Sustainable Supply Chain Towards Managing Food Security of Rice in the North Central Nigeria.

By

Adenike Oluyemi Bello

219096260

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College of Law and Management Studies
School of Management, Information Technology and Governance

Supervisor: Dr Thokozani. P. Mbhele

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ABSTRACT

In a developing nation such as Nigeria, food security which is global agenda that must be achieved by 2030 based on the Sustainable Development Goals is yet to be accomplished. Hence, adoption of sustainable practices across the supply chain of food is fundamental for ensuring food security could be considered. To this end, this study investigates food security in the North central region of Nigeria by examining the strategic role of adoption of sustainable supply chain practices for activities of stakeholders of the rice value chain for availability, affordability, accessibility and competitiveness of rice in the region. The study employed a convergent mixed methods design to provide relevant insights into the stakeholders across the rice value chain. For the qualitative research, 24 rice value chain stakeholders were interviewed (six government representatives, six large-scale rice farmers, and 12 small-scale rice farmers). Quantitative data was collected with questionnaires, which were administered using a stratified sampling technique to 360 small scale Rice farmers association of Nigeria (RIFAN) members. The study from the qualitative data revealed how the available resources of one stakeholder influenced the activity and productivity of another. The regression model revealed that adoption of sustainable practice would impact food security and competitive performance of rice produced from that region. This would improve the profitability and standard of living of rice farmers. The outcome of the quantitative data using Fuzzy Analytical Hierarchical Process-Multi Criteria Decision Making (F-AHP MCDM) weighed the decision-making of stakeholders in line with Triple Bottom Line and the adoption of sustainable practices in activities. The significant implication of the study is that towards food security, adoption of sustainable practices across the rice value chain must be driven by government as a stakeholder. The study recommends the adoption of sustainable practices driven by technology across supply chain of rice and the activities of stakeholders, will improve food security in the region. The study is limited because it could only explore rice stakeholders in the Edu-Patigi local government area of Kwara state, North-central region Nigeria, however, it serves as a foundation for further studies for wider scope or ask specific questions.

Key Words: Sustainable supply chain, food security, rice value chain

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List of definitions and key terms

Food security	Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life
Supply chain management	the strategic and systemic coordination of all the business functions, policies and procedures of a particular company, and across businesses within the supply chain, with the goal of improving the long-term performance of the whole supply chain and the companies that are involved in all its levels
Sustainability	development that meets the needs of the present population without compromising the ability of future generations to meet their needs
Value chain	the range of activities overseen by a firm, right from the conception phase up till to the end users, which can be re-used, recycled or disposed of; these secondary activities are targeted at adding value to the primary ones of businesses or farmers in the process of creating a product
Sustainable supply chain	a supply chain which not only makes a profit and realizes its potential at the same time, but is also responsible to its consumers and providers, to companies and to environments through innovative strategy, tactics and management technologies
SCOR	model for the management of the processes and activities across the supply chain; it does this through the combination of business techniques, benchmarking, and best business practice for the development of framework which is aimed at improving the performance of supply chain management

LIST OF ABBREVIATIONS

ABP	Anchor Borrowers Programme
ADP	Agricultural Development Project
AGRA	Alliance for a Green Revolution in Africa
AHP	Analytical Hierarchy Process
AMOS	Analysis of Moment Structure
ANOVA	Analysis of Variance
APP	Agricultural Promotion Policy
ATA	Agricultural Transformation Agenda
BCT	Block Chain Technology
BRRI	Bangladesh Rice Research Institute
BSC	Bachelor of Science
BVN	Bank Verification Number
CARD	Coalition for African Rice Development
CBN	Central Bank of Nigeria
CBTS	Community Trap Barrier Systems
CL	Clearfield
CP	Competitive Performance
CRRP	Climate Resilient Rice Production
CSCMP	Council of Supply Chain Management Professionals
CSR	Corporate Social Responsibility
DSR	Direct Seeded Rice
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
F- AHP	Fuzzy Analytical Hierarchy Process
FIES	Food Insecurity Experience Scale
FIS	Fuzzy Inference System
FMARD	Federal Ministry of Agriculture and Rural Development

FRRS	Federal Rice Research Station
GAIN	Global Agricultural Information Network
GAP	Good Agronomic Practices GAP
GESS	Growth Enhancement Support scheme
GHG	Green House Gas
GMP	Good Manufacturing Practices
GRiSP	Global Rice Science Partnership
GOI	Government of India
HLPE	High Level Panel Experts
HND	Higher National Diploma
HYV	High Yielding Varieties
ICLEI	International Council for Local Environmental Initiatives
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IRR	International Rice Research Institute
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
KWADP	Kwara State Ministry of Agriculture, Agricultural Development Project
LGA	Local Government Area
LSF	Large Scale Farmers
MANOVA	Multivariate Analysis of Variance
MCDM	Multi-Criteria Decision-Making
MDG	Millennium Development Goals
Mmt	Million Metric Tonnes
MT	Million Tonnes
MTR	Machine Transplanted Rice
MSc	Master of Science

MSP	Minimum Support Price
NACB	National Agricultural and Cooperative Bank
NADMIS	National Agricultural Data Management and Information System
NATIP	National Agricultural Technology and Innovation Policy
NBS	National Bureau of Statistics
NCR	National Collateral Registry
NDP	National Development Plan
NGOs	Non-Governmental Organizations
NIRSAL	Nigerian Incentive-based Risk Sharing System for Agricultural Lending
NPK	Nitrogen, Phosphorus and Potassium
NRDS	National Rice Development Strategies
OECD	Organisation for Economic Co-operation and Development
OFN	Operation Feed the Nation
OND	Ordinary National Diploma
OPDCA	Observe-Plan-Do-Check-Adjust
PPMCC	Pearson’s Product-Moment Correlation Coefficient
PwC	Price Waterhouse Coopers
RDT	Resource Dependence Theory
RICOWAS	Regional Agricultural Policy for West Africa of the Economic Community of West African State
RIFAN	Rice Farmers Association of Nigeria (RIFAN)
RVC	Rice Value Chain
SADC	Southern African Development community
SAP	Structural Adjustment Programme
SCOR	Supply Chain Operations Reference
SCM	Supply chain management
SD	Sustainable Development
SDG	Sustainable Development Goals
SHFs	Smallholder Farmers

SPSS	Statistical Package of Social Science
SRI	System of Rice Intensification
SRP	Sustainable Rice Platform
SSC	Sustainable Supply Chain
SSCM	Sustainable Supply Chain Management
SSF	Small-Scale Farmers
StD	Standard Deviation
TA	Thematic Analysis
TBL	Triple Bottom Line
UAV	Unmanned Aerial Vehicle
UN	United Nations
UNICEF	United Nations Children’s Fund
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VCA	Value Chain Analysis
WCED	World Commission on Environment and Development
WFP	World Food Programme
WHO	World Health Organisation
2, 4-D	Dichlorophenoxyacetic ac

CHAPTER 1 INTRODUCTION

1.1 Introduction

Sustainability in food supplies can result in food availability and security across the African continent and developed nations. Sustainability in supply chain management generally reflects an incessant monitoring for risk and adverse effects, triggered by an array of activities outside the supply chain. The introduction of the Sustainable Development Goals (SDGs) by United Nation in 2016 was aimed at ending poverty, protecting the planet and ensuring peace and prosperity among humanity through the framework that links the economic, social and environmental dimensions of humanity (UN, 2015, p.26; Skene, 2021, p.9994). According to Maratis & Melissen (2019, p.253), one of the issues identified across nations is food shortage among many others. With regards to this, the second goal among the 17 SDGs is zero hunger, whose aim is to improve the food supply, drive food security, improve nutritional intakes and end hunger through the adoption of the sustainability framework. Food security is when all the people of a country in a given situation and at any moment of time, have physical and economic access to sufficient amount of healthy and nutritious food in order to maintain a healthy and active lifestyle (World Food Summit, 1996, pg. 4).

Supply chain management identifies the activities of various stakeholders involved in the flow and transformation of raw materials into a final output for their end-users; it is a flow that begins with the procurement of raw materials which are further transformed into a final product and where feedback on output is provided (Foong & Ng, 2022, p. 66). In accordance with the context of this study, food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2023, p .202; World Bank, 2023).

Consequently, in the quest to attain food security in the North Central region of Nigeria, the study leveraged sustainable supply chain management of the food sector, with a focus on rice as a staple food produced and consumed in the region. The main objective of this study is to investigate food security in the North central region of Nigeria by examining the strategic role of adoption of sustainable supply chain practices for activities of stakeholders of the rice value chain for availability, affordability, accessibility and competitiveness of rice in the region. Theories such as stakeholder theory, resource dependency theory, and force field theory guides the contextual scope of this study in terms of the relevant stakeholders; resource availability and dependence; the method for listing and assessing the forces for and against a circumstance while looking at how the main driving and restraining forces impact an issue. The fuzzy-based framework enabled the identification and assessment of variables, together with the multi-criteria decision-making (MCDM) framework, which focused on the levels of the underlying mixed methods research.

The adoption of sustainable practices across stakeholder's activities in supply chain of rice will enable food security. This may be possible through the introduction of technologically driven innovation in the social, economic, and environmental dimensions of the rice value chain.

1.2 Background of the Study

There is a growing consciousness that organisations are obliged to introduce sustainability in their day-to-day activities, which includes the management of their supply chain. Sustainable supply chain management has drawn considerable curiosity in recent times and become pragmatic for issues in green supply chain management, ethical sourcing, and sustainable operations (Niemann, et.al., 2017, p. 2). While ensuring a seamless and continuous flow of material, human, and other resources to meet human needs, organisations have engaged in compromising activities. These practices have led to global warming, depletion of natural resources, environmental damage, the exploitation of human and child labour, and relaxed regulations or poor operational policies. In response to these growing concerns, this research suggests sustainable supply chain practice as a tool to foster food security in the North Central region of Nigeria; this was done by investigating the activities of stakeholders of the rice value chain and introduced sustainability-related practices at all stages of the supply chain.

1.3 Rice Value Chain in Nigeria

The Rice value chain describes the linkages between the actors in the value chain (ranging from input suppliers, planters, harvesters, processors/manufactures, distributors, exporters, and consumers). It aids in the easy identification of profit, cost, and margin at each level of activity of the chain. However, this rice value chain varies as it is influenced by the value that each actor chooses to add at any stage, some of these values could be in terms of storage, variety (Fadama rice, FARO 44, short grain, ofada, paddy rice, or white rice) (Global Agricultural Information Network- GAIN report 2019, p. 11), transportation, packaging, or grading.

1.4 Research Problem

Rice is a staple that is highly demanded and consumed across the six geopolitical zones in Nigeria. It is consumed by all local governments and demographic groups; the reason for this may be due to consumer preference, increasing income, and rising urban populations (Osabuohien, et.al., 2018, p. 3). Okonkwo, et.al., (2021, p. 2) stated that rice produced in Nigeria accounts for 40% of the total output of rice produced in West Africa which is as the result of the country's rice cultivatable land, yet the country still imports a high quantity of rice. Unfortunately, in the view of ThriveAgric (2020), the country can only produce 3.7 million tonnes annually, whereas it consumes 6.4 million tonnes in the same period, which implies that the balance of 2.3 million tonnes needed is imported from other countries like India, Thailand, and China, which are large producers of rice.

It was identified that the countries with the highest rate of rice production have employed mechanisation and technology across their value chain which boosted rice production systems, improved food security, and the sustainable supply chain management of this produce (PWC, 2018, p. 6). In the North Central region of Nigeria, specifically concerning rice production and distribution, there exists a pressing need to establish sustainable supply chain practices to ensure the long-term management of food security. The current supply chain framework lacks efficiency, resilience, and environmental consciousness, leading to various challenges such as inconsistent rice availability, price fluctuations, and vulnerability to external shocks. These issues pose significant threats to food security, economic stability, and environmental sustainability in the region.

There is a growing need on the drive for sustainable supply chain of food, food security and attainment of the SDG2 (zero hunger) in Nigeria. More importantly, the devastating effect of food shortage on the most populous nation in Africa (Nigeria), has led to the recent attention by scholars in the field of supply chain management and food security. For instance, Ayinde et.al., (2020, p. 809) focused on linkage between food security and development by identifying various intervention programs curated by the Nigerian government to promote food security towards SDG 2; the research identified challenges facing food security in Nigeria generally and identified the state of food security in the Northeast region of Nigeria and further proposed solutions to the Nigerian government on the improvement of and need for food security. The works of Oruma, Misra & Fernandez-Sanz (2021, p. 1) focused on the adoption of digital technologies in agri supply chain towards food security and attaining sustainability in the Nigerian agricultural sector, however, the research did not consider the peculiarity of the geo-political regions in Nigeria, neither did the research specify the adoption of the model for specific food value chain or stakeholder.

In another study, Dankor et.al., (2017) focused on the impact of the presidential policy program for sustainable food security and supply chain of cassava towards food security in Nigeria. The research stated that the presidential initiative program improved the output of cassava towards food security in Nigeria. Also, Olugbire et.al., (2021) identified the contribution of small-scale farmers as stakeholders in the agricultural value chain to sustainable supply chain towards food security in Nigeria. The research focused on the need for the government as stakeholder across the food value chain to enable the activities of the small-scale farmers through policies that can foster provision of resources. Similarly, Hammed (2022) researched of the supply chain practices and sustainable food security in Nigeria. The study focused on the need for inclusion of assessment of the supply chain management system among stakeholders across food value chain especially on existing government initiatives such as subsidy toward drive food security in Nigeria.

Despite these studies, there is dearth of literature on sustainable supply chain on food security in Nigeria as most of the studies either generalize or consider other types of staple food. Hence, there has been no study on managing sustainable supply chain food security on rice as a food type in the North central region of Nigeria. This dearth of comprehensive scholarly literature on the supply chain food security on rice as a food type in the North central region of the country leaves practitioners and policymakers without the basis for making evidence-based decisions, since the understanding of such is based mainly on speculation or conjecture. Without such understanding, time and resources are wasted on policies and programmes for supply chain food security on rice as a food type in the North central region based on anecdotal evidence.

The study explores rice because its production a sub-sector that contributes to between 10 per cent and 12 per cent of total agricultural production in Nigeria (Arouna, et.al., 2021, p. 5); Rice is a common staple consumed by over 50 per cent of the world’s population, and, globally, it offers 19 per cent of human per capita energy (GAIN, 2019, p. 4; PWC, 2018, p. 5); this makes it a major food sub-sector that can aid food security. Based on this background, this research presents a path to food security in North central region of Nigeria by implementing sustainable supply chain management in rice value chain. The study also defines policies and strategies to ensure sustainability.

1.5 The aim of the study

The study investigates the how the adoption of sustainable practices for activities of stakeholders across the rice value chain can enhance rice production towards competitiveness of rice and food security in terms of the availability, affordability, and accessibility of food in the North Central region of Nigeria.

1.6 Research Questions

1. What are the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria?

2. How does stakeholder's activities and resources affect the improvement of food security on the underlying triple bottom line?

3. To what extent does sustainable supply chain management influence the competitive performance of the rice value chain network?

4. What are the sustainable plans, strategic policies and practices to mitigate food security risks and uncertainty?

5. How does the value chain model influence food security through sustainable supply chain of food in the North Central region of Nigeria?

1.7 Research Objectives

The objectives of this study are:

1. To establish the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria

2. To determine the impact of stakeholders' activities, decisions, and resources to improve food security, and the effect of this on the underlying triple bottom line.

3. To examine the extent to which sustainable supply chain management influences the competitive performance of the rice value chain network.
4. To establish the plans, strategic policies, and practices put in place to mitigate food security risks and uncertainty.
5. To develop a value chain model towards food security through sustainable supply chain of food in the North Central region of Nigeria.

1.8 Research hypotheses

H_{1O}: There is no significant impact of sustainable supply chain management on competitive performance of rice value chain network.

H_{1A}: There is a significant impact of sustainable supply chain management on competitive performance of rice value chain network.

1.9 Significance of the Study

The study is important in that it adds to the body of knowledge in three major ways. First, it contributes to the literature on sustainability, sustainable supply chain, and food security in Nigeria. The study intends to specifically explore the adoption of sustainable supply chain for rice towards food security in North central region of Nigeria: developing a framework for food security, especially for the North Central region in Nigeria. Second, the study seeks to establish a model to increase rice productivity in the region, which can be implemented in other regions of Nigeria, with the aim of ensuring food security, providing a model for sustainable supply chain management in the agricultural sector. Third, the study seeks to assist and provide government with the ability to understand activities and roles of stakeholders across the rice value chain the need to monitor the entire rice value chain; as well as other factors to maximise productivity, create employment, and drive food security. Findings will enable the government, policy makers and FMARD to drive adoption of sustainable practices across the rice value chain to improve productivity and competitiveness of rice from the region. A crucial aspect is that the study will be a foundation for scholartic studies in the future on the areas that are not explored in this study.

1.10 Justification

Literature around sustainable supply chain management of rice and its application to the North Central area of Nigeria is limited in scope. For instance, Okpiaifo, et al., (2020, p. 2-3) adopted the Sustainable Rice Platform (SRP) initiative to improve the sustainability of rice production and used the best-worst scaling approach to rank the features of SRP, however, it was basically from the perspective of the consumer. Kok, et al., (2019) did a pilot study that identified the losses across the value chain of rice growers using the case of Olam farms in Nigeria. Although the study identified these losses, it did not adopt the concept of sustainability across the value chain of these rice growers. Osabuohien, et.al., (2018) identified the opportunities available to rice farmers in one part of Nigeria yet did not consider the concept of sustainability across the rice supply chain. This gap has opened a platform for this study to develop a framework for ensuring sustainability in rice supply chains, with the long-term aim of eradicating food insecurity and meeting the global goal of erasing this food insecurity by the year 2030. This framework will increase the productivity of farmers by identifying the forces of food insecurity across the value chain of crops and propelling the government to develop policies for food security. The focus of this study is rice, which is a particular staple crop among others that are available and cultivatable in Nigeria and the study will target the local government area of the North Central region of Nigeria. Furthermore, the study will be applied to the supply chain of other agricultural products and other regions in Nigeria.

1.11 Structure of Thesis

The thesis is structured in seven chapters, which are presented as follows:

1.11.1 Chapter One: Introductory Chapter

This chapter is the introduction of the study which presents its background and problem statement. It includes the aim of the research, the research objectives, research questions, the significance of the study and the justification for it.

1.11.2 Chapter Two: A conceptual perspective of sustainable supply chain management for food security of rice in Nigeria

This chapter reviewed the literature consistent with the research objectives, namely, the concepts of sustainability, sustainable supply chain, sustainable supply chain management, SCOR model, food security, value chain and rice value chain. The chapter further presents the theoretical frameworks that create the background and justification for the research. The theories elucidate the unique concepts and how they are related to one another, via comprehensible arrays of connectivity. Stakeholder theory, Resource Dependence Theory, and Lewin's force field framework are adopted in this research for developing an appropriate sustainable supply chain model for food security.

1.11.3 Chapter three: A contextual perspective of sustainable supply chain management for food security of rice in Nigeria

This chapter reviews the literature on the rice value chain across the rice producing regions of the world. It presented the historical review of rice trends and policies in Nigeria. The review of these pieces of literature is relevant to provide an understanding of rice supply chain in Nigeria and a justification for the adoption of the sustainable supply chain in the existing rice value chain towards achieving food security in the North Central region of Nigeria.

1.11.4 Chapter Four: Research Methodology

The chapter presents the details of the methodology of the study, and the research design adopted to achieve the research objectives. It presents the appropriate philosophical lens and research paradigm used in the study. It further discusses the research approach and design that were adopted. A convergent mixed method design was used for data collection and analysis. The purposive sampling technique was utilized, while stratified random sampling was used for the selection of respondents for the quantitative data collection. Fuzzy AHP MCDM was introduced to measure the weight of the decision-making of participants. Nvivo 12 software was used for the qualitative analysis while SPSS was used for the quantitative analysis. The quality of the qualitative research instrument was measured for trustworthiness and authenticity, while reliability, validity and triangulation were used to assess the goodness of the measurement.

1.11.5 Chapter Five: Data analysis and interpretation of results

The focus of this chapter was on the analysis and presentation of qualitative data collected through semi-structured interviews and of the quantitative data collected through a structured questionnaire. Nvivo and thematic analysis were adopted to identify themes and draw meanings from unstructured data in line with the research questions. Quantitative data was analysed using descriptive statistics and further presented using bar charts and pie charts. Inferential statistics were used to test research questions and hierarchical regression was used for research question three. The fuzzy AHP-MCDM approach was also used for research question two. Methodological triangulation was carried out by comparing the outcomes of the qualitative data with those for the quantitative data.

1.11.6 Chapter Six: Discussion of Findings

This chapter presents an in-depth discussion of the findings from the research in line with the literature review, research objectives and research questions of the study. The empirical research focused on the data that was analyzed and interpreted. In this way, the research questions were answered, serving as a meaningful contribution to the body of knowledge. The discussion was centered on the outcome from the statistical analysis presented in the previous chapter. The research findings revealed that there are restraining and driving forces that influence the rice supply chain. Also, the chapter presents an understanding of the activities and resources of stakeholders, and the extent to which decision making aligns with the triple bottom line in influencing the rice value chain. The study found a significant relationship between the competitive performance of the rice value chain and sustainable supply chain management. The findings further revealed that there is no significant relationship between supply chain management and food security, however, the adoption of the latter for the rice value chain could improve food security in the North Central region of Nigeria.

1.11.7 Chapter seven: Recommendation and conclusion

In this chapter, the proposed rice value chain model is presented and recommendations are made based on the specific categories of stakeholders. Further recommendation and conclusions are suggested based on the research objectives and findings. The limitations of the study, its contribution to knowledge, and suggestions for future research are also presented.

1.12 Summary of Chapter

This chapter introduces the concept of sustainability, sustainable supply chain management, rice value chain and food security in Nigeria. Also, a background information on food security and sustainable supply chain of rice in Nigeria was presented. Similarly, the growing need for the adoption of sustainability across stakeholder’s activities in the agricultural value chain towards achieving food security was mentioned. Subsequently, the problem statement which reveals the dearth of studies on adoption of SSCM as a mediating force for driving food security through improving the rice value chain, was discussed. The chapter provided the aim of the study, the objectives of the research, and the research questions. The chapter also discussed the significance of study, the justification for study and research methodology adopted in the study and the structure of the chapters in this thesis. The next chapter presents a detailed concept on SSCM, rice value chain, and its overview. This is followed by the theoretical frameworks and models adopted in the study.

CHAPTER 2

A conceptual perspective of Sustainable Supply Chain Management for food security of rice in Nigeria

2.1 INTRODUCTION

In the quest to have a proper understanding of how the global objective on adoption of sustainable practices for activities of stakeholders across the rice value chain can enhance rice production towards competitiveness of rice and food security in terms of the availability, affordability, and accessibility of food in the North Central region of Nigeria, it is important to review previous scholarly works on sustainable supply chain and food security. The previous chapter focus on developing the background, aim, research questions and objectives of study. This chapter focus on the conceptual framework of the study and examined relevant scholarly works, theories, approaches and models on the study. The triple bottom line framework which is the pillar of sustainability is pivot to the study, while the study adopts SCOR and value chain models for discuss around supply chain management. Other related theories and frameworks were also adopted in study.

2.2 Background

In recent times, the concept of sustainability has become a mainstay in the business environment Nematollahi & Tajbakhsh, (2020, p. 2) and it has attracted the growing attention of industry and practitioners (Kouhizadeh, et al., 2021, p. 2) while becoming a strategy to improve the demand and loyalty of customers. This makes it important for businesses and sectors that are transforming or transition from the traditional supply chain management approach to sustainable supply chain management (Roy, et al., 2020). The globalisation of markets, reduction in the life cycles of product, digitalisation, diverse demands and expectations of customers, scarcity of resources, and severe demands from regulatory institutions are merging issues in supply chain management (Saeed & Kersten 2019, p. 1). These issues have necessitated the need to incorporate sustainability into the supply chain management operations and activities of organisations. The agricultural sector is not an exception to these issues as stakeholders are considered accountable for their activities across the supply chain of their products.

Koberg & Longoni (2019, p. 1085) stated that SSCM is concerned with integrating environmental, social and economic goals across a focal firm's supply chain process. Over the past two decades, it has emerged as an approach for firms to improve their sustainable outcomes in their supply chain. The work of the above authors further identifies SSCM as the incorporation of stakeholder expectations for profit with the demand on the impact on a local firm's internal and supply management operations on ecological and social systems. From the works of Nematollahi et al., (2020, p. 1) SSCM is seen as the management of the activities of a good, service, or resource (such as information, financial, material and human) across the supply chain without losing sight of profitability or compromising the well-being of society and impact on the environment. Seuring & Muller (2008, p. 1700) described SSCM as "the management of material, information and capital flow, as well as cooperation among companies in the supply chain, while taking goals from all three dimensions of sustainable development into account which are derived from customer and stakeholder requirements". Nematollahi et al., (2020, p. 1) added that the customers anticipate to see the evidence of sustainable practices on the goods and services they consume from manufacturers and service providers, hence, not violating the demands of society and the environment, yet being affordable in line with their economic situation.

Although sustainability addresses issues such as carbon discharges, greenhouse effects, carbon taxes and corruption, it has also triggered a response from organisations to issues raised by various stakeholders in different sectors, which may hinder the performance or productivity of the organisation (Saeed et.al., 2019, p. 2). It, therefore, becomes the responsibility of organisations to identify these issues by interacting with stakeholders across the supply chain, through the free flow of information across the value chain about their needs and challenges (Winter et al., 2021, p. 1503). Siems & Seuring (2021, p. 3106) recommends the adoption of stakeholder management for understanding the interest of stakeholders, through the exchange of knowledge and communication. The authors further described stakeholder management as the process introduced for the acquisition and learning of shared knowledge from stakeholders which is aimed at ensuring development and upgrade that are sustainability related, while at the same time minimising the risk that might arise from pressure groups.

2.3 Evolution of Sustainability and Sustainable Development

Shi, et al., (2019, p. 1) traced the emergence of sustainable development from the period of the ancient agricultural economy up to the industrial revolution when the drive to coordinate human survival and agricultural development emerged. These latter were caused by men's quest to explore wealth from nature, which led to waste and the pollution of the environment. Du-Pisani (2006, p.4) opined that sustainability evolved through centuries, although both the words 'sustainability' and 'sustainable' only appeared in the Oxford English dictionary for the first time in the 2nd half of the 20th century, having existed in French, German and Dutch for centuries. Robertson (2021, p.1) mentioned that the word "sustainability emerged from the Latin verb *sustinēre* which means to maintain, support, or endure; this word is further equal to a German word *Nachhaltigkeit* that appeared for the first time in 1713 in a forestry book called *Sylvicultura Oeconomica* written by Hans Carl von Carlowitz who was of the view that management of resources sustainably can aid the continuous and indefinite availability of timber from the forest.

In 2016, United Nations launched the Sustainable Development Goals (SDG) which combine economic, social, and environmental dimensions, and are a representation of "a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity" (UN, 2015, p.26; Skene, 2021, p.9994). Maratis & Melissen (2019, p. 253) note that the peculiarity of these goals is in their ability to bring the world together within a framework as an invisible yet universal whole (Global Sustainable Development report, 2019, p.1). Issues such as food shortage, growing social unrest, energy crisis, environmental pollution and poor economic growth have forced humanity to adopt the concept of sustainability- even though the world needs a better understanding of it, as such, it is the long-term survival and development strategy to ensure a socio-economic transformation of the world (Shi et al., 2019, p. 1-2). SDG 2, which is zero hunger and is targeted towards ending hunger, achieving food security, improving nutrition and promoting sustainable research is the basis for this research. The reason for this is because the study focuses on improving the supply chain of rice which is a staple food in the North Central region of Nigeria through the adoption of sustainable practices across the rice supply chain. This will further enable food security, improve the competitiveness of rice produced in the region and ameliorate improve the standard of living of rice farmers in the region.

The SDGs contained 17 goals with 160 targets which should be achieved by 2030, some of which reflect the most pressing challenges that face the world today, such as eradicating poverty, zero hunger, ensuring affordable and clean energy, and quality education. They also address the global challenge of inequality, climate change, environmental degradation, peace and justice.

The SDGs, which represent a historical global achievement, were adopted in September 2015 during the General Assembly of the United Nations with 193 countries present; they place emphasis on a holistic approach to end poverty and build shared prosperity in a sustainable manner, with a set deadline of 2030 (SDG-UN, 2020). The event marked 70th session of the United Nations General Assembly; it took place on 25th - 27th of September, 2015- the special summit ended with the adoption of the declaration 'Transforming our World – the 2030 agenda for Sustainable Development; It is a universal call to improve on people, planet, prosperity, peace and partnership, thereby, guide the development agendas and national policies of UN member nations over the next 15 years (Hambrey, 2017, p. 1). It is the reflection of the expectations of the global community which is focused on reversing the destruction of the natural and social habitat and achieve a more balanced and more equitable pathway that ensures well-being of all (Global Sustainable Development report, 2019, p. 1).

The SDGs are described as 'the blueprint to achieve a better and more sustainable future for all. Furthermore, they help to create a platform for the governments of nations to transform the world's social, economic, and environmental status in a universally beneficial way via tough choices and trade-offs (Global Sustainable Development report, 2019, p. 1).

The 17 goals are all interconnected, and to leave no one behind, it is important to achieve them all by 2030' (UN, 2015). The 17 SDGs are the following: (1) No poverty; (2) Zero hunger; (3) Good health and well-being; (4) Quality education; (5) Gender equality; (6) Clean water and sanitation; (7) Affordable clean energy; (8) Decent work and economic growth; (9) Industry, innovation and infrastructure; (10) Reduced inequality; (11) Sustainable cities and communities; (12) Responsible consumption and production; (13) Climate action; (14) Protecting life below water; (15) Protecting life on land; (16) Peace and justice through strong institutions; and (17) Partnerships to achieve these goals. These 17 SDGs are grouped into environmental sustainability, economic progress, and social welfare and peace (Peng 2023, p. 2).

Table 2-1 indicates the goals, targets and indicators relevant to SDG 2, namely, 'End hunger, achieve food security and improved nutrition, and promote sustainable agriculture', which is the focus of this research. It contains five goals, three targets and 14 indicators from the 2030 agenda.

Table 2-1Goals and targets with indicators

	Goals and Targets (from the 2030 agenda)		**Indicators**
2.1	By 2030, end hunger and ensure access by all people, the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	2.1.1	Prevalence of undernourishment
		2.1.2	Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)
2.2	By 2030, end all forms of malnutrition, including achieving, by 2050, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	2.2.1	Prevalence of stunting (height foe age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age
		2.2.2	Prevalence of malnutrition (weight for the height >+2or<-2 standard deviation from the median of the WHO Child Growth Standards among children under 5 years of age, by type (wasting or overweight)
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	2.3.1	Volume of production per labour unit by classes of farming/pastoral/forestry enterprise
		2.3.2	Average income of small-scale food producers by sex and indigenous status
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen the capacity for adaptation to climate change, extreme weather drought, flooding and other disasters and that progressively improve land and soil quality	2.4.1	Proportion of agricultural area under productive and sustainable agriculture
2.5	By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated knowledge, as internationally agreed	2.5.1	Number of plant and animal genetic resources for food and agriculture secured in either medium or long-term conservation facilities
		2.5.2	Proportion of local breeds classified as being at risk, not-at-risk or at unknown level of extinction

2.a	Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular the least developed countries	2.a.1	The agriculture orientation index for government expenditure
		2.a.2	Total official flows (official development assistance plus other official flows) to the agriculture sector
2.b	Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round	2.b.1	Producer Support Estimate
		2.b.2	Agricultural export subsidies
2.c	Adopt measures to ensure the proper functioning of food commodity, markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility	2.c.1	Indicator of food price anomalies

Source: Adopted from: United Nations (2015 p.19-20) and United Nations (2016, p. 3-4)

In their work for ICLEI – Local Government for sustainability, Woodbridge and Zimmermann (2015, p. 1) the SDGs built on the then expiring Millennium Development Goals (MDGs), which were in operation between the years 2000-2015; their focus was to end poverty in various dimensions. The SDGs are the latest stage of a long process of change which began in 1972 at the United Nations Conference on the Environment, in Stockholm, and went on to the United Nations Conference on Environment and Development- the Earth Summit- which took place in Rio de Janeiro in 1992. The Millennium Declaration was then adopted by the General Assembly in 2000, and the United Nations Conference on Sustainable Development (Rio+20 Conference) took place in 2012 (Global Sustainable Development report, 2019, p. 1).

Although the MDGs targeted developing countries, the SDGs are part of a more encompassing and all-encompassing and inclusive agenda that is comprehensively applicable to all members of the United Nations; it abolishes the contrast of developed versus developing nations, a phenomenon that opened the MDGs to criticism. In highlight, the WHO (2015, p.1) mentioned that MDGs set a limited number of human development targets for poverty eradication, health, education, food security, and nutrition; however, the SDGs which are interdependent and interrelated, integrates all three dimensions of sustainable development which are economic, social, and environmental; these will impact the people, planet, prosperity, peace, and partnership of the countries in the world.

2.4 Sustainability

Sustainability is a highly controversial word which literarily mean 'to keep going continuously (Skene, 2021, p. 9996). While the concepts of sustainability and sustainable development have become a relevant in scientific research (Ruggerio, 2021, p.1), and have emerged as a critical topic across various spheres globally, ignorance of these has caused various forms of losses to organisations (Jamwal, et al., 2021, p. 430). While Robertson (2021, p. 1, 13) identified sustainability as a multidisciplinary concept that focusses on the role of man in the emergence of the world as it is today, through the interaction between man and nature over time, it is described as the long-term, self-continuous and uninterrupted operation of a system or process.

In the view of Nematollahi et al., (2020, p. 2), sustainability in the agricultural sector is particularly important because in the quest to ensure food security through an increase in production, farmers have adopted the Green Revolution system of farming; this in turn led to gas emissions and has affected the environment negatively, even though it has aided food production, created employment, and increased the levels of income. Despite the need for an increase in production and distribution, this system can also incur high levels of Greenhouse Gas (GHG) emissions and the conversion of forests into farm lands, which in turn will result in land erosion and deforestation (Nematollahi et al., 2020, p. 2).

The phrase 'sustainable development' covers the three characteristics of ecological sustainability, economic opportunity, and social inclusion. The word was first used in the World Conservation Strategy, a 1980 report by the International Union for Conservation of Nature (IUCN, 2004), it was then popularised by the World Commission on Environment and Development's (WCED) 1987 report called 'Our Common Future', also known as the Brundtland report, which highlighted the link between environment, economics, and equity. "The environment is where we all live; and 'development' is what we all do to improve our lot inside that abode," Gro Brundtland remarked. "The two are inextricably linked." (WCED, 1987, p. 7).

Sustainability is defined as "development that meets the needs of the present population without compromising the ability of future generations to meet their needs" (Brown, et al., 2021, p. 3; Braccini, et al., (2019, p. 2)). It is a three-dimensional concept that emphasises sustaining the health of the population, the society as a whole, and the health of the planet (Brown *et al.*, 2021, p.3). According to Ponte (2022, p.2) through sustainable management, businesses develop a platform through which new opportunities for value creation is identified, created and redistributed across the value chain, leading firms in the value chain to maximise profit by adopting sustainable practices; similarly, through sustainability, other stakeholders across the value chain develop new competencies to maintain relevance. Alam, et al., (2023, p. 2) opine that insofar as UN SDG 2, there is a need for strategies to attain the goal of food security, through the adoption of sustainability practices in agriculture.

2.4.1 Triple Bottom Line

Oelze, et al., (2018, p. 293) mention that the earlier-mentioned definition of sustainability that the single-focused bottom-line view, which exclusively emphasises economic objectives, was broadened to a triple bottom line (TBL) framework that includes the environmental and social dimensions. This framework is called the pillars of sustainability, which was developed by John Elkington (2004) to describe economic, environmental, and social values of investment that should amass separately from a firm's financial bottom line (Elkington, 2004, as cited in Hammer & Pivo, 2016, p. 2). García, et al., (2021, p. 1) are of the view that describing sustainability in line with the triple bottom line framework has been widely accepted, especially for agricultural activities, as it emphasizes their effect on the environment, outcomes in terms of the economy, and the advantages of such activities to society. Birkel & Muller (2021, p. 2) opined that TBL framework relates the expectations of the people as its functionality is dependent on the society and further identified a significant linkage between TBL and supply chain management because the economic, social, and environmental spheres can only be understood by studying the whole supply chain.

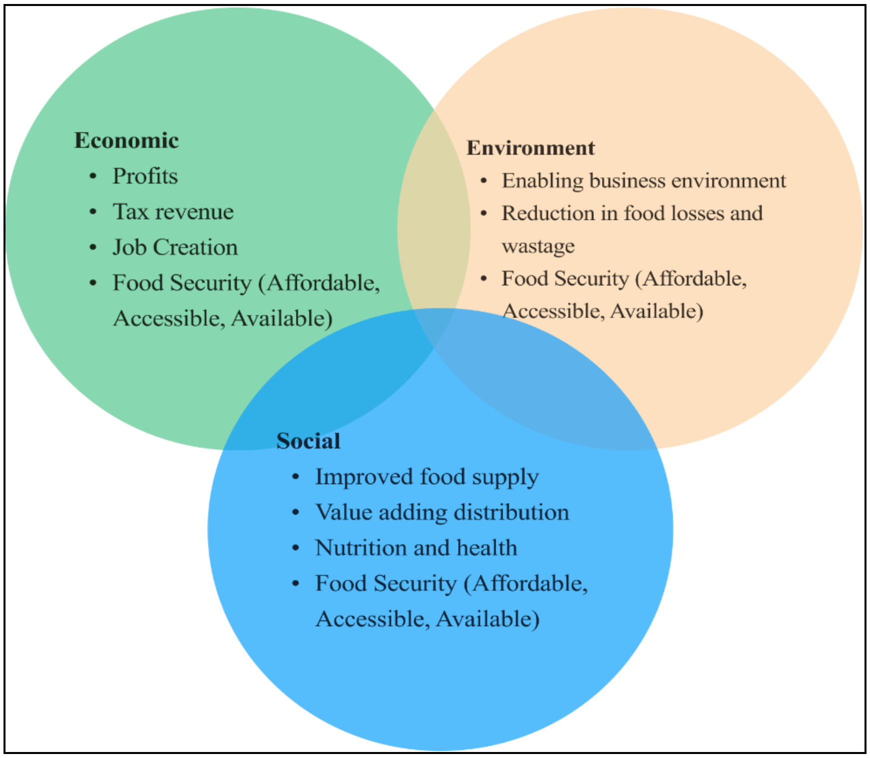
TBL is based on the view that development should be executed to meet the needs of the present while still maintaining the conditions and opportunities for future the generation (World Economic on Environment and Development, 1987, p. 41). TBL has been applied by several authors in different sectors; for instance, Braccini & Margherita (2018, p.1) examined the impact of it on the organisational sustainability of industry 4.0 in the manufacturing sector, towards creating a sustainable value. Agrawal & Singh (2019, p. 1) explored decision making in relation to TBL for reverse logistics in the electronics sector of India. Also, Shao, et al., (2019, p. 1) examined the adoption of TBL in driving sustainable orientation among buying firms and suppliers, with the aim of promoting sustainable supply management. Birkel et al., (2021, p. 1) analysed several articles to identify TBL as it impacts value creation for industry 4.0 and the Internet of Things. Mastrocinque, et al., (2022, p. 6) identified the adoption of TBL in making sustainable decision-making activities in the supply chain of photovoltaic energy in the energy sector of seven countries.

In TBL, Peng (2023, p. 2) mentioned that the economic dimension of a sustainable goal can be attained in a country that has sufficient resources. These must be efficiently and effectively managed and allocated through the creation of a decent work environment, good environmental conditions, and unity among citizens who are satisfied with the resources available to them. The environmental dimension focusses on the reduction in the level of any form of pollution of any form and efficiency in the usage of energy (Shou, et al., 2019, p. 3). Peng (2023, p. 3) mentioned that the focus of the environmental dimension is on adding value to customers and supply chain through the creation of designs that are eco-friendly, as well as through adopting green management of the internal structure of the organisation and suppliers.

The social dimension of SSCM is about organisations ensuring the well-being of their employees and good working conditions, while the economic dimension focuses on improvement in the performance of sales and profit (Shou, et al., 2019, p. 3). This is rooted in corporate social responsibility (CSR) which is aimed at ensuring that organisations are part of the stakeholders within the community, contributing to the development of their environment (Peng, 2023, p. 3).

Foong & Ng (2022, p. 66) were of the view that supply chain management facilitates the attainment of the social and environmental dimensions of sustainability through strategic integration of information among stakeholders and transparency in the utilisation of resources, while enabling the effective and efficient performance of the economic dimension of sustainability across the supply chain in the long run. To this end, adopting TBL in this study considers developing supply chain management that does not compromise the need of the future generations. As such, the study develops supply chain management frameworks that aid food security, ensure profitability, propel job creation, reduce food losses and waste, and improve food supply.

Figure 2-1: Dimensions of sustainability



Source: Author

Robertson (2021, p. 1) described sustainability as the systems and processes that can operate and endure on their own for extended periods of time. The adjective 'sustainable' means "able to go on without stopping" or "able to withstand without failing", and is derived from the roots 'sub', which means "up from below," and 'tenre', which means "to keep" (Robertson, 2021, p. 1). Sustainability science is a branch of science dedicated to addressing the issues of long-term development in the transition to sustainability. This is an interdisciplinary field that is "characterised by the challenges it solves rather than the disciplines it utilises" (Kates 2010, p.26). Its research encompasses population stabilisation, hunger and poverty reduction, the long-term viability of the life support systems on which was relied on, and the linkages between these systems. Understanding the dynamics of these interconnected ecological and social systems is at the heart of sustainability science (Vries 2013, p. 5).

Robertson (2021, p. 2) also stated that since all humans are a part of interconnected and natural systems, the study of sustainability extends beyond environmental issues, and encompasses systems driven by resilience. A system is a set of interconnected elements which are lucidly structured to form a whole, where the whole is always greater than sum of the parts (Meadow, 2008, p. 188). A resilience perspective views life as continuously changing; in other words, it is the ability of a system to endure interruptions without losing its quality, function, and structure (Robertson 2021, p. 5).

The acknowledgment of three interrelated dimensions, namely, ecological, economic, and social, is a crucial feature of sustainability within systems theory. This is because the world is faced with interconnected problems such as poverty, poor health, overpopulation, resource depletion, food and water scarcity, political instability, and the destruction of the existing life support systems, which can only be solved using the systems approach and not as separate part. This conclusion was reached from a discussion among scholars on whether these problems could be solved in isolation because poverty and devastation of the environment are inter-woven (Caradonna, 2014, p. 224) which is why these problems cannot be solved alone since they exist within an open system and are interconnected.

According to scholars Turner & Baker (2019, p. 4); Massa, et al., (2018, p. 62); Grewatsch, et al., (2021, p. 4), an open system is described as one that has an existing structure yet permits the free flow of information, resources and energy with other systems in its environment, whereas a closed system withholds this flow. These authors further adopted the description from Kast & Rosenzweig (1972), who submitted that a closed system is one that has a boundary yet has subsystems which are serviced by forces from the external environment, while an open system is without boundary, which makes it susceptible to benefit from either internal or external environmental forces. This provides an understanding for interconnectedness within the concept of sustainability.

With the focus of resilience on the process and sustainability on the outcome (Robertson, 2021, p.5), the adoption of a sustainability approach focusses on the setting of long-term goals, enabled by specific strategies which are measured by identifiable indicators. Therefore, the essence of integrating sustainability and supply chain management in this study is because the resulting sustainable supply chain management adopts the systems perspective across the activities of firms, thereby ensuring alignment and coordination in the process (Basheer, et al., 2019, p. 275).

2.5 Sustainable Supply Chain Management (SSCM)

The early focus of supply chain management (SCM) was on ensuring the timely and dependable delivery of raw materials and finished goods to customers. As a result, maintaining a smooth operation and constant flow of items and information throughout the chain was a daily task. Furthermore, businesses sought strategies to reduce waste, not for social or environmental reasons, but for the objective of profit (Sarkis et al., 2011). Moreover, traditional supply chain literature viewed suppliers as nonstrategic, with the focus of a company's strategy being the use of its purchasing control (Gold, et al., 2013). As a result, "supply chain operations connected with the transformation and movement of goods and services, including business concomitant information flows from the sources of resources to the end users" became a common definition of SCM (Yu & Tseng, 2014, p. 48).

SCM today, on the other hand, plays a critical role in global economies, necessitating a complete examination that highlights the interdependencies among its participants (Reefke & Sundaram, 2017). It aids in the management and identification of value-added activities across the supply chain, and is made up of various important components, which are operational strategy, outsourcing strategy, channel strategy, customer service strategy, and asset network (Li, et al., 2011, p.36; Putro, et al., 2022, p. 454-455). Operational strategy focuses on the process of the production of goods and services, which in effect structures the whole supply chain, together with outsourcing strategy and the choice of skills, which must be cost effective and where the required expertise is considered. The question of how products are delivered to end users is a concern for a business because it is a function of the market segment in question - this is called the channel strategy; meanwhile, the customer service strategy is the identification of the expectations of the customer and of setting a balance to ensure profitability. Lastly, organising a network for assets such as warehouse, equipment, locations and service centre is important for the performance of the entire supply chain (Putro et al., 2022, p. 455).

Companies that have successfully managed their supply chains have discovered new strategies to respond to and recover from global threats (Closs, et al., 2011). As a result, SCM has been applied to increasingly complicated situations, pursuing not just economic gains, but also sustainable development in its operations (Liu, et al., 2017). Sustainable supply chain management (SSCM) has piqued the interest of researchers, academics, and business leaders (Köksal, et al., 2017). In addition, SSCM methods are becoming a common corporate trend in industry for long-term development (Moktadir, et al., 2018). The necessity for enterprises to achieve sustainability and improve supply chain performance has prompted the development of a Sustainable Supply Chain (SSC), which incorporates operations from a three-dimensional perspective (economic, social, and environmental).

Kim, et al., (2014, p. 8) defined SSC as "a supply chain which not only makes a profit and realizes its potential at the same time, but is also responsible to its consumers and providers, to companies and to environments through innovative strategy, tactics and management technologies". It is a supply chain that integrates sustainable development and operates under its three dimensions. Academics then joined SSC and management over a decade ago to establish the definition of SSCM (Ansari & Qureshi, 2015), which is to meet the goals and overcome the problems of sustainable development, by using tools and technology to achieve this.

According to the Council of Supply Chain Management Professionals (CSCMP, 2013, 2021, p. 187), supply chain management has an integrating function of linking functions or processes which involves the coordination of all activities required for meeting the demand of customers across a value chain. Such activities include matters related to sourcing, procurement, conversion, and logistics, which will require the management and involvement of stakeholders. According to Foong et al., (2022, p. 66) SCM identifies the activities of various stakeholders involved in the flow and transformation of raw materials up to the final output for the end users; it is a flow which begins with the procurement of raw materials, followed by the transformation to the final product, and lastly, the provision of feedback on the output.

Sustainable supply chain management incorporates ecological concerns into the inter-organisational activities of supply chain management (Muchaendepi, et al., 2019, p. 493). Tsai, et al, (2021, p. 2) collated related features of this concept from various authors, then defined SSCM as managing the flow of materials, information, and capital, as well as engagement among several stakeholders within the supply chain, while adopting the triple bottom line; this is aimed at meeting stakeholders’ requirements, yet improving the margin rate, as well as building resilience and fortitude over a period of time. The concept of sustainable development is centered around the resources available to a country and its citizen (Peng, 2023, p. 2).

Several authors (Martins & Pato, 2019; Ahi & Searcy, 2013; Hassini et al., 2012; Ansari & Kant, 2017; Ashby, & Hudson-Smith, 2012; Touboulic & Walker, 2015; Klewitz & Hansen, 2014) have sought to better understand and improve sustainable supply chain management. Ahi et al., (2013, p. 330) cited the two definitions of SSCM, which are: "Management of the material, information and capital flows, and cooperation between enterprises in the supply chain while taking objectives from all three dimensions of sustainable development, i.e., economic, environmental, and social, into account, which are derived from customer and stakeholder requirements" (Seuring & Müller, 2008); this definition is adopted as a guide for this study; Meanwhile, the second definition states that "SSCM entails strategic, transparent integration and achieving the social, environmental and economic objectives of an organization, by systematically coordinating critical inter-agency business operations to enhance the economic performance of each company and its supplier chains on a long term basis" (Carter & Rogers, 2008). Peng (2023, p. 2) is of the view that since the implementation of SSCM practices is for the prosperity of society, an improvement in financial resources and ensuring sustainable use of environmental resources, can enable the achievement of the set SDGs.

Braccini et al., (2019, p. 1) opined that a business is sustainable when it aligns to the scopes of the triple bottom line. Inherently, in sustainable supply chain management research, notions of risk and resilience have been increasingly introduced (Ahi et al., 2013; Carter, et al., 2008; Closs et al., 2011). The three pillars of the triple bottom line concept are often included in the most innovative formulations of SSCM. By describing SSCM as the continuous reduction of the risk associated with the use of resources, such as pollution, global warming, shortage in the use of energy, and management of waste, Yadav, et al., (2023, p. 2) infused supply chain management with the dimensions of sustainability.

