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Supply Chain Risks and Resilience in Grains-Crop Farming in North-Western Nigeria

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Abstract:
Many small-scale grain-crop farmers in northern Nigeria encounter environmental, economic, political, and technological risks. This research investigates the farming supply chain value risks and assesses the resilience capacity of grains-crop farmers in North-Western Nigeria. Data gathering involved purposive sampling to conduct qualitative interviews. Findings suggest that poor infrastructure, activities of insurgent groups, unfavourable weather conditions, limited access to finance, high cost of inputs, and inadequate technologies are some of the major challenges facing small-scale grain farmers in northern Nigeria. Research advocates better support to farmers to help prevent risks or overcome the effects of risks. Training and adult literacy skills for rural farmholders are advocated in this work. Policies delivered to rural farmers will lower risks to farmers and support the ability for stronger resilience. This study adopted qualitative research which implies that the outcome will not represent all the smallholder farmers in North-Western Nigeria. Future researchers may adopt quantitative analysis to be more representative.

Keywords: Supply Chain Management, Agricultural production, Sub-Saharan Africa, Grain- crop farming, Risks and resilience, Northern Nigeria, Sustainable development.

1. Introduction

The agricultural sector in Nigeria is a significant contributor to the livelihood of the Nigerian rural communities, and broadly, the nation's economy. However, many small-scale grain-crop farmers encounter varying difficulties emanating from environmental, economic, political, and technological risks among others. This research investigates the intensity of agricultural supply chains value risks and assess the capacity of the farmers' resilience. Literature review highlights the key factors influencing agricultural supply chains risks and resilience and provides a robust discourse for understanding these issues. Qualitative interview technique was adopted to engage in data gathering. Our findings in this study suggest that poor infrastructure, activities of insurgent groups, unfavourable weather conditions, limited access to finance, high cost of inputs, and inadequate technologies are some of the major challenges facing small-scale farmers in the grain-crops farming sector in Nigeria. We identified rural infrastructure development, strong agricultural policy, access to funding support, adoption of information and communication technologies, and ease of access to market as some of the practical initiatives to mitigate the supply chains risks and increase the resilience of farmers.

2. Background and Rationale

Crop production in Sub-Saharan Africa is predominant among small-scale farms. However, the costs of inputs for small farm holders are usually volatile, preventing them from allocating resources in the most effective ways to achieve production efficiency (Neumann et al., 2010; Acharya, 2018). Previous authors (Neumann et al., 2010; Gentle and Maraseni, 2012; Acharya, 2018) viewed that crop outputs in Sub-Saharan Africa are directly impacted upon by climate conditions, such as uncertain rainfall patterns, undependable plant development, land degradation and unpredictable soil moisture and temperature. They also identified low fertiliser usage, attacks of pests and diseases on plants, and poor production environments such as unfavourable government regulations, poor agricultural pricing policies, low agricultural credit, and land tenure insecurity were prominent factors posing risks to production. The authors noted that the poverty level of farmers, gender issues, low and unstable investment in agricultural research, poor market access, and poor marketing efficiency are also contributory to food crisis and price volatility, which subsequently influence the supply and demand dynamics in the grains market. Tesfaye et al., (2015) opined that to provide food security for its expanding population, the Sub-Saharan Africa's agricultural systems must adapt to the current realities to adequately mitigate the vulnerabilities faced by small-scale farmers.

The risks and resilience in Nigeria's grain production and supply has not been fully explored, despite the industry's importance to the country's economy. Devaux et al., (2018) viewed that for agricultural research centres to impact on the rural poor, they must work in tandem with other initiatives that influence the regulatory environment.

This paper explores the several factors that are influencing the plights of small-scale farmers in Nigeria who are at a disadvantage because of lack of access to modern farming methods which confines them mainly to the manual labour approach, limited financial resource for investment, and the various tariff measures forming barriers from gaining entry to markets (Katie et al., 2014). In most agricultural supply chain cases, farmers bear the most risks and receive the smallest share of the value chain's rewards (Chikowo et al., 2014; Yan et al., 2019; Zingore et al., 2011). Supply chain costs limit farm owners' profit margins (Nguyen et al., 2016), and they are therefore concerned about the volatility of their supply chains (Kingwell et al., 2020). The paper agrees with the view of Jason et al., (2015) that the establishment of strong value chains structure with a focus on ensuring the sustainability of supply chains initiatives would reduce the risks facing farmers, facilitate farmers' wealth and reduce poverty among small farm holders.

3. Trends in Agricultural Production

The World Wildlife Fund (WWF) (2024) reported that agriculture is the world's largest industry. It employs more than one billion people and generates over $1.3 trillion dollars' worth of food annually. The Fund asserted that when agricultural operations are sustainably managed, they can preserve and restore critical habitats, help protect watersheds, and improve soil health and water quality, but noted that unsustainable practices have serious impacts on people and the environment.

Agriculture in Nigeria remain high on the strategic agenda as one of the most important sectors in the national economy with significant political, social and environmental impacts (Saritas and Kuzminov, 2017). In the grains-crop sector, Nellemann et al., (2009) had predicted that the global grain demand was expected to increase by 42 per cent by 2025. However, the hostilities in Ukraine have destabilised the global grain market. In connection with the war, there has emerged a form of monopolistic competition on the grain market where the main producers influence the price on the world market. Because of the Russia-Ukraine war the supply of grains in the world market has depleted, resulting in an increase in the price of grain-crops, hence creating a new equilibrium (Ziolkowski, 2023). The Shortage of grains supply in the market has resulted in food problems in the Middle East region, as well as in North and Sub-Saharan African countries. The situation in Ukraine, however, presents opportunities to Sub-Saharan African grain farmers,

as rising food demand will force food producers to dramatically increase yields and significantly reduce the usual post-harvest losses in the region (Saritas and Kuzminov, 2017).

Brzeska et al., (2012) however, noted that limited investment in African agriculture is a major hindrance to production growth and that domestic investment in agriculture is low in most African countries due to lack of domestic savings and their overreliance on foreign aid funding. He further viewed that financing agricultural investments solely from domestic sources is not only challenging but also strategically ineffective.

Agriculture accounts for less than 10 per cent of most African governments' budgets (Cleaver, 2012). In recent decades, the neglect of infrastructural development and public sector investment in agriculture in developing countries has created a gap between demand and supply (Benin et al., 2012). This has led to scarcity and price increase of food in developing nations. Saritas and Kuzminov (2017) observed that food scarcity has historically resulted in widespread civil wars, revolutions, and extreme political instability in war-torn, less-developed countries. Davis et al., (2016), therefore, suggested that the practical way to address the global food crisis is to increase agricultural production while ensuring sustainable industry practices. An effective agribusiness system in Africa, Haggblade (2011) noted, will impact three important areas of development in the continent. This will include the general rate of economic growth, patterns of spatial development, and progress toward poverty alleviation. Gunasekera et al., (2015) argued that foreign direct investment (FDI), if effectively encouraged, may also help to bridge the gap between demand and supply in African countries.

Wyant, (2021), argued that food insecurity is both a cause and a consequence of low youth orientation and gender inequality; and according to FMARD (2022), women in Nigeria's agro-ecological landscapes provide between 50 and 60 per cent of labour for agriculture and play significant roles as food producers, resource managers, wage earners, and guardians of home food and nutrition security. Despite the women's significant role in grain-food production, their contributions have not been fully acknowledged. The poor recognition of women-famers and low engagement of youths have prevented being fully empowered to tackle the obstacles of limited access to land and money. Alwan Hassan, the Nigerian Managing Director of Bank of Agriculture Limited in 2022 corroborated FMARD's (2022) view when he identified low level of mechanisation and use of agro-technology, lack of training on new farming techniques, limited insight to technical breakthroughs, and poor knowledge of market prospects as part of the key hinderances to the success of agricultural production. He compared Nigerian estimated horsepower per hectare (hp/ha) of only 0.027 to the Food and Agricultural Organization (FAO) recommendation of 1.5 hp/ha. Alwan Hassan emphasized that the level of mechanisation plays a crucial role in the success of agricultural production.

