertainties: Sources, impacts and management. *Outlook on Agriculture*, *45*(3), 199-205.

World Bank (2001), *World Development Report: Attacking Poverty*, The World Bank, Washington, DC.

Yang, D. (2008). Risk, migration, and rural financial markets: Evidence from earthquakes in El Salvador. *Social Research: An International Quarterly*, *75*(3), 955-992.

Yang, D., & Choi, H. (2007). Are remittances insurance? Evidence from rainfall shocks in the Philippines. *The World Bank Economic Review*, *21*(2), 219-248.

Zhang, Y. Y., Ju, G. W., & Zhan, J. T. (2019). Farmers using insurance and cooperatives to manage agricultural risks: A case study of the swine industry in China. *Journal of Integrative Agriculture*, *18*(12), 2910-2918.