Carter et al., (2008, p. 368) expanded their research into non-economic factors, presenting a conceptual framework for incorporating sustainability into supply chain management. This sparked a new line of inquiry, with sustainable supply chain management being defined as the "strategic, transparent integration of the social, environmental and economic goals of an organization in the systemic coordination of key transnational business processes to improve the long-term economic performance of the individual company and its supply chains" (Carter, et al, 2008, p. 368). This definition projects how at every stage the activities of the organisation must take put into consideration stewardship and citizen impact in its business process and supply chain.

To gain a competitive advantage in today's global business climate, firms must focus on SCM (Jermsittiparsert et al., 2019, p. 59; Khaddam et al., 2020, p. 547). The general environmental pressures on organisations that Pfeffer & Salancik (1978) hypothesized, are nearly the same as they were in the 1970s (Davis & Cobb, 2010, p. 21). Resources and their acquisition, according to Resource Dependent Theory (RDT) principles, are at the heart of an organisation's decision-making process (Davis et al., 2010, p. 5). Because of the paucity of resources, businesses are under pressure to find long-term supply chain strategies that will ensure their survival, as well as long-term resource supply and economic success (Karimi & Rahim, 2015, p. 27). Operations management, resource and distribution management, logistics and transportation, marketing, purchasing, and information technology are all functions involved in supply chain management (Li, 2014, p. 1; Roh et al., 2014). For an effective supply chain strategy that influences and enhances the organisation's performance, all these important inter-organisational business operations are connected (Carter, et al., 2008; De Marchi et al., 2013; Roh et al., 2014; Winter & Knemeyer, 2013). Organization managers can benefit from real-time data regarding demand and supply of products, which is useful for supply chain decision makers, thanks to advancements in global supply chain technology (O' Rourke, 2014).

Mastrocinque, et al., (2022, p. 3) defined supply chain management as “the strategic and systemic coordination of all the business functions, policies and procedures of a particular company, and across businesses within the supply chain, with the goal of improving the long-term performance of the whole supply chain and the companies that are involved in all its levels”. This definition considers the activities of other businesses involved in those of an organization, as this impacts the achievement of its long-term goals. With this definition, there arises the need to ensure that connected businesses align with each other in terms of sustainability related practices, to enable the achievement of their long-term goals. Kuwornu et al., (2023, p.2) state that supply chain management adopts theories from management for the design, assembling, maintenance, allocation, and traceability of products across the supply chain.

SCM is the organisation of output activities, which starts from the phase of harvest of output, the processing of output, the storage, and transportation of output from between various stakeholders across the supply chain (Kuwornu, et.al.2023, p. 2)

Alzubi & Akkerman (2022, p.1) opined that the integration of sustainable development and supply chain management is an introduction of strategies employed in efficient utilisation of resources, to produce value in the flow of resources and outputs from the suppliers, up to the manufacturers, and finally to them for storage in warehouses. In sustainable supply chains, members of the supply chain address the environmental and social dimensions through corporate social responsibility (CSR) initiatives, while maintaining competitiveness by meeting consumer demands and needs that satisfy the economic aspect of sustainability (Diabat et al., 2014; Seuring & Müller, 2008). Sustainable SCM is often defined as providing environmentally friendly supply chain practices (Diabat et al., 2014; Govindan, et al.,2014).

Alzubi et al., (2022, p. 2) mentioned that many studies are of the view that the adoption of sustainable practices in the operation of businesses, enables a competitive advantage because such practices give vision to and improve the knowledge of top managers, as well as improving the image and reputation of the business. In this way, such businesses get a leverage over their competitors, for example, by adopting the use of renewable energy and improving the quality of their output. Sustainable SCM practices should promote organizational success (Green et al., 2015). Shou et al., (2019, p. 3) expressed that engaging in collaborative activities with suppliers can equip buyer companies with the required knowledge about input and skill; enhancing performance and joint programmes with the former will help the latter engage in more sustainable practices, such as reduction in energy consumed and elimination of sources of pollution. A focus on driving sustainability across suppliers gives buyer firms the assurance that the resources used are harmless and improve productivity; it motivates and satisfies employees and promotes their occupational safety and loyalty because the employer/ buyer firm gains a good reputation resulting from the adoption of sustainable practices.

Tsai et al. (2021, p. 2) opine that sustainable practices must concentrate on societal development, the interrelated environmental impact, as well as global economic significance. This research incorporates this view in examining the activities of stakeholders throughout the rice value chain. Businesses that implement SSCM can build a stable financial status which enables participation in corporate social responsibility, foster collaboration among stakeholders, and create a platform that monitors the activities and assess the output of stakeholder thereby, improving the performance of the supply chain.

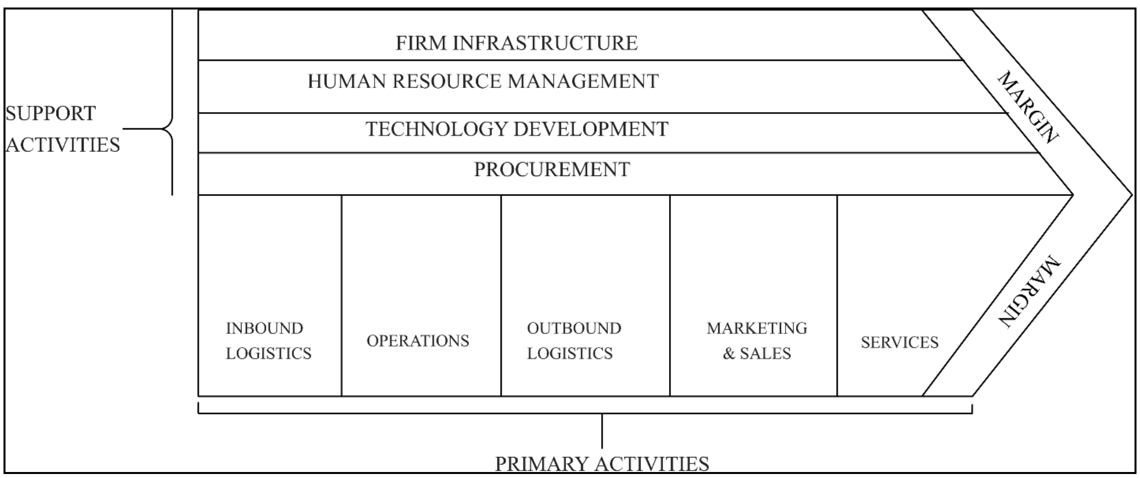
2.6 Value Chain Concept

A value chain is the range of activities overseen by a firm, right from the conception phase up till to the end users, which can be re-used, recycled or disposed of; these secondary activities are targeted at adding value to the primary ones of businesses or farmers in the process of creating a product (Ponte, 2022, p. 6). A value chain is further a network of input suppliers, producers, processors, buyers, and providers of other technical, financial, or business supporting activities (El-Sayed et al., 2015, p. 11). As shown in figure 2-2, it is the full range of activities that are required to bring a product/service from start to finish, through the different stages of production and distribution to the final consumers, and to its final disposal after use (FAO 2015, p. 1); this includes the network of stakeholders involved in the farming, processing, and distribution of food, where the stakeholders are producers, processors, distributors, consumers, and government and non-governmental organisations. Their activities range from research, to processing, marketing, purchasing, consumption, monitoring, and regulating of the entire food value chain (Deloitte, 2015, p.2).

A value chain examines the activities of firms and the interaction in a systematic way, which aids in the identification of the way to gain a competitive advantage (Porter, 2001, p. 50). To create value, a business needs to identify the activities of the suppliers of the firm and the processes involved, while the supply chain is made up of the collaboration's component of the life cycle of a product (Linkov et al., (2020, p. 3). Foong et al, (2022, p. 67) described the value chain as the collection of activities executed by different stakeholders, towards the creation of social, environmental and economic value, by technology and infrastructure in the transformation of raw materials at their lowest value to products at their highest value, facilitating competitive advantage. Linkov et al., (2020, p. 4) described the value chain as the framework that describes the operations and interactions of stakeholders, through which a business improves profitability, and competitive advantage, and its structure thus enabling collaboration, by understanding the system, and creating value that is sustainable.

The value chain of a firm is made up of a generic group of interdependent activities, creating a link between suppliers, buyers, and networks (Porter, 2001, p.51). Kaplinsky & Morris (2001, p. 4) also mentioned that a value chain covers the entire range of actions that are required to bring a product or service from conception through the various stages of production including physical transformation, input of various producer services, delivery to customers, and post-use disposal. Furthermore, a value chain shows the interdependence in activities connected by linkages across it, where these linkages depict the networked performance of one activity as it is connected with the execution of another (Porter, 2001, p. 59).

Figure 2-2: Value chain concept



Source: Porter, 2001, p. 51

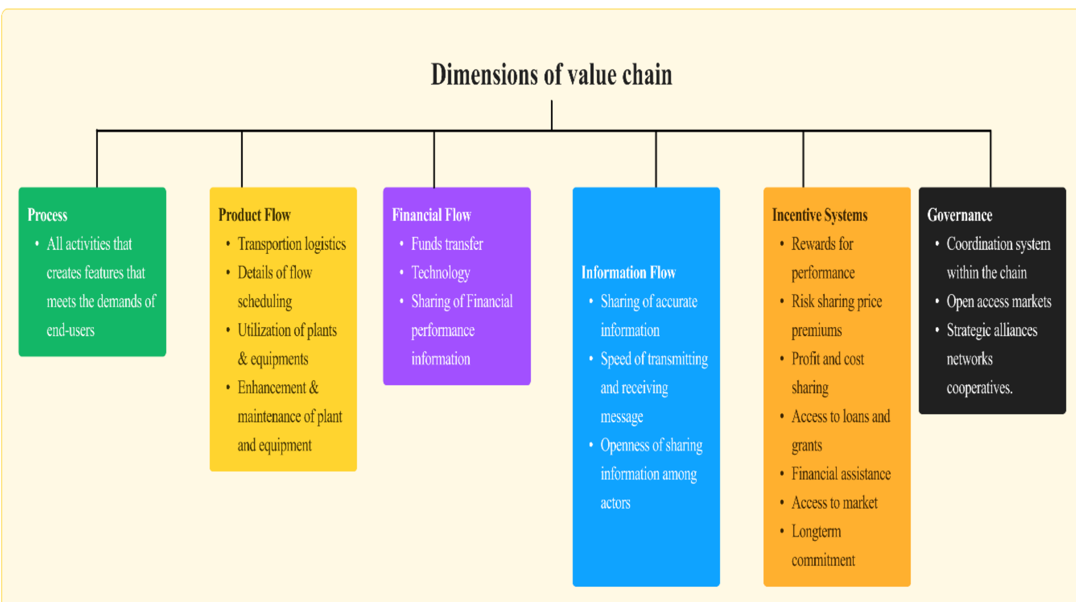
The uniqueness of value chain analysis (VCA) is that; it demands the tracking of the activities of each stakeholder across the chain, which is aimed at identifying the activities, contributions, relationships and linkages of actors/ stakeholders across the chain through which factors that impact their performance can be identified (Zamora, 2016, p. 118). This is called 'mapping of the market', an activity that identifies the enabling environment and service providers, which include factors that facilitate the operational structure for the activities of the actors across the chain, these activities are made up of infrastructure, policies, regulations, institutions and processes within which the actors or stakeholders' function.

2.6.1 Dimensions of Value Chain

As depicted in figure 2-3, Zamora (2016, p. 122) submitted that a value chain is a process that identifies the activities which establish the products that are required by the final consumers, and it is made up of six dimensions, processes, product flow, financial flow, information flow, incentive systems, and governance.

Niemi et al., (2020, p. 2) stated that, with the aim of reducing the rate at which resources remain idle, VCA evaluates the features and added value that a resource or stakeholder can bring into the supply chain, not just focusing on the output of the process, but measuring the value that is added at various stages of the process of transforming raw materials from the initial point to the end user. Whilst supply chains highlight the requirements for how goods or services are to be supplied, value chains explore where the value is added or how it might be produced or lost before delivery or usage. Value can include additional performance factors such as sustainability and resilience, from an organisational and supply chain standpoint (Govindan et al., 2015).

Figure 2-3: Dimensions of value chain



Source: Adapted from Zamora (2016, p. 122)

A value chain is a procedure that describes the full range of activities that contribute to the final value of a product (Dubey, et al., 2015, p. 177). The concept of value chain is advantageous in that it provides a holistic view of the business sector yet identifying relationships and connections between the singular activities and the interaction of subsystems; this systematically reveals available options, sources and leakages of value, substandard activities, and value-creating opportunities across an industry (Foong et al., 2022, p. 67).

Value chains incorporate different stakeholder networks with all their complexity, interconnections and interrelations. Previous applications of value chains have resulted in an increase in trade earnings, improved local competitiveness and poverty reduction (Kaplinsky and Morris, 2001, p. 12). A value chain shows: the total value, value activities, which are the unique activities that create value to buyers; and margins; which are the difference between the total value and total cost of the value-creating activities (Porter, 2001, p.53). The generic value chain as shown in figure 2-2 shows the value adding activities which are further grouped as either primary activities or support activities.

Since the emergence of value chain analysis, it has been implemented in various areas; for instance, it was used by Niemi et al., (2020, p. 1) to analyse animal health. This work argued that VCA ensures an assessment of the stakeholders within that particular value chain thereby making sure that there is sufficient relevant information that is shared across the value chain which can only be driven on the basis of trust and collaboration. While each stakeholder across the chain is required to add value, be able to compete, and improve performance, this is subject to the position of the stakeholder in the chain and the rate of value it can create (Jäckering et al., 2019, p. 117).

Jäckering et al., (2019, p. 116) have identified VCA as a concept adopted in examining and assessing systems, industries, and firms, and implemented in evaluating the activities of firms that spread across various countries, in which case it is called the global value chain. The authors states that value chain analysis aims to provide a reflection of value addition (which is a function of value creation and value capturing) at every stage of a firm's operations, by the various stakeholders within the chain. With value chain, the value created and added to a functioning supply chain of a product is measured, activities of interconnected stakeholders are monitored, ease in detection of faults is ensured, and reliability, which is measured in terms of quality delivered by suppliers, on-time execution of task, cost effectiveness, and completeness in delivery is promoted (Foong et al., 2022, p. 67).

2.7 Drivers of Sustainable Supply Chain Management

Understanding the drivers of sustainable supply chain management will ensure a platform for creating and adopting new practices for supply chain management and for developing models suitable for the integration of the process into the supply chain, such that it will synchronise with the strategy of the United Nations Sustainable Development Goals (Zimon et al., 2020, p. 221).

External drivers of SSCM include, firstly, drivers from a third-party perspective such as government legislation, regulations from either regional, national or international bodies or institutions, and trade or professional associations. The second set of drivers are from society, such as media or press, value-based networks, societal groups, consumer organisations, NGOs, and social well-being or community focus groups. While the third set of drivers are market pressures, such as competitive advantage, competitors' pressure, pressure from stakeholders or investors, pressure from institutions, suppliers, and customers, reputation of organisation and globalisation factors (Zimon et al.,2020, p. 222); Jia et al., 2018, p. 265)

Jia et al., (2018, p. 269) categorised the drivers that can be adopted in SSCM into three groups, which are regulatory, normative and cultural-cognitive. This is shown in the Table 2-2 below.

Table 2-2: Drivers of Sustainable Supply Chain Management

Category of Drivers	**Drivers**	**Description of Driver**
Regulatory	Regulations at national level	These comprise of laws from the government on environmental pollution and labour rights; this is often under-enforced or lacking in developing countries.
	Regulations from importing country	Mostly, these are regulations from international trade. This is common to suppliers in developing countries as it often occurs when exporting to developed countries.
Normative	Pressure from buyers	These are codes of conducts, policies, and social principles that must be adhered to
	Competitive advantage	Earned through operational efficiency or differentiation of products.
	NGO and civil society	This is rare in developing countries but present in developed countries. These are practices that promote the reputation and sustainable practises of the organisation.
	Market position	This is the maintained or improved positioning in the marketplace which is often benchmarked against the competitors' and aimed at attracting more investors.
	Economic incentive	These are subsidies from government such as tax

		reduction.
	Industry association	Industries adopt best practices linked to their membership in an industry association.
Cultural-cognitive	Internal leadership	It occurs from owners or CEOs for both buyers and sellers.
	Intrinsic concern	Sustainability that is infused in the organisation's business and core.
	Health and safety	This is the starting point for identifying sustainability which includes actions that are in line with health and safety requirements in the workplace.

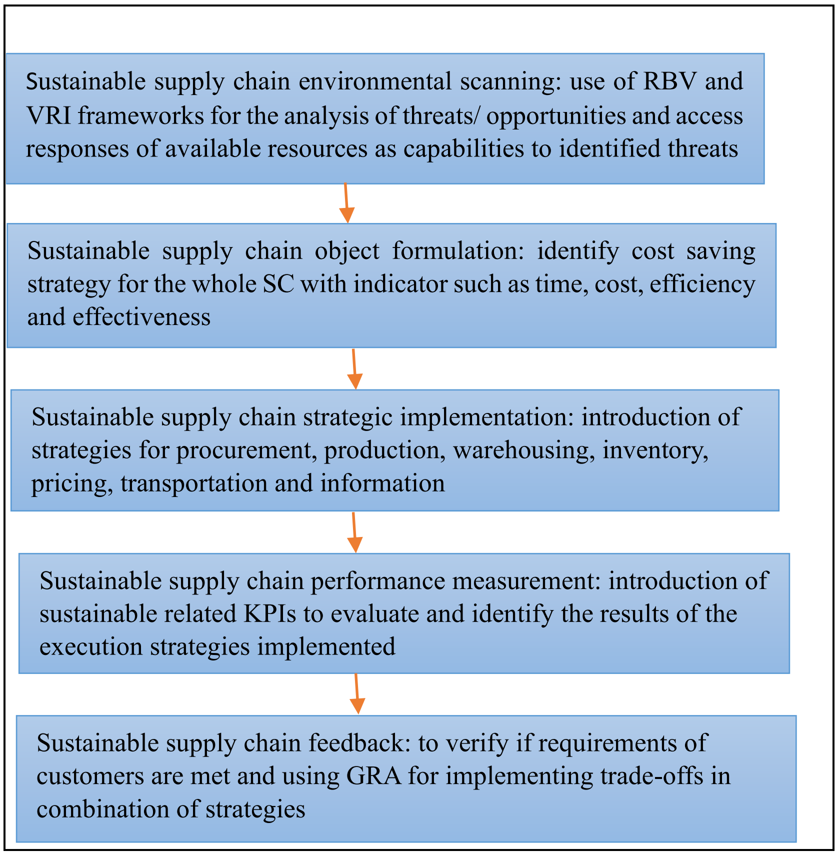
Source: Adopted from Jia et al., (2018, p. 269)

Zimon et al., (2020, p. 223) further identified internal drivers as: corporate strategy, which includes top management commitment, organisation strategy, cost-related pressures, and operational/economic performance; organizational culture, which includes socio-cultural responsibility, innovativeness, code of business conduct, information dissemination, and health and safety; resources of the organisation such as resource depletion, human capital (skills and capabilities), employees' pressure/ involvement, physical capital (technology and equipment), and training and development, and characteristics of the organization which is a function of position in the supply chain, industrial sector, size, geographical location, degree of internationalisation and current level of sustainability actions

Dubey et al., (2017, p. 1120) classified the key drivers of SSCM as the following: green warehousing, strategic supplier collaboration, environment conservation, continuous improvement, enabling information technologies, logistics optimization, internal pressures, institutional pressures, social values and ethics, corporate strategy and commitment, economic stability and green product design. Zimon et al, (2019, p. 221)) carried out a survey from the literature and identified primary SSCM drivers such as regulatory and customer' pressure; environmental and regulatory requirements; organizational vision and strategies; regulatory requirement and global trends; social responsibility; sustainable responsibility; regulatory requirements; and firm competitiveness. Integrating SSCM into food security will enable the development of a stable, efficient, and ethical supply chain management of food supply, in this case, the supply chain of rice.

Hsu et al., (2021, p. 537) argued that to manage the process of a sustainable supply chain (SSC), authors such as Schneider et al., (2016, p. 283) proposed OPDCA (observe-plan-do-check-adjust); this is a strategy that can help users implement, repeat, and improve the performance of SSC. Hsu et al., (2021, p. 540) proposed a strategic framework for SSCM, which is depicted in Figure 2-4.

Figure 2-4: Framework of sustainable supply chain management



Source: Hsu et al., (2021, p. 540)

2.8 Concept of Food Security

The focus of this research is on Nigeria, where food security both at the national and the household levels is on the decline because productivity has not led to an improvement in human, natural, financial or physical resources (Olarinde et al., 2020, p. 2). Food is a necessity of life because it is a major source of life and wholeness; it must also be consumed at the required quality and in the right quantity. In their work, Jiren, et al., (2017, p. 1) conceptualized food security as universal access to sufficient, safe, and culturally acceptable food, without negative effects on biodiversity. Clapp et al., (2022, p. 1) mentioned that since the emergence of the definition of food security as a term used from a policy perspective in the early 1970s, the term has evolved into a four-pillar concept which are availability, access, utilization, and stability.

Today, more than 828 million people across the globe go to bed hungry every night with most of them being small hold farmers whose means of livelihood depends on agriculture (FAO, IFAD, UNICEF, WFP and WHO. 2022, p. 10). The projection that the population of the world is expected to approach 9.7 billion by 2050 has led to an increase in the demand for food which is affected by the challenges confronting the agricultural sectors (Skaf, et al., 2019, p. 1025-1). With this projection in view, food production in developed countries should increase by approximately 70%; yet, food production is challenged by agricultural practices that impact soil fertility and quality, emissions of green-house gas, and environmental pollution (Skaf et al.,2019, p. 1026-2). This situation has been on the rise as mentioned by Omotayo & Aremu (2020, p. 1) and the United Nations have projected that by the end of year 2020, about 265 million people could face insecurity due to the impact of the COVID-19 pandemic, which will affect 9% of the African economy. Watanabe et al., (2021, p.1) mentioned that with the consistently increasing population of Africa, the region is faced with a major problem of food security.

Therefore, the need for food security has become the concern of not just some households, but major issue to which various countries are giving a great deal of attention. Reaching a state of food security is pivotal in reducing hunger or the 'zero hunger agenda' of the Sustainable Development Goal. The concept of food security has attracted various definitions from different areas, yet even though these definitions are conceptualized in different ways, they are complementary. In relation to this, Sharma, et al., (2020, p. 1) underpinned the importance of introducing sustainability in the agriculture as key in ensuring food security and hunger eradication, to increase productivity by 60-110% in order to feed the 9-10 global population by 2050.

As a result of the World Food Summit in 1996, several authors have submitted definitions for food security. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO et al., 2023, p. 202; World Bank, 2023). From the perspective of the International Institute of Tropical Agriculture (IITA, 2019), food security entails a production of diverse, safe, and nutritious food that can sustain the consumption demand of the population. Any situation different from the above description is rooted in poverty and will have a long-term impact on the ability of families, communities and nations to develop and prosper (USAID, 2019).

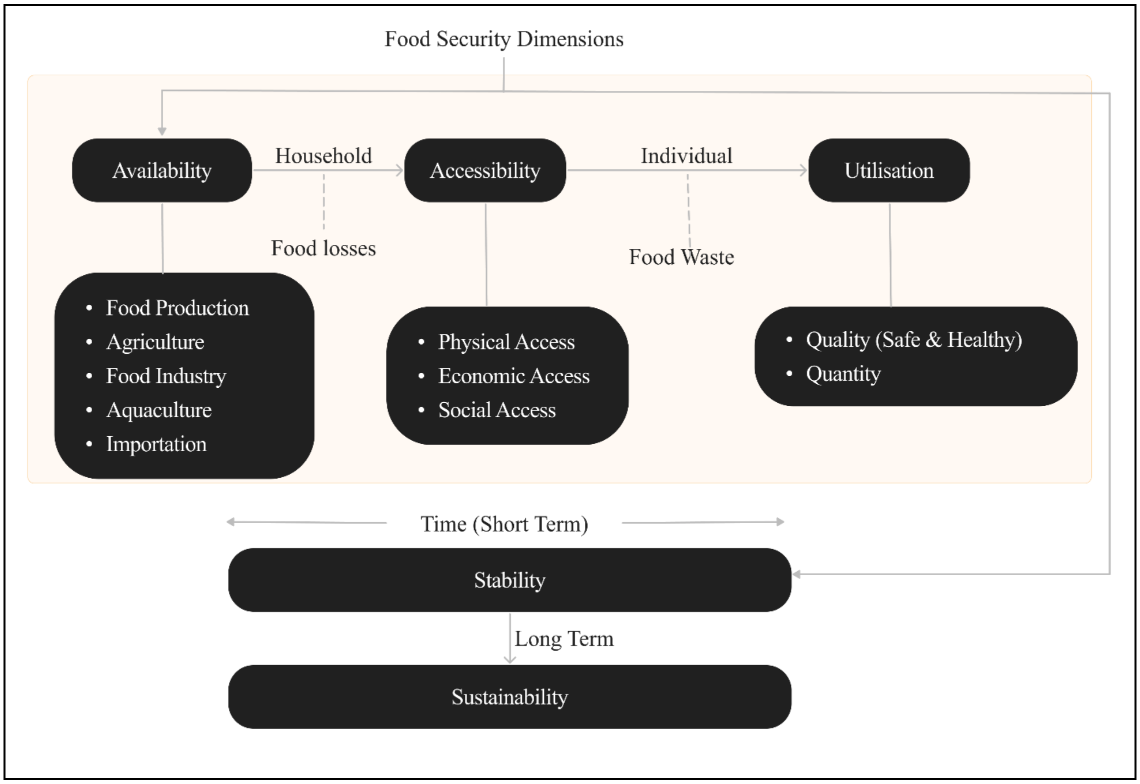
The attention of the 1943 United Nations Conference on Food and Agriculture in Virginia (USA) was on food supply, which was around the need for that countries across the world to ensure security, adequacy, and suitability of the supply of food (Clapp et al., 2022, p. 2). However, food security was only first described as a policy framework in 1974 at the World Food Conference as, "the availability at all times of adequate world food supplies of basic foodstuffs, particularly so as to avoid acute shortage in the event of widespread crop failure, natural or other disasters, to sustain a steady expansion of food consumption in countries with low levels of per capita intake and to offset fluctuations in production and prices" (United Nations, 1975, p.14). In view of this definition, Clapp et al., (2022, p. 2) argued that it only considered the crises of global food at that time which was basically characterized by hunger due to an increase and fluctuation in food prices across the global market; this had the consequence of reducing the supply of food, with the recommended solution back then being to enlarge the capacity for food production. Xie, et al., (2021, p. 1) explained that the definition was focused on the availability of enough food for healthy living. An expanded definition was created in 1983 by the FAO to capture access; that is physical and economic access to basic food by everyone at all times whenever it is needed (Peng & Berry, 2019, p. 4). In 2001, social access was included which refined the definition as economic, physical and social access to food that is safe, sufficient, and that meets up dietary requirements and preferences to enable a lifestyle that is healthy and full of life. (Clapp et al., 22, p. 3).

Food security has become the top priority of the Sustainable Development Goals, aiming for zero hunger by 2030 (Mechiche-Alami, et al., 2021, p. 1). Pozza, et al., (2020, p. 5) mention that the United Nations Sustainable Development Goals brought the concept to the forefront and provided procedures and criteria to boost and sensitize the world to this global challenge. Mechiche-Alami et al., (2021, p. 2) adopts the multidimensional set of indicators for food security, as identified by the FAO (2019), which are availability, accessibility, stability, and utilisation. Kuwornu, et al., (2023, p. 2) mentioned that the various phases of transforming agricultural produce to consumable output is faced with challenges, which are economic, social, political and environmental in nature, and these dimensions influence the performance of the supply chain of food. Although, García et al., (2021, p. 2) argued that despite the challenge of food insecurity being a major challenge to governments of nations, researchers, and institutions, strategies fostered at increasing the production of food such as cereals have focused on environmental, economic, and social resources. However, there is now a demand on these countries to develop and drive policies that align with the SDG especially SDGs 12 and 13, which focus on to maintaining sustainable production and consumption of such resources and curbing the changes in and effects of climatic conditions. The adoption and implementation of sustainability across the three dimensions mentioned earlier, fosters sustainable supply chain management in the performance of the supply chain of products in countries like Taiwan, China, Thailand, India, and Malaysia; this has further increased the profitability and market share of businesses in these countries. Therefore, with the quest to drive sustainability in agriculture as a whole, van Aalst, et al., (2023, p. 2) mentioned that the adoption of different systems of farming that demand a shift in paradigm, will cause a change in the techniques used, even if capital intensive; however, it will impact the farming practices and birth changes in the society.

2.8.1 Dimensions of food security

Amidst the expanded definitions and refinements of the concept of food security as a policy framework, there is the consideration of food security as a human right and nutritional requirement, as well as the need for hygiene in food (Xie et al., 2021, p. 2; Peng et al., 2019, p. 4). As mentioned before, four dimensions have emerged in describing food security which are availability, accessibility, utilization, and stability. Although Clapp et al., (2022, p. 4) recommended using the six-dimensional framework developed at the High-level Panel Experts in 2020, which added agency and sustainability to the already existing four pillars. Agency is viewed from Amartya Sen's 'capability approach' to human development, which propose policies that consider the vulnerable segments in society, both as individuals and communities, to have the capability to access to the food system and reduce inequality; meanwhile, the sustainability dimension focus on the adoption of long-term practices within the food system, insofar as the usage of resources in the present without compromising the food needs of the future generation (HLPE, 2020, p.10). However, this research adopts the four dimensions or pillars as shown in figure 2-5. The four dimensions of food security are also referred to by some authors as pillars. Clapp et al., (2022, p. 3) and Xie et al., (2021, p. 2) opine that these dimensions are interrelated, and that hierarchy exists between availability, accessibility and utilisation. Berry (2022, p.8) identified the interdependencies and connections between the dimensions.

Figure 2-5: Dimensions of food security



Source: Adapted from Berry 2022, p. 8

Authors such as Clapp et al., (2022, p.3), Xie et al., (2021, p. 2), Peng et al., (2019, p. 3), and Berry (2022, p. 8) mentioned that availability focuses on the food production at the national level which could be produced locally or imported; Accessibility identifies the medium in terms of either infrastructure through which users at the household level access the food produced, or economic access, which deals with access to enough money to purchase food that is available. It can also be physical access, focusing on the transport required to access the food produced, and social access, which indicates the acceptability within the community and provision made to assist the vulnerable members to have access to sufficient food. Utilisation refers to the hygienic, suitable, and non-toxic use of food to ensure sufficient quality and quantity of its consumption at the individual level, for the health of the consumer. Stability implies the ability of all the levels to tolerate disruptions caused by nature or man, and the time factor required for the long-term functionality of the other dimensions, which is linked to sustainability.

Beyond consumption, rice has become a major tool for assuring food security, and countries have developed policies to ensure the effective utilisation of this food crop (Uyeh et al., 2021, p. 2). Therefore, this study focuses on rice as a driver for food security in the North Central region of Nigeria because in the West African region, rice is a major staple food that contains high level of calories from which consumers benefit (Watanabe et al., 2021, p. 2) and the land in regions in Nigeria supports the cultivation of high quality and quantity of rice (Okonkwo et al., 2021, p. 1). It is projected that the land used for cultivation will experience an 11% increase by the year 2030 to meet the world's growing demand for food, yet the cultivation of rice is a major source of greenhouse gas emissions (Uyeh et al., 2021, p. 2). Therefore, improving the value chain of rice through the adoption of sustainable practices can increase the productivity of rice, which aids food security, enhances the competitiveness of rice from the region at the international market, the latter will increase the earnings of the country from rice exportation, create employment, and at improve the Gross Domestic Product.

2.9 Supply Chain Operations Reference (SCOR) Model

SCOR is a model for the management of the processes and activities across the supply chain; it does this through the combination of business techniques, benchmarking, and best business practice for the development of framework which is aimed at improving the performance of supply chain management (Putro et al., 2022, p. 455). SCOR is a reference model designed to facilitate communication and enhance the effectiveness of supply chain management, technology and other supply chain activities. It contains two types of elements: performance attributes, such as reliability, responsiveness, agility, cost, and asset management; and metrics (Key Performance Indicators), which measure the performance of the identified process. SCOR is the collection of all the activities of suppliers, customers, material flows, and all market collaborations. The model is made up of six processes, namely, plan (P), source (S), make (M), deliver (D) return(R), and enable (E) any supply chain process is represented by either P, S, M, D, R or E, thereby ensuring the delivery requirement across the plan process.

Furthermore, this model is a merger of performance metrics, processes, best practices and people in one unified structure. The model is a combination of three levels of procedure details which are as follow: level 1 deals with the process type, level 2 focuses on configuration and level 3 is the process element (Supply Chain Council (APICS), 2017, p. 6; Georgies, et al., 2012, p. 3; Rodríguez Mañay et al., 2022, p. 3). The introduction of SCOR enables a concrete explanation of the best practices, process technology usage, and performance metrics provided for understanding the methodology required for the improvement of the operations of the supply chain (Naya & Kasimin, 2020, p. 84). It facilitates the identification of the process, sub-processes, activities of stakeholders, the importance of such activities, and the causes and how these can be corrected (Rodríguez Mañay et al., 2022, p. 4)

For this study, the SCOR model is adopted to describe the rice value chain thereby creating a common language for managing stakeholders across the value chain; it adopts a process reference model that contains the following:

(1) Performance metrics measure the performance of each stakeholder each of which is expected to meet sustainability specifications in terms of the quality of seedlings and fertilizers, the machinery and equipment used and the quality of output.

(2) Process: The process across the rice value chain must adopt sustainability related processes, such that it will not impact the future negatively. For instance, irrigation processes, milling processes, production process and transportation processes must consider the environment. Resources must be user-friendly, and promote productivity in terms of quantity, and quality such that they can meet demand as well as compete in the international market.

(3) Practices adopted must be either best practices (e.g., good manufacturing practices- GMP, and SRP) i.e., contemporary practises, that are organized, established, verified and can be replicated or incipient practices, i.e., practices that introduce new technology or radically different ways of organizing the process. The rice value chain must adopt practices that promotes good value system and do not violate human rights; it must further encourage transparency and avoid corrupt practices.

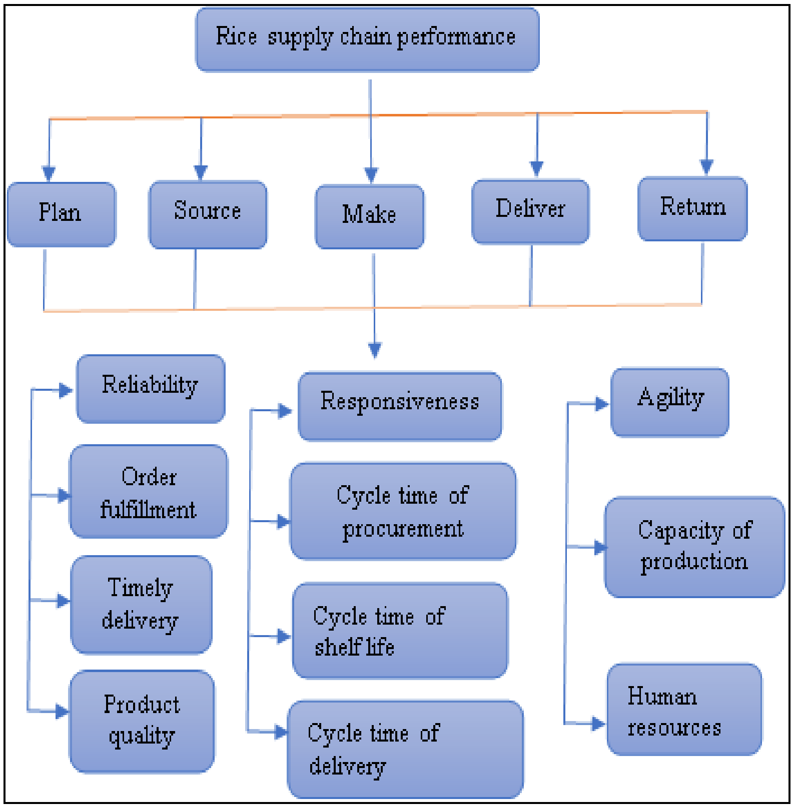
(4) People: Stakeholders across the rice value chain must obtain the required skills especially in handling equipment, machinery, and other inputs. Stakeholders across the rice value chain should create value through trust and justice when relating with one another, understanding the

role of each stakeholder and collaborating with actors across the value chain (Rose, 2019, p. 11-12).

Supply Chain Operation Reference (SCOR) is the initial and all-inclusive industry-wide model adopted in improving supply chain performance; it helps in identifying, measuring, reorganizing, and improving the supply chain (Djatna et al., (2020, p. 77). Moazzam, Akhtar, Garnevska & Marr (2019, p. 13) combined SCOR with a new framework for the analysis and measurement of the agri-food production system. Their work described SCOR as the best model that can be used in the supply chain for identifying performance and for benchmarking; this is because it is comprehensive and sets matrix and standards through which users can examine and improve on their performance at various levels across the entire supply chain.

The model provides an exceptional framework for business, work indicators, best practices, and technology-enabled communication and interaction for stakeholders or partners across the supply chain, with the aim of improving the effectiveness of their activities (Maizi et al., 2020, p. 2). It gives a definite description to business activities that are targeted at customer satisfaction. The model is made up of four levels, where level 1 defines the business included in the planning, sourcing, making, and delivery of the type of process; also, it identifies the content of the supply chain. Level 2 describes the activities of the business process and develops it for the configuration of the supply chain; At level 3, information is provided regarding the planning and goal-setting needed for the successful delivery of improved supply chain; at this stage, each element of the process is identified, while the inputs and outputs required across the supply chain are determined. At level 4, the focus is on key performance indicators and best practices that should be used during implementation (Djatna et al., 2020, p. 77; Maizi et al., 2020, p. 3). Rodríguez Mañay e .al., (2022, p. 4) expressed that with the ability of each process or sub-process to influence each other, analysing the SCOR model process aided in the identification of the processes or sub-processes, and task or activities at each stage in the value chain; this would aid in understanding each process or sub-process, its function and importance to the whole process, the causes of each task or activity and in case of any difficulty or constraints, how it can be corrected.

Figure 2-6



With this disaggregation, the responsibility of each stakeholder across the rice value chain can be understood, and the critical role of each task and activity that they engaged in.

Figure 2-6 depicts the SCOR of the rice supply chain, indicating in levels 1, 2, 3 and 4. While level one indicates the business process, where the sub-process, scope and content are identified, level two shows the attributes of performance, that is, the categories of each process. Level three shows the matrix of the performance, which are the individual elements that constitute each sub-process. In evaluating the performance of the model of the supply chain, the attributes and metrics for evaluating the supply chain's performance are displayed in the SCOR model, in that it reflects the agility, assets, cost, reliability and responsiveness of the supply chain (Djatna, et al., 2020, p. 76). While reliability, agility and responsiveness are categorised as customer-focused dimensions, assets and costs are the internally focused dimension (Moazzam et al., 2018, p. 15). This figure above was adopted from Defrizal, et al., (2020, p. 227) who identified the SCOR model for the rice supply chain in Indonesia.

Reliability connotes the ability to execute a task as required, while responsiveness indicates the time or speed expended in executing the task, and agility, which is measured in terms of flexibility, adaptability, and value at risk - indicates the ability to respond to influences from the external environment and to change if required (Moazzam et al, 2018, p. 15).

Table 2-3: Dimensions of SCOR in rice value chain

Dimension		**Description**	**Level 1 Matrix**	**Level 2 Matrix**	**Matrix for Rice Value Chain**
Customer-focused dimension	Reliability	Ability to execute a given task at the expected level	Timely fulfilment of order with the right quality and quantity	Percentage of orders delivered to customers in full. Delivery made to customers at specified dates. Accuracy of delivery. Condition of item delivered.	Freshness (shelf line), taste, odour, color, appearance, texture, convenience, ease of access, ease of use, compliance with nutritional information, process quality.
	Responsiveness	Speed of executing task	Cycle time for fulfilment of order	Cycle time to source. Cycle time to make. Cycle time to deliver.	Cycle time for sourcing inputs, seedlings and fertilizers; cycle time for planting, harvesting, threshing and milling; cycle time for storage, warehousing, or sales.
	Agility	The ability to respond to influences from the external environment, such as changes from the marketplace, that impact competitive advantage. It is measured in terms of flexibility, adaptability and	Flexibility of upstram supply chain	Flexibility of upstream source. Flexibility of upstream make. Flexibility of upstream deliver. Flexibility of upstream make return.	Flexibility of sourcing for inputs, seedlings, and water; flexibility in accessing information on loans and grants; flexibility in accessing

		value of risk.			machinery such as tractors, planters, harvesters, threshers, seeders, combine harvesters.
			Adaptability of downstream supply chain	Adaptability of downstream source. Adaptability of downstream make. Adaptability of downstream deliver.	Adaptability at planting; adaptability at harvesting; adaptability at post-harvest; adaptability at processing
			Overall value at risk	Risk rating Value at risk (plan) Value at risk (source) Value at risk (make) Value at risk (deliver) Value at risk (return)	Value of risk at land preparation; value of risk at planting; value of risk at harvesting; value of risk at post-harvest; value of risk at processing
			Adaptability of upstream supply chain	Adaptability of upstream source. Adaptability of upstream make. Adaptability of upstream delivery. Adaptability of upstream source return. Adaptability of upstream deliver return.	Adaptability to mechanised system; adaptability to adoption of new technology; adaptability to ethical standards
Internally focused dimension	Asset	Efficiency and effectiveness of use of asset, which is measurable with cash-to-cash cycle time, returns from fixed assets, and returns from working capital.	Returns on working capital	Accounts payable. Accounts receivable. Inventory.	
			Returns on fixed assets	Supply chain fixed assets	

			Cash-to-cash cycle time	Outstanding sales for the day. Inventory for day's supply. Payable Outstanding payments for the day.	
	Cost	Costs of operation of processes in the supply chain	Total cost to serve	Planning cost; sourcing cost; material landed cost; production cost; oorder management cost; fulfilment cost; returns cost; cost of goods sold;	Cost of acquiring land preparation machinery; cost of seedlings and equipment for planting; cost of harvesting machinery; cost of post-harvest activities; cost of processing.

The SCOR model ensures that each stage or actor in the rice value chain goes through the PSMDRE process, such that it conforms to the delivery requirement. It also ensures that the performance metrics, processes, best practices and best-skilled people are employed in attaining sustainable supply chain management to ensure food security.

2.10 Sustainable Rice Platform

The Sustainable Rice Platform (SRP, 2020, p. 7) identifies performance indicators for sustainable rice cultivation, as seen in the Table 3.3. According to Devkota, et al., (2020, p. 2), SRP is an all-encompassing platform for the various stakeholders in the rice value chain, which was established in 2011 by the Division of Technology, Industry, and Economic Agri-food programme of the United Nations Environment (UN-Environment) programme in conjunction with the International Rice Research Institute (IRR). It aims to drive sustainable rice production through the adoption of 12 performance indicators under eight themes and across 41 requirements which incorporate building values among stakeholders; and reducing environmental impacts while increasing profitability among stakeholders and supplying surplus rice to the global rice market (Mungkung et al., 2022, p. 1287).

Table 2-4: Sustainable rice performance indicators

Goal	Performance indicator
Improved livelihood	Profitability: net income from rice
	Labour productivity
	Productivity: gain yield
Resource use efficiency	Water productivity and quality
	Nitrogen-use efficiency
	Phosphorus-use efficiency
Life on land	Biodiversity
Climate change	Greenhouse gas emission
Consumer needs	Food safety
Labour conditions	Health and safety
	Child labour and youth engagement
Social development	Women empowerment

Mungkung et al., (2022, p. 1278) described SRP as a voluntary initiative with the goal of ensuring the adoption of sustainability through the efficient utilization of resources and best management practices across the rice value chain. The Sustainable Rice Platform (SRP, 2020, p. 5) recommends efficiency in the usage of nutrients to avoid the release of excessive nitrogen into the environment. Nitrogen is a required fertizer in rice production, but uncontrolled usage of it can cause global warming, depletion of fossil fuels, acidification, and air pollution (Tayefeh et al., 2018, p. 1). Sadimantara, et al., (2022, p. 1) recommends the application of organic fertilizer, such as manure from animals and other residues from plants, alongside this inorganic fertilizer in order to reduce the harm caused.

Tsai et al., (2021, p. 2) opined that sustainable practices must concentrate on societal development, the interrelated environmental impact, as well as global economic significance. Thus, this research incorporates this view in examining the activities of stakeholders throughout the rice value chain. In this context, it identifies and integrates the actors or stakeholders across the rice value chain, such as input users and suppliers, distributors, or wholesalers, governmental and non-governmental organisations (NGOs), and farmers, whose activities at different stages are linked to each other, with the final aim of satisfying the final consumer.

2.11 Theories underpinning the study

A theoretical framework is an empirical or quasi-empirical theory of social and/or psychological views, at various levels of concentrations, which can improve the understanding of occurrences (Tamene, 2016, p. 53). Saunders, et al., (2009, p.36) define theory as a structure related to the cause, effect, and result of the interaction between two or more variables which may or may not be verified and established. While it has been stated that sustainability is established on the triple bottom line framework, it is also important to align it with other relevant theoretical perspectives. Hence, the study examines Stakeholder theory, resource dependence theory, and Lewin's force field framework are adopted in this research for developing an appropriate model for food security. Also, F-AHP MCDM was selected to project the decision making of stakeholders as it relates to the adoption of sustainable practices. These are discussed below:

2.11.1 Resource Dependence Theory (RDT)

This theory aligns with the research objectives two and four. It is aimed at determining the impact of stakeholders' resources, interdependencies on each other resources and how decisions are made by each stakeholder to sustainably use these resources on improve food security. Also, aids the establishment of the plans, strategic policies, and practices executed by government towards the use of available resources across the value chain of rice.

Resource Dependence Theory was developed by Emerson in 1962 (Van, et al., 2017, p. 25). Hillman, et al., (2009, p. 1404-1405) presented the arguments of Pfeffer, et.al., (1978, p. 26-27) on RDT, by stating that organisations create a platform for understanding the relationship of interconnectedness between themselves and society. Organisations are not in themselves self-governing but are limited by their existing interdependencies on other entities external to them. Such interdependencies and uncertainties may occur due to the activities of other connected organizations resulting in circumstances that demands resilience to get through such situations. Although an organisation strives to manage the results from these activities of the other connected organisations, another trend of dependencies occurs, which leads to a drive for power within and among organisations; this eventually impacts the conduct of the organisation in question.

In describing RDT, Marchildon, et al., (2016, p. 64-65) considers interdependencies between social actors and their effect on driving organisational performance and competitiveness; they opined that organisations are defined by the level of activity under their control related to their core and purpose. That is, the resource a stakeholder/ actor possesses, determines their level of dependence, while actors across the chain depend on each other to provide resources to sustain the processing, production and general availability of rice in the quest to ensure food security. In assessing of this theory, actors that need certain resources link up with others to obtain these (Tilliquist, et al., 2002, p. 93).

From the perspective of RDT, an organization is an open system that is characterized by its reliance on the unforeseen activities of the external environment to function (Hillman., et.al.,2009, p. 1404). According to Pfeffer, et al., (1978, p. 1), the basic concept is that "to understand the behaviour of a company, we must first know the context in which that behaviour occurs".

Resources are things that an actor identifies as important and valuable; these are, information, material, capital, or access to market and organisations will seek a formal agreement that governs the exchange of resources in order to ensure continuous access to it when they are needed (Tilliquist et.al, 2002, p. 93). The resources available to various actors in the rice value chain are information, input, infrastructure, policies, technology, capital and access to market; these are sought by other actors at different stages to ensure productivity and competitiveness. The theory recommends that to ensure continuous access, each actor must be legal bound. León -Bravo, et.al, (2017, p. 4) opined that RDT is the finest medium to study sustainability in supply chain management; this is because RDT explains how the coordination of partners and the allocation of resources can enhance the improvement on the efficiency and effectiveness of the operating environment. RDT recommends that actors in the supply chain need to link up with each other to improve their long-term performance (Sarkis, et al., 2011, as stated in Leon-Bravo et.al, 2017, p. 4).

2.11.1.1 Implication on study

Adopting resource dependency theory in this study shows how actors across the rice supply chain can leverage each other to maintain the availability of inputs/ resources, in order to ensure quality, and the efficient and safe delivery of inputs. This theory is weak in that it does not identify the environment of the other stakeholders and does not state how they are chosen.

Moreover, an increase in reliance among actors may cause complication in handling relationship between each other.

2.11.2 Lewin Force Field Framework

"Force Field Analysis" was developed by Kurt Lewin, a German social psychologist who was born in 1890. Group dynamics are still shaped by Lewin's ideas. He spent much of his career in the United States. This theory shows how every given scenario is the consequence of all the numerous interactions and interdependent elements/actors involved. To comprehend and forecast how change might happen, and if it is conceivable, change managers need to look beyond what is visible to the eyes and get a broader overview. All components, their locations, activities, and interrelationships are included in the 'macro-level perspective' (Lewin,1944). A field is a complete view of a scenario, with all the key factors that can impact it or be affected by it directly or indirectly, represented. The capacity, purpose or 'inclination' of a component or individual that affect an event is called its 'force' (Lewin, 1944). The magnitude and trajectory of the forces exerted by various factors may change. At any time, the relative 'distribution of forces' among the many participants determines the outcome (Lewin, 1944). The outcome is consequently dynamic and susceptible to change with any concentration of forces. To comprehend Lewin's three-stage model of the change process, it is necessary to grasp field theory (Burnes and Cooke, 2013). It explains the function of all the components and their forces in establishing a scenario, which is very useful for agents of change. At the macro level, the framework provides a means of understanding and predicting how change will occur, as well as identifying the players, their roles and interrelationships (Dubey, 2017).