Although the pandemic caused enormous interruption to the global supply chains, in Nigeria, other factors such as production insecurity, lack of infrastructure, poor agricultural policy implementation, low level of education of the upstream farmers, limited information sharing among trading partners, climate change, and a rise in the cost of production had negatively affected grain-crop farming. These inherent factors have created market barriers that disturbed the seamless flow of agricultural goods and services in Nigeria, resulting in rapid upward trend in inflation and consequential low productivity, and having negative impacts on supply chains.

In the grains industry, a reorganisation of the global supply chains is imperative in the context of the recent outbreak of Coronavirus pandemic and the war in Ukraine to be able to conform with the new realities of global trade networks. Contrary to the view that developing countries may struggle harder to adjust to current realities, Nigeria in the Sub-Saharan African region was able to manage the Corona pandemic better than most countries around the world.

4. Agricultural Policy and National Development Plan

The Nigeria Ministry of Agriculture and Rural Development developed the "Agricultural Promotion Policy (APP) 2016-2020" to address critical issues that will promote "food security, import substitution, job creation, and economic diversification." This policy was meant to focus on "agriculture as a business and a key to long-term economic growth and security. It was geared towards crops prioritisation and promotion of food as a human right. The policy was also to examine varying value chains issues such as market orientation, climate change and environmental sustainability, participation and inclusiveness, policy integrity, nutrition-sensitive agriculture, and agricultural linkages with other sectors." However, with a decline in crop production rates between 2010 and 2020, the policy had little impact on the economy. At the expiration of the implementation period in December 2020, it had been replaced by the "National Development Plan (NDP 2021-2025)" (FMARD, 2022).

The National Development Plan (NDP) envisioned a significant increase in grain-crop productivity in Nigeria through massive public and private investments in Innovation, technology, and the adoption of climate-smart practices to ensure continuous availability of affordable and nutrient-densed food (FMARD, 2022). Nevertheless, the 2.2 per cent growth rate in food production in 2020 was lower than the 3.8 per cent growth rate between 2010 and 2019 (NBS, 2021). Considering this decline, the National Agricultural Technology and Innovation Policy (NATIP) was developed using a multi-stakeholder approach by the Federal Ministry of Agriculture and Rural Development (FMARD, 2022).

The policy used a mix of short-term and medium-term multi-stakeholder approaches to achieve a transition from subsistence farming to modern agriculture through farmers' resilience, which can ensure national food security, and make significant contribution to national economic diversification, as well as create at least 12 million jobs (FMARD, 2022). NATIP's goal is to address the major issues confronting Nigerian agriculture and lay the groundwork for modernising the industry in response to shifting global food systems and supply networks (FMARD, 2022).

5. Farming in Nigeria – Contextual discourse

In Sub-Saharan Africa, particularly Nigeria, farming represents a way of life (Poulton et al., 2005; Lipton, 2005). Although 74 million hectares of Nigeria's 98.3 million hectares of land are suitable for farming, only about half of this area (38 million hectares) is used for agriculture (Opara, S., 2011). In most parts of Nigeria, the soil and climate are ideal for agriculture (Enesi et al., 2018), making the agricultural sector an important contributor to the economy. The sector accounts for 25 per cent of the nation's GDP and employs more than 50 per cent of the labour force (Elijah et al., 2017). Despite its favourable agribusiness environment, the critical factor facing the country is insufficient production to meet domestic demand (Osa-Afiana and Kelikume, 2016; Owutuamor and Arene, 2018; Omeje et al., 2019). According to Fawole and Ozkan (2018), this has increased the importation of agricultural products to meet domestic demand.

5.1 Small farms in grain production

In Nigeria, the debate over the relationship between small farms and productivity has remained critical (Poulton et al., 2005; Lipton, 2005). According to Nagayets (2005), smallholders (farms with less than 2 hectares) account for 85 per cent of the world's 525 million farms and roughly 2.6 billion people (Dixon et al., 2001). Farms with less than 5 hectares in Nigeria are regarded as small farms, this is according to the Federal Office of Statistics (FOS) (1999). Small-scale farmers account for more than 80 per cent of the entire farming population in Nigeria (Akinsuyi, Y., 2011). Most of these farmers live in rural communities, which, according to the World Bank (2008), have limited access to good motorable roads for transport as well as for banking services. Government policy typically focuses on measures to increase food production, such include offering fertiliser subsidies to farmers, and placing a ban on importation of certain agricultural products like grains to encourage local production (Blench and Ingawa ,2004) There is also the 'FADAMA' rice production initiative program usually located at lowland regions adjacent to rivers which usually

overflow during periods of heavy rains and high water. These initiatives are usually given little consideration in government's planning on maximising productivity (Obayelu et al., 2009). Tadvocate hese limitations are viewed to be responsible for keeping agricultural investments low and reducing food production in Nigeria.
Despite the impediment of limited transport-logistics and financing, small-scale farmers in Nigeria continue to play an essential role in food security (Apata et al., 2010). Most micro and small-scale farmers sell their crops to meet their cash needs (Akudugu et al., 2013). Due to the influence of price volatility, prices are typically low around harvest season, pushing farmers to always sell in large quantities at lower prices to raise enough cash for their family needs (Akudugu, 2016). This invariably means they run out of stock during the lean season They therefore always have to resort to buying the same crops at higher prices for the new planting season (Akudugu, 2016). Smallholder farmers' productivity index has been linked to unstable domestic economic changes (Allen, 2009), as farmers bear the most risk and receive the unfair smallest share of the supply chain's rewards (Yan et al., 2019).

5.2 A typical Supply chain-value of Food-grain

Adewole, A., and Struthers, J. J. (2019) affirmed that the supply chain of an organisation represents each step in the processes, which begins with the creation of an idea for a good or service, followed by designing and manufacturing of the product, and transporting it to a storage or a point of sale for distribution and selling to the end consumer.
Several terminologies have been employed to describe agricultural supply chains (Routroy and Behera., 2017). Food supply chain, agricultural value chain, post-harvest-fruit supply chain, agri-business supply chain, perishable produce supply chain, fresh food supply chain, and horticulture supply chain are some of the terms that have been used by researchers for agricultural supply chains (Routroy and Behera, 2017). This paper is inclined to use some of these terms interchangeably.