Lewin finds field theory to be, 'a method of analyzing causal relations and of building scientific constructs' (1943a, p. 45). As a method, field theory helps Lewin to understand a situation better so that the possible course of action can be estimated. He was concerned that the general understanding was not able to lead a researcher to understand specific cases (Lewin, 1942). He preferred constructive approach as a solution to this problem and to keep his field theory relevant for understanding specific cases. As such, it is a "constructive" or "genetic" method,' as against a 'classificatory' approach in geometry, since "groups figure according to the way they can be produced or derived from each other", instead of grouping them based on their 'similarities' (Lewin, 1942).

In Lewin's field theory, an entire issue must be considered first, and then each part/element must be considered in depth. This may be done with a productive methodological approach.

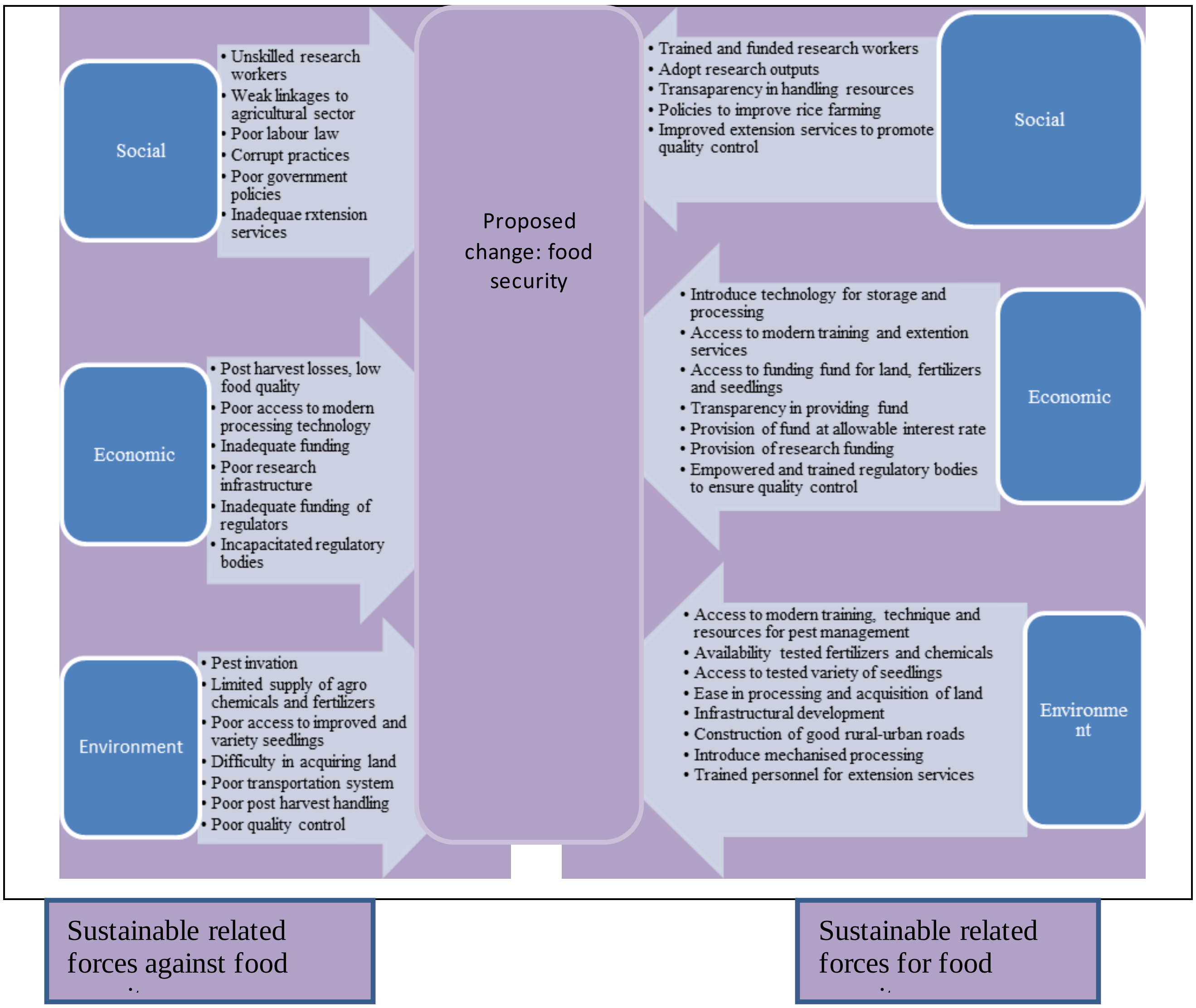
As a social psychologist, Lewin was eager to apply his field theory to the study of social behavior. It was also used to explain groupings. As a result, he saw that it may be difficult to account for both psychological and physiological realities (Lewin, 1939). Groups are characterized by their interconnectedness, not by their resemblance. For his field theory applied to social psychology, Lewin preferred “the characterizations of events and objects by their interdependence rather than by their similarity or dissimilarity of appearance” (1939, p. 145).

In a group, the life space is that of the entire group, not just of one member or a few members. “The social happening is viewed as occurring in and being the result of, a totality of coexisting social entities, such as groups, subgroups, members, barriers, channels of communication, etc.” (Lewin, 1947, p. 200). Lewin explained how a couple may behave in a marriage by considering both, the life space of the husband and of the wife as separate fields, and then a combined group life space as a single field, to demonstrate the outcome of their individual behaviours (1947, p.196). The individual forces make the individuals behave in a way the group’s quasi-stationary equilibrium gets shifted to a new one and stays in that condition until forces shift it further. For Lewin, “change and constancy are relative concepts; group life is never without change, merely differences in the amount and type of change exist” (1947, p. 199). However, it is interesting in field theory when some changes that cannot be explained by the existing group principles occur; this happens when the same conditions do not lead to the same effect anymore (Lewin, 1947, p. 200). Also, Lewin pointed out that resistance to change is greater in groups that have greater social values. To understand this, Lewin suggested that “only by relating the actual degree of constancy to the strength of forces toward or away from the present state of affairs, can one speak of the degrees of resistance or “stability” of group life in a given respect” (1947, p. 200).

The author admitted that the idea was limited by the fact that “one must pay the cost associated with encapsulation”. (Lewin, 1943). "All that impacts conduct at that moment, but nothing else" (Lewin 1943a, p. 58) is a principle that can be difficult to define. If you're not sure which elements will impact the scenario and so should be considered in the field, it's best to leave them out.

In the context of this study, the framework aligns with research objective one and five. It is aimed at establishing the challenges influencing the rice supply chain in the North Central region of Nigeria and establish driving forces for such.

Figure 2-7:Lewis Force field framework for managing sustainable supply chain for food security



Source: *Author*

Also, it assists in the development of the value chain model influencing the security of the sustainable food supply chain in the North Central region of Nigeria. Some of the restraining forces in the rice value chain were poor access to quality input, unstable policies, corruption, limited adoption of research findings and technologies, high dependency on human labour, poor grading systems, poor infrastructural development, poor and decentralised food policies, inadequate storage facilities, poor access to markets, and high postharvest losses and waste.

Meanwhile, the driving forces that will be introduced are technology such as artificial intelligence, drone and blockchain technology, structured and acceptable grading systems, transparency and introduction of quality control across the rice value chain, provision of silos by different local governments, interventions from research institutions, and improved logistics structures. The figure 2-7 illustrates the force field framework as it is adapted to the study.

2.11.2.1 Implication to study

The first stage is the identification of activities and relative challenges at various stages of food the supply chain. At the initial stage, five problems are envisioned across each actor; namely consumer problem, distributor problems, processor problems, farmer's problems and collector problems. Each of these identified problems will be further broken down into three sub categories: environmental, economic and social challenges.

2.11.3 Stakeholder Theory

The stakeholder theory is aimed at research objective two and four. It is aimed at determining the impact of stakeholders' activities (ST) on improve food security, and the effect of this on the underlying triple bottom line. Also, the theory aids the establishment of the plans, strategic policies, and practices that can be introduced to align the activities of stakeholders and use of available resources toward food security. Stakeholder theory can be traced back to early management theory. Preston & Sapienza (1990) dates the origin of stakeholder theory to the era of the Great Depression of 1929-1941. The General Electric Company identified four primary stakeholder groups: 'employees', 'shareholders', 'consumers', and the 'general public'. According to Freeman (1984), the concept emerged from the Stanford Research Institute in 1963 and was defined as those groups that an organisation could not afford to do without (Freeman, 1984). Freeman (1984) proposed a management approach that recognized four important stakeholders: founders, clients, staff, and vendors. He also discovered that throughout the late twentieth century, corporate owners were engaged in "shareholder activism" and supporting inclusiveness.

The stakeholder design structure clarifies the interactions between different groups of players within and surrounding the business. Freeman presented a fresh and concise mission and vision based on comprehensive publications on 'organisational theory and corporate strategy', as well as a substantial number of investigations. The stakeholder model was first described by Freeman (1984) as a diagram where the firm is the centre of a "wheel, and stakeholders are the spokes around the rim".

2.11.3.1 Descriptive, Instrumental, and Normative Views of Stakeholder Theory

Stakeholder theory was defined by Donaldson & Preston (1995) as having descriptive, normative, and instrumental viewpoints as described below.

a) According to stakeholder theory, the company is described as a nexus of cooperative and competing interests with inherent worth.

b) Stakeholder theory is instrumental because it offers a basis for evaluating the linkages, if there are any, between stakeholder and the accomplishment of multiple business performance targets.

c) Lastly, the core underpinning the stakeholder theory is normative in nature, and it includes the adoption of the concept that states “the interest of every stakeholder is intrinsically valuable".

2.11.3.2 Implication on Study

Stakeholder theory is often described as the most appropriate theory for analysing supply chains. It identifies the key actors, also called stakeholders, in the supply chain and describes each of their activities (Lavassani & Movahedi, 2010, p. 14). This theory was used by the Supply Chain Council to develop the SCOR model, which shows how the organisational supply chain is associated with the group supply chain of organisations (Lavassani et al., 2010, p. 23.). Kuwornu, et al., (2023, p. 2) employed stakeholder theory for monitoring the adoption of sustainable practices by members of the supply chain, assessing their output and fostering collaboration towards sustainable supply chain management. This theory identifies the activities of selected stakeholders (input users and suppliers, distributors or wholesalers, co-operators, NGOs, governments, and farmers who are involved in land preparation, planting, harvesting, and post-harvest activities and processing), through which it identifies the challenges associated with such activities and their impacts on food security. It further monitors the adoption of sustainable practices by stakeholders towards SSCM. However, one major weakness of this theory is its ability to give strategies for value creation in the value chain.

2.11.4 Fuzzy- Analytical Hierarchical Process and Multi-criteria Decision-making (F-AHP MCDM) Approach

This framework is adopted for an aspect of research objective two which is aimed at determining the impact of stakeholders' decision making in relation to use of available resources towards improve food security, and the effect of this on the underlying triple bottom line. To effectively understand the problem in the sustainable supply chain management of rice as a major staple food in the North Central region of Nigeria, this research adopts multi-criteria decision-making (MCDM) for managing the series of decision-making activities, such as tactical, strategic, and operational decisions across the supply chain (Beck and Hofmann, 2012, p.182). Pouyakian, et al., (2022, p. 59) state that MCDM is a term generally used for techniques employed to solve decision-making related problems and provide answers using alternative criteria.

The approach will assist stakeholders in supplier selection; to maximise quality and make sustainable decisions that will ensure food security. Also, in order to find, calculate and handle uncertainties and inaccurate data, the research will be guided by the fuzzy-based framework. (Aqlan & Lam, 2015). The MCDM technique used involves of humans and is often employed for judgement in fields like sustainability, risk management, energy, supply chain, safety, environment and quality management for assigning values, weights, and criteria to indicate the hierarchy and importance of options (Pouyakian, et al., 2022, p. 60, 65). The same authors further stated that the development of MCDM techniques have birthed various types, one of which is the Analytical Hierarchical Process which is used when either quantitative or qualitative criterion, or either is available to measure the judgment of decision-makers.

Nguyen, et al., (2022, p. 3) mentioned that the AHP model developed by Thomas Saaty, is a common and widely used model that breaks down problems in hierarchical form to access, rank, weigh, value, and prioritises the options available to the decision makers. AHP is beneficial in that it links the judgments according to the level of importance and compares them pair-wise. It does this by converting decisions into crips values so as to assign these to the notions expressed by the decision-makers; however, the limitation of AHP is that it is vague and information provided is not complete. To deal with these limitations fuzzy sets were introduced to AHP to deal with the vagueness (Pouyakian, et al., 2022, p. 61).

2.11.4.1 Implications to Study

To effectively understand the problem in the sustainable supply chain management of rice as a major staple food in the North Central region of Nigeria, the research adopted MCDM for managing the series of decision-making activities, such as tactical, strategic, and operational decisions across the supply chain (Beck & Hofmann, 2012, p. 182). Mastrocinque, et al., (2022, p.2) adopted fuzzy-MCDM as a decision-making approach for sustainable supply chain management in industry 4.0. To drive the implementation of government policies and foster trust among stakeholders, Yadav, et al., (2020, p. 12); used a fuzzy-analytic network process for the adoption of Block Chain Technology (BCT) in the supply chain of agricultural produce. This approach was relevant in helping stakeholders to prioritise TBL dimensions of various situations or activities.

This framework aids in the identification and effective analysis of activities associated with each actor across the supply chain, namely in assessing the challenges that the actors may face and developing strategies to ease the identified challenges. The model is made up of various stages ranging from stage one, which is the identification of the variables in problem identification and analysis. Stage two is the assessment of the variables, while at stage three, the outcome will pass through the risk inference system known as fuzzy inference system (FIS), which is used in analysing the level and the effect of the problems. All these will be evaluated to make necessary predictions.

2.12 Summary of Chapter

The concept of sustainable supply chain, overview of it and food security were presented in this chapter. The literature reviewed in the chapter provided in-depth understanding of the concepts by expounding on the dimensions of sustainability, supply chain, triple bottom line, food security, and value chain. The chapter also presented the theoretical frameworks that create a scenery and justification for the research. The theories elucidate the unique concepts that are related to one another, via comprehensible arrays of connectivity. Stakeholder theory, resource dependence theory, and Lewin's force field framework are adopted in this research for developing an appropriate sustainable supply chain model for food security.

The next chapter presents the literature review restraining and driving forces of food security in Nigeria, activities of stakeholders across the rice value chain and resources available to them. It further reviewed rice production which enhanced competitiveness in such countries and rice value chain across regions.

Stakeholders across the rice value chain have resources that could drive sustainable food security. Hence adoption of sustainability across the rice value chain should be prioritised to foster food security and competitiveness of rice produced in the North central region.

CHAPTER 3

A contextual perspective of Sustainable Supply Chain Management for food security of rice in Nigeria

3.1 INTRODUCTION

This study seeks to explore the activities of stakeholders across the rice value chain such that it can enhance rice production as this impacts the food supply chain in terms of the availability, affordability, and accessibility of food in the North Central region of Nigeria. The previous chapter examined scholarly works on sustainability, supply chain management and food security. It further explored the underpinning theories, models and frameworks related to the study. This chapter presents the contextual view of food security in Nigeria and rice value chains across selected countries. It further examined political trends, plans, policies and frameworks implemented for rice productivity in Nigeria.

3.2 Restraining and driving forces influencing the rice supply chain in the North central region of Nigeria

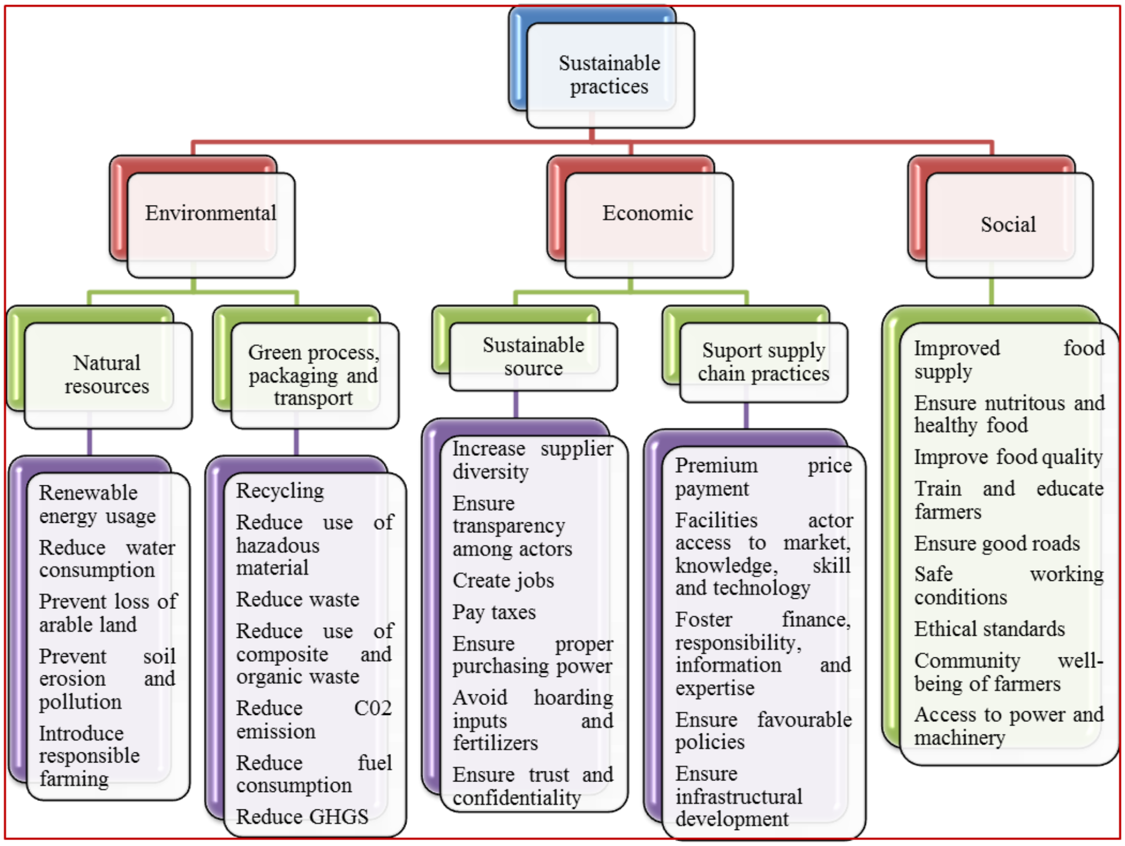
As of February 2021, the United Nations estimated the population of Nigeria to be roughly 209,427,200 million people, making it the largest in Africa, and representing almost 2.64 per cent of the world population (Worldometers, 2021). This study adopts the definition by the Food and Agriculture Organisation of the United Nations (FAO) in 1996, which identified the requirements of food security as food accessibility, food availability, utilisation, and stability (World Food Summit, 1996). Nigeria currently imports 3 per cent of its rice produced worldwide (Cotecna, 2020); this makes Nigeria the 9th principal rice importing country (Statista, 2021). Despite the country being the foremost consumer of rice on the continent and a major producer of rice in Africa, it is still one of the top importers of rice in the world (FAO, 2019). Between 2011 and now, through the Agricultural Transformation Agenda (ATA) and Agricultural Promotion Policy (APP), the nation has implemented policies such as access to available land, soil fertility, availability and access to information and knowledge, access to available inputs, production management, storage, processing and marketing, and trade (APP, 2017, p.14). Although these policies have improved productivity, there is still a wide gap between the supply of and demand for food. This is caused by issues such as out-dated agricultural practice, corruption and poor accountability systems, scarcity of quality inputs, low levels of literacy, poor application of research findings and technologies, high dependency on human and manual labour, lack of agro-tech inputs, a poor grading system, insufficient access to credit, underdeveloped infrastructure, derisory storage facilities, and poor access to markets, keeping agricultural productivity low with high postharvest losses and waste (FAO, 2019).

Kuwornu, et al., (2023, p. 2). Cao et al., (2023, p. 1439-3) mentioned that the need to drive the adoption of sustainable practices in business through block chain technology (BCT) has birthed sustainable communication which is focused on providing stakeholders with information for utilizing business practices that fosters sustainability.

Yadav et al., (2023, p. 2) argued that despite the availability of resources and information for stakeholders in the supply chain, poor communication caused by lack of trust in information usage is a major challenge there. According to Niknejad et al., 2021, p.1), professionals and scholars are of the view that block chain technology can ease the adoption of sustainability, fostering trust in the supply chain. A block chain is a digitally dispersed network that functions through the establishment of a coordinated and organized structures, which enables users to verify the information that is available within the blocks through a software system (Yadav et al., 2023, p. 2). Block chain is a technology that is usable at a low cost and that has a large capacity for organizing the blocks, enabling ease of storage, processing, transmission and retrieval of data and information among stakeholders (Niknejad et al., 2021, p. 2). Cao et al., (2023, p. 1438-2) described blockchain as a platform that enables sustainable communication through information sharing and the storage of the details of stakeholders and activities across the supply chain through which trust is developed, bringing about consumer satisfaction with the output and while ensuring its transparency, traceability, and verifiability of information.

The blockchain technology functions with blocks which are linked through hash- a unique digital authentication system for the security of data working through a dispersed system that ensures the visibility of activities of stakeholder; since the blocks are connected to each other, the system increases as data is added and becomes fixed such that only stakeholders in the chain can makes changes through a unified system (Yadav et al., 2023, p. 3; Yadav et al., 2020, p. 2).

Figure 3-1: *Indicators of Sustainable Supply Chain Practices for Rice*



Source: Adapted from Muangpan, et al., (2015, p. 165) and Aroonsrimorakot, et al., (2022, p. 296)

In the context of this study, blockchain technology it identifies and integrates the actors or stakeholders across the rice value chain, such as input users and suppliers, distributors, or wholesalers, governmental and non-governmental organisations (NGOs), and farmers whose activities at different stages of it are linked with the aim of satisfying the final consumer. This definition reflects the influence of value chain, which will also be adopted in this research. The figure 3-1 shows the driving forces and indicators (recommended sustainable practises) that aid sustainable supply chain management across the rice value chain.

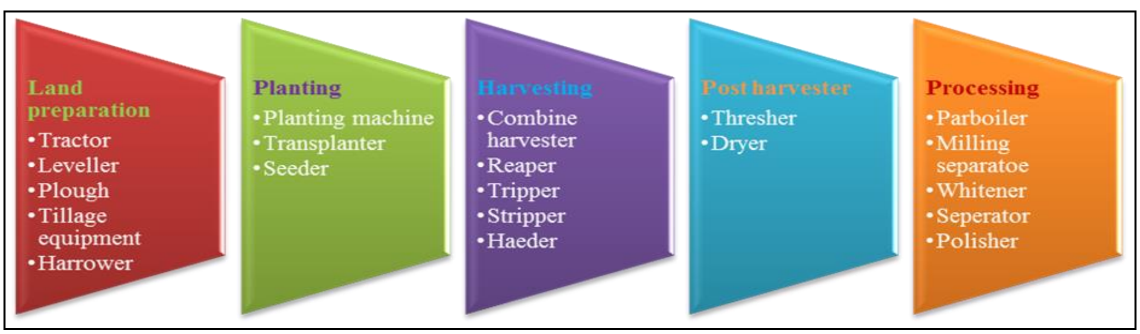
3.3 Impact of stakeholders' activities, decisions, and resources on improve food security, and the effect of this on the underlying triple bottom line

The activities of an actor in the rice value chain that may influence profit or cost, by the is upgrading of the quality of rice, are pre-cleaning, drying, stone-picking, cleaning, weighing, hulling, separating, whitening, grading and bagging (Soullier et al., 2020, p. 4). Tinh & Vang (2020, p. 385) also identified the activities of rice processors as de-husking, removal of rice bran and polishing, but small –scale ones deal with rice consumed on daily basis, while the medium-and-large scale ones deal with the process of de-husking. The value-added activity of rice is a function of how it is used, its variety, and its components; for instance, the varieties of coloured rice undergo three processes, which are pre-cleaning, de-husking, and stone separation, while some other varieties are not touched (Rathan Priya et al., 2019, p. 4). However, the variation in activities performed at various levels will determine the profit that will be earned and cost that will be incurred.

According to Soullier et al., (2020, p. 6), three industrial mills (Olam, Veetee, and Eboyin Rice) in Nigeria source their supplies through production contracts. Olam industrial rice mills rely upon over 3000 rice growers in the Northwestern part of Nigeria. They employ a system where land can be rented to public agencies, local councils or farmers, and millers for controlled paddy production. 400 to 10,000 *ha* of land are controlled by rice millers in Nigeria. This approach has been defined as vertical coordination in the rice value chain and has been fraught with challenges. This approach was also used in Senegal where in 2014, three rice millers used production contracts to source 15,000 tons of paddy grown on 3500 ha by 1500 producers (Soullier et al., 2019, p. 84). The contracts included the supply and pre-financing of seed, fertilizer, herbicides and sometimes technical advice. Farmers were reimbursed with the inputs through paddy.

Figure 3-2 below shows the equipment and machinery that are required at different stages of rice production by stakeholders across the rice value chain. Providing this machinery and adopting a mechanised system will ensure a sustainable rise in rice production in the North Central region of Nigeria.

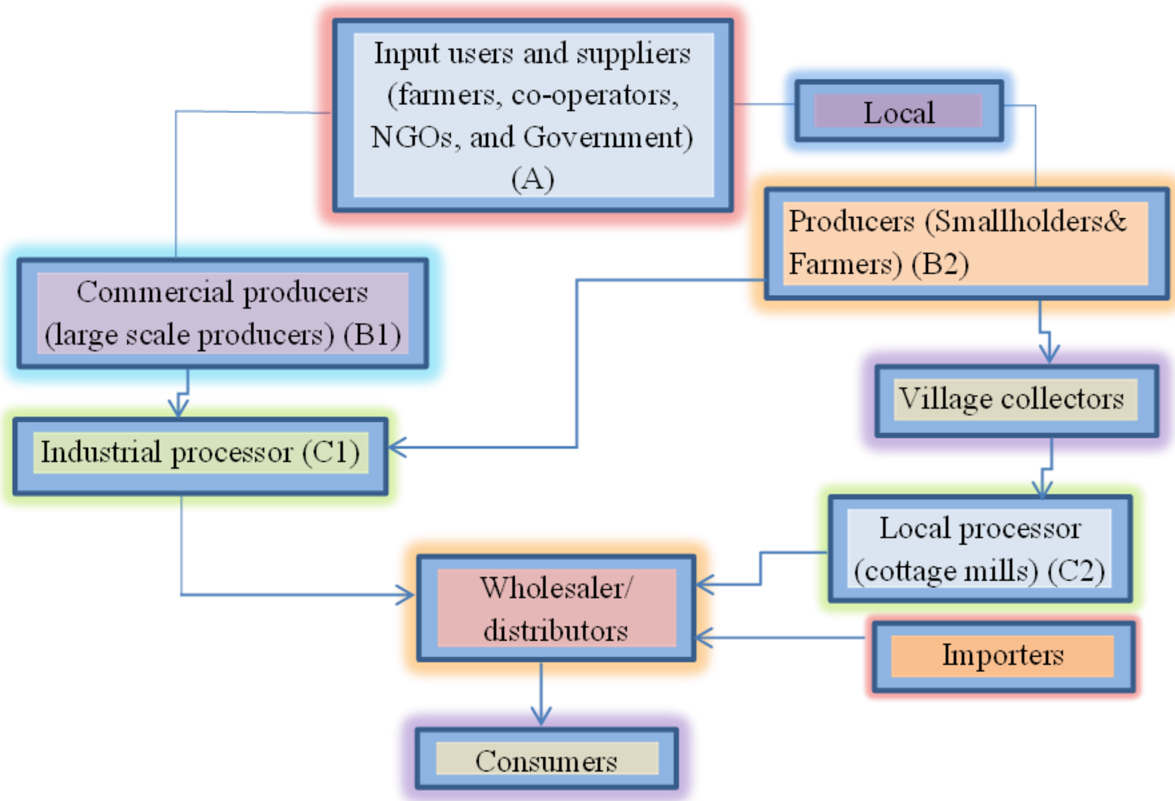
Figure 3-2: stage by stage equipment required across RVC



Source: Adapted from PwC Analysis- (2018, p. 8)

A description of the stakeholders in the rice value chain is shown in figure 3-3. This signifies the stakeholders and contributions of these stakeholders to the value chain. Eighty per cent of the rice produced in Nigeria is by smallholder farmers as seen in boxes A, B2, and C2.

Figure 3-3Stakeholders across Rice Value Chain in Nigeria



Source: PwC Analysis, (2018, p. 9)

The production process is mainly non-mechanised, and farmers make use of manual labour and sometimes animal labour. Boxes B1 and C1, as seen on the figure, represents 20 per cent of the rice produced in Nigeria by intermediate mechanisation: that is by mechanical power sources operated by man.

3.4 Influence of sustainable supply chain management on the competitive performance of the rice value chain network

Rice is a cereal and stable food, which is also called Oryza Sativa, is one of the most important food crops in the world, with more than half of the world's population depending on it for their daily calories, and it forms part of many cultures' diets (Fukagawa & Ziska, 2019, p. 1-S2; Carcea, 2021, p. 1). Rice is produced by over one hundred countries in the world with over 95% of the world's rice being grown in Asia, and roughly 640 million tonnes of the grain being exported (Fukagawa et al, 2019, p. 2-S3; (Rathna-Priya et al., 2019, p. 1). Table 3-1 shows the types of rice cultivated globally and across different regions. However, due to the increasing global population, especially in developing countries, the rate of rice consumption globally is projected to be 550 metric tonnes by 2030 (Yuan et al., 2021, p. 2). This has led to a consistent increase in production across countries in the world (Uyeh et al., 2021, p. 2).

Table 3-1Rice Types Cultivated Globally

RICE	
Japonica (round-grain rice)	Indica (long-grain rice)
Cultivated in temperate climates (Japan)	Cultivated in hot climates (South Asia, Southeast Asia, South China)
Fragrant rice and sticky rice	Long white rice, fragrant rice- Hom Mali from Thailand and Basmati from India and Pakistan, sticky rice
Availability worldwide is low for trading	Available in large quantities for international market

Source: Putra,.et.al, 2022, p. 73

García et al., (2021, p. 2) mentioned that some of the factors that enabled the increase in rice production, were high-powered mechanized farming, use of genetically improved and climatically adaptable varieties of seeds, fertilisers, pesticides, and improved techniques in rice farming, cultivation and production through technology.

Rice is the third most produced crop worldwide and is consumed as the main source of energy for eight countries in the African continent, nine countries in the North and South American continent and 17 countries located in Asia and the Pacific (Rathna-Priya et al., 2019, p. 1). According to Arunrat & Sereenonchai (2022, p. 1), there is a likelihood that by 2035, the population of the world will need a quantity of rice of up to 560 million tons. Economically, the price of rice is seen as the second most inconsistent commodity, yet it is the third agricultural commodity that is consumed and socially accepted across the world; these statistics should propel stakeholders across the value chain in various countries to adopt sustainable practices using international benchmarks for the cultivation of this crop, while improving its quality and quantity (García et al., 2021, p. 2). Rice is rich in multiple nutrients and generates byproducts such as straw and husk, which are good and clean sources of electrical energy with low greenhouse emissions (Silva et al., 2021, p. 1).

Schneider & Asch (2020, p. 491) identified the region of Asia as responsible to produce about 90% of the rice produced in the world; this is attributed to a high availability of water from the river deltas located in the region, which creates the possibility for cultivating rice throughout the three seasons. Rathna Priya., et al., (2019, p. 2) mentioned that the cultivation of rice across all regions of the world except Antarctica could be attributed to the ability of the crop to adapt to various environments, as well as its genomic variety across world; this has been proven by its ability to thrive in the 53 degree northern latitude in the north-east region of China, at the equator in central Sumatra, and at 35 degrees south in New South Wales, Australia.

Bich et al., (2022, p. 2) mentioned that in countries like Vietnam, large-scale farmers are rice farmers whose land usage is over 3 hectares; such farmers can improve their productivity through access to tractors and combine harvesters. Rice farmers in this country also have access to structured credits offered by either commercial or agricultural banks.

Regardless of the increasing demand for and production of rice globally, Yuan et al., (2021, p. 2) identified some sustainability related challenges linked to the increase in the consumption of rice, due to its impact on the environment caused by high water consumption, greenhouse gas emissions, use of fertilisers and pesticides, and costs incurred on labour. Table 3-2 captures some sustainable practices across the rice value chain which was adopted by selected countries towards food security.

Table 3-2: Summary of sustainable practices across selected countries

Country	Sustainable practice adopted
India	adoption of high-yielding varieties of rice seedlings; efficiency in the use of available resources; institution of programmes to support the activities of rice farmers and engagement of good practices; rice husk is converted into electricity to light some villages; private seed firms are permitted to register certified quality

	labelled seeds, which were further distributed to rice farmers; use of machine transplanted rice (MTR) and dry direct seeded rice (DSR); relationship exists between the rice farmers and rice research centres; research centres research the genotype of seeds and provide a variety of seeds to farmers;
Bangladesh	Introduction of high-yielding varieties; use of irrigation infrastructure; provision of credit facilities to farmers who adopt modern technology to improve their productivity; linkage between farmers and extension officers; adoption of the service of extension workers advisory and transfer knowledge to rice farmers
Brazil	Introduction of Clearfield (CL) technological system; i.e. use of certified seeds; early planting especially in September; land preparation as soon as rice is harvested; incorporation of livestock alongside rice cultivation; application of glyphosate before rice appears; introduction of the 'Projecto 10' initiative under the CL system which involves government authorized technological transfer and management practices by technicians to rice farmers; existing relationship between stakeholders across the rice supply chain; adoption of technology, automation and innovation in rice production; the establishment of agricultural institutions to create best practices, techniques of production and research; silo system for the storage of rice grains across rice-producing regions
Thailand	Adoption of integrated rice-fish co-culture system; adoption of technology for rice cultivation; Establishment of Rice production community enterprise (RPCEs) to manage the supply chain of rice; flow of information and financial resources across the rice value chain

Source: Compiled by author

3.4.1 Rice Production in India

In India, rice is not just a surplus staple food that plays a major part in meeting daily calorie requirements, it has served as a means towards ensuring food security for the ever growing population and aids in the growth of the economy; this has been through the adoption of high-yielding varieties of rice seedlings, efficiency in the use of available resources, institution of programmes to support the activities of rice farmers and engagement of good practices (Devkota, et al., 2020, p. 1). India is the second largest producer of rice after China using 43,388,000 hectares of land for planting over 6,000 varieties which contributes 22.5% of the rice produced in the world (Rathna-Priya et al., 2019, p. 2). Prasad, et al., (2022, p. 12) mentioned that between 2020 and 2021, rates of 30kg/ha rates of seeds were sown with rice on 45 million hectares of land which eventually produced 122.7 million tonnes of rice grains. According to the research by Perkumpulan Prakarsa et al., (2022), India exports the unique basmati rice to 40 countries, with a largest quantity of its export being to South Africa, while exporting other varieties to some African, Arab, and Muslim countries (Putra et al., 2022, p. 72). In India, the byproduct generated from rice, which is rice husk is converted into electricity to light some villages (Silva et al., 2021, p. 9).

Apart from India being the world second-largest rice producer (after China) and a major consumer of it (consuming 22.3% of global rice production) in this country, paddy accounts for about a third of the net cropped area, and about half of all farmers cultivate it every year. When it comes to planting paddy, farmers base their decisions on the expected future prices that will be realized during the harvest, (Paidipati & Banik, 2019, p.1). In Tripura, an Indian state in the east, a system of rice intensification (SRI) has gained traction in recent years. A rapid increase in paddy production is required to meet the rising demand for rice. The SRI offers a good alternative to increasing rice productivity, (Majumder et al., 2019). The increase recorded in rice production in India is traceable to the permission given to private seed firms to register certified quality labelled seeds, which were further distributed to rice farmers (Prasad et al., 2022, p. 15).

Towards ensuring sustainability in rice production, India has shifted from the traditional system of rice cultivation to the use of machine transplanted rice (MTR) and dry direct seeded rice (DSR). The latter is a sustainable system that reduces land tillage, lowers the cost incurred in the preparation of the land, improves the fertility of the land, reduces the use of fertilizer, promotes mechanized farming instead of child and woman labour, and improves the income of households; it is supported by the government of India (GOI) by subsidizing the cost of the machines used for transplanting seeds and seed drills for rice farmers (Devkota et al., 2020, p. 2). Also, a relationship exists between the rice farmers and rice research centres, which research the genotype of seeds and provide a variety of seeds to farmers, while the GOI financially assists private firms involved in the seed business with funds for training, production of seeds, and sharing these with users.

3.4.2 Rice Production in Bangladesh

Bangladesh is self-sufficient in rice production and has a yearly per capita consumption rate of 269 kg (Cearcea, 2021, p. 1). It is cultivated during three seasons which are Boro accounting for 54% of the rice cultivated, Aman, and Aus (Islam et al., 2021, p. 2). The rice industry employs about 41% of the labour force and contributes to 4.5% of GDP. Although there were some natural disasters, the country was able to harvest 36.19 MT (million tonnes) of clean rice in 2017–2018, with an excess of 2.66 MT, (Biswas et al., p. 90). Common issues associated with rice farmers, in research carried out on rice growers in Bangladesh by Islam et al., (2021, p. 2) were a lack of support and regulatory programmes, such as subsidies on input, poor policies on market regularization, delayed access to quality seedlings and poor access to credit facilities. However, the Bangladesh Rice Research Institute (BRRI) has successfully introduced high-yielding varieties, and irrigation infrastructure has been expanded, which have led to increased use of irrigated lowland high yielding varieties (HYVs) in traditionally higher crop areas, through which rice can be grown all year round, thus providing year-round employment for the country's working population (Biswa et al., 2020, p. 93).

Moreover, through the extension office, the government provides credit facilities to farmers who adopt modern technology to improve their productivity, through which the country achieves self-sufficiency in the production of rice (Akter et al., 2019, p. 1). The adoption of the service of extension workers is required in an advisory capacity and for them to transfer knowledge to rice farmers (Wehmeyer et al., 2022, p. 2). Gomez et al., (2022, p. 2) stated that agricultural extension is part of the responsibilities of the government as a stakeholder across the rice value chain.

3.4.3 Rice Production in Brazil

Within the last decade, Brazil has emerged in the list of top importers of rice as well as being one of to the top exporters indeed, it is one largest consumers of Asian rice and the ninth largest global producer of this staple (García et al., 2021, p. 2; Fitz-Oliveora & Tello-Gamarra, 2022, p. 199)). According to de Avila, et al., (2021, p. 585), rice is cultivated throughout the agricultural regions in Brazil, except for the north and south regions, Rio Grande do Sul (RS), Tocantins (TO), and Santa Catarina (SC) are the main states where rice is produced with RS and SC producing 70% of rice which adds up to 1.15 million ha being grown annually through the flood-based system. The country has been able to take advantage of the weather conditions, geography and technological developments to ensure the productivity and profitability of rice (Fitz-Oliveora et al., 2022, p. 200).

Rice cultivation in Brazil and other rice-producing countries is faced with weedy rice which affects the output of rice; however, Brazil introduced Clearfield (or CL - a trademark term unique to Brazil) technological system, which involves the introduction of programmes and practices such as rotation of crops, use of certified seeds, early planting especially in September, land preparation as soon as rice is harvested, incorporating livestock alongside rice cultivation, and the application of glyphosate before rice appears (de Avila et al., 2021, p. 585-589). Ferrari et al., (2018, p. 1) mentioned that part of the strategies adopted in Brazil to improve the production of rice include identifying specific seasons and dates for different types of seedlings.

de Avila et al., 2021, (p. 586) identified the improvement of rice produced through the 'Projecto 10' initiative under the CL system which involves government authorized technological transfer, such as training demonstrations to rice farmers by technicians across regions that produce rice and lessons on management practices. With the aim of enabling rice farmers to cultivate rice during different cycles and to increase productivity, the Agricultural Research Institute in Brazil added three other varieties of rice seeds that can be planted during different seasons to the existing varieties of seeds. The success of the CL system in Brazil is traceable to the relationship that existed between stakeholders across the rice supply chain, who are the researchers, extension workers, rice farmers and industry technology experts (de Avila et al., 2021, p. 594). The most productive rice cultivation period in Brazil is between November and December (Ferrari et al., 2018, p. 6).

Fitz-Oliveora et al., (2022, p. 200) mentioned that the increased rice production experienced in Brazil, is a function of the adoption of technology, automation and innovation in rice production, the establishment of agricultural institutions to create best practices, techniques of production and research, and enabling the supply chain of the agricultural sector in general.

Between 2017-2019, about 2.5 million tonnes of husk were generated from over 11.4 million tonnes of rice produced in Brazil (Silva et al., 2021, p. 1). The same authors also mentioned that the use of rice husk for renewable energy will improve the environmental and economic sustainability of the rice industry. Towards the strengthening and enablement of the rice supply chain, Brazil adopted a silo system for the storage of rice grains across rice-producing regions, which ensures a regular supply of rice for marketing and consumption all through the year (Fitz-Oliveora., et.al, 2022, p. 200).

3.4.4 Rice production in Thailand

In 2021, Thailand produced 21.3 million tonnes from 11.17 million hectares of land, making it the 6th largest producer of rice (Arunrat & Sereenonchai, 2022, p.1) and largest exporter of rice in the world with around 70% used for the cultivation of the rainfed type of rice and 24% for irrigated rice (Mungkung et.al., (2022, p. 1278, 1287). Rice is mainly cultivated in the Lower Northern region of Thailand, and is the main source of income at the household level within the country; this is because farmers cultivate rice for their consumption and the excess is sold (Putra et al, 2022, p. 77). Cavite & Suwanmaneepong, (2022, p. 951) submit that the performance of the supply chain of rice in Thailand functions based on the product (rice), information and financial flow which impacts the output and relationship among stakeholders in the value chain, which including policies and programmes introduced by external forces.

As of 2019, Thailand's rice production consisted of 44,418 organic rice farmers, who adopt the integrated rice-fish co-culture system for rice farming, which is a system that has proven to increase the yield of rice, reduce the cost of rice cultivation, and is sustainable (because of less pesticides and herbicides being used), furthermore, this system has improved the income and standard of living of rice farmers (Arunrat et al., 2022, p.1 - 2). To ensure the quality and productivity of rice, Thailand has adopted technology for rice cultivation (Mungkung et al., 2022, p. 1278). Rice production community enterprise (RPCEs) was instituted to manage the supply chain of rice in Thailand especially in the rural areas (Cavit et al., 2022, p. 951). Thailand has a large export market for rice in other parts of Asia and in Africa, and has gained entry to some developed countries like the USA, Japan, and Canada (Putra et al., 2022, p. 72)

3.4.5 Rice Production in West Africa

In West Africa, rice is an important food crop to drive food security for both the rural and urban population (Adaptation fund, 2021). The annual consumption of rice per capita rose from 10 kg to 54 kg per household between 1961 and 2017 (USDA, 2018). Soullier et al., (2020, p. 2) stated that the main producers of rice are Nigeria, Mali, Guinea, and Cote'd'Ivoire at rates of 3.7 million tonnes, 1.4 million tonnes, 1.3 million tonnes and 1.1 million tonnes per year, respectively, and its production has increased over the years with a high contribution from Nigeria, Senegal, Mali, Ghana, and Cote d'Ivoire; yet, the countries still suffer from low yields, which is a result of a high reliance on old and poor agricultural practices, and a low adoption of better varieties and quality seedlings. The region is faced with disruptions such as floods, shortage of water for irrigation, strong winds and storms, invasion of pests, and diseases (Adaptation fund, 2020). Segun et al., (2018, p. 186) added that the Global Rice Science Partnership (GRiSP) mentioned that birds are the second hindrance to rice production in Africa, and 15% of rice produce all around the globe is lost to pests, including birds.

Nawaz et al., (2022, p. 3) found that activities involved in preparing a nursery for transplanting often demand up to 250-350 hours of manpower per hectare; this leads to an increase in labour cost which eventually reduces the profit. Moreover, the rice value chain in West Africa is mainly traditional, that is, the rice millers buy paddy from various farmers without good consideration of its quality, rate of moisture, and impurity. Millers use the traditional system which in itself is slow, and the quality of rice produced is low, in that it often contains broken grains, and a mixed variety of grains, making it impossible for this rice to compete with the global rice market in terms of cost, quality, and scale (Soullier et al., 2020, p. 3-4).

To meet demand, countries in the region such as Nigeria, Cote d'Ivoire, and Senegal rely heavily on the importation of rice (Soullier et al., 2020, p. 2). To improve on the rice value chain, these authors further mentioned that policies are being recommended to modernize the domestic rice value chain in West Africa; these policies are aimed at enlarging the processing capacity of rice. Arouna et al., (2021, p. 2) pointed out that the Coalition for African Rice Development (CARD) policy was instituted to strengthen the rice sector and drive self-sufficiency within Sub-Sahara Africa, therefore enabling food security. This was further simplified into the National Rice Development Strategies (NRDS) aimed at solving problems that exist within the rice value chain such as poor policy, poor irrigation schemes, and poor access to quality seeds and inputs required for production.

Meanwhile, the FAO launched the Integrated Production and Pest Management program for sustainable intensification for farmers across the rice value chain in Mali, Senegal, Mauritania, and Niger; about 6800 rice farmers and 500 extension workers were trained to improve on the production of rice. A credit scheme platform was established for the rice farmers and a drive on the use of high-quality seedlings was aired throughout these countries; also, a platform was set up where rice farmers could access information on the marketing of seedlings (FAO, 2022). Furthermore, to ensure adaptation to climate change, the Climate Resilient Rice Production (CRRP) approach was introduced to improve the welfare of farmers in the rice - farming communities, improve the well-being of the nation and introduce new tasks along the rice value chain; this was a contribution to the RICOWAS project (Regional Agricultural Policy for West Africa of the Economic Community of West African State) that targeted 153,000 rice growers across the region (Adaptation fund, 2021).

Rice farmers hire workers who are responsible for scaring birds through shouting, waving, drumming, or using of a catapult (Segun et al., 2018, p. 186) and mobile scarecrow (Roy et al., 2021, p. 1). Zossou et al., (2020, p. 291) mention that to improve production, rice farmers should be encouraged to adopt the use of technology rather than continue to depend greatly on the experience of other farmers; also, farmers across the rice value chain can access credits, a good welfare system, and information and communication tools. Souiller et al., 2020, p. 4) describe the use of technology as an upgrade in the rice value chain, which was inaugurated through the introduction of policy that propelled technical and organizational changes as well as encouraged investment in industrial milling technologies, with functions such as precleaning, drying, cleaning, stone picking, weighing, hulling, separating, whitening, bagging and grading. Addison et al., (2022, p. 2) mentioned instances of the improvement in the supply chain of rice in Ghana, Ethiopia, and Mozambique, through the adoption of technology across the rice value chain. In Ghana, technology and technological innovation were adopted by rice farmers in the rural areas; this increased productivity and their incomes, while improving food security and reducing poverty in the region. From their research in Ghana, Addison et al., (2022, p. 2) observed that government at the local level provided subsidies for rice farmers to adopt new methods of rice cultivation.

In Egypt, the government intervened in rice productivity through the development of varieties of rice which are high yielding; this intervention highlights on the need to invest in research and development. Also, the Egyptian government promoted the services of extension workers through technology transfer (Eliw et al., 2022, p. 496).

3.4.5.1 Rice production in Senegal

Rice accounts for 34% of the cereal consumed in Senegal (Mané, et al., (2021, p. 1614), yet, its demand exceeds the rate of production which is why the country generally depends on the importation of rice and other types of food (FAO, 2022). To keep up with the annual demand for rice, the government must import 40% of the rice consumed (Escobar et al., (2022, p. 2). The

IPPM programme is also available in Senegal to help strengthen the productivity of agricultural activities and aid the global competitiveness of its rice. Arouna et al., (2021, p. 3) mentioned that with NARD, Senegal was able to implement the 'great offensive for food and abundance'. Although the government is striving towards self-sufficiency in rice production, most consumers prefer the imported rice; this is because the quality of local rice does not match up with the preference of the customer, as it contains a lot of impurities and dirt, which are caused by a high dependence on local technology, therefore it cannot compete either in the international market (Mané et al., 2021, p. 1615). To improve rice production, the government need to implement policies that aids technological innovation and can promote sustainable practices (Escobar, 2022, p. 3).

As for now, the Senegal Rice Valley which is located in Sahel area is the largest irrigated rice-producing centre in Africa, but farmers thresh paddy manually and are faced with postharvest losses (caused by pests and bird invasions), an insufficient supply of fertilizers, poor administration of inputs, and the breakdown of machinery (Ogwuike et al., (2021, p. 1); Escabar, 2022, p. 3). Arouna et al., (2021, p. 2) recommend that effective monitoring and benchmarking of performance indicators of rice production will aid with self-sufficiency, improve the livelihood of small household farmers, reduce labour usage, increase profitability and increase youth engagement in the rice value chain. Despite the importance of technology, Ogwuike et al., (2021, p. 2) opine that it is important to understand the farmers' preferences to encourage them to adopt technology.

3.4.5.2 Rice production in Cote d'Ivoire

Rice is the most consumed cereal in Cote d'Ivoire with a consumption of about 1,300,000 tonnes per annum, when just about 700,000 tonnes produced are produced each year (Soro et al., 2021, p. 95). Therefore, over half of the rice consumed is imported, as the other half of demand cannot be met due to the poor quality of the seed yet there is a constant increase in their quantity (Bakari et al., 2019, p. 11). In the quest to meet the increasing demand, the government has to leverage on importation, despite the adoption of self-sufficiency in rice production which has increased the ratio of local rice - from 25% in 2009 to 35% in 2020 (Twine et al., (2022, p.175). Also, the government has implemented various policies which are aimed at improving rice production and increase the varieties of it available (Bakari et al., 2019, p.13). With the implementation of NARD, Cote d'Ivoire was able to develop a strategy for the recovery of rice (Arouna et al, 2021,

p. 3). To improve rice production, Cote d'Ivoire adopted the Asian yield-enhancing, rice-growing technology which requires in management practices such as straight-row planting, bundling, and levelling (Takahashi et al., 2019, p. 158).

3.4.5.3 Rice production in Nigeria

In Nigeria, rice is a major crop that can aid food security (Chidiebere-Mark et al., 2019, p. 237). With Nigeria being on the drive to focus on self-sufficiency in rice, the country has been able to increase its self-sufficiency ratio from 33% in 2009 to 50% in 2020 (Twine et al., 2022, p. 175). This ratio could be greater because Nigeria has resources such as land area of about 4.9 ha for an increased production of paddy rice (Chidiebere-Mark. Et al, 2019, p. 238). The competitive performance of Nigerian rice could also improve if there were industrial mills; and a supply of high-quality rice; this could yield an extra million tonnes of rice each year, which could be competitive in terms of cost and quality (Obinna et al., 2020, p. 63). Yet, rice production is low due to the continued adoption of the traditional system of farming, poor availability of resources for irrigation, effect of inconsistent climate, lack of access to credit facilities, and inability to adapt to the usage of new technology (Ojo et al., (2020, p. 2). Another problem identified is the invasion of farm lands by the Fulani herds men who are rivals for land usage, water and grazing land (Ojo, 2022, p. 105). This problem is a prevalent occurrence in Nigeria especially the six states of the North Central region of the country, which are Kogi, Kwara, Benue, Nasarawa, Niger and Pleatue states (Mustapha 2022, p. 21).

With an annual consumption of rice of at about 5 million MT and only 2.7 million MT being produced domestically, this means that the remaining 2.3million MT are imported. Unfortunately, 90% of domestic rice is produced by smallholder farmers, who are poor in resources, lack the ability to identify opportunities across the value chain, lack access to inputs, assets, and infrastructure, and support services (Chidiebere-Mark et al., 2019, p. 238).

Rice assumes a very crucial role in the diet of Nigerians, yet countries like India, Vietnam, Pakistan and Thailand still play the leading role in the production and export of rice globally (OECD/FAO, 2021). Although Nigeria is a producer of rice, it is projected that by 2030, the country will be one of the largest importers of this cereal (OECD/FAO, 2021). Uyeh et al., (2021, p. 2) state that Nigeria is the second largest rice importer in West Africa even though it is largest rice producer in region; this is due to its low levels of productivity. There was an expectation in terms of agricultural outlook that during the period from 2018-2019, the importation of rice to the South Sahara Africa (SSA) region would be high; meanwhile, on a completely different note, it is expected that there will be an increase in the world's prices of world milled rice, from US$ 447 per tonne in 2018 to US$ 470 per tonne by 2028 (OECD/FAO, 2019). Regardless of this, Africa has the potential to increase the supply of rice by increasing its production and becoming self-sufficient. To achieve this aim of self-sufficiency, Arouna et al., (2021, p. 1-2) identified a policy framework that was launched at the fourth Tokyo International Conference on African Development called "Coalition for African Rice Development" (CARD); this policy was aimed at doubling the production of domestic rice in countries within SSA in the period from 2008-2018.

As part of the 23 African countries involved in the CARD policy framework, Nigeria also put in place various initiatives to increase the productivity of rice towards food security and encourage consumption of locally produced rice, thereby reducing the importation of rice (Obinna et al, (2020, p. 60); Ayuba et al., (2020, p. 44). These were part of the Presidential Rice Initiative launched in 2002, with the aim of increasing the production and processing of rice; farm inputs and varieties of rice were provided to farmers at a subsidized rate. A growth enhancement scheme, which is an e-wallet initiative, was also introduced in 2011. Furthermore, a database of 15 million registered Nigerian farmers was, developed amongst which were rice farmers; it was aimed at notifying these farmers via text message about where and when to collect agro-inputs and loans, which are provided by the government.

The National Rice Development strategy of 2009, the rice intervention funds of 2011, the Agricultural Transformation Agenda of 2011, and the recent Anchor Borrowers Program were aimed at boosting the productivity of rice in Nigeria and improving self-sufficiency in this area. The last-mentioned intervention, the Anchor Borrowers Programme, was set up in conjunction with Central Bank of Nigeria, and aimed to provide inputs to small holder farmers, who in turn would supply produce at harvest time to Anchor and receive payment directly from the company; this scheme was aimed at improving the livelihood of rice farmers. Nevertheless, despite all these interventions, rice demand in Nigeria is not commensurate with the supply (Ayuba et al., 2020, p. 43), and neither is the amount of price produced supplying enough to the international market.

3.5 Plans, strategic policies, and practices put in place to mitigate food security risks and uncertainty.

Since rice play a very important role in the agricultural and economic system in Nigeria, various policies have been instituted by various political regimes to enhance price productivity and improve value chain of rice in Nigeria. Table 3-2 shows various programs instituted with the aim improving rice productivity since the independence of the country. While Table 3-3 shows the trends of policies enacted towards rice productivity in Nigeria since her independence.

Table 3-3: Agencies and Programs in Nigeria

Year	Agency	Aim/ Objective
1970	Federal Rice Research Station (FRRS)	Establishment of research centres for the development of improved rice seeds
1972	National Accelerated Food Production Program	Ensure quality in rice production through packaging, designing and technological transfer
1974	National Cereals Research Institute	Research engagement in variety of rice for high yield, training of extension workers, and involvement in adaptive research that can improve and multiply seeds
1976	Operation Feed the Nation	Drive towards self-sufficiency in supply of locally produced food; introduction of subsidy on seed and fertilizers, availability of credit, subsidy decree on use of land and improved mechanized farming
1978	Abakaliki Rice Project	Established to increase the processing and production of rice
1987	Agricultural Development Project (ADP)	To create research-farmer linkage and platform for implementation of policies for rice production
1988	National Agricultural and Cooperative Bank (NACB)	Establishment of credit schemes for rice farmers which was aimed at boosting the production of rice
1999	Presidential Rice Initiative	Aimed at ensuring self-sufficiency in rice production and at bridging the gap between the demand and supply of rice

Source: Ayinde et al., (2018, p. 11)

Table 3-4: Political Trends of Rice Since Independence

Date/Year/Regime	President	Policy	Outcome
Pre-ban (1971-1985) Pre-crisis (1971-1980)		Liberal policies on agricultural projects, agricultural institutions and development of agricultural programmes	Reduction in agricultural produce, increase in food prices, increase in the importation bills of food, and increase in importation of rice.
May 1978		Operation Feed the Nation (OFN). Aimed at improving agricultural production, reduce food prices, and increase import bills	Rice importation decline
1980-1981 (April 14, 1980)	Shehu Shagari	Green revolution. Provision of 200 tractors, 50 ten-ton lorries, 250 mobile ridge threshers, 250 irrigation pumps, 500 threshers, 500,000 tons of fertilizers, 500 shellers, and provision of N20 million grant for rice production	Rice cultivation area increased from 400,000 hectares in 1980 to 900,000 hectares in 1989; leading to increase in paddy production from 600,000 tons to 1,422,000

			tons. Green revolution failed due to misappropriation of funds and corruption
Pre-ban (1971-1985) Crisis (1981-1985)		Involvement of government in rice importation, distribution and marketing. Fraudulent and corrupt activities and issuance of licences for importation of rice by the presidential task force set up to curb food shortage- national rice fraud between 1979-1982 To boost local rice production and encourage rice farmers, 20 million Naira grant was disbursed by the regime. Introduction of policies on the supply and distribution of inputs; introduction of policies on agricultural inputs, water resources, irrigation policies, and agricultural cooperation policy. Increase in budgetary allocation for agriculture in 1982 and 1983	Locally produced rice was no longer competitive. Reduction in rice importation. Part of the fund for fertilizer was misappropriated.
1986-1993	Ibrahim Babangida	Introduction of the Structural Adjustment Programme (SAP) in 1986 to restrict importation of rice. Establishment of Directorate of Food, Road and Rural Infrastructure (DFRRI) aimed at: improving agriculture in the local areas, Increasing the production, supply and access to food, building of rural roads and improving water supply in the rural areas. Introduction of trade policies such as tariffs, import restrictions and full ban on importation of rice.	Low production of locally produced rice; little expansion in areas used for cultivation of rice.
1993-2009	Ernest Shonekan, Sani Abacha, Abdusalam Abubakar, Olusegun Obansojo, Musa Yaradua		No regime showed interest in local rice production. Only 6.37% of hectares of land was used for rice production. The period was characterized with smuggling of rice land border
2011-2015	Goodluck Jonathan	Agricultural Transformation Agenda was introduced which was a re-awakening of the agricultural sector in general. Rice Transformation Agenda-	Improvement in rice production. Illegal importation of imported rice due to corruption

		adoption of ECOWAS seed treaty to permit importation of improved varieties of rice seeds from member states. Encouragement of local fertilizer producers. Establishment of de-husking centres in regional areas.	
2015 till date	Muhammadu Buhari	Anchor Borrowers, an initiative by the Central Bank of Nigeria is a programme developed to improve rice production	The importation of rice from Thailand dropped by 90%, that is from 644,131 metric tonnes in 2015 to 20,000 metric tons by 2017. The regime encouraged the planting of varieties of rice across various states. Also, government-imposed ban on importation of rice in order to encourage local production. Yet, there is still inadequate supply of local paddy of high quality, some farmers still battle with bird invasion, flooding, lack of subsidy on fertilizers, poor access to loans, and funds from Central Bank of Nigeria does not get to farmers because of corrupt practices by some state governors. Smuggling of rice across the land borders is still on the increase despite the ban and high tariffs. For Nigeria to become self-sufficient in rice production, farmers and other stakeholders across the value chain must have direct contact with the fund/ resource providers

Source: Adapted from Uche Uwaezuoke Okonkwo, et al., (2021, p. 5-8); Ayinde et al., (2018, p. 9-11)

3.5.1 Coalition for African Rice Development (CARD)

CARD is a policy framework that was birthed by the Japan International Cooperation Agency (JICA) and the Alliance for a Green Revolution in Africa (AGRA) at the fourth Tokyo

International Conference, which focused on the development of Africa (Evans et al., 2018, p. 67; Arouna et al., 2021, p. 2). The policy framework was aimed at doubling rice production between 2008-2018 and encouraging self-sufficiency in rice among 23 participating Africa countries, some of which were Nigeria, Ghana, Kenya, Ethiopia, Tanzania, Uganda, Madagascar, Mali, Cote'd Ivoire (Ivory Coast), Mozambique, and Cameroon, to mention a few. The policy was aimed at improving food security, rural urban development and reduction of poverty within these countries (CARD, 2008, p. 2).

The CARD policy became necessary during the food crisis from 2007-2008, with the increase in the price of rice exportation at over US$1000 (Arouna et al., 2021, p. 2). CARD was also aimed at developing policies for research in rice production, by dialoguing with stakeholders, equipping old research institutes, and strengthening research workers through training and technical guidance in rice production; it was also aimed developing high-yielding, low-land varieties as well as drought-tolerant and pest resistant breeds of rice seed, which were certified and harmonised through legislation in member countries; Other aims of CARD were to equip agricultural extension workers through training on rice farming, encourage knowledge transfer among rice farmers, and provide information through advisory hubs and knowledge centres. The initiative also provides funds to small-scale farmers, provided post-harvest handling by developing mill centres or mobile milling centres, improved road infrastructure, ensured quality checks, and developed information systems for rice farmers (CARD, 2008, p. 9-13).

3.5.2 National Rice Development Strategies (NRDS)

NRDS was developed by countries that participated in CARD in the policy-based dialogue and was led by national institutions in conjunction with relevant rice value chain stakeholders (CARD, 2008, p. 13). It was aimed at developing and achieving short-term, medium-term, and long-term goals for rice production within the participating countries (Arouna et al., 2021, p. 2). NRDS was aimed at tackling challenges across the rice value chain such as poor policies, poor research, lack of availability to quality seeds and inputs like fertilizers and herbicides, poor access to inputs, and issues around water management and irrigation schemes (CARD, 2008, p. 10).

3.5.3 Agricultural Transformation Agenda (ATA, 2011-2015)

The introduction of the Agricultural Transformation Agenda in 2010 was the beginning of the reformation of the agricultural sector in Nigeria; it restarted the clock for driving sustainability in this sector with the aim at improving the Nigerian economy (FMARD-APP, 2016, p. 7). The agenda prioritised rice, which was found to be available in the six geopolitical zones of the country, as one of the crops for job creation and food security, since rice consumption within the country was expected to grow to 36MT by 2050 from 5 MT in 2010 (FMARD-ATA, 2011, p. 32). The Rice Transformation Plan was implemented to ensure self-sufficiency in rice production in Nigeria (FMARD-ATA 2011, p. 32).

The Rice Transformation Plan proposed a compromise between the demand and supply of rice, such as, through an increase in the production of locally milled rice which replace parboiled (imported) rice. This would be achieved by incentivizing the private sector to invest in locally produced fertilizers, large parboiling and de-husking facilities in the regions with a high rate of production and increasing the importation levy on parboiled rice. Also, it aimed at increasing the cultivatable farmlands for lowland rice and irrigated rice; it also aimed to increase domestically improved seeds by leveraging the ECOWAS seed treaty which permits the importation of improved seeds from member countries. Furthermore, local companies who had invested in the provision of improved varieties of seeds, would be allowed to import parboiled rice. The rice value chain was targeted to create 806,000 jobs by the end of 2015.

However, the agenda had challenges such as leakages in farmers' data, which led to the following: a weak distribution of inputs and lack of access to improved varieties of seeds; weak access to credit for smallholder farmers; ineffective investment in infrastructural facilities such as storage processing centres, and warehouses and stagnancy in the food supply caused by a gap in the supply of inputs- an example of this was imported rice cost over $1 billion/annum. With a demand of 6.3 million tonnes and supply of 2.3 million tonnes, there was also illegal food importation; there were further issues with post-harvest losses, while some states still imported fertilizers, which was contrary to the arrangement by the federal government, and lastly, there was corruption as some states held onto the donor funds for the implementation of the programme (APP, 2016, p. 8).

3.5.4 Agricultural Promotion Policy (APP, 2016-2020)

The Agricultural Promotional Policy (APP) was built onto the Agricultural Transformation Agenda (ATA) of the previous year, with priority given to food security, employment creation, diversification of the economy into agriculture and on import substitution (FMARD- APP, 2016, p. 12). The main pillars of the policy were on the promotion of investments in agriculture, financial development programmes in agriculture, and driving innovation and productivity through involvement in agriculturally oriented research. The regime aimed to create sustainable prosperity in Nigeria by collaborating with stakeholders in agriculture, thereby building an agribusiness economy, ensuring food security, creating exports, and driving sustainable sources of income and job creation (FMARD- APP, 2016, p. 10). Unlike ATA which prioritised rice and other crops, APP had general policies for the enhancement of agricultural productivity, some of which were access to land, finance, knowledge, inputs, and information, developing structures for storage, processing, marketing, and management of production. (FMARD- APP, 2016, p. 14)

3.5.5 Anchor Borrowers Programme- ABP (2015)

The Anchor Borrowers' Programme is a Growth Enhancement Support Scheme (GESS) was created in 2015, by the Central Bank of Nigeria (CBN) in collaboration with stakeholders such as the Federal Ministry of Agriculture and Rural Development (FMARD), commodity associations, agro-processors, smallholder farmers (SHFs), and financial institutions (ABP, 2021, 5), as a means of linking anchor companies who process farm output with smallholder farmers who utilise farm inputs for rice and other crops; this was aimed at providing smallholder farmers with inputs so as to boost their production (NIRSAL, 2022, p. 1; ABP, 2021, p. 5; Ayuba et al., 2020, p. 44). It is a value chain agricultural financing initiative for commodity farmers, which adopts the model called the Nigerian Incentive-based Risk Sharing System for Agricultural Lending (NIRSAL) (Akinwale, 2021, p. 9).

The initiative links the agricultural value chain with agricultural financing value chain. The agricultural financing value chain is the anchor; this is made up of the participatory financial institution (PFIs) such as deposit money banks – DMPs, non-interest banks, micro finance banks and development finance institutions (ABP, 2021, p. 8). Meanwhile, the agricultural value chain is made up of the farmers across the value chain of a particular crop (NIRSAL, 2022, p. 1). PFIs have access to funds of about $603million and can disburse single digit loans to verified farmers, based on the Economies of production and repayment period of such loans; while repayment is a function of the gestational period of crops with an interest rate of 5% (NIRSAL, 2021, p. 3; Akinwale, 2021, p. 9). To qualify, farmers are expected to be associated with a registered cooperative society and their application must be accepted through NIRSAL. Interested SHFs must have a bank verification number (BVN) through which disbursement is made to the account of the SHF, if the loan is approved; also, participating SHFs must be listed in the National Collateral Registry (NCR), a public data base that provides information of security interest on movable property (ABP 2021, p. 19-21).

ABP has contributed immensely to rice productivity in selected rice producing state; For instance, Lagos state, a non-rice-producing state, in collaboration with Kebbi state, a rice-producing one, signed a memorandum of understanding for the packaging and processing of rice; this birthed 'LAKE Rice' which competed favourably with imported rice and sold at a cheaper rate. Yet, challenges arose, such as: late/ poor loan repayment by farmer associations; side selling of produce by SHFs; anchors incurring high cost in training and monitoring SHFs; SHFs experiencing delays in receiving of funds and being supplied agro-inputs; poor extension service; supply of inferior seedlings and other agro-inputs by agro-dealers; and corrupt practices among PFIs' staff member (Akinwale, 2021, p. 10).

In Edu-Patigi extension of Kwara State - a rice producing state, Ayinde et al., (2018, p. 24, 31) mentioned that 88.1% of smallholder rice farmers who benefited from the ABP, breached the contract agreement, others did not repay the loan, while others still were involved inside selling and did not deliver produce to the anchor. On the other hand, some of the SHFs complained about poor farming equipment and that the ABP's response time was too long, which eventually impacted the planting season. Ayinde et al., (2018, p. 31) mentioned that the programme increased the level of income of participants in the Edu-Patigi local government by 1%. Ayuba et al., (2020, p. 44) further opined that for the effectiveness of ABP, there is a need for the efficient participation of extension workers, provision of planting technology for rice farmers and improvement in their education and technical efficiency.

3.5.6 National Agricultural Technology and Innovation Policy -NATIP (2022-2027)

NATIP is a policy developed with the aim of harnessing the untapped and available resources in Nigeria, through the adoption of 21st century knowledge, technology, and innovation in agriculture with the aim of ensuring food and nutrition security (FMARD, 2022, p.2). The mandate is about "ensuring food security in crop, livestock and fisheries, generating agricultural employment and services, promoting the production and supply of raw materials to agro industries, providing markets for the products of the industrial sector, generating foreign exchange and promoting rural socio-economic development" (FMARD, 2022, p. 2). It builds on previously existing platforms for food security such as the National Development Plan (NDP, 2021-2025), the global SDGs initiative, the Agricultural Transformation Agenda (2012-2015), and the Agricultural Promotion Policy (2016-2020) (FMARD, 2022, p. 2). One of the areas of focus of this policy is to strengthen the value chain of priority crops, which includes rice, by ensuring the active involvement of small-scale farmers, local government level, and private investors. Another area of focus is the establishment of 100 processing centres, clusters, nodal centres, and cottage industries in rural areas across the country, towards strengthening the linkage between industry and farmers, boosting industrialization, and creating jobs (FMARD 2022, p.4).

NATIP is aimed at improving the commodity markets in the rural areas by organizing them to be effective, and ensuring a good marketing, pricing and grading system. Through it, good agronomic practices (GAP) will be ensured, which will aid in the standardisation of goods for export by providing certificates of traceability on produce (FMARD, 2022, p.19); this is aimed at promoting agricultural produce, such as rice from Nigeria, in the international market. The initiative also seeks to promote digital and climate-smart agriculture, by introducing on-farm and off-farm technologies such as remote sensing system, devices for yield mapping, food blockchain, artificial intelligence, and e-extension, app to promote rental of tractors; thereby introducing these e-agricultural practices that will ensure organic farming, enrich the soil for crops, improve water and irrigation systems, and support structures that can aid ecosystems (FMARD, 2022, p.54). The initiative also seeks to strengthen the loaning and financing structures for investors, agricultural stakeholders, and small-holder farmers through collaborations with the Bank of Agriculture, and the Central Bank of Nigeria, and the Nigerian Incentive-based Risk-sharing systems for Agricultural Lending (NIRSAL) (FMARD, 2022, p.56).

Through the involvement of the National Agricultural Data Management and Information System (NADMIS), the initiative hopes to develop a platform for data management required for monitoring the coordination of activities such as knowledge transfer, provision of subsidized inputs, funding and other extension services for farmers (FMARD 2022, p.58). Through collaboration with stakeholders and local fertiliser producers, the initiative seeks to enact fertilizer and seed laws which will aid access to inputs of high quality, encourage investments of the private sector in the production and distribution of inputs and fertilisers, deregulate importation of inputs and fertilisers and subsequently drive the competitiveness of Nigerian produce, such as rice, in the international market. The initiative supports cooperative operation along the value chain of agricultural produce, by encouraging the formation of clusters especially for women, youths, and the vulnerable groups involved in agriculture; this will be done by providing capacity building, access to finance, and encouragement to learn the 21st century skill set and modern agriculture, as well as developing gender and youth-friendly innovations.

The overall aim of NATIP is to ensure food security through the coordination of state government and agricultural stakeholders to create the National Food Reserve, to ensure resilience in the occurrence of floods, outbreaks of pests or diseases, or droughts. It further aims to reduce food losses and risk in supply, improve storage, and aid stability in the prices of foodstuffs.

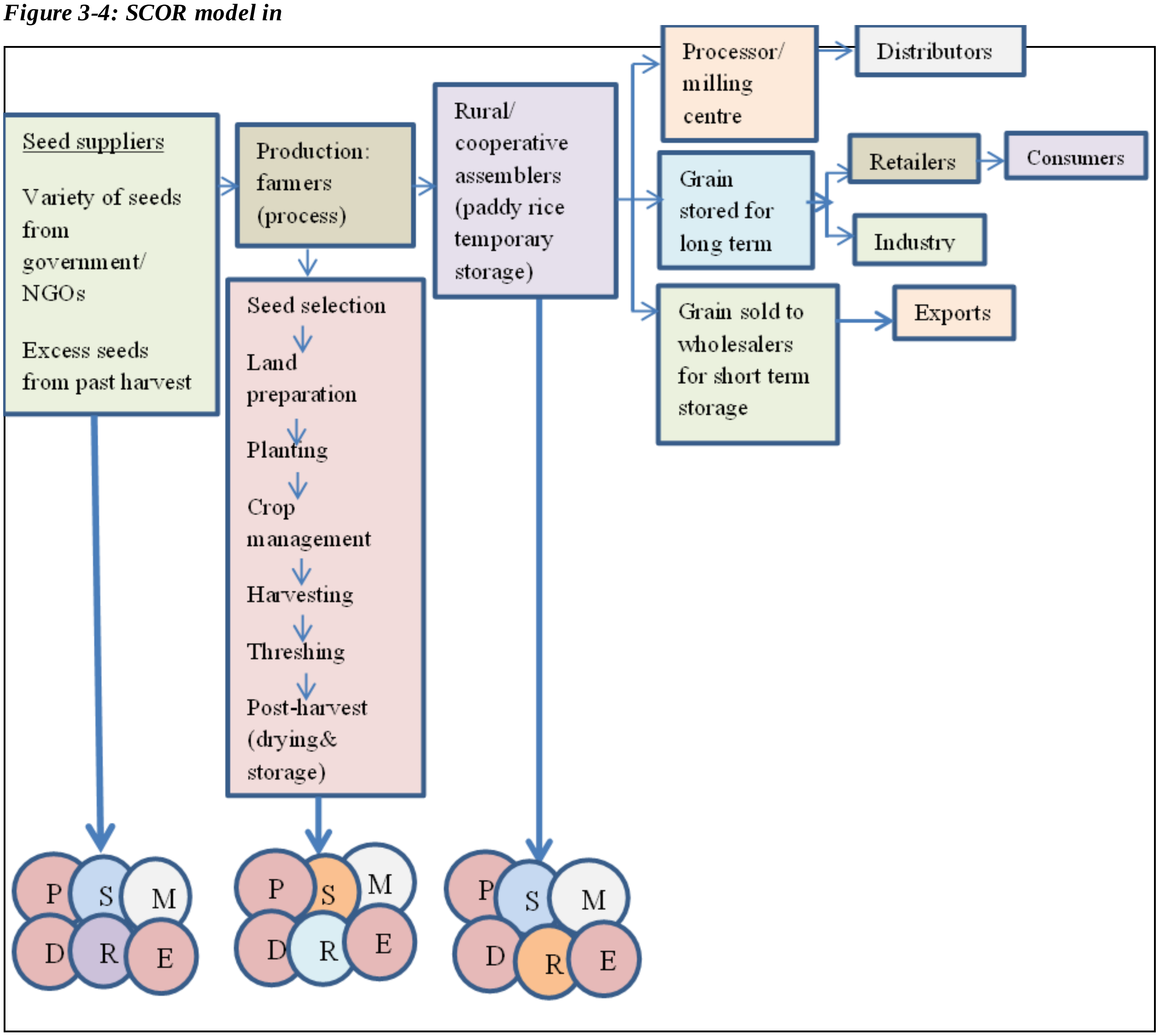
3.6 Value chain model influence the security of the sustainable food supply chain in the North Central region of Nigeria

The rice value chain (RVC) describes the linkages between the actors (ranging from input suppliers, planters, harvesters, processors/ manufacturers, distributors, exporters and consumers) of the rice supply chain (Watanabe, et al, 2021, p. 3). This can aid the easy identification of profit, cost, and margin of each level of activity of the chain. However, the rice value chain varies as it is influenced by the value that each actor chooses to add at any stage, some of these values could be in terms of storage, variety (fadama, FARO 44, short grain, ofada, paddy, or white rice (GAIN report, 2019, p. 11), transportation, packaging, or grading.

3.6.1 SCOR Model across rice value chain

The SCOR model ensures that each stage or actor in the rice value chain goes through the PSMDRE process, such that it conforms to the delivery requirement. It also ensures that the performance metrics, processes, best practices and best-skilled people are employed in attaining sustainable supply chain management to ensure food security. This is depicted in Figures 3-4.

Figure 3-4: SCOR model in



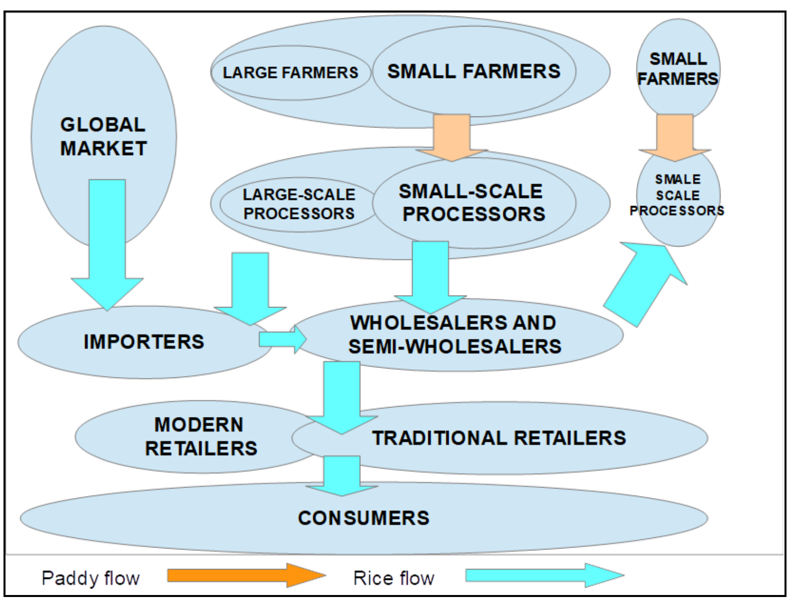
Source: Adapted from SCOR Model, 2017

3.6.2 Rice value chains across regions

Specifically, in this, the rice value chain describes the set of activities and actors that ensure the delivery of the final value of rice to consumers. The rice value chain incorporates collaborations between both public and private stakeholders, where the public, which is the government, is responsible for providing infrastructure, policies, incentives, research and development, inputs and extension services, meanwhile, activities such as the provision of inputs, production, processing and marketing are responsibilities of private stakeholders (Gomez et al., 2022, p. 3). Research has been conducted in this area in the recent past. For example, Watanabe (2021, p. 5) conducted research in the rice value chain through interviews with stakeholder to understand the profitability of the value chain of locally grown japonica rice. In their research, the main stakeholders in the locally grown japonica rice value chain were identified as MIAD, Japanese food store A in Nairobi, and consumers. The cultivation, harvesting, threshing and bagging of rice were conducted by MIAD. The rice was then sun dried, stored in the warehouse, and sold to Japanese food store A. From here, it was then sold to the consumer.

The works by Soullier & Moustier (2021, p. 84) on the value chain of rice in Senegal identified key actors to be farmers, industrial rice millers, processors, wholesalers, retailers, and consumers. According to the research, the Senegal River Valley accounted for 80% of national rice production in 2014 (USDA, 2015), while the remainder was produced in Casamance. Over 360,000 tons of paddy were, therefore, produced in the Senegal River Valley in 2014. Most of this came from small-scale farmers that numbered around 45,000 in 2008. These tons of rice were processed by industrial rice millers. Eight industrial and semi-industrial rice millers processed between 2,000 and 13,000 tons of paddy each, making a total of 45,000 tons. These figures represented between 38% and 75% of their individual milling capacity respectively. The volumes of paddy milled were constrained by the volumes of it that rice millers were able to purchase. Furthermore, there were 420 small-scale processors that milled 87% of the paddy in 2014, with each processing an average of 750 tons of paddy.

Figure 3-5:Value Chain of rice in Senegal



Source: Soullier & Moustier (2021, p.84)

It was found that the rural population in the valley totaled 500,954 people, and the per capita rice consumption in Senegal was 95 kg/year **(**Domgho, 2014, p.2). The valley was then able to supply 187,000 tons of rice to the rest of Senegal. This was not enough for the rest of Senegal, which had to rely on the importation of rice for its consumption. This is illustrated in the diagram in Figure 3-5.

3.6.2.1 Rice Value Chain in Mekong Delta, Vietnam

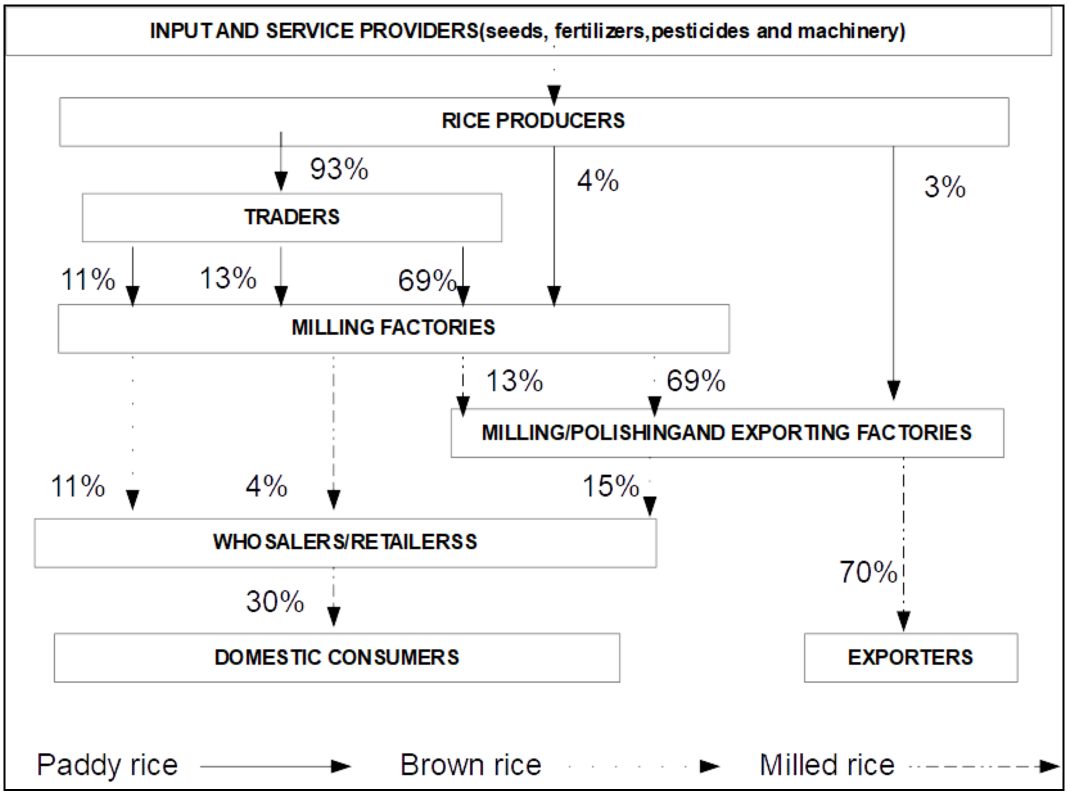
Rice cultivated in the Mekong Delta province of Vietnam accounts for over half of the quantity of rice produced in Vietnam; the province is noted for rice cultivation and is called the 'rice bowl' (van Aalst, et al., 2023, p. 2). Anh, et.al, (2020, p. 375-379) conducted research in the rice value chain in the Mekong Delta, where the number and type of value chain actors interviewed included 300 rice-growing households, 20 commune authorities where rice is grown, 70 millers in the production region, 60 traders in the production region, 50 wholesalers in urban areas, 85 traditional retailers, 45 modern retailers, input and service providers for land preparation such as seed, fertilizer, extension, and post-harvest, and 14 provincial policymakers. According to the research, the rice value chain in the Mekong Delta is a large and complex system which link about 1.5 million small-scale rice farmers, cultivating over 4 million ha per year, to large numbers of traders, processors, wholesalers, retailers, and exporters. This gave about 30% of domestic production while 70% is exported, accounting for over 90% of national exports. The research suggested that the government should implement a policy to promote the quality of rice through contract farming between cooperatives and private enterprises based on quality standards. It was also put forward that a revised policy should open the export market to private enterprises that obtain export contracts based on quality.

Furthermore, the empirical result from the research on the Mekong Delta province by van Aalst et al., (2023, p. 8), revealed that the application of fertilisers resulted in an increase in farmlands being used for rice cultivation, which led to an increase in the output and income of rice farmers.

In the last decades, the Vietnamese government introduced the 'rice first' policy, which was aimed at driving food security and rice productivity in the province of the Mekong Delta, this policy accounts for the abundance of rice cultivation in the region (van Aalst et al., 2023 p. 2). The authors further noted that the government intervention included: huge investment in and improvement of the hydraulic system, which improved the soils located in the region use of mechanized system for the preparation of land; construction of infrastructures for irrigation;

adoption of new rice farming techniques, use of new technological equipment; and use of fertilisers and high-yielding varieties of rice. All of this resulted into triple the amount of rice being cultivated within the year. The whole value chain is described in Figure 3-6.

Figure 3-6: Rice Value Chain in Mekong Delta

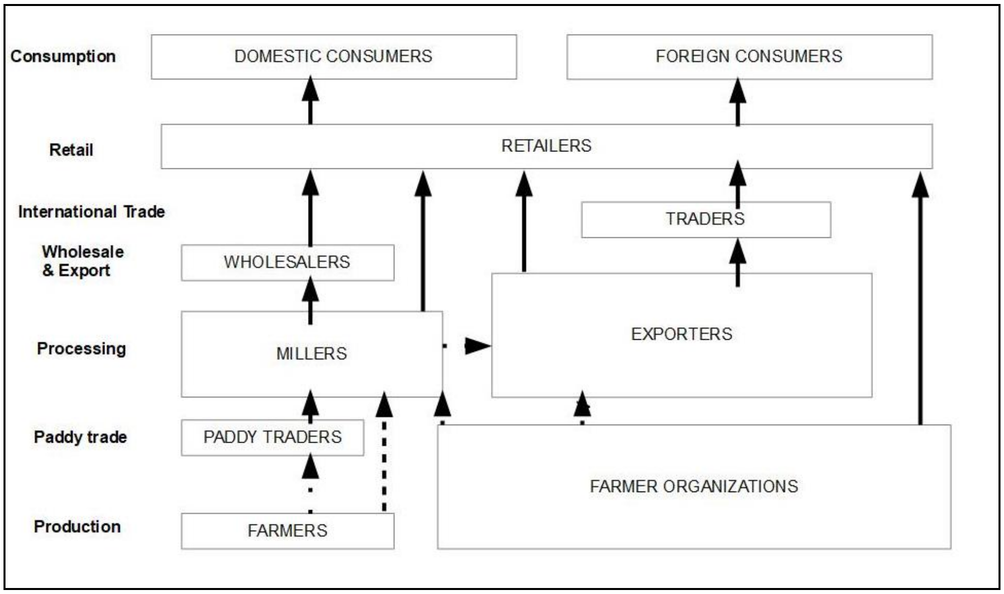


Source: Anh et al., (2020, p. 375-379)

3.6.2.2 Jasmine Rice Value Chain, Thailand

Kumse et al., (2021, p. 2-3) conducted research on the jasmine rice value chain; jasmine is a premium quality rice variety in Thailand. This rice commands a premium price in both domestic and international markets (Bairagi et al., 2020, p. 3474). The main value chain actors include paddy traders, millers, retailers, and exporters. The exporters are the primary intermediaries that connect individual rice farmers to domestic and international consumers. Jasmine rice growers organize themselves in farmer organizations to consolidate their marketing operations, in order to reduce the marketing disadvantages of small farm size and benefit from the advantages of large-scale economies in the rice value chain. This allows them to expand their operations into paddy trading, processing, and wholesale, as shown in Figure 3-7 below.

Figure 3-7: Jasmine Rice Value Chain in Thailand

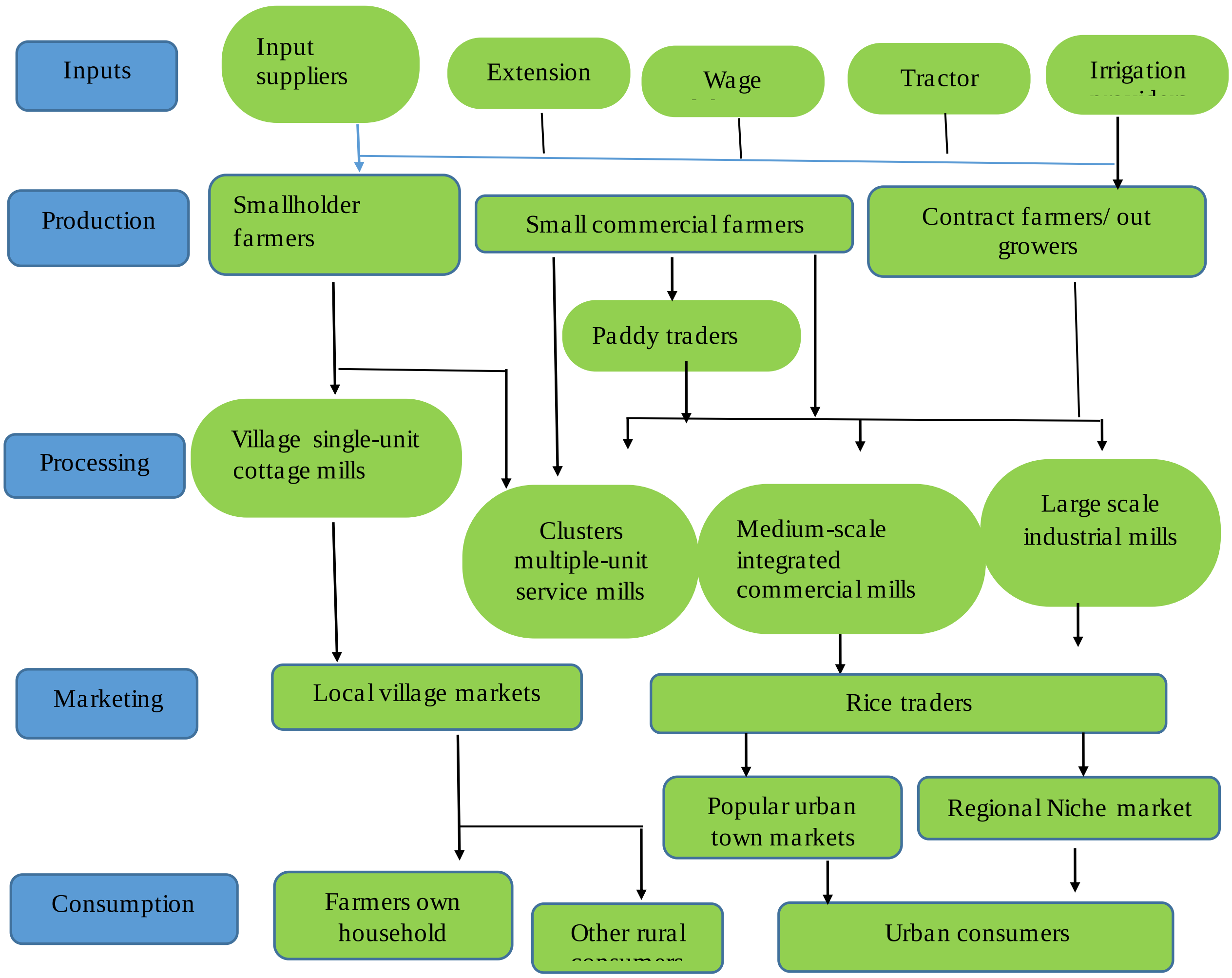


***Source*:** Kumse, et.al, (2021:2-3)

3.6.2.3 Rice value chain, Nigeria

The current state of the rice value chain in Nigeria is shown in Figure 3-5. Eighty percent of the rice produced in Nigeria is by small-holder farmers, as seen in items A, B2, and C2. The production process is mainly non-mechanised, and farmers make use of manual labour and sometimes animal. Items B1 and C1 in the figure represents the 20% of the rice produced in Nigeria by intermediate mechanisation; that is, use of a mechanical power source operated by man. The rice value chain in Nigeria characterised by difficulty in accessing agricultural inputs such as seed, fertilizer and credit facilities. It lacks agricultural infrastructure, such as irrigation facilities, feeder roads, rice storage and processing facilities.

Figure 3-8:Value Chain of Rice in Nigeria



Source: Adapted from USAID/Nigeria (2021, p. 78)

3.7 Summary of Chapter

This chapter reviewed the literature related to the research objectives. Literature on sustainability, sustainable supply chain, sustainable supply chain management, SCOR model, food security, value chain and rice value chain were reviewed. This scientific step, namely the literature review, is to ensure a consistent reference to literature that aligns with empirical data analysis. Literature on the rice value chain across rice producing regions and a historical review of rice trends and policies in Nigeria, was presented. The review of these pieces of literature is relevant to provide a justification for the adoption of the sustainable supply chain in the existing rice value chain towards attaining food security in the North Central region of Nigeria.

The next chapter presents the research methodology of the study.

CHAPTER 4

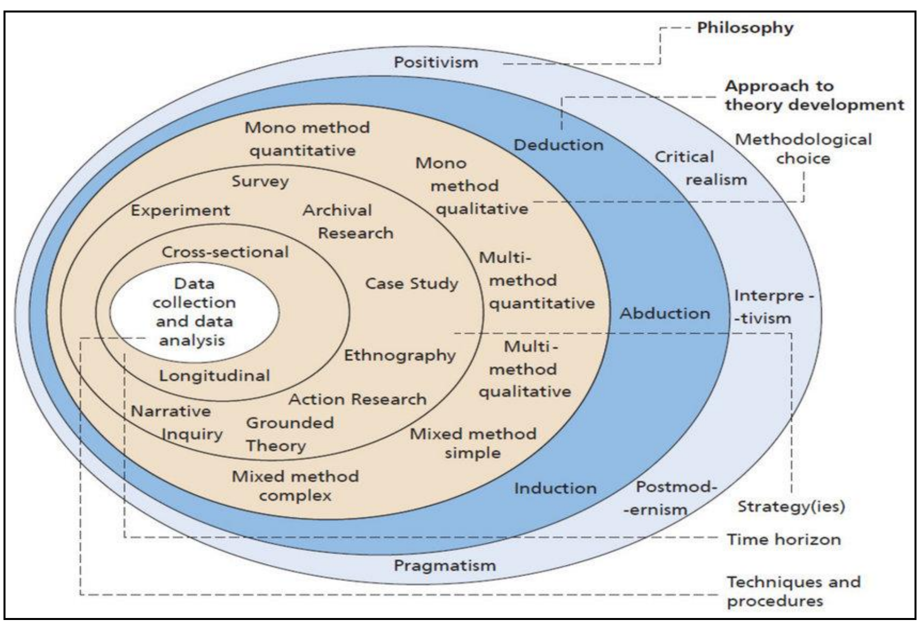
RESEARCH METHODOLOGY

4.1 INTRODUCTION

The intention of this chapter is to unpack the research methodology upon which this study is founded. As such, the study adopts a methodology that is scientifically acceptable, through fundamental assumptions that act as a map for the incorporation of suitable methods that respond to the research questions and accomplish the set research objectives. The research methodology is a systematic problem-solving approach that provides a detailed plan on how the research is executed (Goundar, 2012, p. 10). It explains the intent of the research and how this intent will be executed, thereby explaining the underpinning traditions and philosophies upon which the research is based (Moon et al., 2019, p. 296). This section will discuss the research philosophies, approaches for theory development, and design adopted in the study. It will further discuss the choice of research methodology, data collection, and time horizon, procedure of data analysis and measurement of the research instrument in this study. The last section will focus on the methods of data analysis and assessment.

The following research onion shown in figure 4-1 by Saunders et al., (2019, p. 130) provides a framework for the methodology adopted in this research.

Figure 4-1: Research onion



Source: Saunders et al., (2019, p. 130)

Adopting this framework of the research onion shows a scientific background for the research and depicts the methodology adopted in the research which was further embedded in the research. It enabled clarity in the investigation of activities of stakeholders across the rice value chain, as it impacts the food supply chain in terms of the availability, affordability, and accessibility of food in the North Central region of Nigeria.

4.2 Research Design

In choosing a research strategy, key aspects such as the research questions, research objectives, sources of data and time must be considered (Sekaran & Bougie, 2016, p. 96). The research design gives the required guide for the process of the research study (Cresswell & Cresswell, 2019, p. 49), by providing the blueprint for data collection, its measurement, and its analysis with the aim of answering the research questions (Sekaran et al., 2016, p. 95). The design indicates the structure and plan that is used to answer the research questions linked to the design of a sustainable supply chain model for the rice value chain, which will be developed to promote food security in the North-Central region of Nigeria.

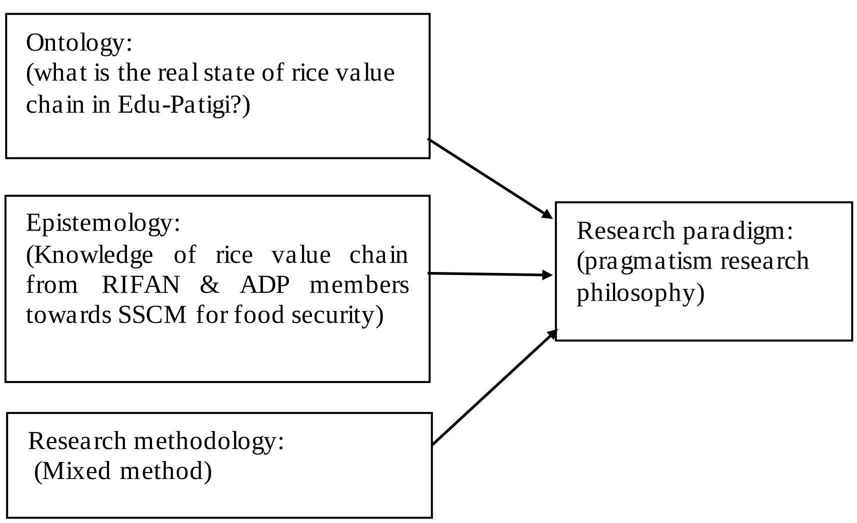
The various forms of research design available are experiment, case study, ethnography, grounded theory, survey and action theory; for the sake of this study, the researcher adopts the survey design. A survey design denotes the collection of information through an in-depth examination of a population, with the sole aim of making a conclusion on the findings made for that group (Bihu, 2021, p. 2). Chen et al., (2021, p. 59) identified it as the most effective method for the collection of information, which is unique to a particular group of people, with the aim of studying the population of interest. With this type of design, the researcher was able to gather both quantitative and qualitative data to answer different types of research questions (Sekaran et al., 2016, p. 97). Also, the researcher compared the literature with the data collected, with the aim of interpreting the data from a theoretical lens. To this end, the researcher used a mixed methods approach which provided a broad basis for understanding the perspectives of rice farmers and other stakeholders.