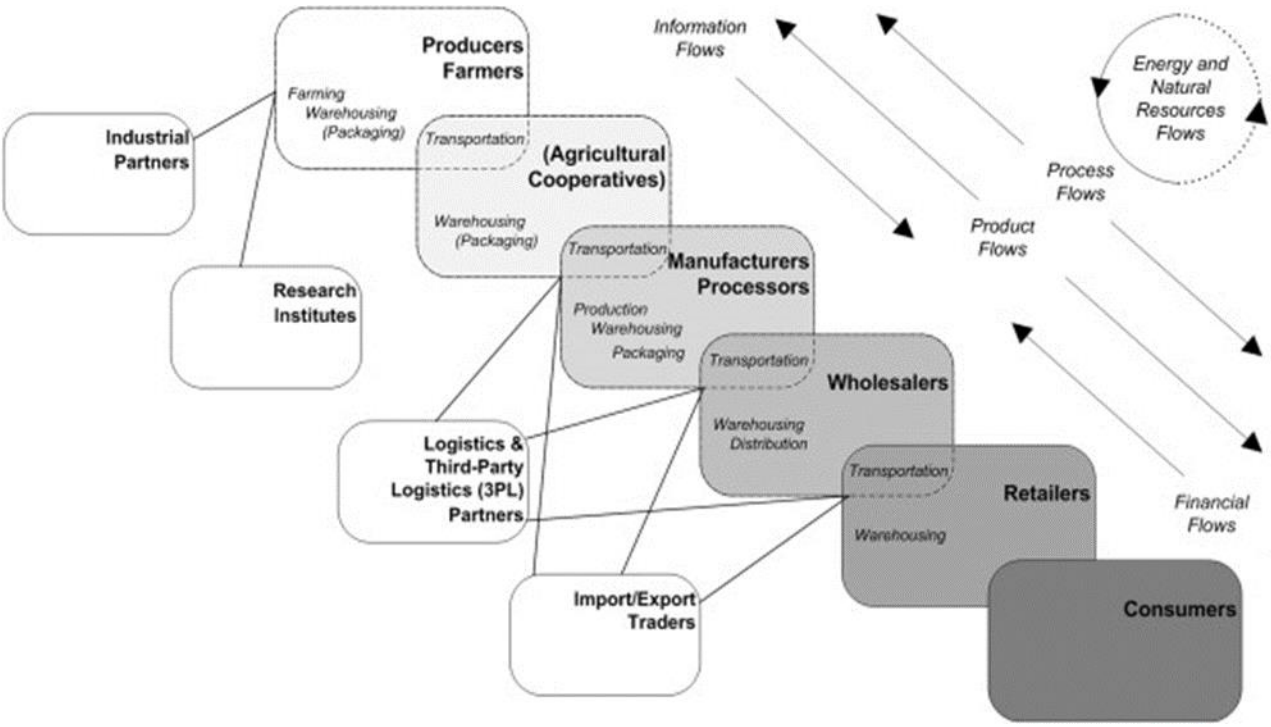

Figure 1. A Simplified agricultural (grains) supply chain operations model. Source: Tsolakis et al., 2014.

The agricultural value chain seeks to gain a competitive advantage through collaborative efforts that connect producers, processors, suppliers, transport and distribution, retailers, and a series of support activities involving procurement, research and development, including technology and human resources (personnel),

that are included in the holistic agricultural (grain) value chains, that require the coordinated participation of the full spectrum of agri-business economic activities (Eboh and Lemchi, 2010; Olomu et al., 2020). An efficiently coordinated value chain is therefore critical for the agri-food industry, as it can be used as a tool to increase the chain's profitability and sustainability (Johns et al., 2016). In efforts to satisfy global clients through a competitive distribution channel, Chandrasekaran and Raghuram (2014) argued that agricultural supply chain strategy (ASCS) should encompass a critical quality procedure including production management that involves product testing and packaging, supplier management, customer relationship management, and market demand management.

From the Nigerian perspective, however, Industry analysts (Olomu et al.,2020) viewed that the performance of supply chain in the agricultural sector has traditionally been poor, with little innovation and development. They noted that the average Nigerian rural farmer only farms for subsistence and will simply produce seeds for sowing, growing, harvesting, and selling to their immediate consumers. They suggested that as more commercial grain production is needed to meet the growing global market demand, rural farmers should be encouraged to increase production beyond the local level. This could be achieved by assisting farmers to improve their capacity through mechanisation and funding for the purchase of farm inputs such as seeds, fertilisers, and herbicides among others (Haggblade, 2011; Adaku and Amanor-Boadu, 2023). In their survey of small-scale farmers, Anyiro, and Oriaku (2011) noted that most farmers either did not receive agricultural funding when they had applied through cooperatives, or the funding was disbursed too late to mitigate poor output

Hansen et al., (2019) identified other hinderances facing small farm owners as lack of information for small-scale farmers, limited access to modern agricultural technology, high cost of farm inputs, the tenure system, inadequate agricultural credit, and poor marketing channels. Tadesse et al., (2019) also identified barriers such as unfavourable climate change, inadequate network of physical and social infrastructure such Rail, roads, and waterways, and lack of agricultural insurance facilities for small-farm owners, which may contribute to permanent loss in farm produce and income. This has necessitated small-scale farmers initiatives to collaborate and invest in crop enhancement and establishing agricultural storage facilities that give support to production and distribution activities. This initiative has also attracted funds from local and international investors to support the procurement of farming equipment (Clasadonte et al., 2013; Ani et al., 2022).

5.3 The Agricultural Value Chains

The value chain is a range of economic activities associated with bringing a product or service to end users and beyond (reverse logistics) at affordable cost (Gereffi and Fernandez-Stark, 2016). Typically, in global value chains, agricultural production takes place far from the geographical location of final consumption (Kingswell et al., 2020). Activities included in a value chain are “design, production, marketing, distribution, and support to final customers” (de Backer and Miroudot, 2014). Orr and Donovan, (2018) opined that selecting channels for getting products to the market is an essential part of the commercial supply and value chains activities which involve the movement of goods from production to consumption.

The grain farm sector's GDP value chain increased only marginally between 2009 and 2019, averaging 26.75 per cent in 2009 and 21.91 per cent in 2019 (NBS, 2021). Reddy et al., (2018) noted that complex value chains necessitate both capital and knowledge sharing, supported by strong institutional arrangements that should alleviate farmers risks. They said it is critical that institutions encourage farmers to participate in their value-added supply chains with new forms of technologies and other agro-allied resources leverage value enhancement.

5.4 Grains-Crop production and distribution network in Nigeria.

The main food grains staples in Nigeria comprise maize, wheat, sorghum, and rice. Grain farming is predominantly undertaken by smallholder farmers, who face challenges regarding access to funds and the availability of quality inputs to improve yield.

Figure 2 below helps to understand the simple local movement of maize grains from the farm to the consumers. It also reveals the activities involved in the movement of grains from the farm, to processing mills and packaging to multiple end products, to the wholesaler's warehouse, and onward distributions to the retail buyers and homes. For products with extended shelf lives, the harvested yields undergo processes like threshing and drying before being stored away or transported to the end customer. Upstream processing (Flour mills) tasks are carried out at locations suitable for the characteristics of crops and the intricacies inherent in the ultimate products. This demonstrates the principles of specialised diversification and the division of labour along the value chain, where each producer, processor, and distributors operate interdependently, whilst engaging in value added activities, to ensure quality delivery to the next link without causing obstructions to the production lines. (Larsen, 2016).