A survey design consists of a cross-sectional design that is related to a set of data collected through a questionnaire or structured interviews at a particular moment in time, to gather quantifiable data that is related to two or more variables, with the aim of identifying patterns of association that may exist (Bryman 2012, p. 60). Through this approach, the researcher was able to gather information related to the trends in rice production and gather the opinion of rice farmers and other stakeholders, thereby identified the connection that exists between the sustainable supply chain of rice and food security. Information was gathered from 320 rice farmers in Patigi and Edu local government area, which are a representative of the population of farmers in terms of food security. The sole aim of this is to identify the problems across the rice value chain as they relate to food insecurity in Nigeria.

4.3 Research Paradigms

Paradigms describe perspectives or worldviews which describe the basic beliefs associated with a phenomenon, are based on three types of interrelated questions: ontological questions, epistemological questions, and methodological questions (Guba & Lincoln, 1994, p. 108). While the focus of ontological questions is on the reality of the existence of a phenomenon, epistemological questions deal with the process of acquiring knowledge and validating the phenomenon, while the methodological questions describe how the phenomenon should be viewed by identifying the strategy to study it, and the type of data, data collection tools, and analysis required (Rehman & Alharthi, 2016, p. 51-52). The figure 4-2 depicts the research paradigm for this study.

Figure 4-2: Research paradigm for study



Source: Adapted from Rehman et.al., 2016

The ontological question on the reality is the question around the real state of the rice value chain in the Edu-Patpgi region. While the epistemological question encapsulates the knowledge of rice value chain acquired from RIFAN and ADP members to SSCM for food security in the region.

The research methodology adopted in the study was mixed methods, where data was collected through interview and questionnaire. Data was further analysed thematically and SPSS was used to analyse the quantitative data.

4.4 Research Philosophies

The research philosophies introduced in a study create a structure for the theoretical perspectives such as assumptions, ideas, and concepts, which stimulates the questions asked and how they are answered (Moon et al., 2019, p. 296). The central theme of a research philosophy is about the development of knowledge, while its nature and the perspective that the researcher adopts is a function of the assumptions underpinning the research strategy and method (Saunders et al., 2007, p. 101). The research philosophy forms the basis for the choice of strategy, formulation of the research problem, collection of data, and processing and analysis of data (Žukauskas et al., (2018, p. 121). In research, there are four types of philosophies that can be adopted, namely: positivist, interpretivist, pragmatic and realistic. This study adopts the pragmatic research philosophy because pragmatists' perspective is about situations, consequences, and since the emphasis of research is on research problems and questions, solutions are sought by using the available approaches. The application of this to the study is further discussed in Table 4-1 below.

Table 4-1: Implication of Pragmatic View on Study

Pragmatist view	It's implication for study
Research begins by identifying a problem and aims to find solutions which can also be applied to future occurrences. This is done by identifying research problems and research questions, which in turn propel outcomes that are practical in nature and can be applied in the future to other issues.	The study aims to identify the cause of food insecurity in the North Central region of Nigeria by focusing on rice farmers; it aims to develop a framework for practical solutions which can be applied to other regions of Nigeria and other food crops, with the aim of solving the issue of food insecurity in the country
No singular way of solving a problem; that is, there are many methods to solving a problem and the more methods are applied, the more accurate the outcome. They recommend the use of a method or methods that drives credibility, reliability, and collection of relevant data for the study, which makes the research more grounded.	The study adopts mixed methods instead of fixating on qualitative or quantitative methods alone. This is aimed at ensuring a well-founded, credible, and reliable collection of relevant data. Therefore, the study adopts the use of an unstructured interview with 24 stakeholders; alongside this, the researcher developed questionnaires that was administered to 380 stakeholders, which cut across the different categories of rice farmers. This was aimed at ensuring credibility and reliability of data of the study, thereby made the research more grounded.
The focus of the researcher is on what and how the research is executed with the final result in view, thereby stating the purpose for adopting mixed methods	The mixed methods approach is adopted for this study to analyse the perceptions of stakeholders and actors in the rice value chain. Also, the convergent mixed research method is used to explore the opinions qualitatively and quantitatively and analyse the perceptions of the

	stakeholders and actors in the rice value chain.
The pragmatists opined that research must be practical and applied, such that participants supply solutions to an identified business problem.	The focus of the study in on rice farmers and it is aimed that through interacting with them, the researcher can identify issues causing poor rice production in the country; through the interaction, the researcher can identify solutions which was further developed into frameworks that can be applied on other food crops. This is done with the aim of ensuring sustainable supply chain management in the food sector.
Pragmatists believe that theories are developed from practice of an identified truth; therefore, theories and concepts are adopted as instruments for informing practice and solving problems. Further application of such practice enables the achievement of another intelligent practice.	This study draws from theories such as stakeholder theory to understand the activities of stakeholders within the rice value chain; and Resource Dependency Theory in aiming to identify the resources of each stakeholder and how these can benefit other stakeholders. Meanwhile, through value chain analysis and the triple bottom line (TBL) framework, the study analyses the activities of rice farmers as these relate to sustainability and develops sustainability-related strategies that can be adopted to ensure food security in the North Central region of Nigeria. Lewin's force field framework is adopted to show the expected change if sustainable supply chain management is introduced to ensure food security.

Source: Adapted from Creswell & Creswell, 2019, p. 48; Sauders et al., 2019, p. 151

The aim of this study is to develop a conceptual framework/ model for driving sustainable supply chain management in the rice value chain, to promote food security in the North Central region of Nigeria. The pragmatic view that underpins the mixed methods research design (Creswell & Creswell, 2019, p. 48; Sauders et al., 2019, p. 151), creates a fuller view of the world, thereby giving "*an understanding of the subject (individual), the intersubjective (language-based, discursive, cultural) and objective (material and casual) realities in our world*" (Johnson & Christensen, 2020, p. 154); as such, it is appropriate for investigating the current state of the rice value chain, the forces confining the yield of the rice supply chain and the sustainability related activities of the stakeholders in the rice value chain that can ensure food security in Nigeria. In this way, the researcher adopted a convergent mixed methods design, by collecting qualitative data using unstructured interviews conducted among various stakeholders across the rice value chain concurrently with a structured questionnaire administered to other rice farmers and stakeholders across the rice value chain.

Bias associated with the use of a single research method is reduced with the merging of both qualitative and quantitative methods for the collection and analysis of data. The collection of qualitative data through unstructured interviews with 24 stakeholders was compared with responses from questionnaires administered to 360 RIFAN members. The interview linked to answering research Objective one and two. Research Objectives One is to establish the effects the of driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria; Research Objective Two is to determine the effect of stakeholders' resource dependence in improving of food security on the underlying triple bottom line.

4.5 Research Approaches to Theory Development

The purpose of a theory is to provide an explanation to certain occurrences which may happen in various settings, while undertaking scientific research (Sekaran et al, 2016, p. 3). Scientific research may take one of three approaches, which are abductive, deductive, and inductive. The deductive approach is the most popular in describing the relationship between theory and research in the social sciences (Bryman, 2012, p. 24). Its conclusion is derived from an approach that is driven by theory; it works from the general in narrowing down to specific research questions (Sekaran et al., 2016, p. 26; Burke 2020, p. 95). Meanwhile, the inductive approach requires that the researcher builds a theme, categories, and patterns in accordance with the database until he or she is able to develop concrete themes; it works in such a way that even if a premise is true, it is not sufficient to establish a conclusion, while the deductive approach demands that researcher search through the data for themes to know if more information will be required (Creswell et al., 2019, p. 257).

This research adopted both the deductive and inductive approaches. Adopting the inductive approach in this study include the collection of sufficient data with which the researcher accessed the phenomenon, thereby identifying the activities and resources available for stakeholders across the rice value chain. Obtaining this data ensured sufficient data for exploring the forces for and against the rice supply chain alongside the SCOR model. These forces cut across the triple bottom line. By integrating these, the researcher was able to develop a conceptual framework for the sustainable supply chain management of rice.

To identify the restraining forces and effects of the driving forces influencing the rice supply chain in the North Central region of Nigeria, and to understand the activities and resources of stakeholders, qualitative data was gathered to identify the themes, subthemes, and patterns; the aim of this was to develop a conceptual framework for the sustainable supply chain of the rice value chain. This qualitative was further analyzed using Nvivo 12 software. The major variables were food security and sustainable supply chain management. The quantitative data was collected and analysed using mean, standard deviation, inferential statistics and hierarchical regression, using SPSS (Ver. 25) software.

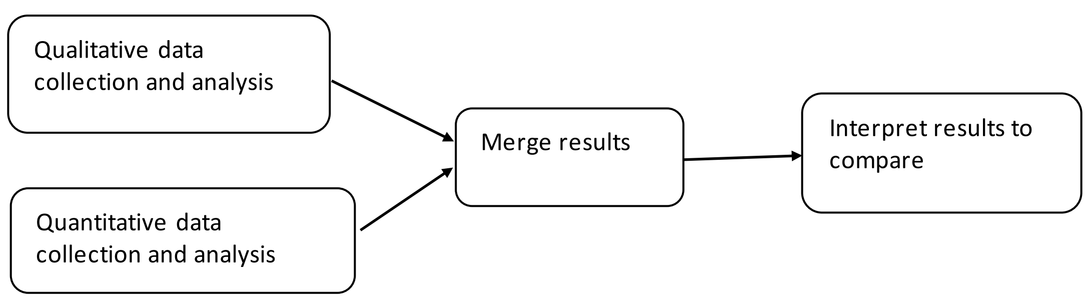
4.6 Methodological Choice for the research

The methodological choice for the research is the approach or system that the researcher decides to adopt in the gathering and analysing both qualitative and quantitative data. Saunders et al., (2019, p. 130) identified these methodological research choices as mono-method quantitative, mono-method qualitative, multi-method quantitative, multi-method qualitative, and mixed methods. Cresswell et al., (2020:299) further identified three types of mixed methods designs as explanatory sequential mixed methods design, exploratory sequential mixed methods design and convergent mixed methods design. This study adopts the convergent mixed method design.

4.6.1 Convergent Mixed Methods Design

Convergent mixed methods design is a one phase data collection process that merges both qualitative and quantitative data collection and analysis. The results from the analysis are further merged, interpreted, and compared. As shown in figure 4-3, for the convergent mixed methods process, data are collected simultaneously but analysed independently.

Figure 4-3: Convergent mixed method process



Source: Adapted from Cresswell et al., 2020, p. 300

This method gives an in-depth view of a population through the interview process, and with a questionnaire, a generalised view of the population is collected (Cresswell et al., 2020, p. 306). This method was adopted for this research because it allows the researcher to converge results for validation; that is the data was collected and analysed independently, and afterwards compared for complements, differences and similarities. For this study, the researcher gathered and analyzed qualitative data from stakeholders through interviews and a questionnaire, which is a quantitative instrument, was developed to administer to other stakeholders. A total of 24 actors were interviewed; six of these actors were ADP extension government representatives from Kwara State Ministry of Agriculture and Rural Development, six of them were large-scale farmers; and the remaining 12 of them were small scale rice farmer. The qualitative data was analysed using Nvivo as the data analysis tool, after which the results were coded, and themes developed. The data from the questionnaires administered to 360 RIFAN members were analysed using SPSS software for statistical results. Both sets of results were integrated using side-by-side comparison.

4.6.2 Data Collection and Analysis Procedure

The target population, sampling frame, sampling techniques, sample size, data collection, measurements of scale, and data analysis associated with this study are discussed in the following subsections.

4.6.2.1 Target Population

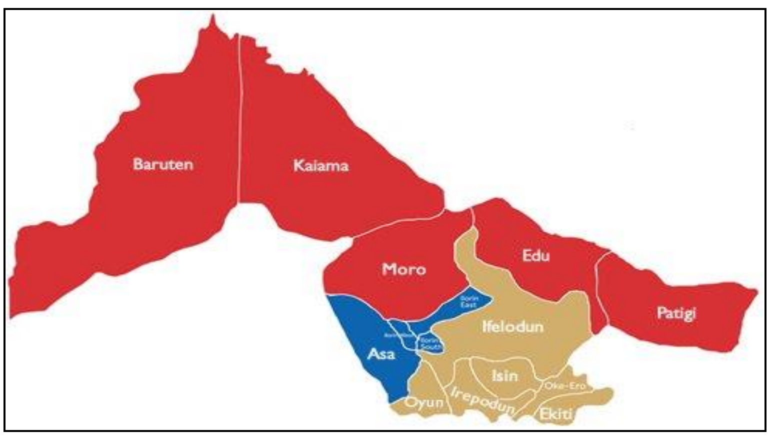
The target population, which is also referred to as population in research, is the total group of people that the researcher is interested in studying, and on whom he or she wishes to apply the study sample results (Burke, 2020, p. 681). In research, sampling starts from the moment that the target population is identified; the latter is defined based on elements, geographical boundaries, and time (Sekaran et al., 2016, p. 240). It is important to define the population from which the samples required for the research are taken; this is because the researcher can only gather sample data from this target population.

The target population for this study were the rice farmers from Edu and Patigi Local government area of Kwara state. The study targeted approximately 10,000 registered rice farmers of the Rice Farmers Association of Nigeria (RIFAN) in Kwara State under the supervision of Kwara State Ministry of Agriculture, Agricultural Development Project Extension (ADP); this association is recognised by the government and consults for the government on policies regarding rice fields, cultivation, warehousing, and exporting. The association collaborates with the state governments, foreign governments, academic institutions, and other institutions (RIFAN, 2018). RIFAN is the connection between the divisions and subdivisions of stakeholders across the Nigerian rice industry with over 12.2 million members who participate in various divisions such as farming, milling, storage, management, trading and marketing, export, research, and allied businesses of rice; the association is on a mission to safeguard the interests of its members while equally ensuring that rice production meets local demand.

4.6.2.2 Study Site

The study site for the research was Kwara state, which is one of the six states in the North Central region of Nigeria. The North Central region is made up of six states, which are Benue, Kogi, Kwara, Nasarawa, Niger, and Plateau. "Kwara State is one of the 36 states in Nigeria with a population of about 2.5 million people, (est. 4.10 million in 2019, Adesiji, et al., 2022, p. 2); it belongs to the six North-central states in Nigeria. It is situated 306km from the coastal city of Lagos and 500km from Abuja, the federal capital of Nigeria, with a total landmass of 32,500 square kilometres. The state is made up of 16 local government area. The state is known for agro resources some of which are sheanut, rice, sorghum, neem tree, sugarcane, melon, millet, yam, groundnut, fisheries, livestock, pawpaw, mango, cashew, citrus, and cowpea" (Nigeria Galleria, 2017). Rice, which is the main stay in this study, is found abundantly in all the local governments in the state, but this study will focus on two of them namely Edu and Patigi local governments areas (LGA) where about 90% of rice is produced (Adesiji et al., 2022, p. 3)

Figure 4-4: Map of Kwara State showing Edu and Patigi LGA



Source: Nigeria Galleria

4.6.3 Sampling Strategies

This study used both probability and non-probability sampling strategies. Probability adopts proportional stratified sampling and non-probability adopt purposive sampling. The

Disproportional stratified sampling is used for quantitative data collection, as it randomly selects representatives from the population with the aim of selecting a sample objectively. The qualitative data collection adopts nonprobability sampling using purposive sampling. Hair et al., (2020, p. 193) mentioned that purposive sampling permits the researcher, through judgment based on expertise, to select samples which can represent the entire group, this is a function of the knowledge of the samples.

4.6.4 Sampling technique

This study adopts the probability sampling technique, which ensures that every element in the population has a known, non-zero probability of selection (Zikmund, et al., p. 395), and that the sample is generalisable to the entire population of the study (Quinlan, 2011, p. 209). This is to ensure that the sample selected from the population (RIFAN) is representative of the population. Stratified random sampling was used so that stakeholders who make up the RIFAN population of the study are selected in line with the known features of the population which will impact the research (Quinlan, 2011, p.210). Disproportional or non-proportional stratified sampling (Easterby-Smith et al., 2015, p. 80; Zikmund et al., 2010, p. 400) will be adopted because each stratum is not grouped according to the population size. The stratified sampling technique is advantageous in that it helps to obtain a more efficient sample and that the sample reflects the population because of the characteristics or criterion used for stratification (Zikmund et al., 2010, p. 400-401). The shared characteristics used to select respondents include: (1) Actors or stakeholders across the rice value chain who are residents in the selected LGA; (2) Actors must be residents in the selected LGA; (3) Actors must be registered members of RIFAN in Kwara state; (4) Actors must participate in at least one activity across the rice value chain. Also, purposive/ judgment sampling is adopted in the choice of actors from the KWADP extension; this is because the information and knowledge required for the qualitative data can only be obtained from them (Sekaran et al., 2016, p. 248).

4.6.5 Sample Size

The sample size was determined using the Taro Yamane (Yamane, 1973) formula as stated below:

$$n = \frac{N}{1+Ne^2}$$

Where n = current sample size, N= population size, e= margin of error (MoE, which is 0.05) Using 95% confidence level

Therefore $n = \frac{10,000}{1+10,000(0.05^2)} = \frac{10,000}{26} = 384.61 \sim 385$

Therefore, the ideal sample size is 385 actors. Amongst this group, seven large-scale farmers and 12 small-scale ones were interviewed, while 360 questionnaires were administered to other RIFAN members who are involved in the rice value chain. Also, six actors representing the government and NGOs, were interviewed from the ADP extension of the Kwara State Ministry of Agriculture and Rural Development, ADP extension.

Table 4-2: Instruments Completed by Various Categories of Stakeholders

Stakeholder	Number of Participants Interviewed	Completed Questionnaires
KWADP	6	Not applicable
Large scale farmers	6	Not applicable
Small scale farmers	12	300
Total	24	300

Source: field survey 2022

In total, 24 actors were interviewed with specific questions suited to ADP extension workers, and RIFAN large-scale farmers and small-scale farmers, while the questionnaire was designed and administered to 360 rice farmers.

4.6.6 Data collection method

Mixed methods research design was adopted in this work and the process of convergent mixed methods was introduced for data collection as seen in figure 4-3 above.

4.6.6.1 Qualitative Data Collection

For the collection of data relevant to the stated research questions and objectives, interviews were conducted. The focus population of the interviews were the stakeholders across the rice value chain who are residents and workers within the Edu and Patigi local government area of Kwara State. This group consisted of six large-scale farmers, 12 small-scale farmers and six actors from the Kwara state Ministry of Agriculture and Rural Development. Responses from participants during the interviews were transcribed and developed into relevant themes and subthemes. The sample size for data collection for the qualitative part of the research was 24 participants, while questionnaires were administered to 360 respondents. The rationale for using

12 small-scale farmers from RIFAN is because this category constitutes the RIFAN members in the region. This also initiated the administering of questionnaires to 360 small-scale RIFAN members. Creswell et al., (2018, p. 300) are of the view that the sample for qualitative data is often smaller than for quantitative because the aim of an interview is to infer detailed information from participants whereas, through a larger group of respondents, the information gathered meaningful and from which the researcher can infer results that give meaning statistically.

Participants were asked questions which focused on their activities in the rice value chain and how these can be improved on so as to increase the productivity of rice; challenges encountered in terms of production, sourcing of materials, marketing and distribution; access to resources such as inputs, equipment, information, seedlings and fertilizers; and loans and other credit facilities from the government. In the quest to ascertain their perspective on sustainability, questions such as quality of inputs used, access to loans and interest rates, grading system, method of production and disposal of waste were posed. Participants were asked semi-structured questions, and the answers provided were explanatory as they were allowed to respond freely. This is in accordance with the convergent mixed method adopted in this research (Cresswell, 2020, p. 299).

Each interview session was for about 30 minutes long which availed the researcher the opportunity to better understand the activities of the participants (actors) in the rice value chain. It further created an avenue to ask questions related to the research objectives of the study (Saunders et al., 2019, p. 130). Before the commencement of the interview, the participants were well advised about the purpose of the interview and their anonymity was guaranteed. Also, participants signed the consent form.

At the point when respondents were no longer providing new information about the subject at hand, the researcher identified this as data saturation. This is in line with authors like Fusch & Ness (2015, p. 1408) and Saunders et al., (2007, p. 499) who submit that data saturation occurs during data collection and analysis, when the researcher no longer gets new and relevant data from the respondents, and there is no more allowance for further coding/ analysis, and therefore, the study has sufficient information to reproduce itself. Saturation is often reached on average at the 13th interview (Mwita, 2022, p.415). The researcher identifies depth in the information provided in comparison with initially drafted themes, and documented the process to notice when no new and relevant information was provided. Saturation further assures the validity and credibility of information provided by the respondents.

4.6.6.2 Quantitative Data Collection

The instrument used for collecting the quantitative data was the structured questionnaire. Items in the questionnaire were drawn from responses from the initial interviews which were also in synchrony with the research problems and objectives. The questionnaire was divided into sections A and B. Section A captured the demographic information of participants such as gender, years of experience, educational qualification, age group, employment status, location and activity involved in across the rice value chain. This section provided a background information on the respondents and further enabled the researcher to make decisions, identify patterns and details about the respondents, thus helping her to formulate make unbiased discussion based on the information provided.

Items in section B, which was focused on the objectives of the research captured the responses from respondents. These objectives are: to establish the effects of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria; to determine how the activities of stakeholders and their resources improve the food security aspects of the underlying triple bottom line; to examine the extent to which sustainable supply chain management influences the competitive performance of the rice value chain network; to establish the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty; and to develop the value chain model influencing the security of the sustainable food supply chain in the North Central region of Nigeria.

The Likert rating scale, which was developed in 1932 by Renis Likert, an American Psychologist is a survey research tool that is often used in questionnaires and was adopted in this study (Willits, et al., 2016, p. 127). It is an ordinal ranking scale developed to scientifically measure attitudes, agreements, and probability of respondents, which can be validated for capturing their feedback (Gries, et al., 2018, p. 5; Joshi, et al., 2015, p. 397). The Likert scale uses either five scales, six scales or seven scales to access the opinion; and level of agreement or disagreement of participants to various statements (Hair et al., 2019, p. 245). The rating scale adopted in this research is six scale which ranges from 1 (strongly disagree) to 6 (strongly agree).

A total of 58 items were developed to capture participants' responses. These items measured the six constructs in the study. The six constructs are sustainable supply chain management (17 items); competitive performance (six items); rice value chain (24 items); food security (seven items); supply chain for food security (seven items); and value chain model influencing the sustainable food supply chain security (eight items).

4.6.6.2.1 Measurement Adapted for the Study

Six constructs were measured in this study and further adopted to test the validity of the research instrument used. The scales that were adapted are further identified below:

I. *Sustainable Supply Chain Management*

SSCM was measured with the introduction of 17 items, which are forces for or against rice supply chain. These items cover the adoption of the triple bottom line dimensions in improving the supply chain of the rice value chain. Some of the items are access to technology and machineries, policies from government, good infrastructure, access to financial support, access to inputs, access to training and appropriate grading system.

II. *Rice Value Chain*

Nine items were developed to measure sustainable practices that can enhance the competitive performance of rice produced in the region. The items developed covered the economic, environmental, and social factors which in turn impacts the competitiveness of rice produced in the region. The activities of stakeholders were measured with the aim of identifying the adoption of and compliance with sustainable practices by each actor or stakeholder across the rice value chain.

III. *Competitive Performance*

The competitiveness of rice produced in this region was measured using eight items such as the inputs available to the stakeholder across the rice value chain. Competitive performance measures information, access to infrastructure and quality checks which are determinants of the competitiveness of the rice produced in the region.

IV. *Supply Chain for Food Security*

Items developed in this section measured the improvement of supply chain management for food security. These items include safe working environment, good transport system, access to a good health system, job creation and use of available resources.

V. *Food Security*

Seven items were developed in this section to measure the storage structure for grains, government policies to improve rice production, access to grants and financing of rice farmers, good management and training for extension workers and quality assurance structure to ensure food security.

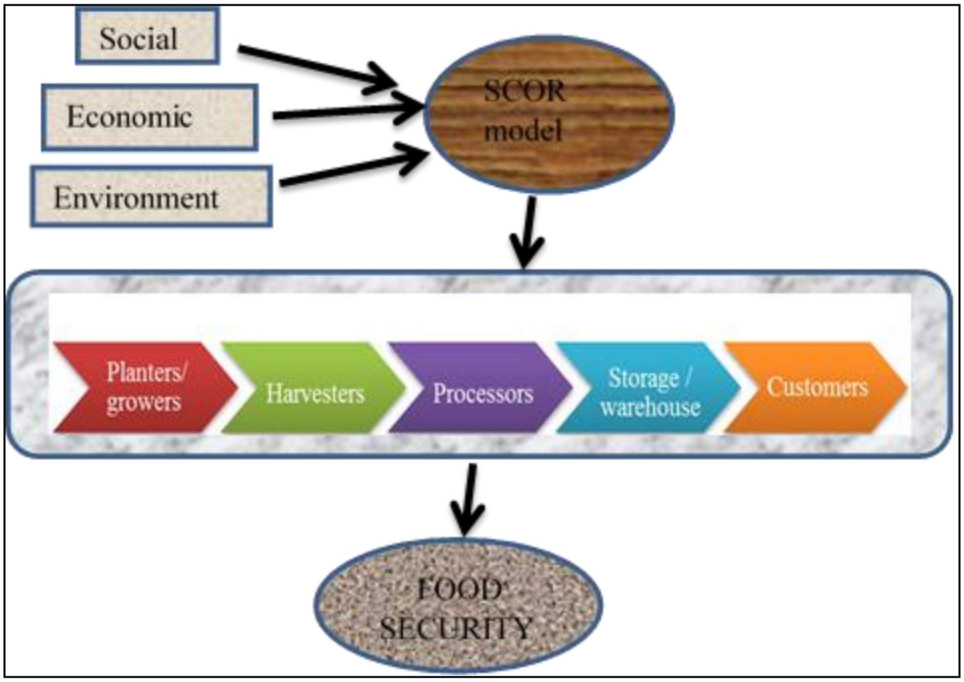
VI. *Value Chain Model for Rice*

Eight items were developed in this section to measure the activities and relationship among the RIFAN members for developing a value chain model. These include communication, access to information, training and skill development for RIFAN members, adoption of new technology and access to quality inputs.

4.7 Conceptual Framework

An important component of the theory is the development of concepts. (Bryman, 2012, p.8). Conceptual frameworks identify and expresses the correlations that may exist between concepts and their effects on the situations under exploration. They are developed from connected concepts or constructs that are related to the research, to enhance the understanding of phenomena (Ngulube, et al., 2015, p. 45; Tamene, 2016, p. 51).

Figure 4-3: Conceptual framework



Source**:** Author

4.7.1 Methods of Data Analysis

This section describes the tools utilised for the analysis of the qualitative and quantitative data gathered through interviews and questionnaires.

4.7.1.1 Thematic Analysis

Thematic analysis is used to analyse the qualitative data which was collected through in-depth interviews. Thematic analysis is a unique analytical method that is malleable, void of confusion and manageable, with an increase in its adoption and popularity over the years (Clarke & Braun, 2018, p. 1). Cresswell (2019, p. 258) argues that a qualitative study requires that the researcher develop a visual model of different perspectives from participants and the meaning they hold about an issue; the researcher reports the multiple perspectives of participants and develops meaning of the issue from these. Thematic analysis is a process which begins from the data collection phase to the transcription of the data and involves the reading and rereading of data from which patterns and themes that are related to the research questions are identified and data is interpreted, to make sense of what it connotes (Evans & Lewis, 2018, p. 3). Xu & Zammit (2020, p. 2) opined that thematic analysis is the identification of frequently or repeatedly used meanings that are important in explaining the phenomenon at hand as it exists within the particular data set. Evans et al., (2018, p. 3) argued that thematic analysis is a useful data analysis technique when the researcher aims to understand the meaning that participants attach to certain experiences, and the significance of such experiences in the lives.

The qualitative data in study was analysed using Nvivo version 12. The first step was to organize and prepare data by transcribing the interview using Nvivo version 12. After which the researcher familiarised with the data by reading the transcript, took notes and made relevant comments. Initial codes were generated from the notes and comments to form the first codes, these codes were further developed into themes. To ensure reliability and validity of data, the themes that were developed were reviewed by comparing transcript with field notes to ensure accuracy of developed themes. Finally, reports were developed from the findings.

The elaborate NVivo analysis is presented in the data analysis chapter.

4.7.1.2 Structured Questionnaire

A data management and analysis programme (IBM statistical package for social sciences – SPSS, version 25) designed for the analysis of statistical data was adopted for the coding and analysis, such as for descriptive statistics, sophisticated inferential (correlation coefficient and multiple regression), and multivariant statistical procedure (MANOVA) (Sekaran et al., 2016, p. 328). Hierarchical regression was used to answer research questions three and five. In view of the use of SPSS, AMOS was introduced to test. A detailed description of these statistical tools will be discussed in the next sections.

I. Descriptive Statistics

Descriptive statistics is used for the comparing the data value of a variable (Saunders et al., 2019, p. 597), and for explaining, summarising and describing a data set into a form that can be easily interpreted (Burke, 2020, p. 1256, p. 1258). Descriptive statistics is a tool that organizes, describes, and gives a summary of either a quantitative or qualitative dataset turning it into a reduced, manageable, and yet usable form which can be further presented by frequency distributions (Sulistyani, 2019, p. 2; Mukasa, et al., 2021, p. 1512). To ensure that the mean value is not affected by single outliers, the median option is presented as well (von Brömssen & Röös 2020, p. 2101). Descriptive statistics is further categorized as univariate, which is based on the number of variables in the data set, where univariate describes one variable (Newman, 2014, p. 396). This is discussed further and adopted in the study.

In this study, the demographic section of the questionnaire is used to explain, summarise, and describe the demographic information of the stakeholders across the rice value chain. This categorised the participant' responses based on age, gender, educational qualification, activity involved in and years of experience. Descriptive statistics is divided into two categories: measure of central tendencies and measure of dispersion. Measure of central tendencies is the single numerical value often identified as the most typical value of the quantitative variable (Burke, 2020, p.1276). The commonly used measures of central tendencies are mean, median and mode (Burke, 2020, p. 1276; Sekaran et al., 2016, p. 282).

A measure of dispersion, such as standard deviation identifies the amount of vulnerability or inconsistency in the sample, in comparison with values from central tendency (mean) with the aim of identifying an approximation of the exact value (Bryman, 2016, p.345). Measures of dispersion describe the difference in data values and how they spread around the central tendency (Bryman, 2012, p.339). To measure the reliability of the composite scale among the variables under observation, the Cronbach alpha was used, where a value greater than 0.70 connotes that the level of reliability is acceptable (Easterby-Smith et al., 2015, p. 649).

II. Univariate Variable and Technique

For the analysis of one variable at a time, the univariate technique will be used for the distribution of cases, such as demographic data and other information regarding the rice value chain (e.g., access to information, machines, technology, equipment, loans and other inputs). The mean measures the central tendency providing a summarized value for the data (Bryman, 2016, p. 344), while the median gives the centre of distribution of some data or the 50^{th} percentile, and the mode provides information of the most occurring value of some of the data. Data for univariate variables was presented using frequency distribution graphs and charts (Newman, 2014, p.397).

III. Inferential Statistics

Inferential statistics provides statistical evidence about a population from a sample with the aim of drawing conclusions from it. Inferential statistics are methods adopted in statistics for the deduction of features or properties of a given population from a set of data sample using both descriptive measures and a probabilistic approach to draw conclusions (Zhang, et al., 2022, p. 244; von Brömssen et al., 2020, p. 2101). To use inferential statistics, authors such as von Brömssen et al., (2020, p. 2101) stated that sample must be selected randomly within the study under observation, with the data therein assuming a given probability distribution; from there, the sample data can be used to conclude or generalize about the population as a whole.

To check the relationship between a dataset from which a sample is drawn from and what is expected, a test for significance was carried out. This validates the existence of random variation in samples. This can be done by using either a parametric or non-parametric test. In this study, parametric statistics was adopted because they are measurable and met the assumptions by Saunders et al., 2019, p. 603 which stated that such data must be measurable and that the dataset from which such data is drawn must have more data distribution around the mean. The assumption further stated that the probability of selecting one dataset from the same sample must not affect the probability of it being selected in another and that the dataset from which the sample is drawn must have equal distribution or be spread out from the mean value.

Both parametric and non-parametric (distribution free test) statistics were adopted in this research to respond to the research question, meet the research objectives, and analyse the Likert items.

IV. Bivariate Variables and Techniques

Bivariate statistics allows the consideration of two variables together at a time and indicates the existing statistical relationship between them; this is aimed at proofing that variation in one variable will match a variation in the other (Newman, 2014, p. 403; Bryman, 2012, p. 325). Statistical relationships are based on covariation and statistical independence. In covariation, there exists variability between two variables at a particular time, and that values from one variable gives information about the other variable with which it exists. Meanwhile, with statistical independence, there is no relationship between two variables, in that knowledge of the values of one of them does not give information about the values of the other. To examine the existing relationships among variables, the study used Pearson's Product-Moment Correlation Coefficient.

Pearson's Product-Moment Correlation Coefficient

In answering the stated research questions in this study, Pearson's Product-Moment Correlation Coefficient (PPMCC) was adopted. PPMCC, which is often represented by R or *r*, is a scale that measures the degree of linear relationship or strength that exist between related variables that meet the condition of normal distribution (Senthilnathan, 2019, p. 3). It draws the line of best fit that exists between two variables X and Y, with r indicating the distance between the data and the best fit (Obilor & Amadi, 2018, p. 16). Bryman (2012, p. 347) identified the features of PPMCC as follows: the strength of relationship is indicated by the position of the coefficient, which is either 0 or 1, where 0 connotes no relationship between two variables and 1 means a perfect relationship exists between them. Also, a strong relationship between two variables is indicated in the closeness of the coefficient to 1, while the closeness of the coefficient to 0 indicates a weak relationship. The direction of the relationship between the variables is either a positive or negative coefficient.

Analysis of Variance (ANOVA)

Verma (2020, p. 12) identified ANOVA as a method of inference, and further described it as a statistical measure adopted in the analysis of two or more populations which can be compared with one another, with the aim of identifying the significant differences or similarities that may exist between their mean values. ANOVA analyses the spread of data for the groups of data and compares their means for a significant difference; this difference is represented by the *F* ratio or *F* statistics (Saunders et al., 2019, p. 615). In identifying the differences, ANOVA reveals the true nature of the selected series, by verifying if the existing difference is caused by in the mean value is due to chance or any significant cause (Verma, 2020, p. 12). The F statistics indicates whether the two sample variances are from the same population or if a difference exists (Sekaran et al., 2016, p. 314). This variance can exist either within the samples or between them (Verma, 2020, p. 12).

To use ANOVA Verma (2020, p. 13) and Saunders et al., (2019, p. 615) stated some assumptions must be met. Thus, it is assumed that the randomly drawn data value must be independent of each other and not related in some way and that samples must be drawn from a population that is normally distributed (although the samples drawn in this research is large, therefore, this assumption is not important). Lastly, it is assumed that samples drawn from each group must possess similar variance; that is there must be no significance difference between their variances.

4.7.1.3 Multivariate Variables and Techniques

The multivariate statistical technique analyses and tests the relationship that exists between various (three or more) variables. Multivariate techniques are used when the relationship between variables is non-spurious, there are no intervening variable, and a third variable cannot moderate the relationship (Bryman, 2012, p. 351). With the multivariate technique, the relationships between variables such as interdependencies are identified, as well as the result/ effect of such interactions (Easterby-Smith et al., 2015, p. 728). Such interdependencies that may occur are the effects of interactions between variables, synergies between variables, or influences that the variables have on each other because they occur together; these variables are independent (cause) and dependent (effect) variables. Using this technique allowed for the inclusion of various variables in a single analysis, and for the identification of the importance and functions that they perform.

Multiple Regression Analysis

According to Easterby-Smith et al., (2015, p. 744**),** multiple regression is made up of single dependent and independent (predictor) variables that are measured through scales, which are either continuous or in a category. Multiple regression is a multivariate technique in which more than a single independent variable is introduced, when explaining the variance in a dependent variable (Sekaran, et al., 2016, p. 314) for calculating the coefficient of multiple determination and regression analysis (Saunders et al., 2019, p. 618) (the calculation of the coefficient of determination is represented by R^2 with one independent variable). R^2 is the degree of goodness of fit for the regression equation being estimated and the importance of the independent variable. In other words, it is the spread used and the proportion of this spread in the dependent variable caused by the independent variables; this value is always between 0 and 1. (Easterby-Smith et al., (2015, p. 745; Newman, 2014, p. 421) and Sekaran, et al, (2016, p. 315) identified R^2 as the amount of spread that the independent variable has compared to the dependent variable.

For this study, the adoption of multiple regression analysis began with the conceptual model which was developed by the researcher; it enabled the researcher to develop the existing interconnectedness between the identified variables in the study (Sekaran et al., 2016, p. 314). For instance, multiple regression was useful in establishing the existence of a relationship between sustainable supply chain management and the competitive performance of the rice value chain network. In this way, predictions can be made on the dependent variables of the identified independent variables also, the results from multiple regression provide the path and size of the impact that each variable has on a dependent variable (Newman, 2014, p. 421; Saunders et al., 2019, p. 621) The accuracy of the prediction is calculated with the formula below (Wilson 2014; Easterby-Smith et al., 2015, p. 744-745).

$$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + \ldots + b_n x_n + e \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Y= dependent variable

x = independent (predictor) variable

a= intercept/ constant (y value when x=0)

b= gradient of line or regression weight

e= residual/ error term

Hierarchical Multiple Regression Model

The hierarchical multiple regression model is introduced in this study because the independent variable is allowed to be inputted in two stages: the dependent variable and control variables are entered into the regression model in the first stage, while the independent variable is entered in the second stage (Hair, et al., 2019, p. 417). This model is used for this research as it permits the choice of variable to be entered and determines the stage at which it should be entered (Edward, 2019, p. 5). It was used to analyse the contributions beyond the initially chosen one, which is aimed at gaining statistical or variable control and to validating the change in R^2 that may occur in the process (Arese & Muche, 2019, p. 8). The F test was used to determine if the change in R^2 which occurred at the first stage is significant to the second stage. If there is a level of significance, it implies the importance of the independent variable (predictor) that was entered at stage two (Hair et al., 2019, p. 417).

4.8 Data Quality Control

4.8.1 Methods of assessment

To access the goodness of the measurements, the reliability of the instrument is tested, and the validity of measurements is established.

4.8.1.1 Reliability

Reliability is a standard of enquiry in scientific research that verifies its quality in terms of stability and consistency. Saunders et al., (2019, p. 213, p. 518) described it as the ability of a researcher to redesign and replicate an earlier research design with consistent findings, regardless of difference in times and conditions. Creswell et al., (2019, p. 215), in agreement with the above authors described it as the consistency achieved in repeating a finding using a research instrument, and the best test for reliability is the adoption of internal consistency for the scale of instruments through Cronbach's alpha value, however, there are other approaches which are testing, re-testing and alternative forms (Saunders et.al., 2019, p. 518). Reliability identifies the accuracy of observed variables, which are correlated based on their average with values ranging between 0 and 1; the greater values between 0.70 and 0.90 depicts that the level of reliability is acceptable (Easterby-Smith et al., 2015, p. 649, Creswell et al., 2019, p. 215) in other words, the questions drawn in the scale are internally consistent in the measurement (Saunders et al., 2019, p. 518).

Cronbach's alpha, which is a measure of internal consistency was developed by Lee Cronbach and named after him; the coefficient is a correlation which ranges between 0-1.00 (Cronbach, 2004, p. 4). This can be calculated as:

$(k/k-1)(1-\sum S_t^2/S_t^2)$

(Cronbach, 2004, p.4)

S= standard deviation

K= number of items in a scale

For the verification of reliability of major constructs composite reliability which gave internal consistency of the instruments - was used for measuring latent variables.

Table 4-3: Test for reliability

Instrument	Scale statistics Scale variance		Reliability statistics	
Test items (themes)	No. of items	No. of samples	Cronbach's Alpha	Interpretation
Driving and restraining forces	7	300	0.682	Reliable
Restraining forces	10	300	0.687	Reliable
Activities of stakeholders and their resources	23	300	0.783	Highly Reliable
SSCM for competitive performance of the rice value chain	6	300	0.749	Reliable
Strategic role of SSCM policy practices for food security	5	300	0.678	Highly reliable
Value chain model for sustainable food supply chain security	7	300	0.701	Reliable
All variables	57	300	0.920	Highly reliable

Source: Field survey (2022)

To measure the internal consistency and identify the accuracy of observed variables of the constructs of the quantitative research instrument, reliability test was carried out on the pilot survey data. The items tested were grouped based on the related questions and research objectives; these questions are the constructs that was put into consideration during the process of designing the research instrument. With Cronbach's alpha coefficient there is an indication that a moderate level of correlation among each construct. For this study, the alpha coefficient for all the constructs and 57 items is 0.920 which means highly reliable coefficient and that constructs have good internal consistency. Also, the strategic role of SSCM policy for food security, driving and restraining forces are approximately 0.70 while the activities and resources of stakeholders is 0.783. The adoption of SSCM for competitive performance and the value chain model for food security were 0.749 and 0.701 respectively. As such, the results depicts that the constructs are reliable, and that research aligns with the test of the reliability of the research instrument.

4.8.1.2 Validity

Validity also judges the quality of the research; it verifies if the research instrument measures what it was designed to. Validity was applied to the questionnaire to identify errors that occurred in the process of implementing; for the interview, the researcher ensured that the proposed procedure was followed, and the respondents did not have to change their behaviour but were expressive in the conversation (Bryman 2012, p.280). A valid research instrument will ensure the accuracy of the data collected and guide against instructional, lexical, or sentimental misconceptions which thus further aiding in answering the research (Saunders et al., 2019, p. 516, 517). Validity could be internal or external; the focus of internal validity is to assess if there is a match or link between what is being observed and the previously developed theoretical perspectives, while external validity measures the extent to which findings from the study can be generalized and applied to other social or organizational settings (Bryman 2012, p. 390; Gray 2016, p. 704). For this study, external validity is applicable because findings from the research will be generalized across rice farmers' settings in the Nigerian context as well as across different types of farmers in the country.

Construct validity also adopted to test the validity of the research instrument. This was done by operationalizing the indicators/ concepts associated with sustainable supply chain management. Gray (2016, p. 391) recommended certain techniques for the researcher to enhance internal validity; one of them is the analytical and presentation technique, which involves respondents verifying that their responses are accurately captured, and establishing an audit structure on the available concepts, constructs, or dataset; this allows analysis and data to be linked so that other researchers who act as validators can establish evidence. Also, experts who check for interpretation by using the same data by undergoing through an extensive review of literature to compare findings with previous ones can arrive at similar conclusions. Low-inference descriptor/ review by participants was done by writing precisely what interview respondents said, with them being allowed to review this afterwards for accuracy. Furthermore, to ensure that participants understood the instructions and to avoid misconception, an interpreter was employed for interpret for the participants who were mostly Yoruba language speakers.

4.8.1.3 Triangulation

Triangulation was adopted in this study by using the mixed methods research. The study used more than a single method for data collection, data analysis, and data interpretation. This was aimed at ensuring the reliability (Gray 2016, p.184) and validity of the study (Saunders et al., 2019, p. 218). There are different types of triangulations, namely; data triangulation, investigator/ researcher triangulation, theory/multiple triangulation, and methodological triangulation (Sekaran, et al., 2016, p. 106; Gray 2016, p. 184). Data triangulation was adopted along with time triangulation, where data is collected at different times for the same phenomenon. Also, space triangulation was used because data was collected in different locations, namely in the Edu and Patigi local government areas, and at the ADP offices; there was also person triangulation in that data was collected from large-scale rice farmers, individual rice farmers from an association (RIFAN) and the ADP. Finally, methodological triangulation was adopted in this study by using both qualitative and quantitative data.

To measure the quality of the qualitative research, trustworthiness and authenticity were adopted.

4.8.1.4 Trustworthiness

There are four criteria for trustworthiness:

Credibility: This criterion stresses that for research findings to be accepted by others in the social world, a respondent must be able to confirm that they have arrived at through good and ethical practices; this process is called respondent validation (Bryman 2012, p. 390) and is used to assure that what the researcher captured and represented matches what the respondent actually intended (Saunders 2019, p. 217). This can be done by the researcher providing a form of feedback to the people or organization being studied. For this study, the researcher will provide the ADP with a script on the study which was carried out on RIFAN in Kwara State.

Confirmability: This criterion ensures that the researcher has displayed absolute objectivity in the research, by not allowing personal perspectives and other theoretical views to interfere in the research and results (Bryman 2012, p. 393). This was adhered to in this research as the researcher strictly represented the views of the respondents.

Transferability: Due to the depth involved in qualitative research, there is a need to provide a rich account, such as a database which can possibly ensure the transferability of the findings to others in the same setting (Bryman 2012, p. 392; Gray 2016, p. 185). By providing details of the research questions, research design, same context, findings, and interpretations to other readers, the latter can assess if same these can be transferred and applied to another similar setting (Saunders, 2019, p. 217). The findings from this research can be generalised to rice farmers and farmers of other types of food crops in Nigeria.

Dependability: This is an auditing approach which requires that the complete process involved in the research process such as notes kept from the fieldwork, selection of research participants, formulation of research problem, draft manuscript, data set, transcription of interview, research diaries, and changes and modifications, are kept at each phase and can be accessed if need be.

Auditors can thereafter access these if the due procedures are followed, if they are able to understand the research focus, can verify that the inferences drawn by the researcher are justified, and are able to build a research platform for future research. (Bryman 2012, p. 392; Saunders 2019, p. 217; Gray 2016, p. 185). Manuscripts, transcripts, data set, research diaries, and other resources associated with this research will be kept for future access.

4.8.1.5 Authenticity

This criterion ensures fairness in the representation of the views of all participants, creates awareness and better understanding of the phenomenon, educates members and propels change and impact (Saunders 2019, p. 217; Bryman 2012, p. 393). In this research, the findings of each participant were duly presented, and the researcher included sustainable supply chain practices that can be adopted in the rice value chain in the feedback note; such suggestions are to educate RIFAN members, ADP, and the Nigerian government which should propel change in rice production which will obviously impact the rice value chain.

4.8.1.6 Crystallisation

Crystallisation adopts credibility and trustworthiness in ensuring rigour in qualitative research (Stewart, 2017, p. 1). It views research from a positivist through to an interpretivist paradigm and is a transformational approach which requires in-depth analysis and reflection of the phenomenon to produce meaningful substance of great value (Elligson, 2008, p. 5). Crystallisation involves deep reflection, awareness, intuition, consideration, thoughts, and insight based on credibility and trustworthiness, which are reflected in the planning and development of the research instruments, as well as in the data collection and analysis (Stewart et al., 2017, p. 7).

In this research, crystallisation was achieved through participants' validation (Bryman 2012, p. 390); that is participants confirmed that the findings were arrived at through ethical practices, and that what the researcher captured and represented matched what they intended to express (Saunders, 2019, p. 217). Crystallisation can be done by the researcher providing feedback to the people or organization concerned. For this study, the researcher will provide ADP a writing on the study which was carried out on the Kwara state RIFAN.

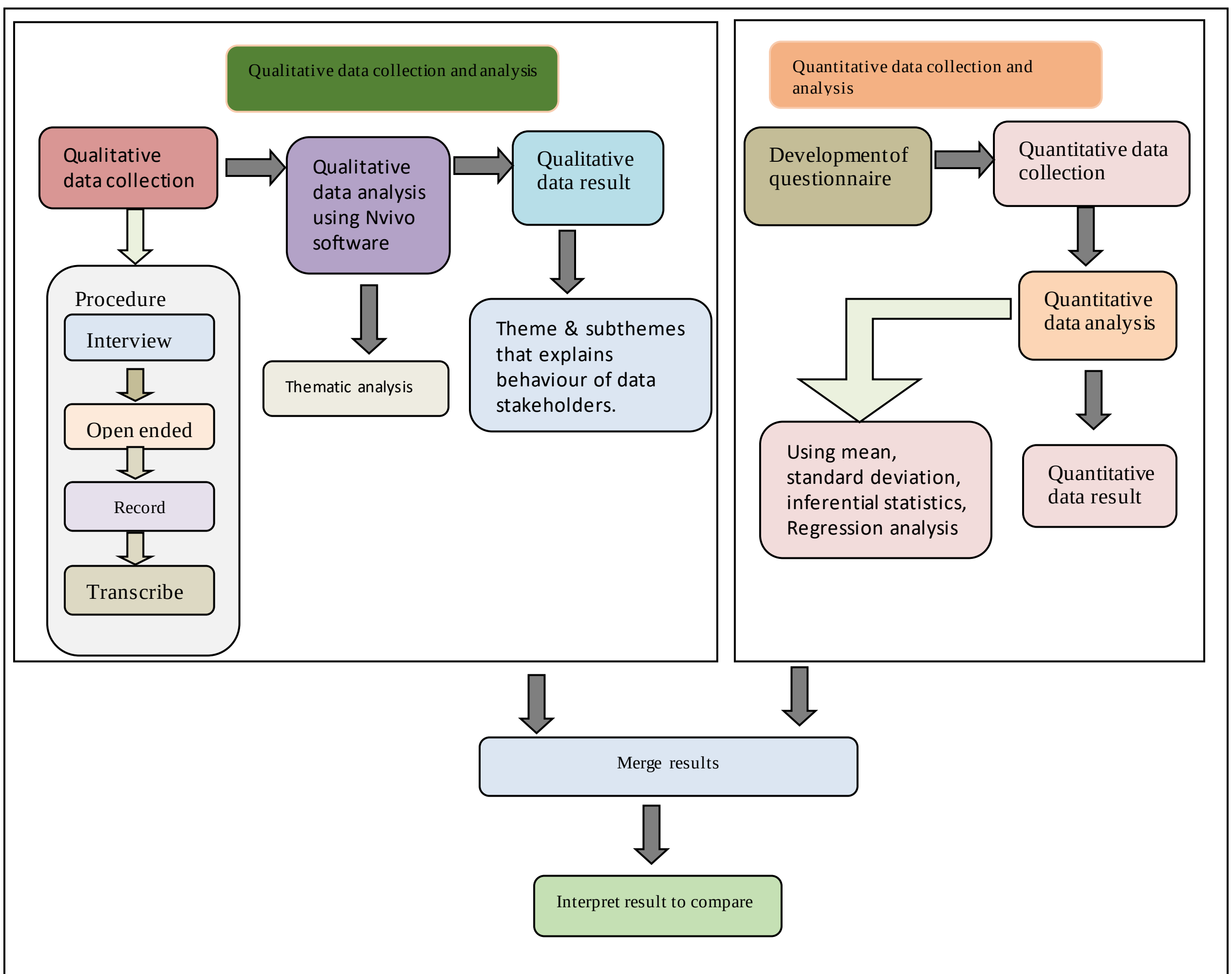
Crystallisation was further displayed in the transparency in planning and executing the interviews with the RIFAN stakeholders, adherence to evidences and data collected, and act of being methodical, which involved compiling, disassembling and reassembling of data during collection and analysis; as proof of adherence to evidence (Stewart et al., 2017, p. 10).