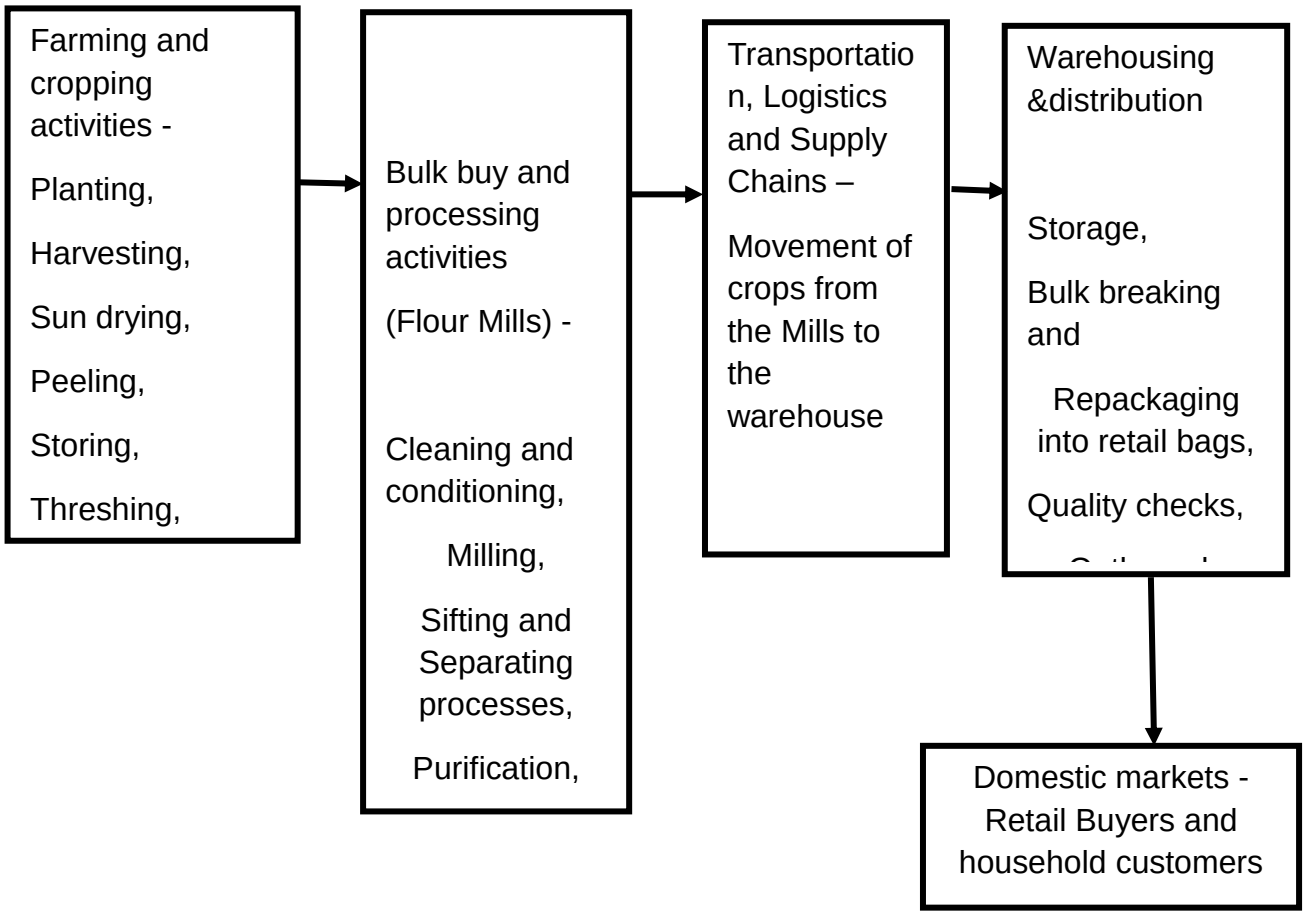

Figure 2. Typical grains-crop supply chain network. Source: Adewole & Obed (2023) Model developed from the literature .

5.5 Contract Farming and Crop Diversification Coordination

Rural economies in the sub-Saharan Africa are undergoing rapid form of transformations that have given rise to new types of agricultural systems that align with their supply chain networks, in which the 'vertical coordination among production, processing and distribution activities are closely monitored and regulated' (Bijman (2008). Most smallholder farmers in the country use crop diversification, which is described as growing a diverse mix of crops in a multiple cropping system in spaces that are adapted to various agro-ecological zones (Ajibefun, 2006). According to Singh, (2000), crop diversification is regarded as a phenomenon that has attracted considerable interest among peasant farmers for reasons of achieving better

yields, mitigating potential risks against uncertainty, generating income and employment opportunity, increasing the ability to reduce diseases, weed and insect build-up, and the possibility to increase soil fertility.This kind of coordination and efficiency in supply chains lowers transaction costs and enables competitive prices and deliveries (Singh, 2019).

Setboonsarng et al., (2008) and Singh, (2005), regarded contract farming and crop diversification as a practical intervention in agricultural system that has the ability to bring improvement in incomes and employment. Contract farming is an arrangement between the farmers and produce buyers under a pre-production agreement. The essence of such agreement is to pre-determine the quantity and quality of produce from the farmers at a predetermined time and price (Bellemare, 2012; Eaton & Shepherd, 2001; Sharma, 2016; Singh, 2002).

Under contract farming, the buyers have substantial control over the raw material production without any land ownership and thereby, get consistent supply of raw materials with the preferred quality at lower costs, while the farmers get assured market and price for their produce (Singh, 2005c; Tripathi et al., 2005). In most cases peasant farmers are typically too small to develop their own marketing plans; they therefore partner with larger networks involving wholesalers, food processors, and retailers or marketing cooperatives in a contract farming arrangement. Such mutual arrangements enable farmers to derive a win-win benefit from the risk-averse approach to faming.

6. Risks and resilience in grain-crop production

Christopher (2016) argued that supply chain complexity leads to uncertainty, and this uncertainty increases the likelihood that prediction error will rise in tandem with complexity. Simangunsong et al. (2016) noted that the unpredictability of global events has increased the level of uncertainty in supply chain activities. They also stated that understanding and managing these uncertainties have become challenging for organisations. Knight (1965) explained the key differences between risk and uncertainty, when he said, "uncertainty" is a phenomenon that cannot be measured, although "risk" can be.

Chopra and Sodhi (2014) and Ivanov (2018) said that supply chain risks can be classified into two, that is, recurrent-operational risks, and disruption risks. Recurrent-operational risks, they said, could be described as ‘random uncertainty’ in demand and supply, and that significant success can be achieved in mitigating recurrent-operational risks through improved supply chain planning and execution. On the other hand, they viewed that disruption risk is more complex due to the challenges of globalisation and outsourcing complexities that are presenting supply chain managers with new challenges. Attempts at mitigating these risks, Greening, and Rutherford (2011) noted, are more tasking due to their unpredictable nature. A supply chain vulnerability is defined as an exposure to serious disruption caused by risks both within and outside the supply chain network (Christopher and Peck, 2004).

The work of Ivanov (2018) identified several challenges militating the grain market value chains in Nigeria. Some of these challenges include inadequate capital, poor agronomic practices that are largely subsistence-based, poor seed varieties, insecurity in key grain production belts, climate change, and inadequate storage and distribution facilities. To mitigate these disruptions and risks, it is crucial that small-scale farmers participate in value-added supply chains, especially with the introduction of logistics technologies that facilitate organisational linkages. Ivanov (2018) also identified disruption risks that could have a long-term impact such as, political conflicts, natural disasters, terrorism, maritime piracy, economic crises, the destruction of information and communication systems, and transport infrastructure failures (Figure 3 below).