Crystallisation was suitable for this research because the researcher was immersed in it, and demonstrated this in the reflection, exploration, and interpretation of the responses from the 24 RIFAN interview participants; this aided the researcher's ability to further create questions for the quantitative data collection instrument for the 360 RIFAN respondents. This is because through crystallisation, according to Elligson (2008, p. 10) the researcher has the freedom to learn from participants, identify themes and patterns, and define meaning from their responses.

4.9 Research Process

Figure 4-6 is a summary of the process adopted in this research. Convergent mixed methods research was used, which are a combination of qualitative and quantitative research with both being executed concurrently.

Figure 4-4: Convergent mixed method design for the



The structured interview questions were designed with drafts of predefined themes (these are similar to the constructs of the study) and encouraged open-ended responses from participants; this is to guide the researcher on the questions to ask participants in the questionnaire. The interviews were carried out, then recorded; the recorded responses were further transcribed, after which Nvivo software was used to develop themes.

The quantitative data was collected concurrently with the qualitative data. Questions for the questionnaire were developed from the operationalised concepts (constructs), which were developed from the research concepts and research objectives; the same constructs were used as predefined themes for qualitative data collection. The data collected was prepared (data cleaning and coding), followed by an analysis of the data using SPSS. Descriptive statistics was analysed using mean and standard deviation, statistical techniques such as PCSSM, ANOVA, and correlation coefficient was used to test for relationships between the variables. Regression and Hierarchical regression were used to test relationships between variables. The results were merged through side-by-side comparison and are presented in the discussion section of the study.

Table 4-4: Thematic Analysis for the Research

	Phases of Thematic Analysis	Description of Phases
Phase 1	Familiarisation	This was be done through the continual, rigorous reading of data with the aim of identifying possible patterns. It also involved transcribing data from audio recordings.
Phase 2	Generating initial codes	Coding detected the characteristics of data that seemed motivating to the researcher, and it organised the data into meaningful groups. The theory-driven approach was adopted for this; this approach is based on the research questions. This was done with Nvivo.
Phase 3	Searching for themes	At this phase, different codes were sorted into probable themes and the organising of applicable coded data was extracted with identified themes.
Phase 4	Review themes	In this phase, themes were refined at three separate levels. At the first level, codes were extracted from the research questions of the study. The second level witnessed a review of the coded data which was extracted by reading collated extracts for each theme and noting if they were displayed consistently. At the third level, the cogency of individual themes was viewed in alignment with data sets, and the thematic maps that precisely replicated meanings apparent in datasets were also authenticated.
Phase 5	Define and name themes	This phase entailed recognising the crux of what each theme

		signifies and shaping what aspects each theme captured. This was done by going back to organise the data extracted for each theme and grouping it using into clear and internally dependable descriptions with complementary narratives.
Phase 6	Produce report	The final phase consisted in the analysis and write-up of the report. Write-ups offer a terse, lucid, coherent, and non-repetitive story of the data. They give an ample indication of themes within the data. The researcher interwove literature with the findings in order to verify and confirm them and provide a platform for challenge.

Source: Adapted from Bruan et al., (2006); Nowell et al., (2017).

Table 4-5: Quantitative Analysis of Questionnaire (Using SPSS)

		Phases of Analysis	Description of Phases
Data Preparation	Step 1	Coding	Quantifying data into numeric information
	Step 2	Tabulate data	For easy classification, summary and distribution of numbers using frequencies and percentages.
Data Analysis (Univariate Analysis Using Descriptive Statistical Technique)	Step 3	Frequency distribution	This was be done by using tables and diagrams such as pie chart, bar charts and histogram.
	Step 4	Measures of central tendency	This involved the differentiation of values of the data set using mean, median, skewness, and standard deviation
Data Analysis (Bivariate Analysis) and Test for Statistical Significance	Step 5	Bivariate analysis	This involved analysis of two variables at once to identify relationships that may exist among. This was done by using Pearson's correlation. Also, ANOVA was used to examine the existence of statistical significance and differences between the means of both dependent and independent variables. The relationships between variables, such as interdependencies were identified and the result/ effect of such interactions. Pearson's correlation was used for this study.
Control variables	Step 6	Multivariate analysis	A control variable was introduced to identify the impact that an independent variable would have, which may exceed the effect of another independent variable. This was done using hierarchical multiple regression.

Source: Adapted from Bryman, 2012, p. 330-375

4.10 Multi-criteria Decision-making (MCDM) and Fuzzy Analytical Hierarchy Process (F-AHP) Approach

Multi-criteria decision-making is a tool among existing options in policy making, which is used for making choices and providing the right solutions to problems (Bhole & Deshmukh, 2018, p.

889). Kamari et al., (2020, p. 47) and Edjossan-Sossou, et al., 2020, p. 1) identified it as an approach that can be adopted for making a choice and prioritizing options among various alternatives based on specified inter-attributes, and intra-attributes, and choosing the option with the highest level of alignment with a specified criterion.

Bhole et al., (2018, p. 889) traced the emergence of MCDM to the works of Von Neuman and Morgenstern in 1944, who introduced utility theory as a basis for decision-making science; this evolved into goal programming which further created the school of MCDM from which user-friendly decision-making tools have been developed.

For this research, MCDM is applied to understand the decision making and alignment of stakeholders across the rice value chain with sustainable practices in their activities, such as choice of partners, inputs resources and even produce. This is a procedure in which several attributes were considered. The criterion was obtained from responses questionnaire and further categorised into sustainable practices in relation to the triple bottom line, which are the social, economic, and environmental dimensions. These were further defined based on the inter-attributes and intra-attributes sustainable practices.

Edjossan-Sossou et al., (2020, p. 2) opined that MCDM has several methods which can be misused by decision-makers and will in turn mislead them. The problem could stem from computational problems arising from the identification and increase in multiple options, or from inadequately capturing uncertainties associated with each attribute. In solving this problem, a fuzzy method is used, allowing that such attributes or data associated with uncertainties are presented using a fuzzy approach, which is an approach that permits the adaptation of the thought of humans to linguistic values. With this method, sets of non-statistical data which are obtained from the views of participants and may be filled with uncertainties are dealt with using the fuzzy logic. The uncertainties are interpreted with fuzzy logic and a value is assigned to the set with a degree of membership, which is a set of values with different degrees of truth ranging from 0 to 1. To do this, a membership function is generated for each linguistic value identifying and displaying each value’s degree of membership in an interval of zero to one; it further introduces Fuzzy Analytical Hierarchy Process (AHP) which combines fuzzy logic with AHP.

Fuzzy AHP aids in the calculation of the level of importance of identified criteria and sub-criteria. Ramadhanti & Pulansari (2022, p.3) opined that fuzzy AHP simplifies identified problems hierarchically and uses an eigenvector concept for prioritizing the process of ranking for the sub-criteria using a pairwise comparison matrix. Fuzzy AHP is a method used to evaluate and prioritize complex decision-making problems. It is an extension of the traditional AHP method, which allows for the inclusion of imprecise or uncertain data in the decision-making process. Bello et al., (2019, p. 555) expressed that F-AHP is an innovative aspect of the AHP model developed by Satty which has been deployed in the MCDM model in various fields of research.

Fuzzy logic is associated with Boolean logic that adopts the use of partial truth which mathematically describes and resolves vague judgements when ambiguity or uncertainty is identified in the process of individuals making decision (Bakar & Ab-Ghani, 2022, p. 4). Fuzzy logic is a concept that was established by L.A. Zadeh in 1965, and which uses human reasoning for generating linguistic variables and membership functions that capture vague entities or those with some level of uncertainty (Bakar et al., 2022, p. 4; Mastrocinque et al., 2022, p. 3). In dealing with the vagueness, fuzzy values are employed to improve crisp value (Bello et al., 2019, p. 555)

Fuzzy Set

The following is a fuzzy set as illustrated by Soni & Vaishnavi (2019, p. 3):

$$\boldsymbol{A} = \boldsymbol{x}, \boldsymbol{\mu A}\ (\boldsymbol{x}))/\boldsymbol{x} \in \boldsymbol{X}\}\ ,$$

Where A is a set of ordered pairs and $\mathbf{X}$ is a subset of the real numbers $\boldsymbol{\mathcal{R}}$, and where $\boldsymbol{\mu A}(\boldsymbol{x})$ is called the membership function, which assigns to each object "$\boldsymbol{x}$" a grade of membership ranging from zero to one.

Triangular Fuzzy Numbers (TFN)

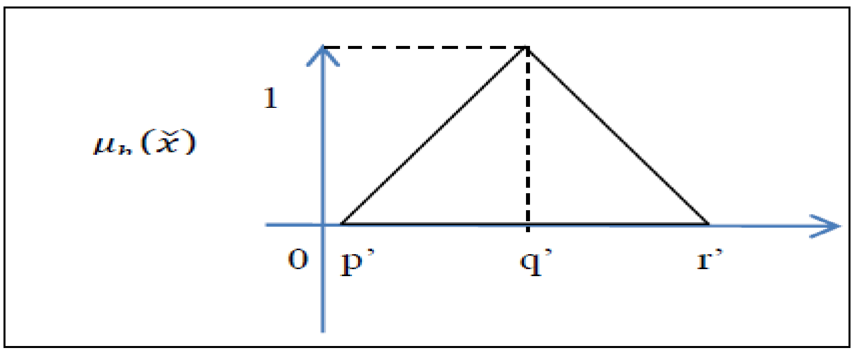
A triangular fuzzy number, according to Soni (2019), is illustrated by a triplet (p’, q’, r’) where p’, q’and r’ represent lower, middle and upper values of support of a fuzzy number, respectively.

Equation 4-1

$$\mu_h(x) \models \begin{cases} \dfrac{x - p'}{q' - p'} \, (p' \leq x \leq q') \\ \dfrac{r' - x}{r' - q''} \, (q' \leq x \leq r') \\ 0, otherwise \end{cases}$$

With $-\infty < p' \leq q' \leq r' \leq \infty$

Equation 4-2 Triangular Fuzzy Number



Source: Soni et al., 2019, p. 3

Equation 4-1 shows the triangular fuzzy numbers with p' and r' as the lower and upper limits respectively. (Adopted from Soni et al., 2019, p. 3)

The following is a general outline of how to apply fuzzy AHP [adopted from Soni et al., 2019, p. 4, Ramadhanti et al, 2022, p. 4]:

1. Define the problem into a hierarchy: clearly define the problem that you want to solve and identify the criteria and sub-criteria that will be used to evaluate the alternatives.

2. Create a pairwise comparison matrix: create a matrix that compares each criterion and sub-criterion with every other criterion and sub-criterion. Use a scale to rate the relative importance of each pair.

3. Calculate the priority vectors: use the pairwise comparison matrix to calculate the priority vectors for each criterion and sub-criterion.

4. Calculate the consistency ratio: check the consistency of the pairwise comparison matrix by calculating the consistency ratio. A consistency ratio of less than 0.1 is considered acceptable.

5. Calculate the fuzzy weights: use the priority vectors and the triangular fuzzy numbers to calculate the fuzzy weights for each criterion and sub-criterion

4.11 Summary of Chapter

In this chapter, a detailed discussion on the method used to achieve the research objectives of the study was presented. It also presented the appropriate philosophical lens and research paradigm used for the study. It further discussed the research approach and design that were adopted. A convergent mixed methods design was used. The purposive sampling technique was used for the selection of participants for the qualitative data collection, while stratified random sampling was used for the selection of respondents for the quantitative data collection. Fuzzy AHP MCDM was introduced to measure the weight of decision making of participants.

Nvivo 12 software was used for the qualitative analysis while SPSS was used for the quantitative analysis: both were discussed in this chapter. The quality of qualitative research instrument was measured using trustworthiness and authenticity, while reliability, validity and triangulation were used to assess the goodness of the quantitative measurement.

In the next chapter, the results of the data analysis using thematic analysis, as well as descriptive and inferential statistics are discussed.

CHAPTER 5
DATA PRESENTATION AND ANALYSIS

5.1 INTRODUCTION

Data analysis is aimed at establishing the perception of the respondents, who are stakeholders across the rice value chain, in investigating its current state, the forces limiting the yield of rice, and the sustainability related activities of these stakeholders that can ensure food security in Nigeria. To achieve this, the researcher adopted a convergent mixed method approach and was able to collect qualitative data using semi-structured interviews conducted with various stakeholders across the rice value chain; alongside this, a structured questionnaire was administered to other rice farmers and stakeholders across the rice value chain. With this, the chapter is divided into three sections to capture necessary information and aid proper understanding. Section A provided a background for the data presentation and analysis such as information about the thematic analysis and the demographic analysis of data. Section B is focused on the presentation and analysis of data in line with research objectives, while in section C, a methodological triangulation was achieved by linking the result from both quantitative and qualitative data together with the research objectives.

The previous chapter on research methodology identified the use of thematic analysis for the analysis of qualitative data that was collected through interview and use of univariate, bivariate and multivariate tools for the analysis of data collected through the questionnaire. Nvivo was used for transcribing, analyzing, finding, and developing categories for themes, which Nvivo identified as parent nodes and as child nodes for sub-themes.

The Statistical Package of Social Science (SPSS) software was used for the analysis and interpretation of the quantitative data. The data collected was coded in an Excel spreadsheet and further imported into the SPSS for preliminary analysis to identify missing data and outliers. Descriptive statistics was used to the demographic section of the questionnaire; this is presented with the use of pie charts and bar charts. To respond to the research questions, the Pearson correlation coefficient along with hierarchical regression, a multivariate tool, was used to answer Research Questions Three.

5.2 Section A

This section provides a preliminary discussion for the data presented and analysed. It provides a background both the qualitative and quantitative data which is later presented in section B. The demographic data that is used for the quantitative data analysis is also presented in this section.

5.2.1 About the Qualitative Findings Based on Thematic Analysis

The aim of the study was to investigate how the adoption of sustainable supply chain management by rice farmers can impact food security in the Edu and Patigi local government area of the North Central region of Nigeria. Thirteen themes were extracted from the interview guide in line with the objective of the study. Themes that were in line with the adoption of sustainability in the rice supply chain and enablers food security were captioned.

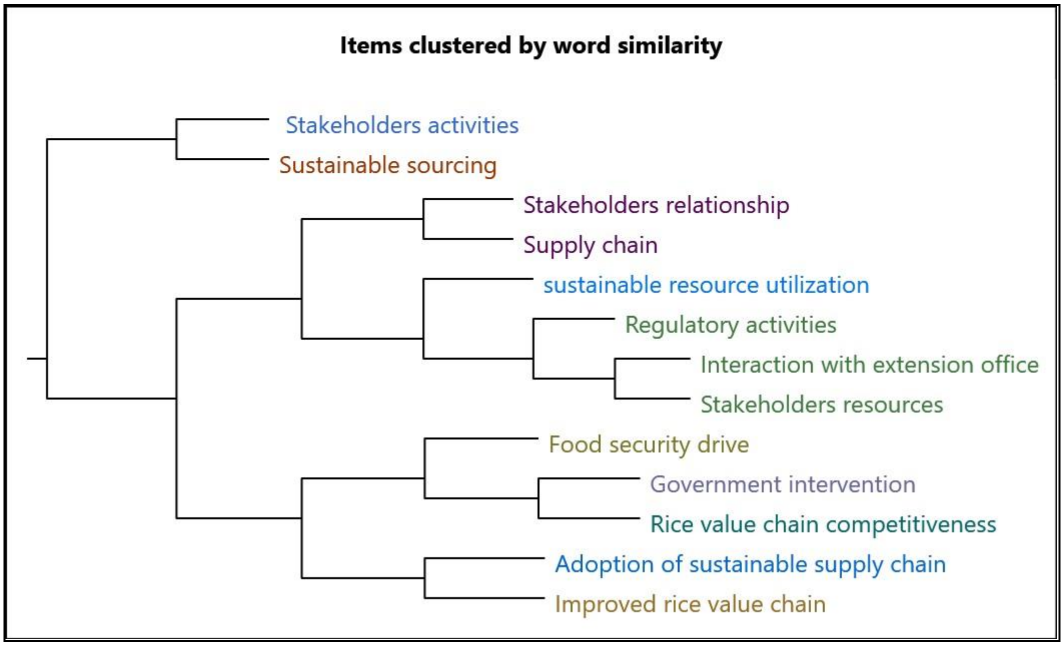
A total of 24 stakeholders were interviewed; these included 12 RIFAN small-scale farmers, six RIFAN large-scale farmers and six extension workers from ADP. The anonymity of the participants was agreed to be protected, as indicated in the informed consent forms. The report from the qualitative data that was gathered, transcribed, and analysed using Nvivo 12 software, is presented below.

Table 5-1: Tabular Presentation of the Theme of the Study

THEMES
stakeholder's activities
sustainable sourcing
stakeholder's relationship
sustainable resource utilisation
regulatory activities
supply chain
interactions is ADP extension workers
stakeholder's resources
food security
government intervention
rice value chain competitiveness
adoption of sustainable supply chain
improved value chain

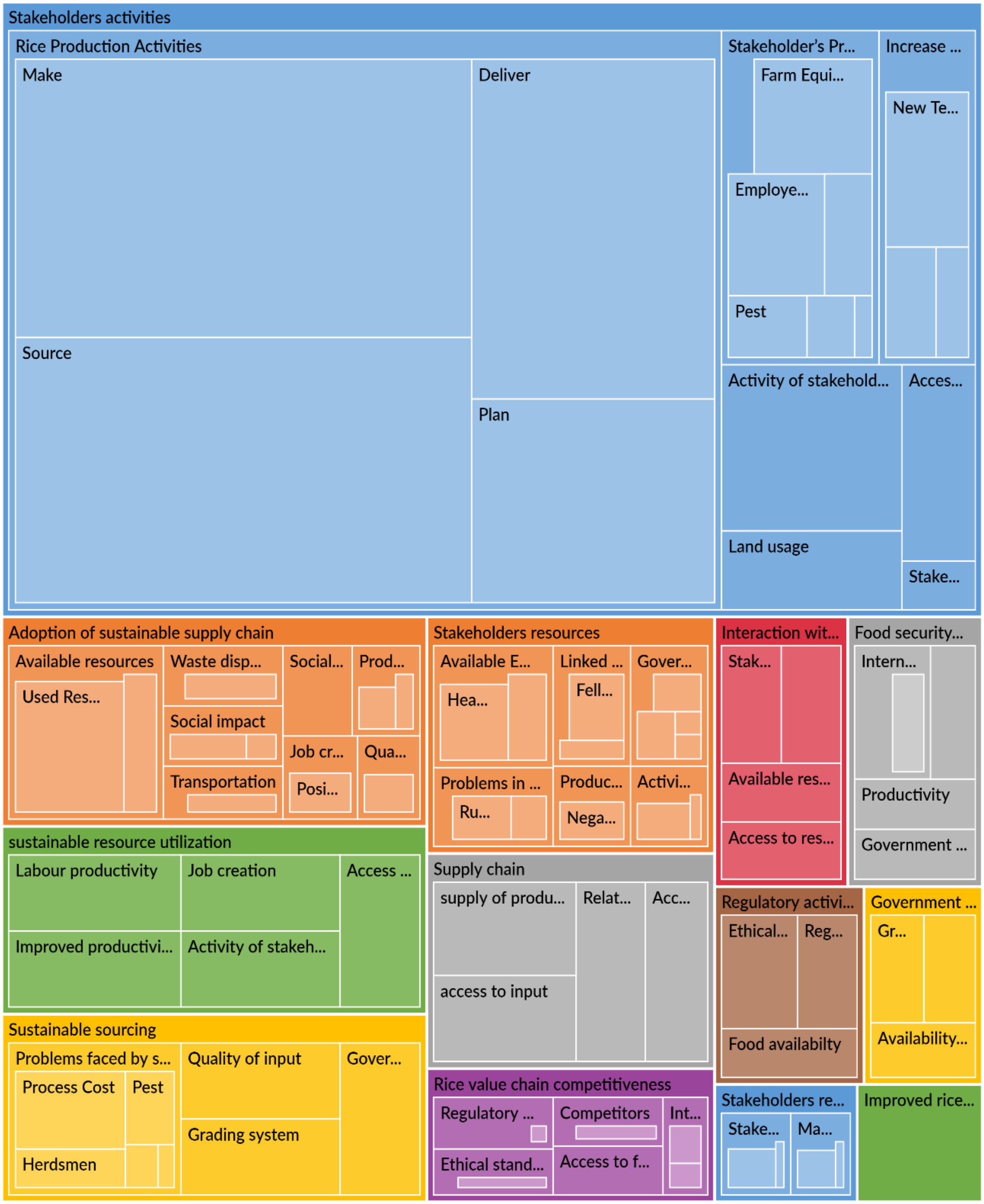
Source: Deduced themes from interview questions

Figure 5-1: Themes of study



Source: Deduced themes from interview questions (Nvivo generated)

Figure 5-2: Nvivo generated Theme of study



Source: Deduced themes from interview questions (Nvivo generated), field survey, 2022

The themes were developed from the objectives according to the categories of stakeholders. Using the Nvivo 12 application, the themes were further analysed based on the following files and references which are depicted in Table 5-2.

Table 5-2: Themes, Files and References Generated by Nvivo 12

s/n	Deduced themes	Files	References
1	Stakeholders's activities	24	468
2	Adoption of sustainable supply chain	6	69
3	Food security drive	6	28
4	Government intervention	6	18
5	Regulatory activities	6	23
6	Improved rice value chain	12	12
7	Rice value chain competitiveness	6	30
8	Stakeholders' relationships	6	13
9	Stakeholders' resources	6	53
10	Rice Supply chain	12	48
11	Sustainable resource utilisation	12	62
12	Sustainable sourcing	12	62
13	Interaction with extension office	6	28

Source: Author's own compilation

Following the adoption of Nvivo 12 application, theme on stakeholder's activities was generated with 468 references birthed from 24 files. The theme for adoption of sustainable supply chain had 69 references from six related documents. For the theme of food security, 28 references were created from six files. While the theme on Government intervention had 18 references from 6 files; the theme on Regulatory activities had 23 references from six files regulatory. For the theme on Improved rice value chain 12 references emerged from 12 files. Another theme on Rice value chain competitiveness which had 30 references from six files emerged from the thematic analysis. Also, theme on stakeholders' relationships with 13 references which emerged from six files was generated. The theme on Stakeholders' resources, had six files which produced 53 references. Out of 12 files for rice supply chain, 48 references were generated. The theme on sustainable resource utilisation had 12 files from which 62 references were produced. From sustainable sourcing theme, 62 references were reflected from 12 files. Lastly, the theme on interaction with extension office had six files which reflected 28 references.

The reference column in the Table 5-2 represents the number of statements and words that generated items related to the themes induced from the research objectives which were linked with to the questions from the structured interviews for the various categories of stakeholders.

5.2.2 About the Quantitative Data Analysis and Presentation

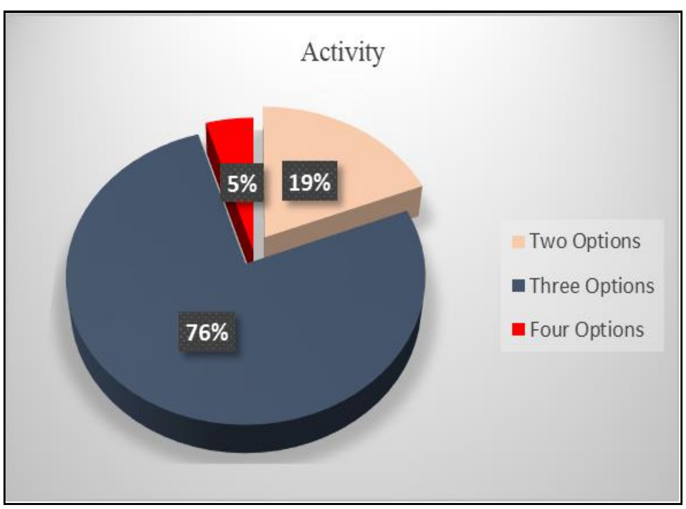
5.2.2.1 Response Rate

There were 360 questionnaires administered to selected RIFAN stakeholders were all filled out and returned, with a 100% response rate; these were then coded and analysed. This high response rate is attributed to the fact that the ADP extension workers responsible for the Edu and Patigi extensions, assisted in gathering together and interacting with the RIFAN members. These ADP extension workers are familiar with the RIFAN members and were able to communicate with the farmers using simpler language while assisting some of them in filling the questionnaires. Also, the respondents were interested in taking part because the research is mindful of the challenges that they face, and they believe that there will be solutions to these based on the recommendations to the government by the researcher, through publication of relevant articles.

5.2.2.2 Analysis of Demographic Data Using Frequency Distribution: Pie Charts

Frequency distribution shows a graphical representation of data variables and gives details of the responses associated with values from specific variables (Hair et al., 2020, p. 333). Using this, the researcher can present the features of each variable in a concise and summarised manner. In this study, histogram was used to show the characteristics of variables. For the collection of quantitative data, the questionnaire used consisted of eight sub-themes which were gender, type of activity involved in (unit), category of involvement, educational qualification, age group, years of experience, location and population of other stakeholders involved; these subthemes constitute the demographic data of the participants.

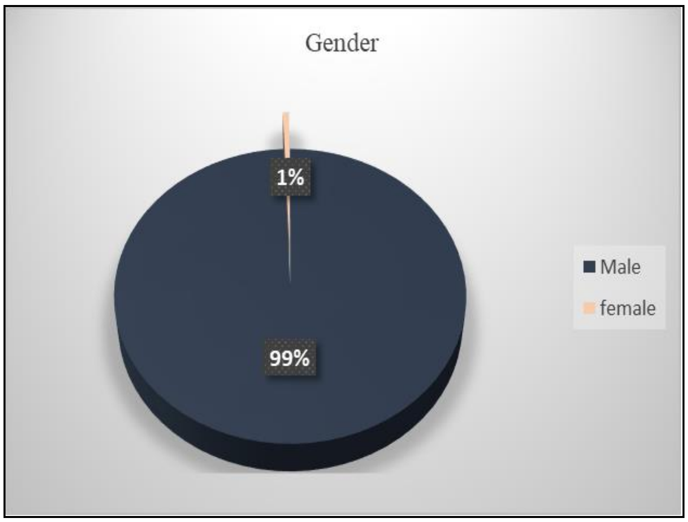
Figure 5-3: Activities of Stakeholders



The frequency distribution of respondents based on the type of rice farming activity they are involved in, is shown in Figure 5-3.

The figure presents respondents' involvement in the rice supply chain in terms of planting or growing rice, harvesting rice, preparing the ground, processing price paddy and storage or warehousing. The figure reveals that 19 percent of the respondents indicated that they were involved in two options (i.e., more than two activities), that s more than two activities, 76 percent indicated involvement in three options and 5 percent indicated they are involved in four options. The statistics, as presented in Appendix 17 are as follows: the mean was 6.8583 and the median was 7.0000.

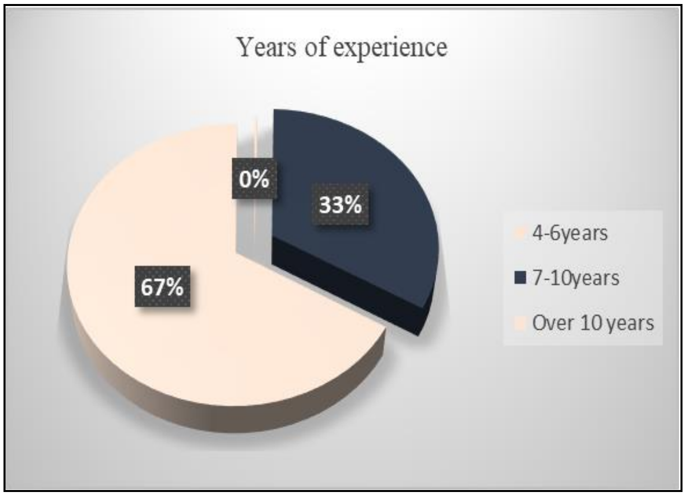
Figure 5-4: Gender



The frequency distribution of respondents by gender is shown in Figure 5-4.

The figure presents the distribution of respondents according to their gender, which revealed that 94.2% percent of the respondents were male while 0.61% percent are female. This indicates that almost all the respondents were male. This result is not surprising, as males dominate the agricultural sector in Nigeria. The statistics, as displayed in Appendix 19 shows the mean as 1.0059 and the median as 1.0000.

Figure 5-5: Years of experience

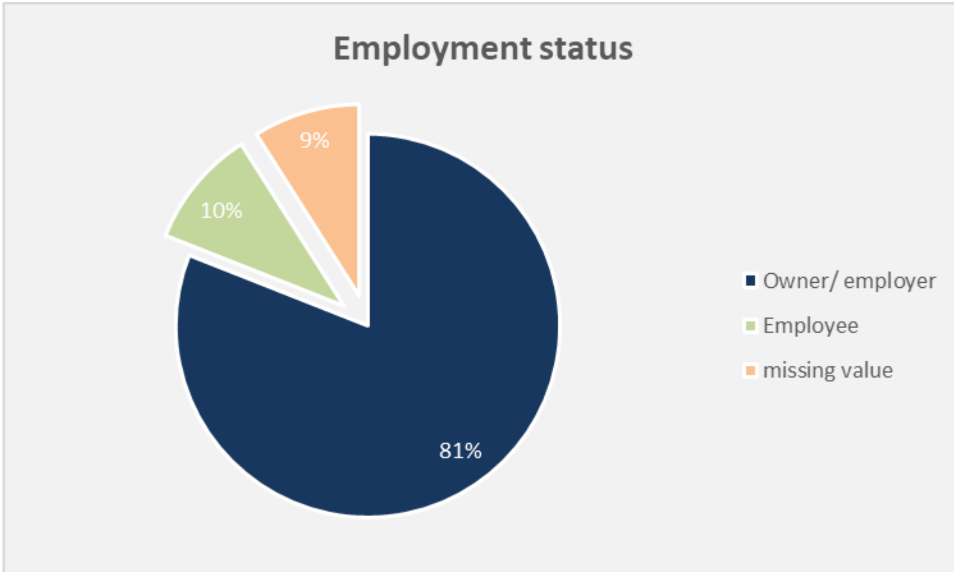


The frequency distribution of respondents based on years of involvement in rice farming, is shown in Figure 5-5. The figure presents how long they have been in rice supply chain. The chart reveals that 67 percent of the respondents indicated having been involved for over 10 years, 33 percent for 7 to 10 years, while one person indicated between 4-6 years. With 67% of the respondents having over 10 years of experience within the rice value chain, this indicates that the rice farming technique that these respondents are familiar with is the manual system.

Linking these responses to the ones based on age where 50% of the respondents were between the ages of 36-45 years, and 34% over 46 years old, this indicates that the involvement of respondents in the rice value chain started at a young age, and they have quite a few years of experience in using the manual technique. Considering this, one can question the ease or willingness of these respondents to adapt to new technology, which is a major drive for increasing productivity.

The statistics, as presented in Appendix 21, show the mean as 4.6629 and median as 5.0000

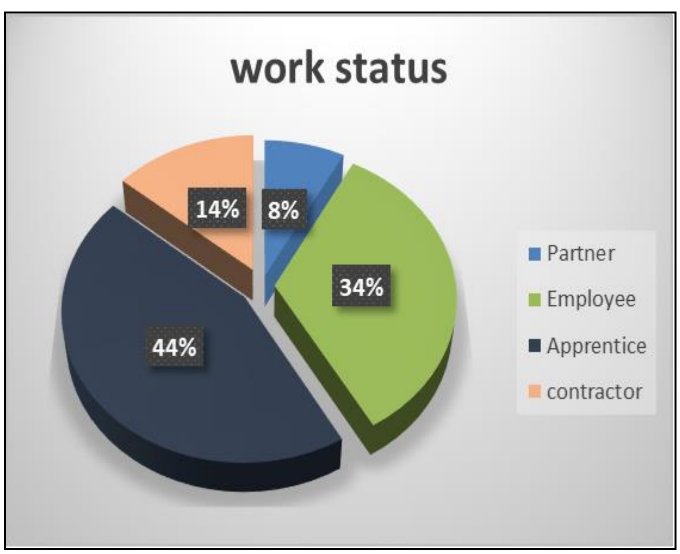
Figure 5-6: Employment status



The frequency distribution of the employment status of the respondents who participated in the survey is depicted in Figure 5-6. From this figure, 81 percent of the respondents are owners or employers, 10 percent are employees, while no one was either a contractor or an apprentice. The percentage of owners is expected especially with the response on years of experience, where 67 percent had over 10 years of experience across the rice value chain.

The statistics, as presented in Appendix 23 show the mean as 1.1077 and median as 1.000.

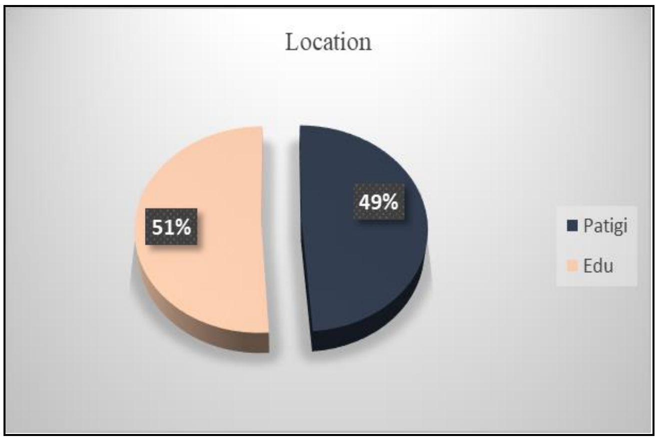
Figure 5-7: Work status



The frequency distribution in figure 5-7 shows the responses of employers who work with contractors and/ or/ have employees and apprentices.

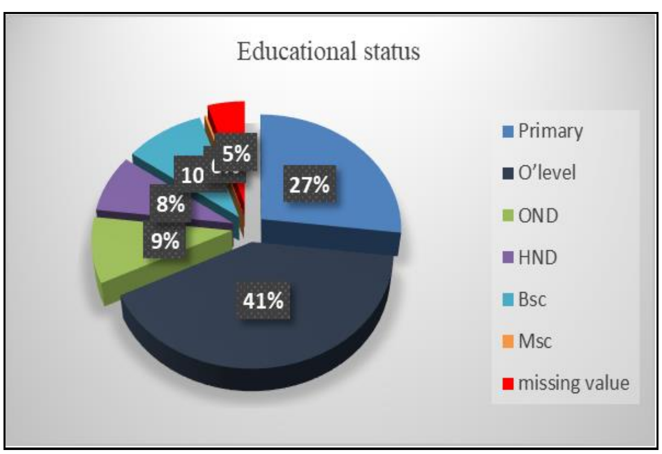
The statistics for the figure as shown in Appendix 24, revealed that among the 84 percent of respondents who own rice farms, as shown in figure 5-7, eight percent have partners, 34 percent have employees, 44 percent have apprentice, while 14 percent had contractors. Appendix 25 shows the statistics where the mean was 2.6 and median was 3.0.

Figure 5-8: Location



The frequency distribution of respondents by location is depicted in Figure 5-8 which shows that 51 percent of the respondents were located on Edu while 49 percent were based in Patigi. This revealed that the respondents were evenly located between Edu and Patigi. As shown in Appendix 27, the mean was 1.5 and median was 2.000.

Figure 5-9: Educational status



The frequency distribution of respondents based on educational qualification is shown in Figure 5-9. The figure shows respondents' highest level of education, which is further represented by Appendix 28. It revealed that 27 percent of them indicated primary education as their highest educational level, 41 percent had attained a secondary level, nine percent had attained Ordinary National Diploma (OND), eight percent had passed their Higher National Diploma (HND), 10 percent indicated having a first degree (BSc), and one person had attained a second degree (MSc.). The statistics are displayed in Appendix 29 showing a mean as 2.31 and median of 2.00.

Figure 5-10: Age

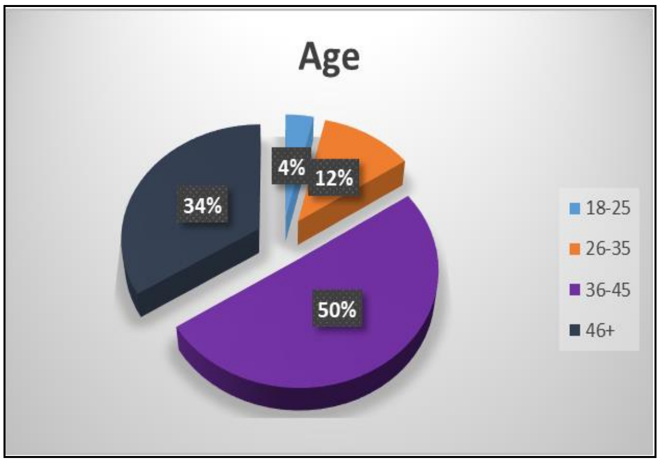


Figure 5-10 depicts the age distribution of respondents. The figure revealed that four percent were aged between 18 and 25 years, 12 percent were aged between 26 and 35 years of age, 50 percent were aged between 36 and 45 years old, while 34 percent were aged above 45 years of age. This suggests that many of the respondents were above 35 years old (84.4%). The statistics displayed in Appendix 30 show the mean being 3.15 and median as 3.00.

5.3 Section B- Presentation of data and analysis based on research objectives

This section presents the data and the analysis obtained in accordance with the research objectives and research question of the study. In each sub-section, the quantitative data analysis, the thematic analysis and inferential analysis are presented and discussed along the research objective. Also, the multivariate data analysis and F-AHP MCDM are further discussed in this section.

5.3.1 Restraining and driving forces influencing the rice supply chain in the North central region of Nigeria

Figure 5-11: Restraining forces of rice supply chain

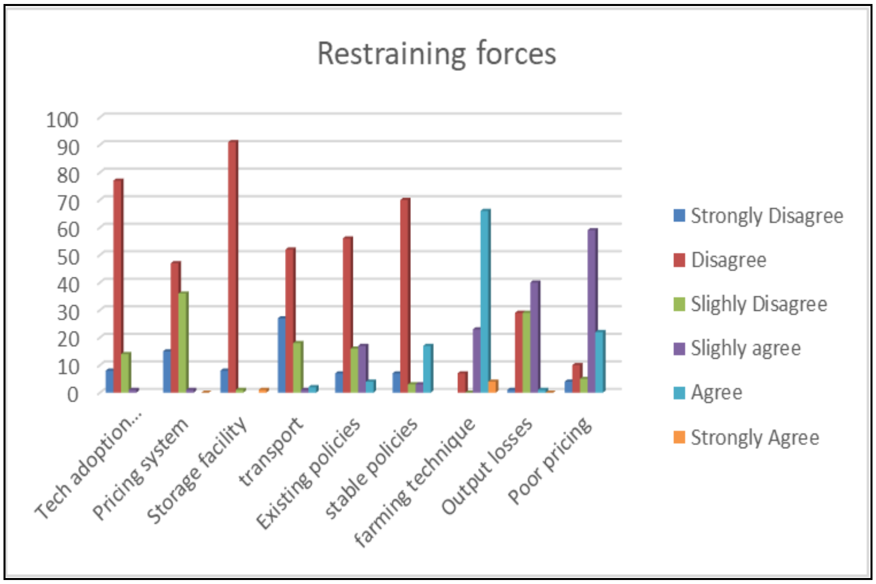
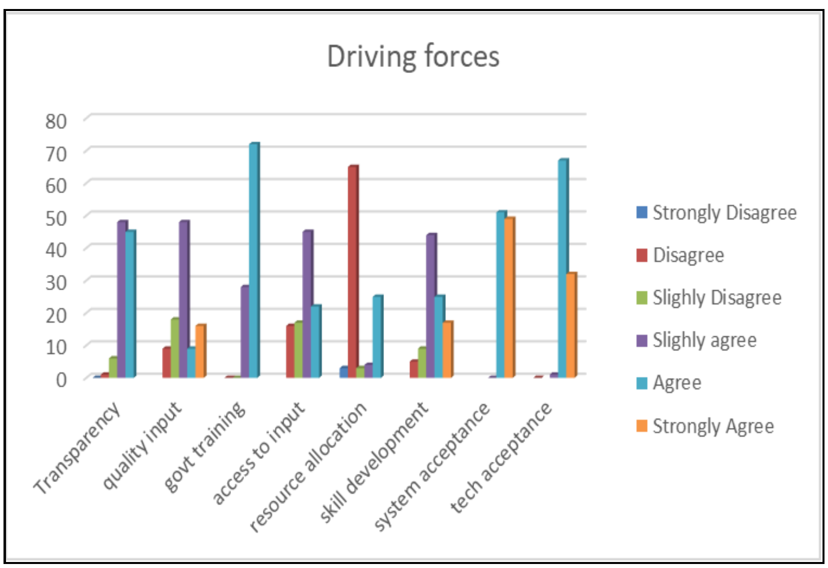


Figure 5-11 shows the restraining forces of the rice supply chain in the North Central region of Nigeria. These restraining forces are those mitigating the productivity of the rice supply chain in the region. Technological equipment such as drones, spray taps, and machines like planters, harvesters, and threshers could help to improve productivity of the respondents, however, an overwhelming majority of 84% of them asserted not having access to such equipment, but were rather, using hand tools such as hoes, cutlasses, and sickles; meanwhile 14% showed neutrality regarding technological equipment, and 1% had access to such tools. By the same token, 93% of the respondents agreed that the current technique of rice farming was old while just 7% disagreed with this notion.

The absence of a centralised and fixed pricing system was a restraining force to the profitability of the respondents. This can be seen as 62% of respondents disagreed that there was the presence of such a system. Although 36% seemed to be comfortable with the existing yet unstable pricing system, only a tiny minority of the respondents asserted the existence of a centralised pricing system. This was consistent with 64% of the respondents agreeing that grains were sold at any price to buyers because of a lack of information regarding to the price that rice grains were sold at the cities. Nonetheless, just 4% disagreed with this statement while 32% of the respondents were neutral. This shows inconsistency in the price of output.

Ninety nine percent of the respondent asserted that the absence of storage facilities for rice grains set up by the local government in their specific locations, was a restraining force to the rice supply chain. This resonates with the response regarding loss of grains, with 41% agreeing to the notion that some of their produce was destroyed by pests and rodents. Although 30% seemed not to be affected by pests and rodents, 29% were neutral to the statement. A poor transportation system seemed to be another restraining force for the rice value chain in the region; this was seen by the 79% of responses in agreement with this, with 18% seeming unsure about the transport system, and just three percent agreed with the existence of a good transport system for output. Despite the role of rice in the community as the most consumed staple food, a high majority of 63% of respondent asserted that policies for enhancing rice productivity and the rice value chain did not exist. By implication, 77% agreed that there were no stable policies to enhance the rice supply chain. Although 16% were unsure of the existence and stability of policies for the rice supply chain, 21% agreed that there were stable, existing policies to improve the profitability and productivity of rice.

Figure 5-12: Driving Forces of Rice Supply Chain



The driving forces are factors that can improve the productivity and competitiveness of the rice supply chain in the region. Transparency among stakeholders ensures access to information, resources, and also a corruption-free environment, which and will have a great influence on the rice value chain. Although 93% of the respondent agreed that transparency existed between them and other stakeholders that they interact with, such as the processors of grains. This question further addressed by transparency in the allocation of resources such as loans, grants, seedlings and other inputs provided by the government, especially through the ADP extension office and NGOs. However, 68% of the respondents disagreed with this notion, while 29% agreed that there was transparency in the allocation of resources. Fifty seven percent of the respondents concurred that there was provision of quality inputs, 34% of the respondents were neutral, while 9% disagreed. The first question focused on the quality of inputs in use, while there was a follow-up question on access to inputs provided by the government; regarding this second part of the question, 64% of the respondents agreed that government provided inputs, 16% disagreed, while 17% were neutral.

For government training and skills development, 99% of respondents agreed that there was access to training and development platforms provided by the government to improve their productivity. By the same token, 69% responded that through access to skill development sessions on the use of machinery and equipment, they had developed new skills for use in rice farming. However, 5% disagreed while 26% were neutral. Respondents showed high rate of acceptance and willingness to access new techniques and technology for operations with 100% acceptance.

Table 5-3: Descriptive Statistics on Forces Influencing Rice Supply Chain (A)

Restraining forces	**N**	**Mean**	**Median**	**Std. deviation**
Poor pricing	359	4.8524	5.0	.9988
farming techniques	359	4.5877	5.0	.8732
Output losses	359	3.1086	3.0	.8856
Existing rice policies	359	2.5543	2.0	.9869
Stable rice policies	359	2.5320	2.0	1.2068
Pricing system	359	2.2535	2.0	.74
Technological adoption	359	2.0947	2.0	.51
Transport system	359	1.978	2.0	.8218
Storage facilities	359	1.9387	2.0	.3609

Source: Compiled by the researcher from SPSS results

The average response for the restraining factors influencing the rice value chain was poor pricing (M=4.85) as the highest mean value. This was indicated by respondents disagreeing about the existence of uniform pricing and grading structures for the sales of rice grains to the local rice collector. Prices are not regulated; hence, they fluctuate based on the demand for rice grains. Respondents agreed that the farming technique (M=4.59) adopted by respondents was old, hence it affected the rate of productivity and the entire value chain of rice. Respondents were faced with invasion of rodents, especially birds (M=3.11) which affected the level of productivity, as birds invaded rice farms and reduced the quantity of rice grains harvested by respondents. The adoption of technological devices for chasing birds away, such as drones, could assist in tackling this issue, but instead, respondents resolved this by using family members like children to chase the birds away. Since rice is a staple food consumed by households within the country/ region, policies towards rice production (M=2.55), especially by the government should have been in place, however, they were lacking. This explains the lack of stable rice policies (M=2.53). The previous government regimes instituted policies to improve the rice value chain, although these were not stable and often overlooked due to corrupt practices. Policies such as the ban in the importation foreign rice was instituted with the aim of improving and encouraging the local production of rice and its consumption, unfortunately, these policies were unstable.

A result of the poor pricing of rice grains was the inconsistency in prices, especially since the respondents disagreed with being familiar with the prices of output in the cities, leading to the sales of output at any price, especially since the pricing system (M=2.25) was inconsistent and not regulated by a stable regulatory body. Adoption of technology (M=2.09) was low as respondents disagreed to having access to technological equipment such as planters, harvesters, drones, and sprayers which could improve productivity. This further buttressed the assertion of respondents on the use of old and manual farming techniques. For transportation of output (M=1.97), respondents used road transportation coupled with a poor road network. At times, these roads leading to local markets were flooded, which made transportation expensive at such times, and obviously reduced profitability rate. Since respondents did not produce enough, they, disagreed that the provision of storage facilities (M=1.94) for the storage of a percentage of the output would be a useful system for improving food security, even though such facility was not provided. There was equality in the estimated mean values and median values of items, except for stable policies and existing policies. The equal mean and median values indicate symmetric distribution with the standard deviation value, which shows the spread in the distribution of scores.