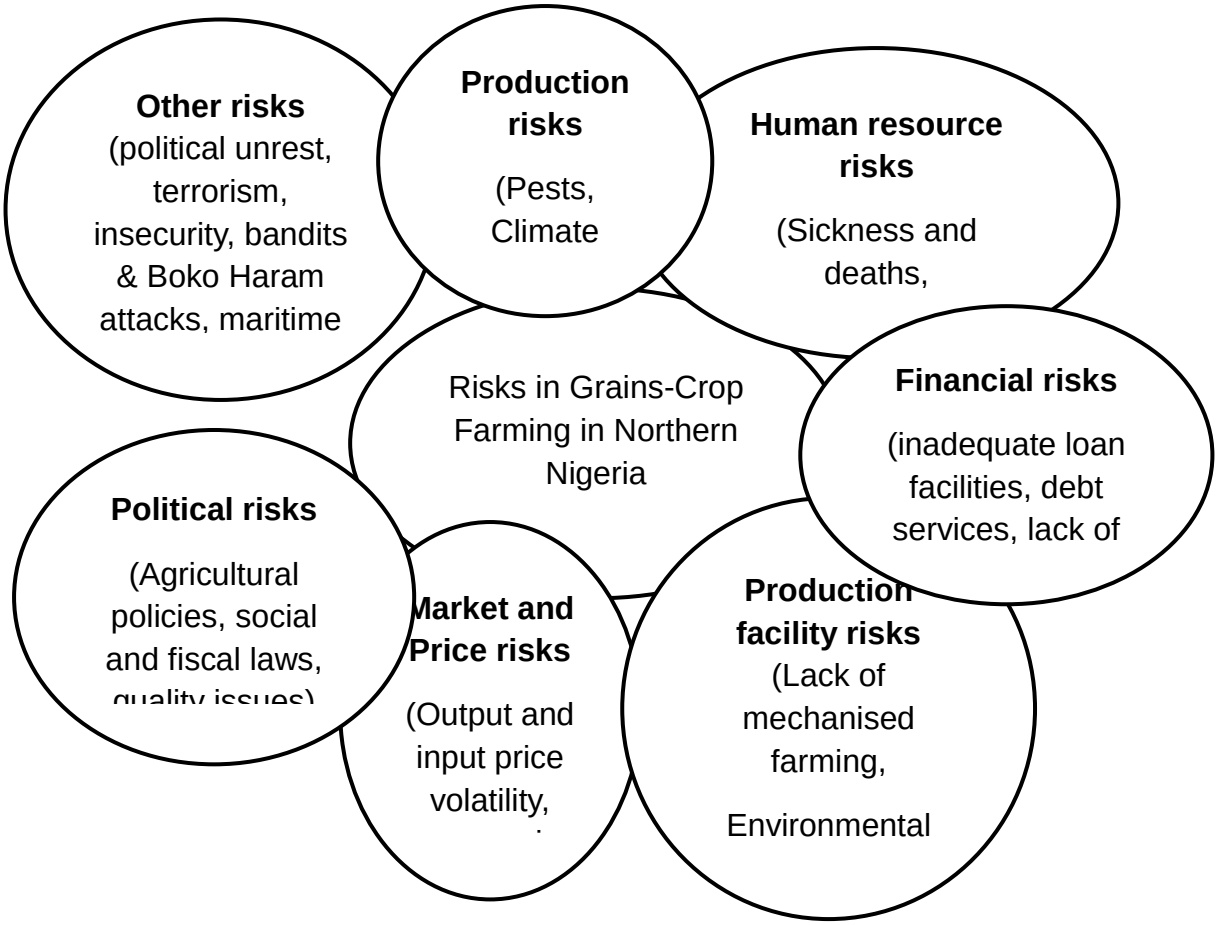

Figure 3. Showing the key risks facing grains farmers in Nigeria. Source: Adewole & Sambo (2024) – Derived from secondary sources. .

Because high efficiency and output must be maintained in a complex and changing environment, resilience is required (Asbjørnslet, 2009). Resilience according to Christopher and Peck (2004), is a system's ability to change from an unfavourable situation to a new, more desirable state or to go back to its initial state. According to Deloach (2000), business risk is the amount of uncertainty that an organisation must understand and successfully manage while implementing its strategy to achieve its goals and add value. Resilience is the level of adaptability to uncertainties and the ability to recover after a disruption.

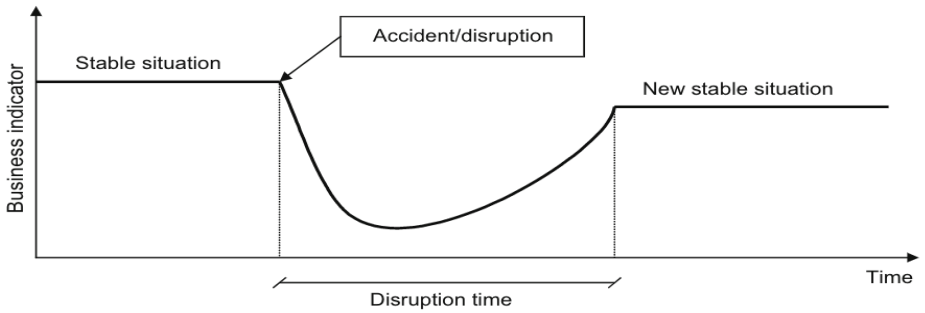

Figure 4. Regaining stability after disruptions. Source: Asbjørnslet, B.E., (2009).

6.1 Supply Chain Disturbances

Disturbances refer to unexpected events or changes that cause temporary disruptions or deviation to the normal operations of the supply chain. Disturbances, when not dealt with strategically, bring about persistent disruption in the supply chain process. Barroso et al., (2008) defined disturbance as "an unforeseeable event

that affects the usual operations and stability of an organisation or its supply chains". Disturbances can be classified as social, economic, or environmental issues. In most cases, disturbances arise from sources, such as natural disasters, equipment failures, labour strikes, raw material shortages, or quality issues (figure 4 above). These events have the potential to disrupt the flows of products, information or finances within grain the supply chains. Disturbances are typically short-term in nature and can be resolved or managed through, for example, contingency plans, alternative sourcing, or temporary adjustments in operations. The result of most disturbances is unfulfilled orders (Carvalho et al., 2014), leading to customer dissatisfaction.

6.2 Disruptions and Insecurity

Disruptions, on the other hand, signify a more severe and long-lasting events that cause significant interruption or breakdown in the supply chain. Disruptions are often unexpected and can have a broader impact, affecting multiple stages of the supply chain and multiple stakeholders involved. Disruptions can stem from major incidents such as political unrest, geopolitical conflicts, pandemics, economic crises, or large-scale natural disasters. The demographic nature, ethnic and religious differences, and geo-domestic politics have caused severe levels of unrest and conflicts in most parts of the country. A large area of Northern Nigeria has been riddled by conflicts, banditry, farmer-herder clashes, robberies, kidnappings, and general insecurity (FMARD, 2023). Lack of security has posed major threats to food production and distribution.

6.3 Risks mitigation (Resilience) strategies for grain crop production

From the discussion above, it can be suggested that disturbances and disruptions can have varying degrees of impact on different supply chains depending on their specific vulnerabilities, dependencies, and preparedness. Effective risk management practices, robust contingency plans, and proactive measures might therefore help agricultural organizations to mitigate the effects of disturbances and disruptions and enhance the overall resilience of their supply chains.

(Eaton & Shepherd, 2001; Singh, 2002). Adedayo et.al., (2009); Bellemare, (2012); Sharma, (2016); Amare et al., (2021) suggested several strategies to mitigate risks and build resilience in the production and supply chains of grains. These include:

Crop diversification. Farmers employ this technique to help them to reduce the impact of weather-related risks. Planting different varieties of crops and utilizing different agricultural practices help farmers to mitigate the potential losses associated with a single crop failure.

Contract farming (risk-sharing) and Insurance mechanisms. Farmers mitigate the financial impact of crop losses by purchasing crop insurance or participating in contract farming (risk-sharing) programs. These mechanisms provide compensation in the event of yield losses due to weather, pests, or diseases.

Credit guarantee Schemes. This is meant to support investment in affordable conditions, amount, duration, nature of transaction, and type or size of farms.

Climate change and forecasting decision support systems. Advanced weather forecasting systems and decision support tools to assist farmers in making informed decisions related to planting, irrigation, and pest management. Timely and accurate information can help farmers to reduce the impact of weather-related risks and optimise crop production.

Co-ordination and information sharing: Integrated partnerships among stakeholders, such as farmers, processors, transport logistics and distributors, warehouse operators, as well as commodity buyers in the supply chains can improve coordination and reduce information gaps. Sharing of relevant and timely crop information can help to reduce risks and disruptions through improved forecasting, updated market trends, and optimised transportation logistics.

Enhanced storage and post-harvest management: Modern and secured storage facilities with post-harvest management practices will minimize losses due to pests, diseases, and quality deterioration. Implementing

techniques like adequate cleaning, drying, and pest control measures can improve the shelf life and marketability of grain crops.

7. Research Methodology and design

The primary work in this study adopted the qualitative interview approach, using the interpretive inductive analytic techniques to explore the experiences of grain-crop farmers in the northern part of Nigeria. The researchers follow the view of Cottrell (2014, p98) that social phenomena do not exist in abstract and cannot be known objectively, and that they are constructed by the society, therefore their meaning can be interpreted. Interpretivism therefore becomes our preferred choice as, in social constructivism, the researcher cannot stand outside ideological positions. We selected 2 interviewees from each of the seven states in North-Western Nigeria, making 14 participants overall. Purposive method was the preferred sampling technique. The intention of this research was not to generalise results but to specifically interrogate farmers who are willing to participate, as qualitative research is about the expression of human feelings and emotions and the ability to make narratives of experience and knowledge of things.

Initial secondary review explored wide sources including academic journals, technical agricultural journals, government and commission reports, online sites and databases, to provide insights to key underlying questions in the Nigerian grain food sector. Information was structured into sections, heading and sub-headings for analysis. It is our view that secondary research is of value when multiple sources of documented information are juxtaposed with empirical data and analysed to perform critical review of the subject under discourse.

Data analysis employed both deductive and inductive approaches. While deductive themes are derived from the literature involving collecting and analysing existing data, the inductive themes emerge from the data involving analysis of field data without preconceived categories or theories.

8. Findings and Discussion

In this study, we found that price volatility, unfavourable climate, poor access roads to rural farmers, and crops insecurity, are amongst the major challenges facing small farm holders in North-Western Nigeria. Due to the influence of price volatility, prices are typically low around harvest season, pushing farmers to always sell in large quantities at lower prices to raise enough cash for their family needs. This invariably means that farmers run out of stock during the lean season after selling in large quantities during harvest season.

8.1 Key themes from investigations

Major risks facing farm owners, as our field work revealed, include dysfunctional information sharing with small-scale farmers, insecurity to life and crops due to herders' invasion, limited, or no access to modern agricultural technology, high cost of farm inputs, unfavourable land tenure system, insufficient agricultural credit, gender equality and low youth engagement, and unstructured route to market. Farmers also spoke about their experiences relating to unfavourable climate change, inadequate network of physical and social infrastructure such Rail, roads, and waterways, lack of adequate storage facilities, poorly implemented agricultural policies, and lack of agricultural insurance facilities to support rural farming. They said these factors have always resulted in permanent loss in farm produce and in income.

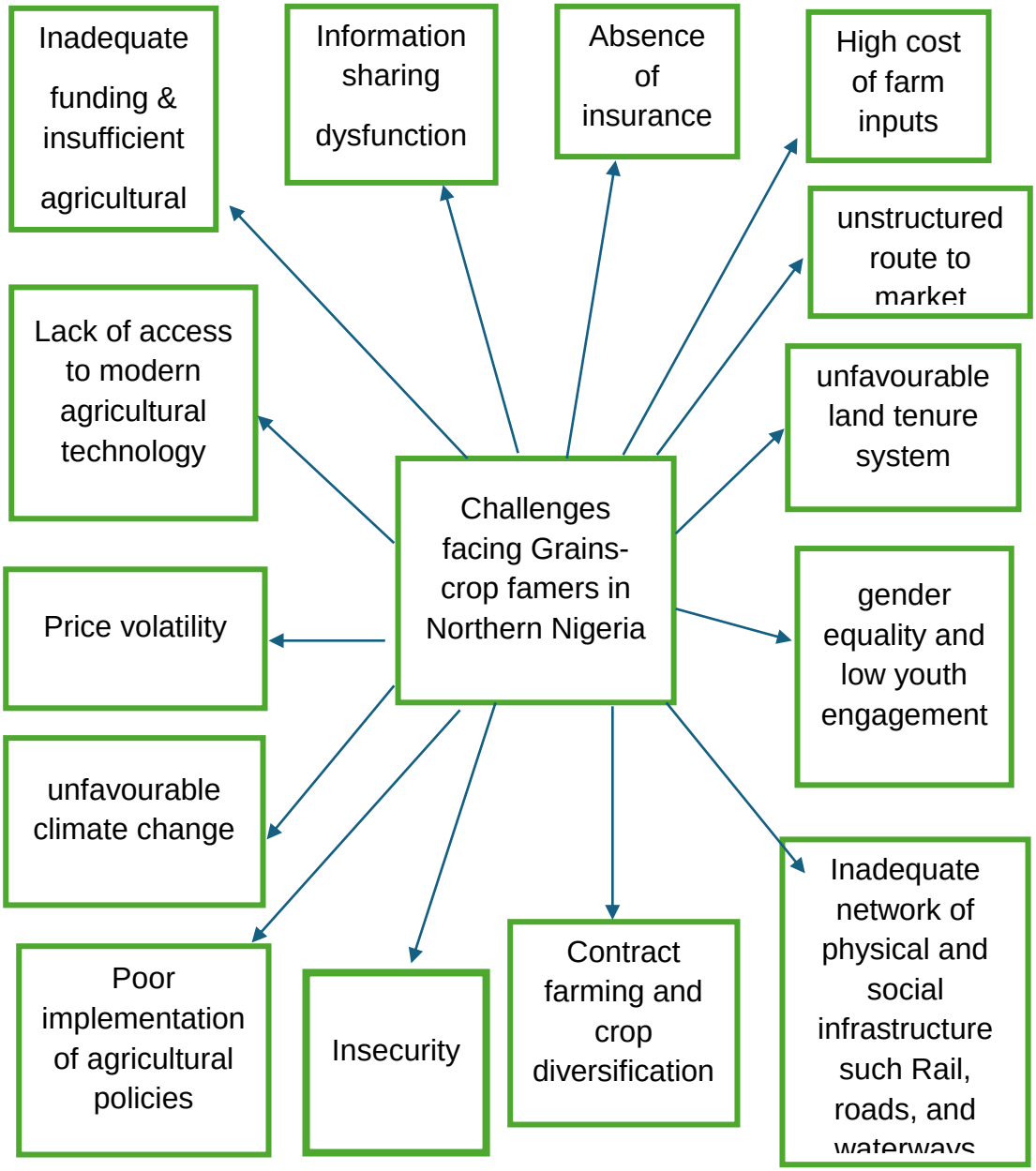

Figure 5. showing the thematic constraints influencing grain-crops production in Nigeria. Source: Adewole and Obed (2023) Model developed from field interviews.

Understanding these influences is crucial for developing integrated strategies that will address multiple challenges where and when they arise. It requires a holistic approach that considers the interplay between different factors and seeks to find synergies and solutions that can break the cycle of constraints and promote sustainable agricultural development in Nigeria.

8.2 Inadequate funding

Despite the Federal Government of Nigeria's partnership initiatives with the World Bank and other private organisations to develop agricultural schemes and funding for the agricultural sector, these initiatives brought little improvement to funding problems of farmers. Although, the Central Bank of Nigeria (CBN) had reported that funds were disbursed to farmers as and when the farmers needed the fund. The work of Anyiro and Oriaku (2011) emphasise the importance of funding to farmers outputs. Farmers in Northern Nigeria told us of their experience of inadequate access to funding support.

A farmer said, *"the few of us who had access to the fund received it after the farming season".* Giving the level of bureaucracy in the Nigerian systems, these discrepancies between what was disbursed and what gets

to the farmers could be attributed to the high number of intermediaries (middlemen) between the funding authorities and the farmers in the supply chain, leading to high prospect of delays, corruption and misappropriation of funds.

This paper suggests an overhaul of the methods of disbursement of funds to farmers, ensuring limited number of intermediaries to enable easier and timely flow of funds to farmers. We found that major factors that hinder access to farming loans includes high-interest rates, lack of collateral, and farmer's reluctance to provide guarantors, whilst the Federal government loans that are available with low-interest rates are difficult for farmers to access.