Table 5-4: Descriptive Statistics on Forces Influencing Rice Supply Chain (B)

Driving forces	N	Mean	Median	Std. deviation
New technique acceptance	359	5.4847	5.0	.5060
New technology acceptance	359	5.3092	5.0	.5088
Government training	359	4.7131	5.0	.4769
Skill development	359	4.3928	4.0	1.0270
Stakeholder transparency	359	4.3593	4.0	.7
Provision of quality input	359	4.0641	4.0	1.1
Access to input	359	3.7382	4.0	.9708
Resource allocation transparency	359	2.8217	2.0	1.3377

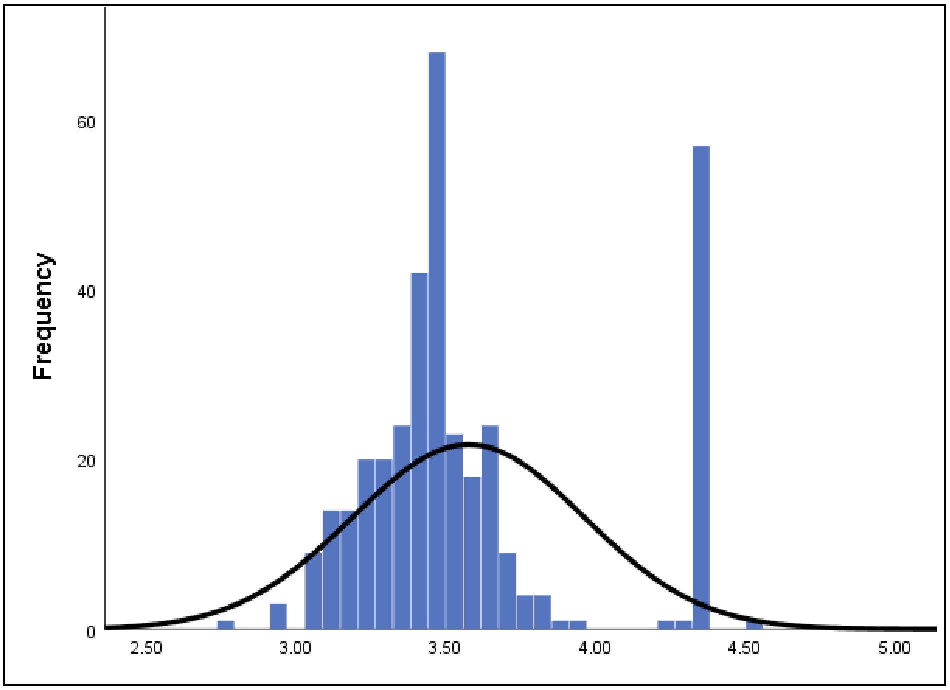
Source: Compiled by researcher from SPSS results

Acceptance of new techniques (M=5.48) in rice farming as a driving force for the rice value chain, had the highest mean value. Respondents were willing to accept new techniques of farming which would improve productivity and profitability. This was also evident in the willingness to accept new technology (M=5.31). Skills and development platforms should be organised by the government as training (M=4.71) and skills development (M=4.39) sessions had high mean values. Such skills and training go beyond the new techniques of farming and use of new technology, they include the development of the literacy level of respondents and farm management training. A high mean value for transparency in the interaction among stakeholder (M=4.35) indicates good access to information and communication among stakeholders. Through this, a functional and stable pricing system could be put in place by the stakeholders across the rice value chain. Resources such as loans, grants and inputs should be accessible to the users, and the allocation of these should be corruption free and accessible, as long as the stakeholder is qualified to receive these. Especially with the provision of quality inputs (M=4.06), such as seedlings and fertilizers, respondents agreed that access to these (M=3.74) as well as transparency in allocation (M=2.82) would improve the rice value chain.

All the variables indicate the symmetric distribution of scores, apart from transparency in resource allocation (M=2.82), which has the lowest mean value that is also higher than the median value; the standard deviation (SD=1.33) indicates that the distribution of the scores for the item is clustered around the mean value.

5.3.1.1 Inferential statistics

Figure 5-13: Frequency Distribution for Forces Influencing Rice Supply Chain Using Histogram



The mean, median, mode and standard deviation values for the respondents' perception of influencing forces for sustainable supply chain were 3.58, 3.471, 3.47, and 0.387, respectively. The mean value is more than that of the median, thus suggesting that the distribution of the scores is positively skewed. This is consistent with the value of the coefficient of skewness of 1.062, which is positive. The coefficient of Kurtosis was 0.163. The positive Kurtosis suggests that the distribution of the scores associated with the respondents' perception of forces for sustainable supply chain is platykurtic. Compared to the other variables, the mean for the respondents' perception of the driving forces was the fourth highest while its standard deviation was the second highest, thus indicating the variability in the values for the respondents' perception of the driving and restraining forces. The range value for this item was 1.76, in comparison with the other range values, this suggests that it had slimmer range and smaller variability.

A comparison of the statistics of all the variables indicates that the coefficients of variation were 10.81% for driving and restraining forces influencing the rice supply chain in the North central region of Nigeria, 6.85% for the activities of stakeholders and their resources improve food security, 7.21% for activities of stakeholders and their resources improve food security on the underlying triple bottom line, 7.08% sustainable supply chain management policy practices mitigate the food security risks and uncertainty, and 9.65% for the factors influencing the sustainable food supply chain security in the North Central region of Nigeria respectively. The implication is that the respondents' perceptions, of the forces influencing the rice supply chain were the most dispersed. Nevertheless, the computed values of the coefficients of variations T are suggestive that the data was generally not too dispersed from respective means, thus indicating that the values for the respondents' perception of the items had some reasonable degree of reliability. This outcome is without prejudice to the reliability of the instrument (See Table 5-5).

Table 5-5: Inferential Test for Research objective one

Parameter	N	Mean	Std.Dev	Std. Error Mean
Influencing_forces	360	3.5758	.38664	.02038

Table 5-6: Inferential Test (t calculated and p values) Research Objective one

	Test value = 3.5					
	T	Df	Sig. (2-tailed)	Mean difference	95% confidence interval of the difference	
					Lower	Upper
Influencing_forces	3.720	359	.000	.07580	.0357	.1159

An examination of the respondents' perceptions of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria revealed that the mean score associated with the respondents' perception was 3.58, with a standard deviation of 0.246 and a standard error mean of 0.0204 (See Table 5-5), against a test value of 3.5, this resulted in a mean difference of 0.0758. A one sample t-test for significance of respondents' perception of this same item yielded a computed t statistic of 3.72 and a significant p value ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-6). This, therefore, rejects the null hypothesis that the driving and restraining forces influencing the rice supply chain in the North central region of Nigeria are not significant. The implication is to infer that, at the 99% confidence level, the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria are significant.

5.3.1.2 Qualitative (interview response) Challenges/ restraining and driving forces

Table 5-7: List of Other Generated Codes in Stakeholders' Activities

Stakeholder's Problems across Rice value chain\Employees+High Cost of Labour
Stakeholder's Problems across Rice value chain\Environmental Issues
Stakeholder's Problems across Rice value chain\Farm Equipment +Variable Cost
Stakeholder's Problems across Rice value chain\Financial Implications
Stakeholder's Problems across Rice value chain\Pest
Stakeholder's proposed solution\Artifical Water Supplies
Stakeholder's proposed solution\Considerate Equipment Price
Stakeholder's proposed solution\Financial Assistance
Stakeholder's proposed solution\Governmental Intervention
Stakeholder's proposed solution\Governmental Intervention\Input Subsidy
Stakeholder's proposed solution\Labour Cost Reduction
Stakeholder's proposed solution\Pesticides
Stakeholder's proposed solution\Production Cost Reductions
Increase productivity\Governmental Intervention
Increase productivity\Managerial Fixing
Increase productivity\New Techniques
Increase productivity\New Techniques\Rice Production Innovation
Increase productivity\New Techniques\Tech Reinvention

***Source*:** Deduced from Nvivo generated codes

As shown in Appendix 3, the cost incurred on labour and equipment had the highest weighted percentage (5.55%), and 26 aggregate references from the problems identified across the existing value chain of rice. Other issues identified were financial (1.28%) from six references and environmental issues (0.64%). Participants suggested that government intervention and the child nodes of subsidy on inputs (2.35%) would solve the problem. Also, another respondent mentioned the lack of access to water during the dry season and proposed an artificial water supply. Technological inventions (1.28%) and techniques (1.07%) had the highest weighting, when participants were asked how productivity could be increased.

This is evident in the responses from the participants, as stated below:

RIFAN-SSF 1 stated that *"My problem is high cost of production and expensive equipment. Government can assist the farmers by giving subsidized input and with new techniques of rice farming, I can increase my productivity"* while **RIFAN-SSF 2** also agreed by stating that *"Government should train me in new technological way [s] of farming and subsidize input."*

To improve productivity **RIFAN-LSF 4** was of the view that *"I can increase my production if I adopt new farming practice[s]".*

Meanwhile, **RIFAN-SSF 3** mentioned *"I do have access to water during [the] rainy season but not during [the] dry season"* and **RIFAN-SSF4** further mentioned that *"The problem is [a] poor road system, high cost of inputs and equipment. We want government to give us subsidy and help us with new farm technologies."*

Managerial fixing (1.28%) emerged from six references where participants such as **RIFAN-SSF 9, *7*** mentioned "*I can increase my production through proper farm management"* while **RIFAN-LSF 5** further stated that *"The production of my rice will increase by proper management,"*

The word cloud diagram below (figure 5-14) reflects the frequency and weightings of responses on the stakeholders' activities across the three categories.

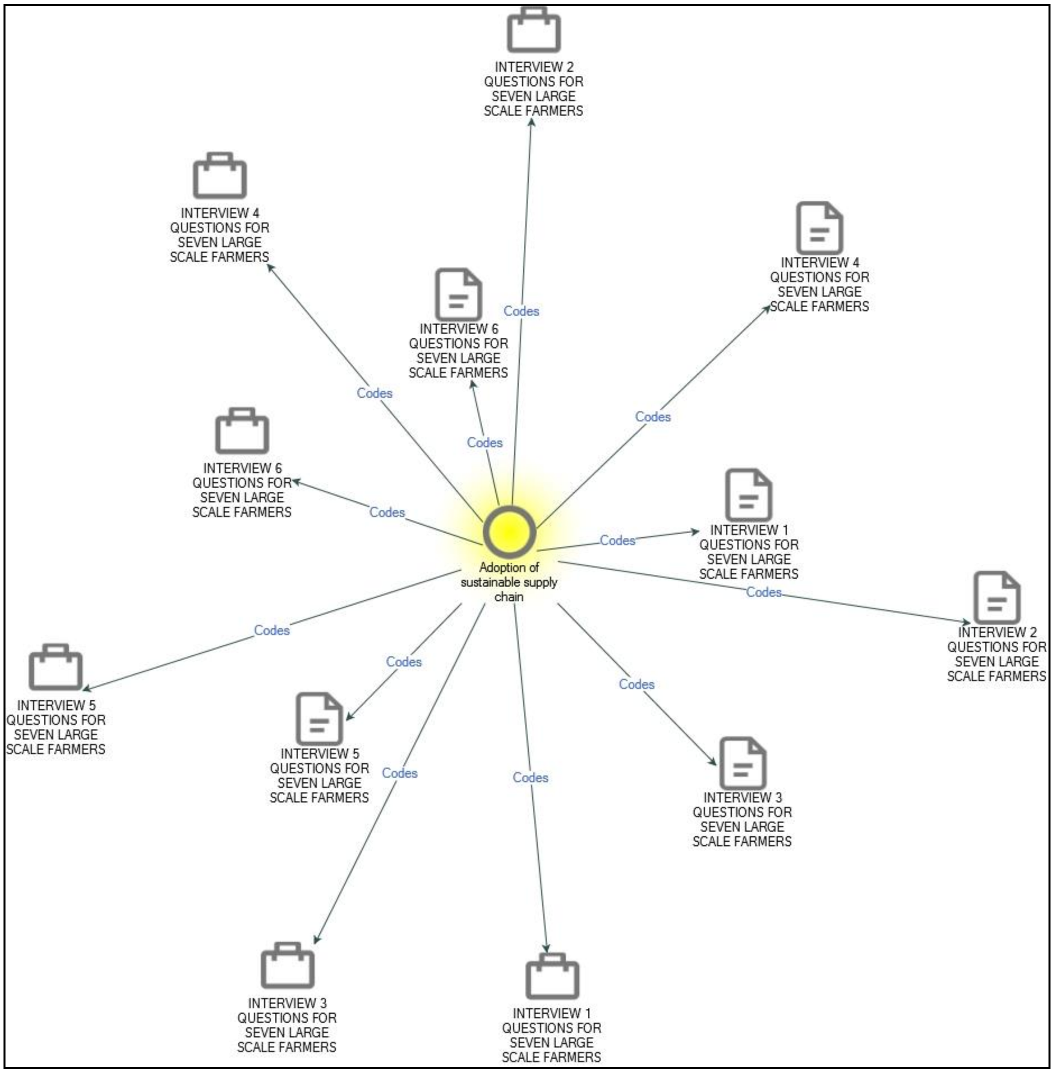
Figure 5-14: Word cloud presentation of stakeholder's activities

Source: Emerged from Nvivo analysis

Adoption of sustainable supply chain

For this theme, the participants were mainly the RIFAN members who are large scale farmers, this is shown in the explored diagram in figure 5-15.

Figure 5-15: Diagram Exploring of the Theme Adoption of Sustainable Supply Chain



Source: Emerged from Nvivo analysis

Questions were designed to identify the extent to which existing sustainable supply chain practices had been employed in activities and resource utilisation. With 69 references gathered from six files, the information transcribed from the theme represented 6.1% of the documents used (Appendix 8). The derived child nodes that are relevant to the study were displayed in group query in Appendix 9 and the table 5-8 below.

Table 5-8: Group Query Output for Adoption of Sustainable Supply Chain (Nvivo 12 generated)

Codes\\Adoption of sustainable supply chain
Codes\\Adoption of sustainable supply chain\Available resources
Codes\\Adoption of sustainable supply chain\Available resources\Source of Utilized Resources
Codes\\Adoption of sustainable supply chain\Available resources\Used Resource during the

Process\Financial
Codes\\Adoption of sustainable supply chain\Available resources\Used Resource during the Process\machineries
Codes\\Adoption of sustainable supply chain\Available resources\Used Resource during the Process\Personnel
Codes\\Adoption of sustainable supply chain\Job creation
Codes\\Adoption of sustainable supply chain\Job creation\Positively
Codes\\Adoption of sustainable supply chain\Productivity
Codes\\Adoption of sustainable supply chain\Productivity\High Quality Purchase Produce
Codes\\Adoption of sustainable supply chain\Quantity of resources
Codes\\Adoption of sustainable supply chain\Quantity of resources\Negative Cash Supply
Codes\\Adoption of sustainable supply chain\Social development
Codes\\Adoption of sustainable supply chain\Social impact\Provided Employee Welfare
Codes\\Adoption of sustainable supply chain\Social impact\Roles of Community Employee
Codes\\Adoption of sustainable supply chain\Transportation
Codes\\Adoption of sustainable supply chain\Transportation\Designated Transport
Codes\\Adoption of sustainable supply chain\Waste disposal
Codes\\Adoption of sustainable supply chain\Waste disposal\Agric Feed

Source: Emerged from Nvivo analysis

The relevant subthemes from the nodes generated were as waste disposal (0.71%), personnel (0.71%), transportation (0.61%), employee welfare (.051%), social development (0.61%), available financial resources (0.61%), job creation (0.61%), available machinery (0.61%), and utilised resources (0.61%). The triple bottom line (TBL) dimension will be adopted in presenting this theme.

Table 5-9: List of Codes Generated for Adoption of Sustainable Supply Chain

Available resources
Job creation
Social development
Employee welfare
Waste disposal
Transportation
Available resources/sources of utilized resources
Available resource/financial
Available resource/ machinery
Available resources/personnel
Productivity/high quality produce purchase
Social impact/roles of community employee
Quantity of resources/negative cash supply

Source: Emerged from Nvivo analysis

Comments by participants such as *"I use tractors, planter thresher and simple farming tools but the problem is high cost of diesel and spare part"* from **RIFAN-LSF 2,** were common responses among the RIFAN large-scale farmers to the node of available machinery utilised by this category of stakeholders in the rice supply chain. Linking available resources to the adoption of a sustainable supply chain, in this case the economic dimension of TBL, indicates that although some of the large scale farmers use small farming tools such as cutlasses, hoes and sickle as well as machinery such as tractors, planters, and threshers, the cost of maintenance is high; some of RIFAN members even have to hire machinery and equipment from other farms which shows that big tools are not readily available. Instead of equipment, the stakeholders resolve to use manual tools which explains the node 'available resource/personnel'. Although this resolved the node 'job creation', it has not improved the productivity of these stakeholders even though these are large scale farmers. This is evidenced by the level of productivity as stated by **ADP extension worker 2** who commented that: "*Farmers in this region produce more than 5,000 tonnes [of] rice yearly".* Other ***ADP extension workers*** could not categorically mention the rate of output monthly or yearly; the common response was that '*they produce moderate output'* or *"they produce lots of rice"*

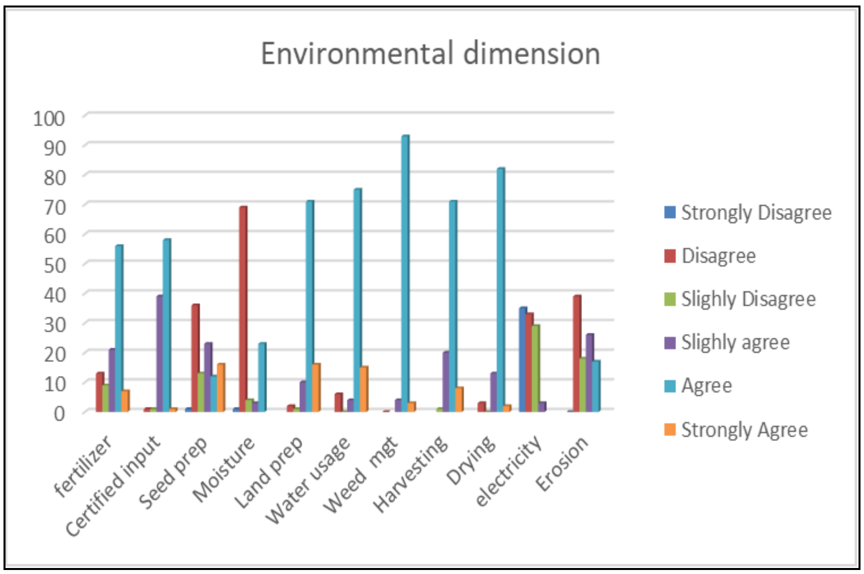
This output is the total output as a region and considering the land usage which is the environmental dimension of TBL; because the large-scale RIFAN members are described as those who utilise more than three hectares of land for rice planting, the output is not commensurate to the available land resource. This could be linked to the fact that RIFAN members in this region still engage the use of manual labour for their activities.

Financial resources or credit facility weighted high as available resources, job creation and personnel. Participants identified access to loan as a medium for improving production output. Although some of the participants accessed loans from the RIFAN society, government could make other grant or loan options available. Also, some of the participants made comments on the need for subsidies from the government; this could reduce the cost incurred on inputs such as seedlings, fertilizers and pesticides. In this case, the economic dimension of TBL with focus on sustainable sourcing applies. Alluding this, **RIFAN-LSF1**, asserted that *"Government should subsidize inputs".* In terms of how production capacity could be improved, a similar comment stressed "*I can improve my production capacity by subsidy from government, loans and market linkage."* Thus, the financial resources available are insufficient for the stakeholders to access other resources, such as mechanised tools, varieties of quality seedlings and quality fertilisers to improve the rice supply chain and productivity, which could in turn enhance food security in the Edu and Patigi region. Thus, adopting the economic dimension of TBL will ensure sustainable sourcing of the required resources. Although the RIFAN large-scale members employ workers within the community, with one some employing between 20-50 people, another employing 15 people to thresh rice, another 30 people, no focus was placed on employee welfare, as shown in responses such as - *"I pay [them] daily according to their work" (***RIFAN-LSF 2).** This is indicating that employees are not paid according to the stated minimum wage, and neither do they have access to welfare package for instance, health. The category of workers employed are often unskilled labourer who engage in weeding, planting, scaring of bird, harvesting and packaging. Therefore, the social dimension of TBL is not adopted as no focus is given to social development.

The ‘waste disposal’ node was aimed at identifying the sustainable practice adopted in disposing waste; the most common response was “*I use them for [my] poultry farm,*” and the other one was *“I feed them to animals.”* These responses promote green packaging in terms of the environmental dimension of the TBL. Also, all the respondents commented that the produce was transported using the road system, even though the road network from the farm to the market is bad. This comment further connotes that in this case, the environmental dimension of the TBL is not practiced. A good road network should be part of infrastructural development across the rice value chain which is the responsibility of the government as a stakeholder in the rice value chain.

5.3.2 The Activities, Decisions and Resources of Stakeholders to Improve Food Security on the underlying Triple Bottom Line.

Figure 5-16: Stakeholders' Resources and Activities (1)



Figures 5-16 to 5-18 indicate the categories of items based on TBL dimensions of stakeholders’ activities and available resources, using a six-point Likert type scale to rate at what degree respondents agreed with each statement. The responses for the environmental dimension indicate that many responses agreed (77%) with the use of natural fertilizer resources in the planting activity, 13% disagreed and 8% were neutral. With regards to the use of seedlings, 98% agreed with the use of seedlings with certified labels, with 35% underpinning the need to treat seedlings before planting them to have quality output, 36% disagreeing with this, and 29% being neutral to the notion. For the measurement of the moisture content of rice grains, 26% of respondents supported the adoption of this sustainable practice as a means of checking the quality of rice grains after the harvest activity, while 70% of respondents were not in agreement with this practice.

Eighty one percent of respondents engaged in land preparation activities after each harvest, while 17% were indifferent about the practice. With the drive for water management, 79% of respondents constructed field channels to avoid excessive flow of water from or to the field while 16% of them were neutral about this sustainable practice. Linked to this, 43% of respondents agreeing that they did not experiencing erosion, although 37% disagreed with this statement, while 18% of respondents were neutral to this experience. Concerning weed management, 96% of respondents agreed that they were involved in this activity to prevent losses and have good quality of rice grain. Ninety eight percent of respondents harvested grains manually and sun-dried them on mats and pavement. Regarding having access to good supply of electricity, 97% disagreed with the statement while just 3% agreed with it and had to use less fuel daily.

Figure 5-17: Stakeholders' Resources and Activities (2)

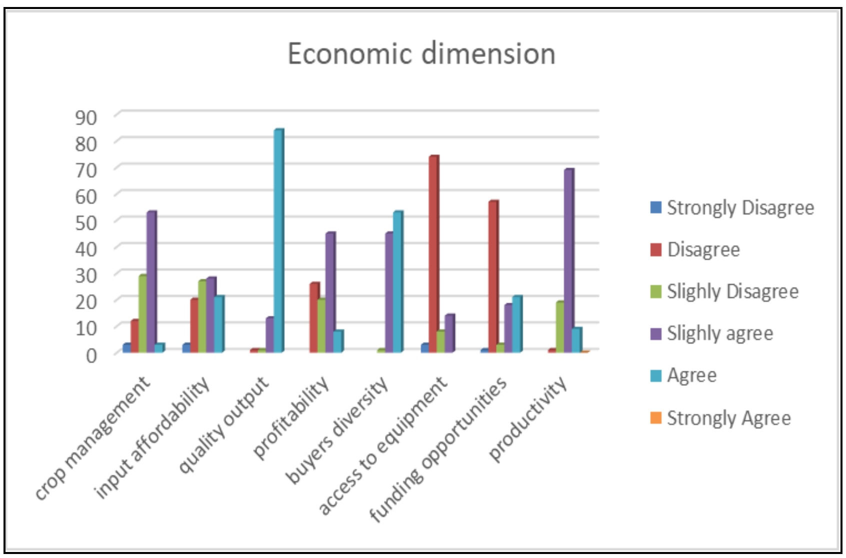
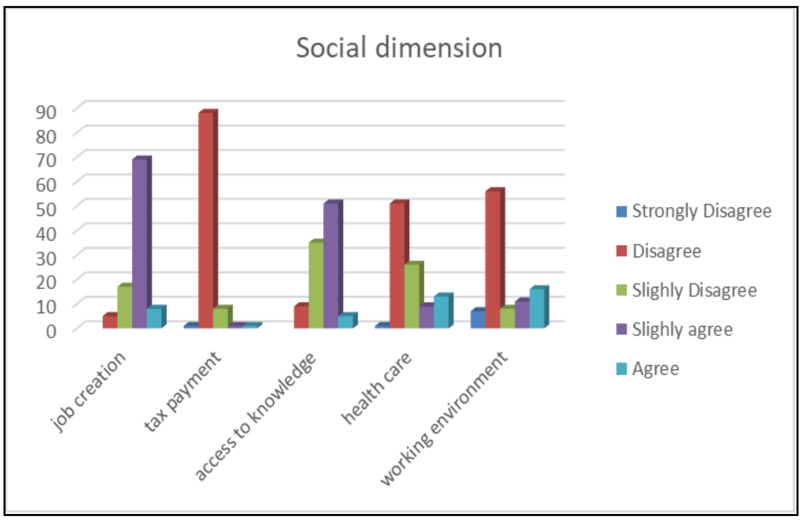


Figure 5-17 represents the economic dimension of the resources and activities of the stakeholders. With regards to crop management as an activity, 83% of the respondents agreed that extension officers as a human resource helped them in controlling pests and disease while 15% of the respondents were indifferent to the statement. By the same token, 97% of the respondents trusted the quality of the seedlings and other inputs that they bought from suppliers.

In view of the available quality inputs, 49% of respondents could afford them while 23% disagreed, and 27% were neutral to the statement. While 96% of the respondents agreed that they had diverse buyers for rice grains, 53% of them made sufficient profits; however, 27% disagreed with this statement and 20% were indifferent.

With regards to whether they had access to good machinery and equipment as resources which are aimed at increasing productivity, 82% did not agree with this statement, although 78% of respondents agreed that these did increase productivity; part of that latter group may have also been amongst the 14% of respondents who had access to good equipment. From the responses regarding whether they had access to good financing opportunities, such as loans and credit facilities as resources, 58% of the respondents agree to this statement while 39% did not.

Figure 5-18: Stakeholders' Resources and Activities (3)



The social dimension of the resources and activities of stakeholders are depicted in Figure 5.18. In terms of level of profitability, 77% respondents could employ more workers as a human resource to increase productivity, while 5% could not, and 17% were neutral to the question. As part of the social responsibility activity of respondents, government should provide a structure to enable tax payments, unfortunately, 90% of the respondents disagreed that there was the availability of such platform. Regarding the access of respondents to acquire knowledge and improve their skills to improve the competitiveness, productivity and profitability of rice, 56% of the respondents agreed that they had access to improve their skills and knowledge, while 9% did not, 35% respondents were neutral to the statement. Insofar as good health care services in the community/ local government area, 51% of respondents did not have access to such service, while just 22% asserted that they did, and 26% were neutral to the statement. A minority of 27% respondents were sure about the safety of their working environment against attacks from animals and herdsmen, but an overwhelming 63% respondents, who are mostly from Patigi area, did not agree with the statement, while 8% were neutral. This shows that the Patigi local government area is more likely to be attacked by herdsmen and animal.

Table 5-10: Descriptive Statistics for TBL Categorisation of Activities and Resources (A)

Environmental dimension	N	Mean	Median	Std.deviation
Land preparation	358	4.994	5.0	.6610
Weed management	359	4.978	5.0	.298
Water usage	358	4.9218	5.0	.8629
Harvesting method	359	4.8691	5.0	.5463
Drying method	359	4.8189	5.0	.5962
Certified input usage	358	4.5838	5.0	.5525
Crop management	359	4.401	5.0	.849
Natural fertilizer usage	359	4.2284	5.0	1.07
Seed preparation	359	3.5850	4.0	1.4734
Erosion	359	3.201	3.0	1.1355
Moisture measurement	359	2.7632	2.0	1.2759
Supply of electricity	355	2.0	2.0	.8667

Source: Compiled by researcher from SPSS output

Table 5-10 shows the environmental dimension of the categories of activities of stakeholders shows that land preparation (M=4.99) had the highest mean value. Respondents agreed that this activity was often carried out after each harvest with the aim of ensuring the productivity of the land. This was followed by weed management (M=4.98), which involves the application of gyphosate chemical and the weeding of plants that can disrupt the growth of rice. Water usage (M=4.92) was about ensuring that water does not flow out from the beds to cause erosion, and requires that respondents have sufficient and good water at all times. For this, some adopted irrigation method. Respondents agreed that they used manual system of harvesting and threshing (M=4.86), which often led to a loss of output. Also, respondents agreed that sun dried grains (M=4.81) on the ground, which is obviously time consuming and unhygienic, especially to consumers. Respondents agreed that they used sustainable inputs that are certified (M=4.58), such as NPK chemical and 2-4-D chemical, seedlings and other fertilizers as resources to improve their activities towards food security. Respondents agreed that they used crop management (M=4.40) as an activity rendered with the assistance of extension officers for the control pests and disease. Respondents agreed that they used of natural fertilizers (M=4.23) as a sustainable resource for planting; this was used alongside other fertilizers. To avoid diseases in seedlings and grains and improve the quality of grains, respondents agreed that they prepared seeds (M=3.89) as a sustainable practice before planting. Respondents stated that they did not experience soil erosion and pollution (M=3.20); this could be linked to the prior construction of water beds to avoid excess flow of water. Although moisture measurement (M=2.76) is a sustainable practice to ensure the accuracy of moisture content in grains after harvest, however, respondents disagreed that they took part in this activity. The poor supply of electricity (M=2.0) forced respondents to use more fuel and diesel as resources for activities that require electrical supply. Unfortunately, the absence of electricity may not encourage the adoption of technology.

The estimated mean and median values of seven variables were equal, indicating a symmetric distribution of scores. However, the variables for crop management, natural fertilizer usage, and moisture measurement had the mean values lower than the median ones which indicates asymmetric distribution. Also, the standard deviation values for natural fertilizer usage (1.07), seed preparation (1.47), erosion (1.14) and moisture measurement (1.27) indicate that the distribution of scores for these items were clustered around the mean value.

Table 5-11: Descriptive Statistics for TBL Categorisation of Activities and Resources (B)

Economic dimension	**N**	**Mean**	**Median**	**Std.deviation**
Quality of input	359	4.8134	5.0	.4972
Buyer diversity	358	4.5279	5.0	.5164
Increase productivity	357	3.8739	4.0	.5789
Input affordability	359	3.4568	3.0	1.1175
Profitability rate	359	3.3565	4.0	.963
Funding opportunities	358	2.994	2.0	1.272
Equipment accessibility	359	2.3370	2.0	.758

Source: Compiled by researcher from SPSS result

As depicted in table 5-11, the economic dimension of the resources and activities of stakeholders, respondents agreed that they trusted the quality of input (M=4.81) obtained from suppliers, and that there were diverse buyers (M=4.52) for output. This indicates a good demand and ready market for output. With regards to increasing the level of productivity (M=3.87), respondents agreed that they increased the level of productivity often; because of this, there should be a percentage of output reserved for storage towards food security, however, there were no provisions for this by the local government. Respondents agreed that inputs and fertilizers were easily available and affordable (M=3.45), although the sources of these were not mentioned; to enable sustainable practices, the sources of inputs must be known so as to ensure traceability in case of eventuality. Respondents agreed that they made sufficient profit (M=3.36) after their activities, although this may not be commensurate with their rate of productivity and improved standard of living. This would demand that respondents have a high level of literacy to enable the calculation of profitability in relation to productivity. Also, respondents still need funding opportunities (M=2.99) to improve their productivity. There is therefore an indication that profits obtained are not easily ploughed back into enlarging ventures, meeting basic needs, and accessing basic equipment (M=2.34) and machinery to improve productivity.

In general, the estimated mean and median values of five variables were equal, indicating a symmetric distribution of scores except for profitability rate which had a higher median value and funding opportunities that had a lower median value. Standard deviation values for input affordability (SD=1.12), funding opportunities (SD=1.27), and equipment accessibility (SD=0.758) show that the distribution of scores for the items were clustered around the mean value.

Table 5-12: Descriptive Statistics for TBL Categorisation of Activities and Resources (C)

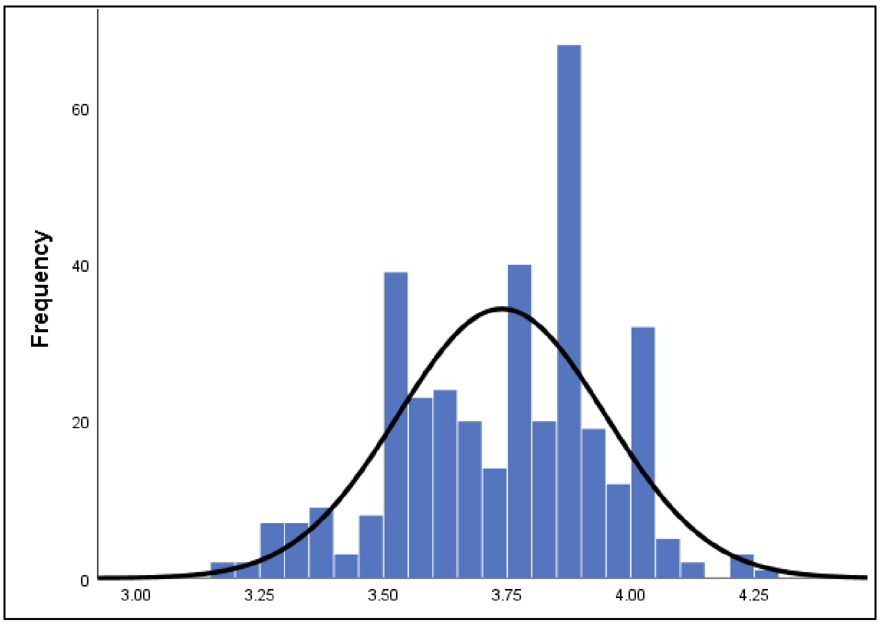
Social dimension	**N**	**Mean**	**Median**	**Std.deviation**
Job creation	359	3.811	4.0	.6539
Knowledge acquisition	358	3.5196	4.0	.7283
Good health care	359	2.8273	2.0	1.059
Safe working environment	357	2.7255	2.0	1.2465
Tax payment	358	2.1145	2.0	.4309

Source: Compiled by researcher from SPSS result

The social dimension of activities and resources available to stakeholders as shown in table 5-12 indicates that some respondents made sufficient profit and created more jobs (M=3.81) within the community. Despite this, the wage paid did not meet the daily minimum wage for workers. The jobs created were mainly to engage workers and provide them with wages that were just sufficient to live by, but not enough to improve their standard of living. Through knowledge acquisition and skill development (M=3.5), especially by improving the literacy level and adoption of new techniques respondents could improve their productivity and profitability, they disagreed that they had access to such opportunities. Respondents disagree that they had access to good health care facilities (M=2.83) and a safe working environment (M=2.73), especially those in the Patigi region who were faced with attacks from herdsmen. It is the responsibility of the government to create a platform for tax payment (M=2.11) as a form of civic and corporate social responsibility, however, this platform is not available. The estimated mean and median values for these three items were equal, which depicts a symmetric distribution of scores, while the standard deviation showed that responses were dispersed from the mean values. Meanwhile, good health care and a safe working environment were asymmetrically distributed due to the mean values being higher than median values. The standard deviation of the same items indicates that the distribution of scores were clustered around the mean value.

5.3.2.1 Inferential statistics

Figure 5-19: Frequency Distribution for TBL Categorisation of Activities and Resources



The respective values for the mean, median, mode and standard deviation for the respondents' perceptions on the activities of stakeholders were 3.58, 3.58, 3.88 and 0.245. The mean and median values were equal, suggesting a symmetric distribution, however, the mode value was higher, which made the distribution negatively skewed. This aligns with the coefficient of skewness of -.328, which was negative as seen in figure 5-19. The coefficient of Kurtosis was negative where the value was -.684 and less than 3, indicating that the distribution of scores associated with the view of respondents on activities of stakeholders was platykurtic, which indicates a uniform distribution. The range value for this item is 1.13, which is the smallest in comparison with the other range values, herein depicting small variability.

In comparison to the other variables, the mean value for this variable was the third with standard deviation indicative of spread from the mean value; that is, variability in the perspective of respondents was high and not influenced. When comparing the coefficient of variation of the variables, the value for the activities of stakeholders and their resources that improved food security was 6.85%, which indicates that the values for the perceptions of respondents of this item had some degree of reliability. This result is without prejudice to the reliability of the instrument.

Table 5-13: Inferential Test for Research Objective two

	N	Mean	Std.dev	Std.error mean
Stakeholders_resources_food_security	360	3.5880	.24594	.01296

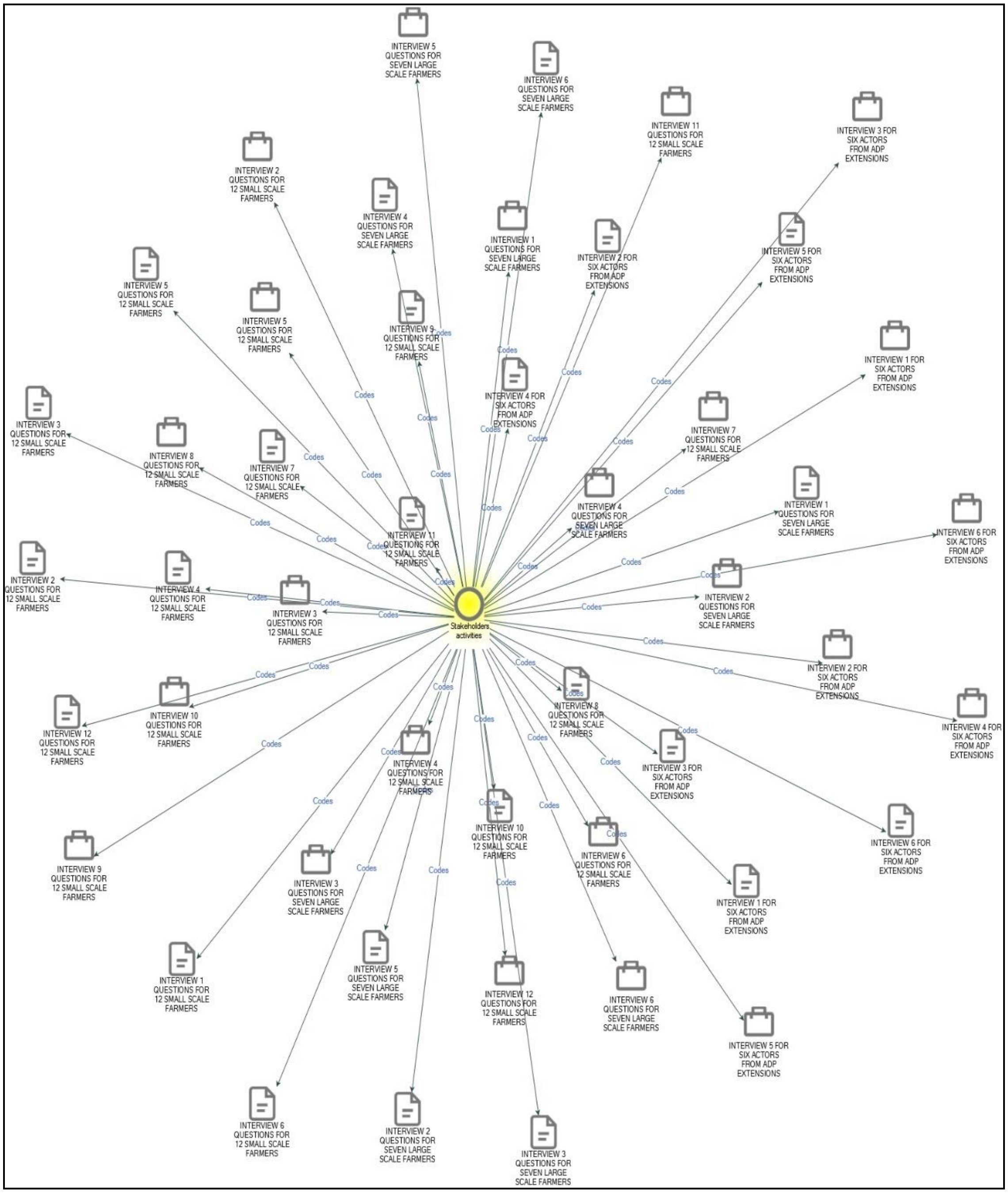
Table 5-14: Inferential Test (t calculated and p values) Research Objective two

	Test value = 3.5					
	T	Df	Sig. (2-tailed)	Mean difference	95% confidence interval of the difference	
					Lower	Upper
Stakeholders_resources_food_security	6.792	359	.000	.08804	.0625	.1135

An examination of respondents' perceptions of how the activities of stakeholders and their resources improve food security on the underlying triple bottom line revealed that the mean score associated with the respondents' perception was 3.58 with a standard deviation of 0.387 and a standard error mean of .0130. Against a test value of 3.5, this resulted in a mean difference of 0.088. A one-sample t-test for significance of respondents' perception of this item yielded a computed t statistic of 6.792 and a significant p value ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-13, 5-14). This thus, rejects the null hypothesis that the activities of stakeholders and their resources improve food security on the underlying triple bottom line are not significant. The implication is to infer that, at the 99% confidence level, the activities of stakeholders and their resources improve the food security on the underlying triple bottom line in the North Central region of Nigeria are indeed significant.

5.3.2.2 Qualitative analysis

Figure 5-20: Explored diagram for theme stakeholder's activities



Source: Emerged from Nvivo analysis

Stakeholder's Activities

The participants were made up six large-scale RIFAN members, and 12 small-scale RIFAN members and six ADP extension workers; all were asked to describe the activities they were involved in within the value chain of rice. This theme was generated by exploring the linkages between the three categories of respondents in terms of stakeholders' activities.

The following subthemes were arrived at from their responses, with 468 references deduced from the information transcribed, as seen in the document used (Appendix 2). The child nodes or subthemes that are deemed to be of major importance to this study are extracted and displayed below.

Table 5-15: Nvivo generated Codes for Stakeholders' Activities

Codes\\ Stakeholders activities\Rice Production Activities\Plan\Farm land selection
Codes\\ Stakeholders activities\Rice Production Activities\Plan\land preparation
Codes\\ Stakeholders activities\Rice Production Activities\Source\Weeding
Codes\\ Stakeholders activities\Rice Production Activities\Source\Artificial Enhancers
Codes\\ Stakeholders activities\Rice Production Activities\Make\Water Control
Codes\\ Stakeholders activities\Rice Production Activities\Make\Planting
Codes\\ Stakeholders activities\Rice Production Activities\Make\Scaring of Bird
Codes\\ Stakeholders activities\Rice Production Activities\Make\Harvesting
Codes\\ Stakeholders activities\Rice Production Activities\Deliver\End-Processing
Codes\\ Stakeholders activities\Rice Production Activities\Deliver\Packaging
Codes\\ Stakeholders activities\Rice Production Activities\Deliver\Marketing
Codes\\ Stakeholders activities\Rice Production Activities\Deliver\Transportation
Codes\\ Stakeholders activities\Increase productivity\New Techniques\Rice Production Innovation
Codes\\ Stakeholders activities\Increase productivity\New Techniques\Tech Reinvention
Codes\\ Stakeholders activities\Increase productivity
Codes\\ Stakeholders activities\Increase productivity\Governmental Intervention
Codes\\ Stakeholders activities\Increase productivity\Managerial Fixing
Codes\\ Stakeholders activities\Increase productivity\New Techniques
Codes\\ Stakeholders activities\Increase productivity\New Techniques\Rice Production Innovation
Stakeholders activities/problems
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain\Employees+High Cost of Labour
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain\Environmental Issues
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain\Farm Equipment +Variable Cost
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain\Financial Implications
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain\Pest
Codes\\ Stakeholders activities\Stakeholder's Problems across Rice value chain\Rice Network
Codes\\ Stakeholders activities\Stakeholder's proposed solution
Codes\\ Stakeholders activities\Stakeholder's proposed solution\Artificial Water Supplies
Codes\\ Stakeholders activities\Stakeholder's proposed solution\Considerate Equipment Price
Codes\\ Stakeholders activities\Stakeholder's proposed solution\Financial Assistance
Codes\\ Stakeholders activities\Stakeholder's proposed solution\Governmental Intervention

Codes\\ Stakeholders activities\Stakeholder's proposed solution\Governmental Intervention\Input Subsidy
Codes\\ Stakeholders activities\Stakeholder's proposed solution\Labour Cost Reduction
Codes\\ Stakeholders activities\Stakeholder's proposed solution\Production Cost Reductions

Source: Extracts from Nvivo analysis for the study

The codes generated in Appendix 1 were grouped according to the SCOR reference model, which is made up of plan, source, make and deliver. The 'enable' and 'return' action of the SCOR model were not used because the existing activities across the rice value chain do not have a platform for enable and return. While the plan node activity consisted of land selection (3%), and land preparation (6.62%) as child nodes, the source node activity consisted of weeding (9.19%) and application of artificial enhancers (14.32%) as child nodes. While the make activity was made up of water control (3.21%), planting (6.41%), bird scaring (3.21), and harvesting (11.75%) as child nodes, the deliver node activity was made up of packaging (7.91%), marketing (2.99%), and transportation (4.49%) as child nodes.

This theme used stakeholder's theory for defining the supply and value chains of rice in the North Central region of Nigeria. To achieve this, the SCOR model was adopted to categorise the activities of the stakeholders into nodes and child nodes. Therefore, the activities of the rice supply chain were represented as shown below:

Table 5-16: List of Codes Generated for Activities of Stakeholders (SCOR)

SCOR (nodes)	Activity (child nodes)
Plan	Plan/farm Land preparation,
	Plan/ land selection
Source	Source/weeding
	Source/artificial enhancers
Make	Make/water control
	Make/planting
	Make/scaring bird
	Make/harvesting
Deliver	Deliver/packaging
	Deliver/transporting
	Deliver/marketing

Source: deduced Nvivo generated code

Participants, who were stakeholders in the rice value chain, identified the activities in the supply chain of rice, through which the driving forces and restraining forces influencing sustainable supply chain management towards food security, were identified.

Participants' replies regarding the activities they were engaged in across the rice value chain were the following:

"…*after having the fadama land, you prepare the land for planting of rice seed, apply glyphosate chemical, weeding, you do the bed to control water, NPK application, weed again and you apply 24D chemical. Then you scare bird in the area, harvest the rice, gathering threshing, winnowing and bagging, transport, processing and marketing"* **ADP extension worker 1.**

ADP extension worker4 added that "…*clearing of land preparation of land, chemical application, planting of rice seed, weeding, making of beds, NPK fertilizer application, second weeding, scaring of birds. After, harvest, then gather the rice, threshing, winnowing by the women and bagging, then transport."*

RIFAN-LSF2, however mentioned that "*Some people site nursery before planting to permanent site. They will select nursery site, planting of seed, then preparation of permanent site, transplanting, construction of beds, weeding, chemical application, second weeding, 24-D application, bird scaring, harvesting, gathering, threshing and winnowing and package, then transport and marketing."*

RIFAN-LSF3 identified the activities as *"…the site selection, the land preparation, planting, chemical application, second weeding, bed construction, urea fertilizer application, scaring of birds, harvesting, threshing, packaging, transport, storage, and marketing."*

This is similar to the response by **RIFAN –SSF4,** who stated *"…land selection, land preparation, planting, chemical application, weeding, construction of beds, application of NPK fertilizer and urea, second weeding, harvesting, pa-boiling, milling to the end user."*

*The r*esponse from **RIFAN-SSF7** emphasized the previously stated activities as *"…selection of farmland, seed and nursery, planting of seed in nursery, preparation of permanent site, chemical application, transplanting of chemical, application of fertilizer, construction of bed, weeding, urea application, harvesting, threshing, winnowing, bagging and transport."*

The responses above identify the part of the value chain which is peculiar to stakeholders; this implies that the value chain of rice is not constant for all the stakeholders, but their uniqueness and innovativeness is a function of their environment and the resources available to them.

The activities of the stakeholders across the rice supply chain in this region begin with the selection and preparation of land which are the child nodes for the plan node in Table 5-4. Farm-land selection had a weighing of 3% while this was 6.62% for land preparation; in total, planning represented 9.62% of the activities of the stakeholders. ADP extension workers are involved in this activity as well; this was noted in their responses when asked which of the activities of the rice value chain they were engaged in.

ADP extension worker1 indicated that "*I do all except processing"*.

ADP extension worker2 concurred that he did *"...all of the above except processing and marketing."*

The responses from the ADP extension workers imply that except for processing and marketing, they are engaged in all the other activities with the RIFAN members from the plan node right through to the make code. This collates with the response to the question on the role of the ADP office in relation to RIFAN members, and how often the latter are visited in the region; some of the responses are stated below:

ADP extension worker 2 stated that *"ADP train farmers and give them technical advice and we visit them always by monitoring and supervising their activities. We visit to make sure the knowledge passed to them is well practicalised".*

This was corroborated by response from **ADP extension worker 3** who said that *"We visit [them] twice a month to give technical advice and training to them"* and further mentioned that *"The problem is high cost of labor and farm input."*

The responses also imply that there is a good level of interaction between both categories of stakeholders which if well managed, should foster good communication, transparency information sharing, and trust to enable a sustainable supply chain for rice in that region.

For this region and the stakeholders, the source node has the second highest percentage (23.51%) among all the nodes. This node has child nodes of weeding (9.19%), and use of artificial enhancers (14.32%), such as the 24-D fertiliser.

RIFAN members indicated that seedlings, fertilisers, and other inputs that they use are not provided by the government, while the quality of their sources for these are not verified and come from various unmonitored markets with unregulated prices. Although ADP extension workers mentioned that government did provide inputs to RIFAN members, several of the RIFAN members responded that there is need for government intervention and subsidies on sourcing the inputs. This implies that there is a leakage in the system which hinders the flow of resources across the supply chain of rice. Introducing a system of transparency, monitoring and accountability will ensure sustainability across it.

RIFAN-SSF 7 said that "*I get my seedling and fertilizer at [the] open market*".