We suggest the establishment of local loans board for famers to mitigate their current limited access to credits and loans for agriculture. Farmers should have access to credits or loans with reasonable payback time and interest rates. This, in our view, will help to improve productivity, and build resilience amongst grains-crop farmers.

8.3 The lack of agricultural Insurance

Secondary data sources on farmers' experience (Mulubrham & Bedru (2023) revealed that there was little or no insurance scheme facilities available to small-scale farmers. The issues of climate change, farmer-herder conflict, community conflict, and banditry have destroyed small-scale grain farms in Nigeria without any insurance back up.

Farmers interviewed expressed dissatisfaction with the government's poor responses, or lack of it, whenever their farm crops and properties were destroyed by bandits and herders.

"Our farms are being constantly destroyed every year. We are helpless against cattle herders who are carrying weapons when they bring their cattle to feed on our crops. We need both financial and insurance support to enable us to continue to farm", a farmer told us.

We identified low level of confidence of farmers in insurance schemes. Because there are no insurance schemes in place for rural farmers, farmers believe they have no hope of receiving compensations for their economic loss on farm produce destroyed by bandits.

This research views that the National government, through the structures of state and local governments, should be more proactive in addressing the plight of farmers in the North-Western region of Nigeria. Similarly, we hold the view that it is imperative to build a high level of trust between the insurance service providers and the farmers to mitigate farmers loss and inability to return to the farm for planting and harvesting.

8.4 Insecurity

Interviews with farmer-participants revealed that the issue of insecurity in Nigeria is complex due to many prevailing socio-cultural and political factors.

One significant observation during field work revealed how the demographic nature, ethnic and religious differences, and geo-domestic politics have caused severe levels of unrest and conflict in most agrarian part of the Northern region. Significant parts have been riddled by conflicts, banditry, farmer-herder clashes, inter-community clashes, cattle-rustling, robberies, kidnappings, and general insecurity. Insecurity has posed serious threats to food production and distribution. Bandits and terrorist gangs (Boko Haram) consistently destroyed farmlands and engaged in cattle rustling, as well as killing of farmers.

This development poses unprecedented challenges to the Nigerian agricultural sector, which has significantly hindered agricultural activities and food production in the Northern region of Nigeria where grain-crops farming is predominant. Nigeria needs strong political leadership to influence local Emirs and community leaders to play positive parts in community policing and information sharing with government established security networks to identify and arrest sources of insecurity.

8.5 Low Level of education and language barrier

Across most of our interviewees, we found inability to read and write in both local and English languages as one of the major barriers. Their low level of education constitutes a disadvantage to farmers. Most farmers could only speak in their local dialects and barely able to read or write as they have little knowledge of literacy education.

Because most leaflets and literature relating to agricultural practices, marketing and funding opportunities are written in English language, the local farmers are left out of opportunities to access the required support they need for farming. Where farmers had some level of education, they were found not to have knowledge of modern agricultural production practices due to the absence of adequate agricultural training. A farmer said, "*Yes, our low level of education affects us because knowledge is power; you cannot give what you don't have".* This response established the critical role of education and training, and demonstrates that knowledge equips individuals to make informed decisions, highlighting the importance of knowing "what to do, when to do it, and how to do it" in agricultural production business.

Our research noted the efforts of both the Nigerian Federal and State governments as they collaborate with farmers cooperatives and the media to translate information into local languages. Despite this, there were noticeable areas for improvements where vital information could be adequate translated.

8.6 Low engagement of youths and gender inequality

Although FMARD (2022) postulated that more youth participation in agriculture and natural resource management will improve Nigeria's food security, *our field work revealed that low participation of youths in agriculture is prevalent due to lack of incentives to take up agriculture as a vocation. Young people find farming unattractive because of the labour-intensive nature of the job, where you work more hours and earn less. Across the region, our investigation found that the youths view agriculture as a vocation that involves rough labour with low financial benefits, and only reserved for the uneducated rural sector.*

On gender inequality, we found this is prevalent in Northern-Western Nigeria. Field enquiries found cultural and religious norms to be responsible for women to stay indoors and take care of the home whilst men go out to the fields. Most women who are involved in farming, can only work in their husbands' farms, and only a negligible number have the opportunity to own their farms.

8.7 Price volatility and high cost of agricultural inputs

Another significant finding was how the sector has been responding to high level of inflation. Farmers complain about the costs of production, as prices of agricultural inputs were at an all-time high in the country. Price volatility play a major role due to unpredictable increases in agricultural inputs, while the price of grain crops, particularly maize, decreased from N17,000 to as low as N13,000 in 2023, while prices of other crops fluctuate slightly high or low.

Small farm owners respond to price volatility by practising mixed cropping to achieve balance of income from other farm products. Farmers express concerns on the continuous increase in inputs, especially herbicides and fertilisers, which keeps rising due to the economic challenges affecting the country. This indicated critical challenge for many farmers.

Famers tend to increase their risks management strategy by selling their produce during harvest season, despite low volatility, to push their products to the market to avoid spoilage and to safe money to purchase seeds in the following planting season.

A small farm holder told us "I have to resort to buying seedlings at higher prices for the new planting season because I sold most of my crops in the harvest season when there are plenty to get money to feed my family. My harvests will spoil if I don't do that. I have nowhere to keep them. so, it is good for me to sell them when I can get the money from selling them".

8.8 Low adoption of modern farming techniques

Data from interviews confirmed the view of FMARD (2022) that there is low level of application of mechanised farming and processing equipment such as tractors, power tillers, threshers, crushers, harvesters, choppers, hay balers, and mixers among others. This may have been one of the factors responsible for limited utilisation of cultivated land and low grains productivity. One interviewee said "*I do not have enough money to buy or hire tractors and other machines. I need government to help me, but there is no hope for help. I can only do my best to feed my family and sell in small quantity to get small money to take care of my family in my small way".* This farmer's statement emphasised the preponderance of low adoption of modern faming equipment and the barrier it poses to agricultural development in the North-Western region of Nigeria. This research views that Agricultural policy makers could alleviate the plight of farmers with a turnaround of the 'Tractorisation Programme' of government in collaboration with the Bank of Agriculture (BOA) to enhance productivity.

8.9 Contract farming, crop diversification and route to market

In confirmation of the suggestions of Bellemare (2012); Eaton & Shepherd (2001); and Singh (2002), Our interviews revealed that contract farming was attracting considerable interest among peasant farmers for reasons of achieving better yields, increasing incomes, mitigating potential risks and guiding against market uncertainty. Contract farming also offers farmers the opportunity to improve their ability to reduce diseases and pests as well as increase soil fertility.

The assertion of Akudugu (2016); Allen (2009); and Yan et al. (2019) that smallholder farmers' productivity index are linked to unstable domestic economic changes and that farmers bear the most risks and receive the most inequitable share of the supply chain's rewards is evident in the challenges farmers are facing in northern Nigeria. Most smallholder farmers mitigate their challenges through crop diversification by growing mix of crops in multiple cropping systems (Ajibefun, 2006). This is because peasant farmers are typically too small-sized and not financially capable to develop their own agro-zones and market routes. They also collaborate with larger networks involving wholesalers, food processors, and agents such as marketing cooperatives for their crops to get to the markets.

As routes to markets are critical to commercial supply and value chain activities (Orr and Donovan, 2018), contract farming and crop diversification are essential tools for addressing possible risks facing production in northern Nigeria. Small farm-holders leverage on these techniques to develop farming networks for selling their products, especially where merchants provide inputs and guarantees purchase of farmer's produce.

8.10 Information Dysfunction

Information sharing can enhance smallholder farmers' knowledge and decision making. This study founds that there is largely a low level of information sharing mechanism amongst smallholder farmers. This was as a result of low level of education, lack of capacity to access information, inaccurate and unstructured information channels, and high cost of simple information tools such as mobile phones.

In order to mitigate farmers challenges, this study suggests organised short training programmes, through respective farmers local government and cooperative unions, to improve farmers' skills in adult literacy and in the use of information and communication technology (ICT). While Oladele (2008) and Zhang et al. (2016) proposed use of audio-visual guides as means to enhance utilization of information especially among the illiterate, Opolot (2016) proposed regular and interactive communication with external information sources for proper application of agricultural information. Oladele and Opolot's suggestions were consistent with the studies conducted by Lwoga et al. (2010), and Zhang et al. (2016). In their work, Lwoga et al. (2010) expressed the need for capacity building in the use of ICTs to enhance information flow between farmers and information providers. This research therefore suggests that State governments should

encourage local governments, cooperative organisations and other stakeholders in their jurisdictions to establish knowledge sharing hubs at farm cluster levels to support farmers with translation of information into local languages, and in the use of mobile phone technologies.

Responses from key informants corresponded with the view that the implementation of these measures will significantly enhance awareness of farmers and increase their access to useful sources of information.

8.11 Climate change

FMARD (2022) claimed that climate change constitutes severe danger to the country's food security, as more than 90 per cent of Nigeria's agricultural output depends on the rain, leaving the country susceptible to erratic weather inclement. Smallholder communities whose livelihood depends mainly on grains farming, with no other noticeable economic activities are largely affected by unpredictable weather conditions. *Most of the farmers we interviewed testified to how the effects of prolonged drought and occasional floods caused by erratic changes in climate conditions significantly impacted negatively on their farms.* Their experiences supported FMARD's report that variations in rainfall patterns and levels, the frequency of droughts and floods substantially contribute to reduced productivity. In most parts of northern Nigeria, drought is the major concern to farmers since agriculture in Nigeria is rainfall dependent. Late or early rains have consequences on agricultural yields. This study noted that the hope of achieving food security, poverty reduction and wellbeing as proposed by the United Nations's Sustainable Development Goals 1,2 and 3 is limited with rural smallholder farmers in Northern Nigeria as the production of grains and fibres becomes riskier and more uncertain because of unreliable climate change.

Understanding climate change patterns is key for small-scale farmers in adopting risk mitigation strategies for managing climate uncertainties. This study advocates that relevant agencies should prioritise efforts on research to improve the development of seeds with the ability to withstand drought, pests, and diseases, to enable the UNDGs 1,2, and 3 achievable.

8.12 Inadequate Agricultural infrastructure

Our research observed that due to extensive, inadequate and unmotorable rural road and rail network in Nigeria, the grains supply chains value appears to be in perpetual stagnation. From our observation, inadequate agricultural infrastructures such as rail, road, water ways, and storage facilities are perennial, especially in the rural communities. The poor state of rural road networks contributes to high cost of transportation-logistics. It is the view of this study that adequate and regular maintenance of access roads and innovative investment on possible extension rail lines to rural will reduce the cost of logistics and enable ease of access to markets, as well as increase profit margin for farmers. An interviewee, who is a leader of a local Cooperative Union told us:

"If we have good roads reaching our farms and villages, or if the roads we already have are maintained by government, we will be able to move our crops out to the cities and sell them at good prices. We will also produce more. Our children will stay to farm with us instead of running to the cities for greener pastures. Our condition will be better in our villages, if we have good access to markets in the cities."

8.13 Agricultural policies in Nigeria

Our investigation in this study identified varying government initiatives that support grains farming in Nigeria. Some of these projects have been developed by the Federal Ministry of Agriculture and Rural Development (FMARD), of which include the FADAMA projects, The Agro-processing, Productivity, Enhancement, and Livelihood Improvement Support (APPEALS) programme, the LIFE Project, and the ZERO REJECT. These initiatives have their focus on measures to increase food production. Examples are the provision of fertilisers to farmers, and the introduction of tariff restriction or outright prohibition on importation of certain grain products to encourage local production. Despite these government initiatives,

farmers, spoke of their concerns about the government's agrarian policies and interventions not "*being efficiently and effectively implemented to achieve the desired results for the rural farmers."*

9. Conclusion, Limitations and Suggestions for Future Research

In conclusion, this paper, has provided robust insights into the challenges facing grain-crops production in Nigeria and the role of government of Nigeria and other stakeholders in supporting grain-crops farming in the North-West of Nigeria to alleviate risks to production and increase supply chain-value resilience. Key issues revealed from field data analysis included, unstable market prices (volatility), unfavourable climate change, ineffective agricultural policies, inadequate infrastructure, lack of agricultural insurance and credit scheme, and insecurity due to the activities of terrorists, cattle herders, and bandits. Factors responsible for low yield and productivity were attributed to low level of education, gender inequality and low incentive for the youths to engage in farming, high cost of inputs, low adoption of modern farming techniques, and lack of access to market.

To address these challenges, the paper recommends the importance of effective and improved implementation of agricultural policies, improved and timely access to funding, accessible credit schemes, and agricultural insurance that can empower small-farm owners. The paper suggests that policy interventions should also prioritise climate change adaptation, agricultural infrastructure development, and the adoption of modern farming techniques.

This study underscores the significance of capacity building and knowledge transfer to enhance the resilience of small-farm owners. It highlights the need for initiatives that will focus on improved agricultural practices, adequate facilitation of route to market, and encouragement of efficient information sharing between rural farmers and their trading partners.

Limitations This study adopted only the qualitative research approach and limited its sample size to a few farmers purposively selected from the seven North-Western states of Nigeria. This means the outcome will not be representative of all the smallholder farmers in North-Western Nigeria.

Future Research In view of the limited sample size and non-generalisability of the outcomes in this research, we recommend future research that will extend to the rest of the five states in the northern region of Nigeria where the production of grains is the predominant occupation. This may be achieved through quantitative analysis for a more representative finding.

10 Research deliverables and Contributions towards Sustainable Development Goals (SDGs 1, 2, 3, 5, 9, 10, 12, 13, 16, 17)

This research was conducted with the views to contribute to the socio-economic and technological changes that will change policy and practice, and influence the agrarian community in the North-Western Nigeria.

Economic: It is expected if small-holder grains farmers will have access to funding support, fertilisers and a level of technology for communication, they will enhance their economic status through improved outputs and ease of access to market. (SDGs: 1- eradication of poverty; 2 - Zero hunger; 3 - good quality health and wellbeing)

Enhanced method of farming: Innovative approached to techniques of crop diversification and contract farming will help famers to manage farm spaces, increase yields, and increase incomes and employment. Through farmers' cooperatives, farmers can benefit from series of training support to improve their capacity to increase soil fertility, fight crop pests and reduce the risks of diseases destroying their crops. (SDGs: 9 - industry innovation and infrastructure)

Social impact: Employment in the agrarian sector – adequate rural access roads, fertile soil and access to farming inputs, including finance will more likely motivate the youths and women to participate. (SDGs: 5 - gender equality; 8 - decent work and economic growth; 10 - reduce inequality)

Environmental impact: Availability of modern sheds (small to medium) storage facilities, through cooperative associations and government agencies, will prevent farmers from incurring large spoilage of crops in the time of heavy rainfall or prolonged droughts, and other weather acclamations. (SDGs: 12 - responsible consumption and production; 13 - climate actions)

Influence on policy: This research intends to influence and direct the attention of State and Local governments toward making favourable policies that will support and encourage grains production in Nigeria. It is also to advocate effective policies that will improve crops security and farmers safety though facilitation of peace between farmers and cattle herders, ensuring that the Federal Ministry of Agriculture and Rural Development (FMARD) programmes are adequately and efficiently delivered to achieve these purposes. (SDGs: 16 - peace, justice and strong institutions; 17 - partnership for goals)

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