This is corroborated by a response from **RIFAN-SSF 9** who stated that *"Seedling and fertilizer are bought from the market."*

In a quest for a change in this, **RIFAN-SSF 4** mentioned *"We want government to give us subsidized input."* This was further emphasized by **RIFAN-LSF 4,1.**

In contrary, **ADP extension worker 1** mentioned that *"Government gets the seedlings and fertilizer from [a] reliable supplier"* while **ADP extension worker 2** stated that *"Through RIFAN, government give input to farmers as loans."*

A follow-up question was asked on how resources provided were monitored to ensure effective use, and **ADP extension worker 5** answered that *"There are no measures put in place."*

Also, these responses identified 'bird scaring' as a value-adding activity which is demanding for the farmers. This activity had the same weight of 3.21% as child node of water control but a higher one than marketing of produce and land selection. The scaring of birds and rodent invasions are problems that cause low productivity for RIFAN members. Often RIFAN members engage their family members or pay workers specifically for this activity which impacts on the cost incurred for labour.

Four child nodes were further generated from the make activity node, which had the highest weighted percentage of 24.58%, with water control standing at 3.21%, planting 6.41%, bird scaring at 3.21%, and harvesting at 11.75%, which indicates that this is the second most common activity across the rice value chain. The planting activity could be tedious, especially for the small -scale RIFAN members, who still farm manually using simple tools such as hoes, sickle, and cutlass.

The deliver node had four child nodes with end processing as the smallest with a 0.64% weighting; followed by marketing with 2.99%, transport with 4.49%, and finally packaging, with a (7.91%) weighting.

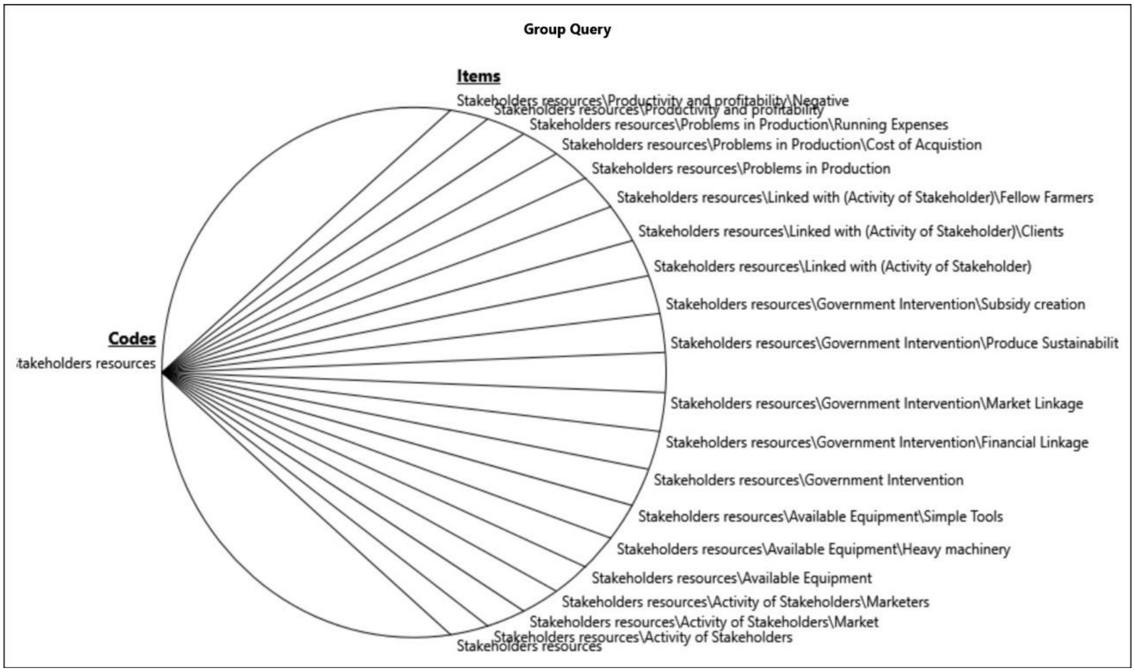
While identifying the activities, stakeholders stated the problems encountered while engaging in them, and proposed solutions which could aid productivity across the rice value chain.

From figure 5-20 the participants identified basic activities across the rice value chain such as 'application', 'weeding', 'land', 'preparation', 'harvesting' 'chemical' 'fertilizer' 'construction' and 'planting'. This indicates that the activities engaged in during the plan and source stages of the rice supply chain are of great importance while being major determinants of the output. This could mean that greater importance must be placed on the sources of application of chemicals and sourcing of seeds. Unfortunately, RIFAN LSF and RIFAN SSF mentioned that the inputs were sourced from the normal market, and as such, the quality of input is not guaranteed which then affects the output. Introducing sustainable sourcing by the government might help deal with such issues. Also, 'construction' of water beds, and 'scaring of bird' are important activities in the rice value chain. Some words like 'cost', 'high', and 'labour' indicate the problems associated with the costs incurred across the rice supply chain. For instance, 'weeding' activity had to take place twice, which connotes higher cost of labour.

Stakeholders' Resources

The aim of this theme is to adopt stakeholder theory and resource dependency theory in identifying the resources available for the categories of stakeholders and how such resources can be leveraged by other stakeholders across the rice value chain. With 53 references derived from six files, as seen in Appendix 11, the relevant and significant nodes to stakeholder's resources are available equipment; and government intervention which has child nodes such as financial linkage, marketers, subsidy creation, market linkage, and resources linked to fellow farmers. This node will be further linked to the theme 'government intervention' in Appendix 5, which has 18 references that emerged from six files.

Figure 5-21: Nodes Generated for the Theme Stakeholders' Resources



Source: Emerged from Nvivo analysis

Table 5-17: List of Generated Codes for Stakeholders' Resources

Marketers
Available equipment
Government intervention\availability of output
Government intervention\grading system
government intervention\financial linkage
government intervention\produce sustainability
government intervention\subsidy creation
government intervention\linked with other clients
productivity and profitability

***Source**:* Deduced from Nvivo generated codes

5.3.3 Sustainable supply chain management influences the competitive performance of the rice value chain network.

Table 5-18: Descriptive Statistics on Influence of SSCM for Competitive Performance of Rice Value Chain

	N	Mean	Median	Std.deviation
Output demand	359	4.95	5.0	.2428
Quality input	359	4.8217	5.0	.1872
Supplier diversity	359	4.559	5.0	.565
Supplier information	358	4.5642	5.0	.608
Ease of delivery	359	3.1671	3.0	.9916
Quality check	359	2.2953	2.0	.6401

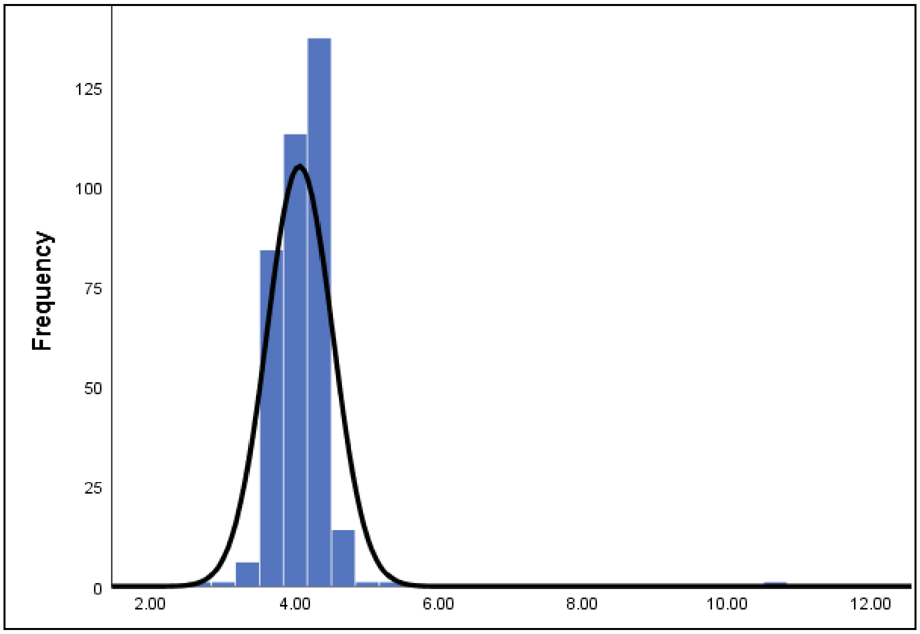
Source: Compiled by researcher from SPSS results

Sustainable supply chain management was adopted to improve the competitive performance of the rice value chain of the Edu and Patigi region. In this regard, as shown in table 5-18, respondents agreed that rice grains were in high demand (M=4.95), and inputs obtained from suppliers were of good quality (M=4.82), which in turn produced quality output. They also agreed that such inputs were from different suppliers (M=4.55); however, traceability is questionable because the information regarding the supplier and source of input was not known. Due to the literacy level of respondents, information about the source of inputs and suppliers (M=4.56) should be the responsibility of the extension officers. This is important because the quality of inputs is a great determinant of output, which by same token determines the competitiveness of rice grains both at the local and international markets. With regard to the delivery of rice grains to the local rice collectors, respondents agreed that there was ease of delivery (M=3.17) despite the poor road network and transportation system. Respondents disagreed that there was a platform for quality checks (M=2.29) for the moisture content, purity, brokenness, and lack of stones of the grains; therefore, this brings into questions the quality of the output because it was not benched -marked against any requirement. Although the output was in demand at the local level, it may not have met the international requirements. The estimated mean and median values of all the items are equal, which depicts a symmetric distribution of scores, while the standard deviation shows that the responses were dispersed from mean values.

The inferential statistics on the adoption of sustainable supply chain management improved rice value chain is shown in figure 5-22

5.3.3.1 Inferential statistics

Figure 5-22: Frequency Distribution for Influence of SSCM for Competitive Performance of Rice Value Chain



For the perception of respondents on the item of sustainable supply chain management and the competitive performance of rice, the values for the mean, median, mode, and standard deviation are 4.03, 4.00, 4.00 and 0.454 respectively. The mean value was approximately equal to the values of the median and mode, thus indicating a perfectly symmetric distribution while the standard deviation value indicates a spread and variability in the views of respondents on the item. This is consistent with s skewness of 8.436 which is positive. The coefficient of Kurtosis was 2.437, which is suggestive that the distribution of the scores associated with the respondents' perceptions on the item of sustainable supply chain management and the competitive performance of rice is platykurtic. Compared with other items, sustainable supply chain management and the competitive performance of rice had the highest values for the mean, median, mode and standard deviation, demonstrating that the perceptions of respondents were the highest for this item. The range value for this item was the highest at 2.50, in comparison with the other range values, this suggests that it had broader range and depicted more variability. When comparing the coefficients of variation of sustainable supply chain management and the competitive performance of rice with other items, the values for the perception of respondents were dispersed from mean, this is suggestive that the data was generally not too dispersed from its respective means, thus indicating that the values for the respondent's perception of this items had some reasonable degree of reliability. This outcome is without prejudice to the reliability of the instrument.

Table 5-19: Inferential Test for Research Objective three

Parameter	N	Mean	Std.Dev	Std. Error Mean
Sustainable_supply_chain_mgt_and_competitive_perfeormance	360	4.0388	.29133	.01535

Table 5-20: Inferential Test (t calculated and p values) Research Objective three

	Test value = 3.5					
	T	Df	Sig. (2-tailed)	Mean difference	95% confidence interval of the difference	
					Lower	upper
Sustainable_supply_chain_mgt_and_compt_perfc	35.090	359	.000	.53880	.5086	.5690

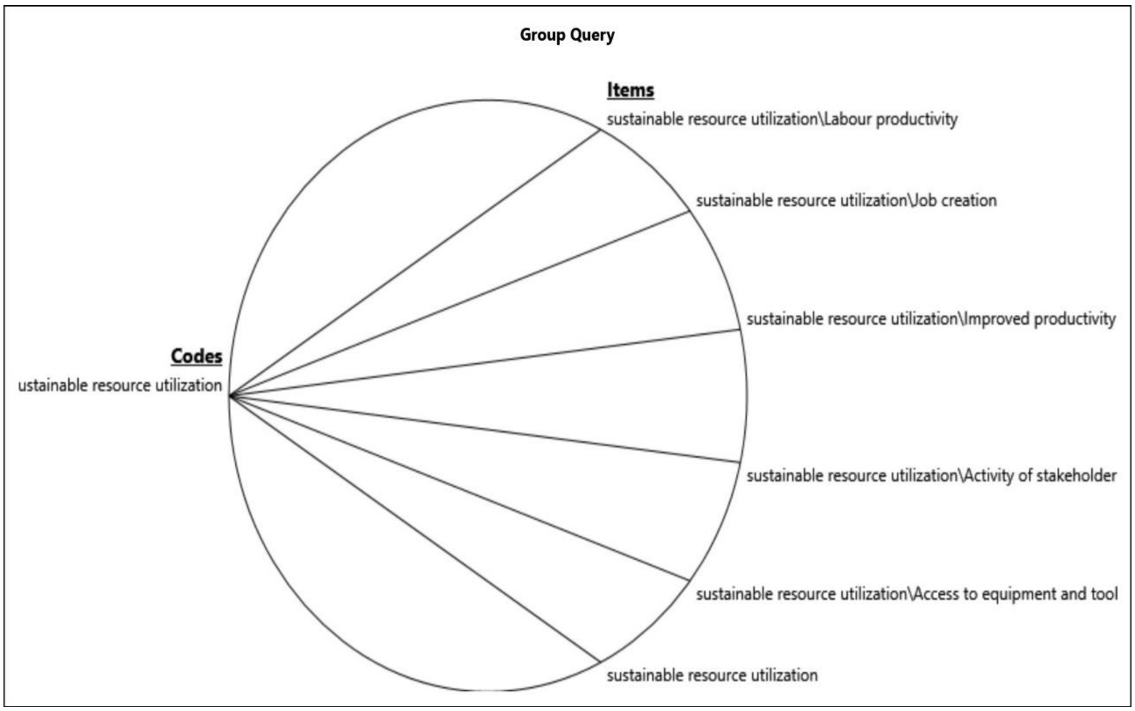
An examination of respondents' perceptions of the extent to which sustainable supply chain management influences the competitive performance of the rice value chain network, revealed that the mean score associated with respondents' perception was 4.04, with a standard deviation of 0.291 and a standard error mean of 0.015. Against a test value of 3.5, this resulted in a mean difference of 0.5388. A one-sample t-test for significance of respondents' perception of the extent to which sustainable supply chain management influences the competitive performance of rice value chain network yielded a computed t statistic of 35.09 and a significant p value ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-39). This thus, rejects the null hypothesis that the extent to which sustainable supply chain management influences the competitive performance of rice value chain network is not significant. The implication is to infer that, at the 99% confidence level, sustainable supply chain management significantly influences the competitive performance of the rice value chain network.

5.3.3.2 Qualitative analysis (thematic analysis)

Sustainable Resource Utilization

This theme focuses on the responses from RIFAN small-scale farmers, and is aimed at verifying their adoption of sustainable practices in the utilization of resources. Their views were benchmarked again the TBL dimension. With 62 references and 12 files, the transcribed information cumulated in 6.62% of the document used (Appendix 12). The child nodes or subthemes which were deemed to be of major relevance, are shown below.

Figure 5-23: Nodes Generated from the Theme Sustainable Resource Utilization



Source: Emerged from Nvivo analysis

From the appendix 14, it was determined that codes that were extracted with the coverage above 1%, were relevant and significantly applicable to the theme. These were access to equipment and tools (1.22%), activity of stakeholders (1.22%), improved productivity (1.33%), job creation (1.22%), and labour productivity (1.22%)

Table 5-21: List of Generated Codes for Sustainable Resource Utilization

Access to equipment and tools
Activity of stakeholders
Improved productivity
Job creation
Labour productivity

Source**:** Deduced from Nvivo generated codes

An interesting comment was made by **RIFAN-SSF1** in response to the question about labour productivity per land usage, "M*y production is per annum, I get 20 bags per year from my one and [a] half hectare of land and six people are working for me."* RIFAN SSF are those with a land usage of less than 3 hectares; if the land usage is between 1-3 hectares of land, production is calculated per annum to be between 20 and 45 bags of rice, with the participation of five to 15 employees. Another participant, **RIFAN-SSF 3,** commented *"I have two and [a] half hectares of land and I employed 15 people to work with me; in a year, we produce 45 bags of rice."*

Sustainable resource utilisation was further determined by the child node of access to equipment and tools, where respondents only had access to simple tools such as hoes, cutlasses and sickles. The labour productivity child node is important because the input can be measured by input vis-à-vis output. Inputs such as fertilizers and seedlings were sourced from the open market by the stakeholders. For instance, one respondent one whose output was 20 bags yearly, used 70kg of seed and six bags of NPK. This is corroborated by another participant who said, "*I have two hectares of land where I employed between five and seven people; my production is 15 bags per year and my seeds and fertilisers are of good quality" (***RIFAN-SSF7)**

These child nodes are important for measuring the node on sustainable resource utilization because they measure the sustainable use of available resources to improve the supply chain of rice. The respondents mentioned that the seed and fertilizers that they use are of good quality, with some buying them from the market, others mentioned that they bought them from RIFAN meetings. Although quality can be determined by the output, there may be a need to set requirements in place for sustainable sourcing by the ADP extension office by the government, so as to measure the quality of such inputs. **RIFAN-SSF11** commented: *"I can improve the capacity of my production by acquiring new knowledge about rice farming and proper management"* while **RIFAN-SSF8** added, *"I can improve my production through trainings on* *[a] few [types of] farming technology."* This shows the willingness of the RIFAN members to adopt sustainable skills for improving the rice value chain. Also, it indicates the desire that these RIFAN members have to migrate from the use of simple tools to mechanized equipment which will improve their productivity and as well as the supply chain of rice in the region. These responses align with the comments of other participants who mentioned factors such as adopting new techniques and technology, re-training, and getting assistance and intervention from the government to improve their productivity.

Figure 5-24: Word Cloud Presentation for Sustainable Resource Utilization

Source: Emerged from Nvivo analysis

From Figure 5-24 above, participants identified the present state of the rice value chain 'People' implies the number of persons employed by each RIFAN members which cumulates in job creation within the Edu and Patigi local government areas. Also, the figure shows the factors that can improve the sustainability of the rice supply chain and increase rice productivity towards food security. Some of these factors are acquiring new knowledge, need for tractors instead of tools that they presently use, such as the hoes, cutlasses and sickles; government assistance, subsidy on inputs; and developing new farming knowledge and training.

Sustainable Sourcing

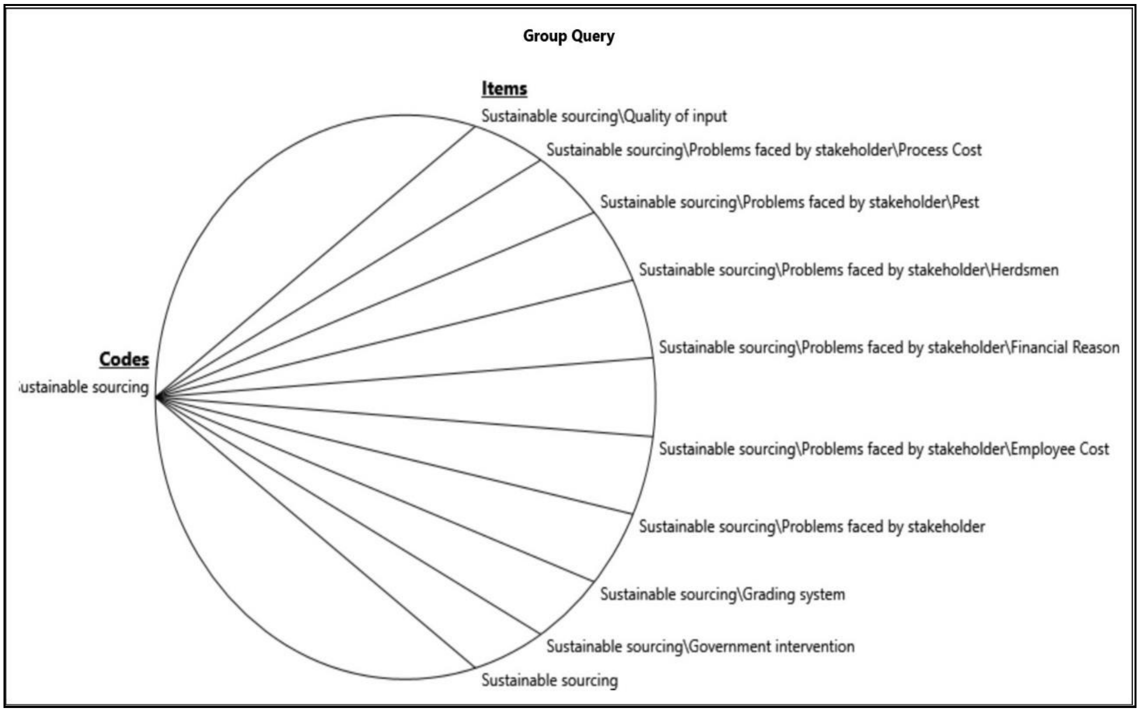
For this theme, 62 references emerged from 12 files; sustainable sourcing is also linked to the theme ‘regulatory activities’, for which 23 references emerged from six files. The theme is aimed at improving food security through the identification of the problems faced by the category of stakeholders and providing solutions to aid in the sustainable sourcing of inputs for the rice supply chain. To this end, the major nodes that were deduced, as shown in appendices 6 and 13 were ‘stakeholders’ problems’ with a weighing of (2.64%), amongst other grandchild nodes such as employee cost, herdsmen, pest, and processing cost, as well as quality of input (1.22%), grading system (1.22%), government intervention (1.22%), ethical standards (0.92%), and food availability (0.71%); these are displayed in Table 5-22 below.

Table 5-22: List of codes Generated for Sustainable Sourcing

Government intervention
Grading system
Quality input
Problems faced by stakeholder\Herdsmen
Problems faced by stakeholder\Pest
Problems faced by stakeholder\Process Cost
Regulatory activities\Ethical standards
Regulatory activities\Food availability

***Source**:* Deduced Nvivo generated codes

Figure 5-25: Nodes for the Theme Sustainable Sourcing (Nvivo 12 generated)



Source: Emerged from Nvivo analysis

The response from **RIFAN-SSF3** to the question on the problems faced by this category of stakeholder, was: *"The challenges I face are high cost of inputs, birds and Fulani".* This was further reiterated by the response from **RIFAN-SSF5** who mentioned, *"I lack funds, Fulani problem and cost of inputs is too high."*

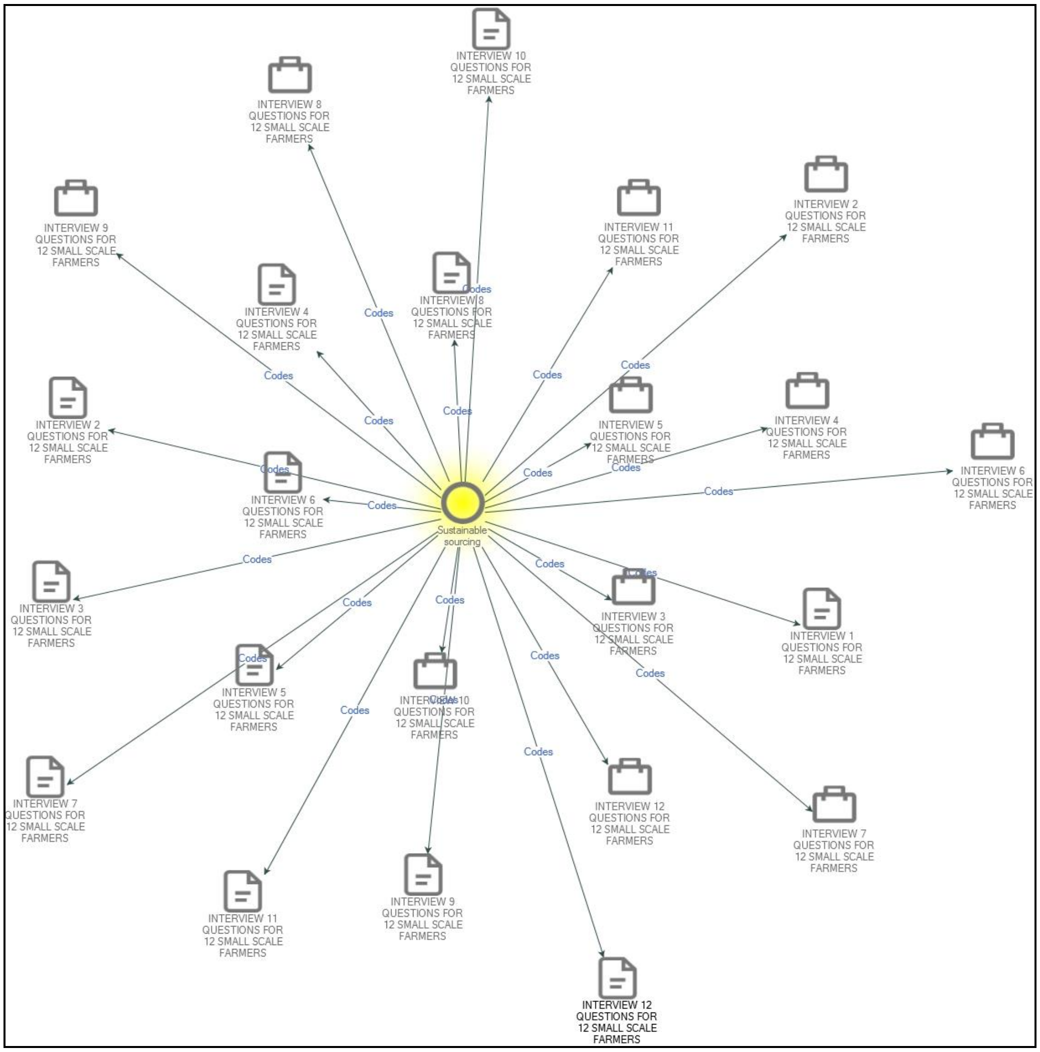
The 12 RIFAN SSF gave similar responses to the above. Fulani (herdsmen) invasions are such that cattle owned by the herdsmen invade farms to graze on crops. Unfortunately, RIFAN SSF mentioned that the government is not providing any solutions to them; this further linked to the theme 'government intervention', where the RIFAN-LSF mentioned the need for interventions from the government which they opined could solve these problems, thus enabling the farmers' levels of productivity to rise. Although laws are enacted to this effect, the Fulani herdsmen still defy these, and engage in battles with farmers, which often leads to mass killings of people. The problems identified by this category of participants, i.e., RIFAN SSF, is not peculiar to them, as they were also mentioned by the RIFAN-LSF under the theme 'stakeholder activities' in which the problems across the rice value chain faced by these respondents were mentioned. For instance, the processing and labour (employee) cost were earlier discussed as these were seen across the supply chain of rice; bird invasions were also identified, whereby rice farmers need to employee people to scare the birds away.

From the responses about the existence of a grading system, all respondents answered that there is no such system in place. Grading systems are often implemented by the government in collaboration with relevant groups concerning the crop/ item; in this case it could be with RIFAN. Such a system is to ensure uniformity in pricing and measurement of output. But in this case, it does not exist which means there are always fluctuations in the prices of paddy, either sold by RIFAN-LSF or RIFAN-SSF. This further links the discussion to the theme 'regulatory activities' which identifies existing ethical standards for the rice value chain either by RIFAN or government, towards ensuring the availability of rice. Some responses to questions about the existence of the monitoring and evaluation of rice farmers activities to meet set ethical standards, were: "*There is no one to police rice production" (***ADP extension worker 1)** with **ADP extension worker 2** adding that *"Although there are no policies to guide rice production in this region, we still visit them to monitor and supervise their farming activities"*

Also, the RIFAN – LSF all mentioned that there are not standards set by the government to monitor their activities. This implies that both the quality of inputs and outputs are not monitored, since there is no quality assurance platforms or requirements to benchmark quality against. This could affect the international competitiveness of the rice from the region. Since the quality of inputs is not benchmarked, the adoption of poor-quality seedlings, fertilizers and varieties of inputs will in turn, affect the availability of rice, which implies that the region cannot produce and supply sufficient outputs to contribute to the country's drive towards self-sufficiency in rice production and food security. Sustainable sourcing can be made possible through regulatory activities across the supply chain of rice.

Exploring the linkages between the generated themes from the interviews reflects, that the category of respondents who helped to bring about the determinants of the theme were the RIFAN-SSF and ADP extension workers.

Figure 5-26: Diagram Exploring the Theme Sustainable Sourcing

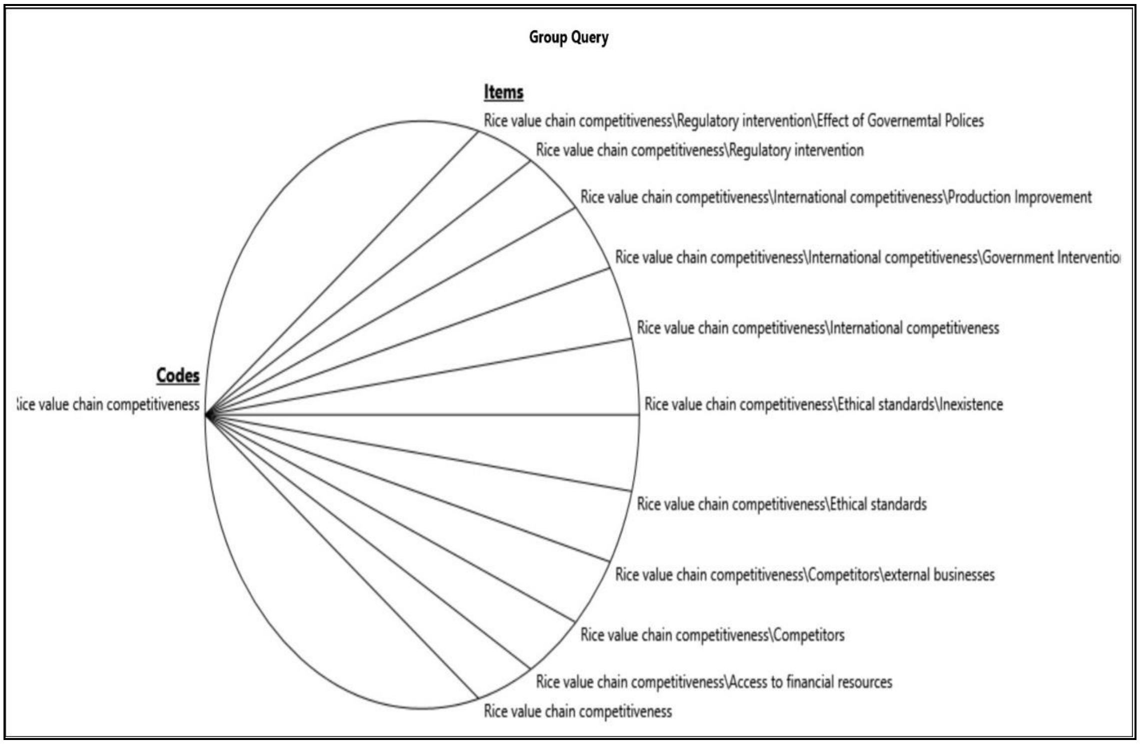


Source**:** Emerged from Nvivo analysis

Rice Value Chain Competitiveness

The theme of 'rice value chain competitiveness' aimed to identify the existing factors for improving the competitiveness of the rice value chain and questions were designed to provide strategies to achieve this. With 30 references which emerged from 6 files, the transcribed information indicates that this theme had a weighting of 3.05% in the document (Appendix 10). The relevant child nodes (subthemes) from this theme were access to financial resources (0.61%), competitors (0.61%), ethical standards (0.61%), regulatory intervention (0.71%), and international competitiveness (0.51%). These are displayed in Figure 5-27 below.

Figure 5-27: Nodes for the Theme Rice Value Chain Competitiveness (Nvivo 12 generated)



***Source*:** Emerged from Nvivo analysis

Table 5-23: List of Codes Generated for Competitiveness of Rice Value Chain

Competitors
Ethical standards
International competitiveness
Regulatory interventions
Access to financial resources

***Source*:** Deduced Nvivo generated codes

For questions aimed at identifying the existing competitors and how the participants coped with them, most of the **RIFAN-LSF**, made comments such as, "*My competitors are the foreign market and with my access to loan and credits, I can produce to more to supply to [the] international market"* (**RIFAN-LSF 1).** This is similar to the responses from **RIFAN-LSF 4** who commented that *"My competitors are the international rice marketers, and I can improve my production if I adopt new technology,"* and **RIFAN-LSF 2** who stated that. *"My competitors are the foreign rice marketers, but [the] government should help me improve [my] rice farming equipment"*

In line with improving productivity, **RIFAN-LSF5** said that *"I can improve my production to meet up with international standard[s] by producing [a] high quality product"*

These comments show that the major competitors for the local rice farmers are the importers of rice from the foreign market. To improve the capacity of production and the competitiveness of the locally produced rice, there is a need for improvement in the quality and quantity of the rice produced; this can be realized through access to credit facilities to purchase mechanized and improved equipment for rice production, introduction of ethical standards, and government intervention through policies on rice importation, such as bans. Responses to the existence of policies and ethical standards were met by the answer ‘none’. This implies that there is no benchmark for production.

Although banning the importation of rice was a mechanism adopted by previous administrations, it was sabotaged by corrupt practices which allowed the smuggling of foreign rice. On the other hand, the insufficiency in the capacity of rice produced in Nigeria and its poor quality have been reasons for importation; as such, there is the need to invest in improving the quality and quantity of production of Nigerian rice, which in turn will demand strong and high-level intervention by the government.

Moreover, responses from the RIFAN-LSF on access to loans and credit facilities indicated that they have access to these, however, the problem with their rate of productivity may therefore be linked to the utilization of available financial resources, knowledge of management of financial resources, or high cost incurred on equipment and maintenance. For instance, one response like, *“The problem is high cost of inputs on tools and even labourers”* by **RIFAN-LSF 2** supports this claim.

This further points out that the reason for low productivity is not directly the result of lack of access to loans and other credit facilities.

5.3.4 Plans, strategic policies, and practices put in place to mitigate food security risks and uncertainty.

Table 5-24: Descriptive Statistics for Role of SSCM Practices for Food Security

SSCM practices	N	Mean	Median	Std.deviation
Government subsidy	358	4.7765	5.0	.5401
Government intervention	360	4.720	5.0	.6459
Access to processing facilities	359	3.515	4.0	.9479
Food security drive	360	2.136	2.0	.5741
Monitoring and evaluation	357	2.031	2.0	.2837

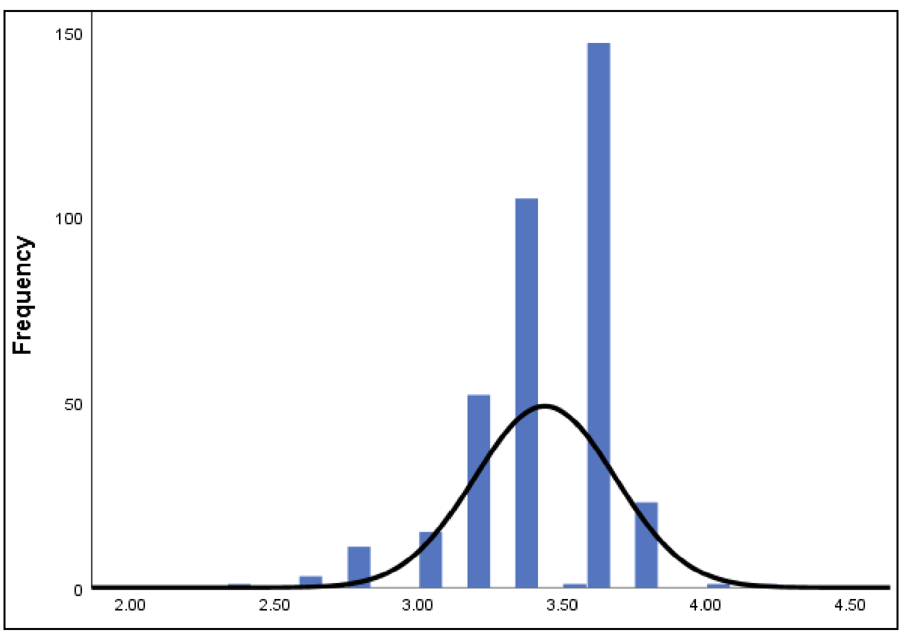
Source: Compiled by researcher from SPSS results

Sustainable supply chain management practices were adopted in the drive towards food security in the provision of subsidies on inputs by the government ranked highest (M=4.77), and government intervention (M=4.72) ranked next. Respondents disagree with the statement that government grant rice farmers loans, grants, and subsidies to improve rice production or that it provided training to rice farmers on the use of new technological tools that can improve productivity. Respondents were neutral regarding, whether they had access to processing facilities (M=3.52), which aligns with previous statement that respondents performed activities manually. Respondents disagree that there was the existence of silos and storage facilities (M=2.14) that could enable food security. In the same way, they disagreed about the availability of monitoring and evaluation platform (M=2.03) to drive food security. The estimated mean and median values of all the items were equal, which depicts a symmetric distribution of scores, while the standard deviation shows that responses were dispersed from mean values.

The inferential statistics on role of SSCM on food security in the North Central region of Nigeria are shown in figure 5-28.

5.3.4.1 Inferential statistics

Figure 5-28: Frequency Distribution for Role of SSCM practices for Food Security



The mean, median, mode and standard deviation values for of the respondents' perception of the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty were 3.43, 3.40, 3.60 and 0.24 respectively. The mean value was approximately equal to the median with higher mode, thus suggesting that the distribution of the scores was negatively skewed. This is consistent with the value of the coefficient of skewness of -1.060, which is negative. The coefficient of Kurtosis was 1.84. The negative Kurtosis is suggestive that the distribution of the scores associated with the respondents' perceptions of the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty is platykurtic. The range value for this item was 1.80, which is the smallest range value in comparison with the other range values, herein depicting small variability. Compared to the other variables, the variables for respondents' mean perception of the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty was the smallest, which was the same for standard deviation, thus indicating the variability in the values for the respondents' perceptions of this item.

A comparison of the statistics of all the variables indicates that the coefficients of variation were 10.81%, for the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria, 6.85% for the activities of stakeholders and their resources improve food security, 7.21%, for the activities of stakeholders and their resources improve food security on the underlying triple bottom line, 7.08% for sustainable supply chain management policy practices mitigate the food security risks and uncertainty, and 9.65% for the factors influencing the sustainable food supply chain security in the North Central region of Nigeria. The implication is that the respondents' perceptions of the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty was the most dispersed. Nevertheless, the computed values of the coefficients of variations are suggestive that the data was generally not too dispersed from its respective means, thus indicating that the respondent's perceptions of these items had some reasonable degree of reliability. This outcome is without prejudice to the reliability of the instrument.

Table 5-25: Inferential test for Research Objective four

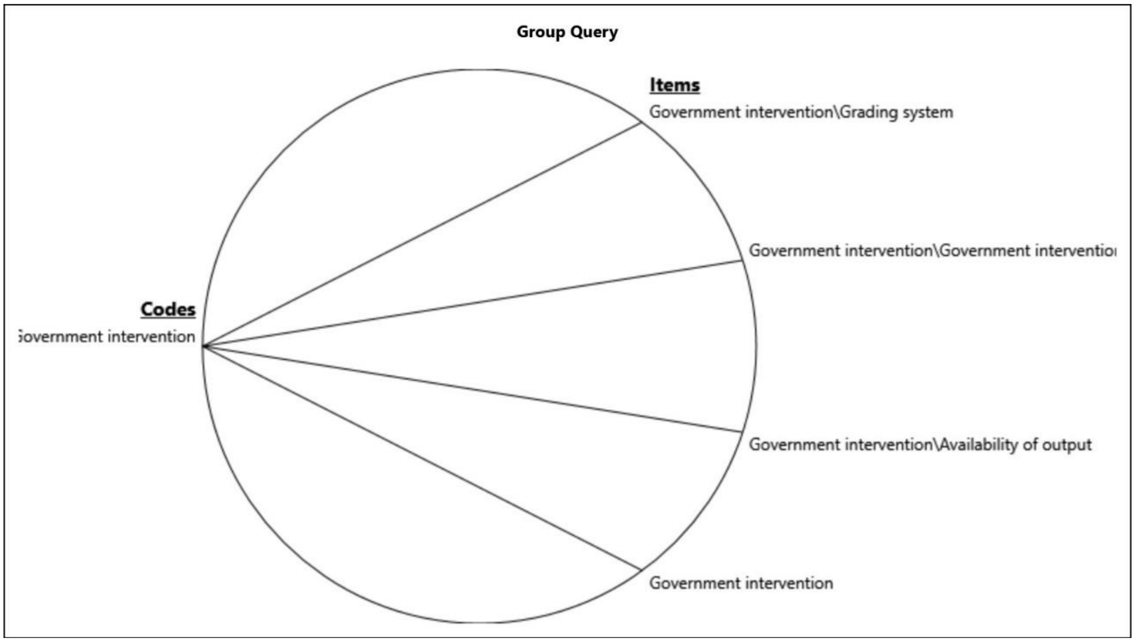
Parameter	N	Mean	Std.Dev	Std. Error Mean
Strategic_role_of_SSCM	360	3.4375	.24337	.01283

Table 5-26: Inferential Test (t calculated and p values) Research Objective four

	Test value = 3.5					
	T	Df	Sig. (2-tailed)	Mean difference	95% confidence interval of the difference	
					Lower	Upper
Strategic_role_of_SSCM	35.090	359	.000	-.06250	-.0877	-.0373

An examination of respondents' perceptions of the extent to which sustainable supply chain management policy practices mitigate the food security risks and uncertainty revealed that the mean score associated with the respondents' perception was 3.438 with a standard deviation of 0.2434 and a standard error mean of 0.028. Against a test value of 3.5 (See Table 5-25), this resulted in a mean difference of - 0.06250. The negative value suggests that the respondents majorly disagreed with the item. A one-sample t-test for significance of respondents' perceptions of this item yielded a computed t statistic of -4.873 and a significant p value ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-26). Thus, therefore, reject the null hypothesis that sustainable supply chain management policy practices mitigate the food security risks and uncertainty, is not significant. The implication is to infer that, at the 99% confidence level, sustainable supply chain management policy the food security risks and uncertainty.

Figure 5-29: Nodes Generated for the Theme Government Intervention (Nvivo 12 generated)



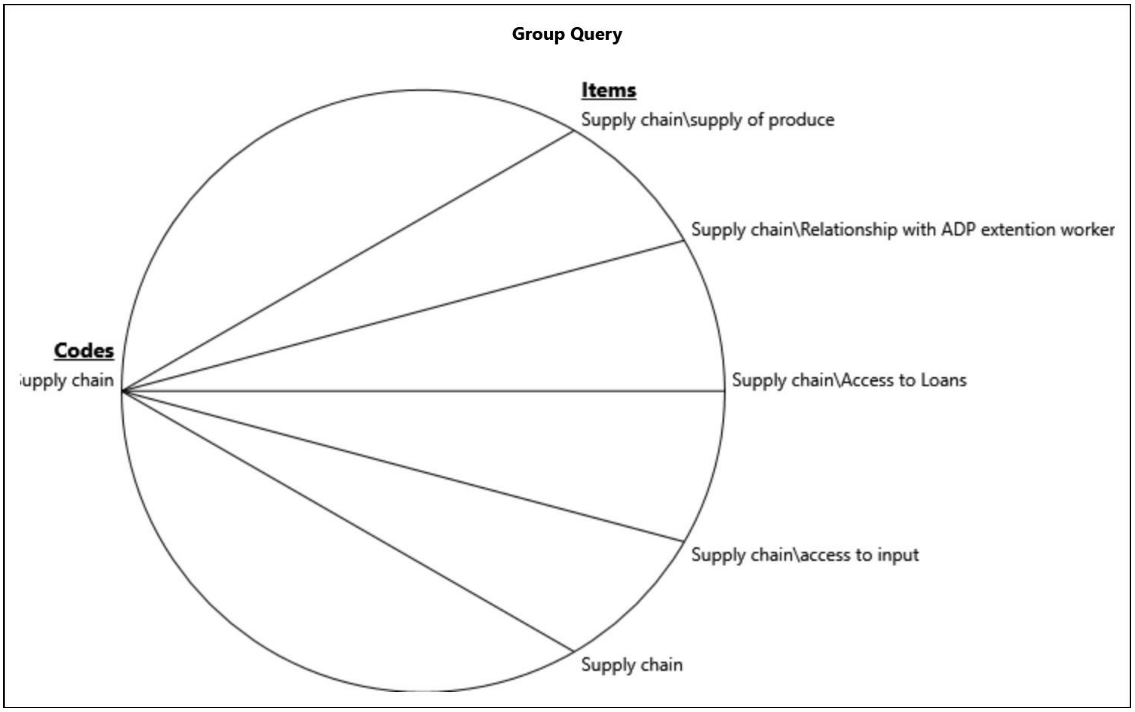
***Source*:** Emerged from Nvivo analysis

Responses by the SSF on the question to identify specific stakeholders whom they interact with during production and across the rice supply chain, found other farmers, input suppliers, buyers of output/ marketers, rice collectors, and the government. Also, responses from the ADP extension workers identified that the office interacts with the RIFAN members, which makes them part of the value chain.

The recurring response among the ***RIFAN SSF*** was, "*I interact with other farmers and buyers. "In addition,* ***RIFAN-LSF 5,*** said *"I sell to local rice collectors" w*hile other participants added, *"I buy quality seedlings from input suppliers."*

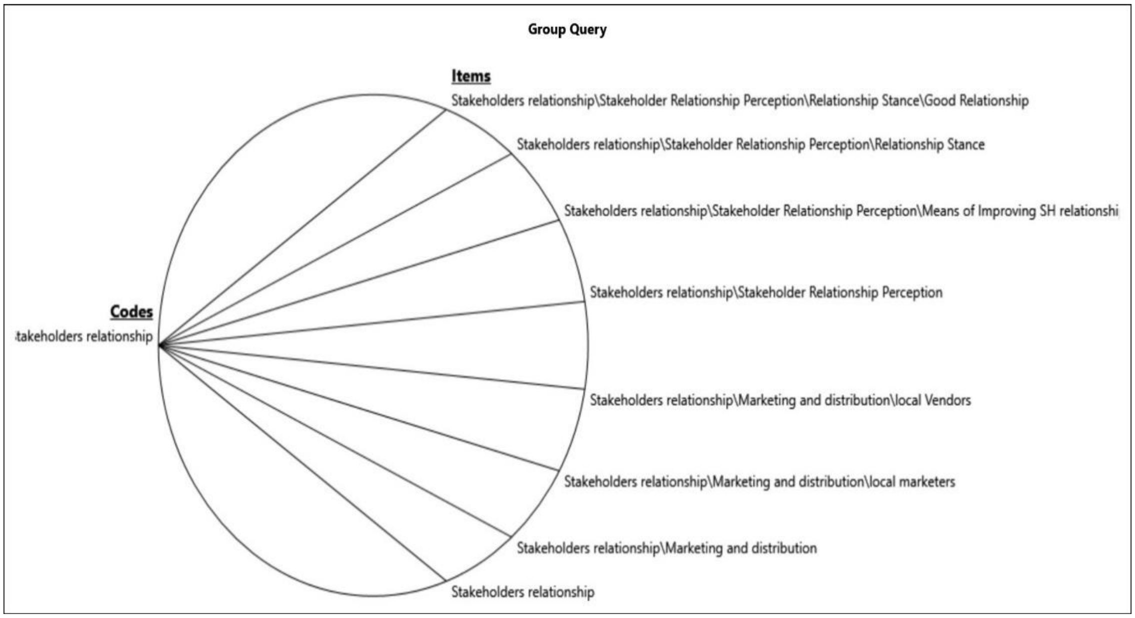
Furthermore, the child node on 'government intervention weighed 1.06%, while as a node it had a weighting of 1.83%, which brings it to the scale of relevance and significance. Grandchild nodes such as subsidy creation, grading system, market linkage, financial linkage and sustainable production are worth mentioning because these are related to the expectations of the RIFAN members from the government as a stakeholder in the rice value chain and will improve their productivity. The response below indicates the resources available by the government as a stakeholder in the rice value chain: *"Through government intervention, I can increase the production of my rice. Government can also help me by linking me to* *financial institution and international market" (***RIFAN-LSF5).** The linked 'government intervention theme has child nodes such as 'grading system' and 'available output'. Some of the responses from the ADP extension workers on the existence of government policies were: *"there are no policies to guide rice production in this region" (***ADP extension worker 2)** and *"There is no one to police rice production" (***ADP extension worker 1)**.

Figure 5-30: Nodes for the Theme of Supply Chain of Rice (Nvivo 12 generated)



***Source*:** Emerged from Nvivo analysis

Figure 5-31: Nodes for the Theme of Stakeholders' Relationship (Nvivo 12 generated)



***Source**:* Emerged from Nvivo analysis

Respondents from the RIFAN SSF category of stakeholders commented that interactions with the ADP extension office, foster a platform for technical advice for farming, and support, and introduce them to new farming techniques. To corroborate that and in response to the questions from the theme 'interaction with extension office', **ADP extension worker 1** made the following comments: "O*ur office provide technical advice to the farmers, we invite them to our office for training, we also visit them twice every month and interact with them on their farm" w*hile **ADP extension worker 6** commented, *"We train farmers and offer them advisory service, we train them and visit them like three times monthly on their farms to make sure the knowledge passed to them is well practicalised."*

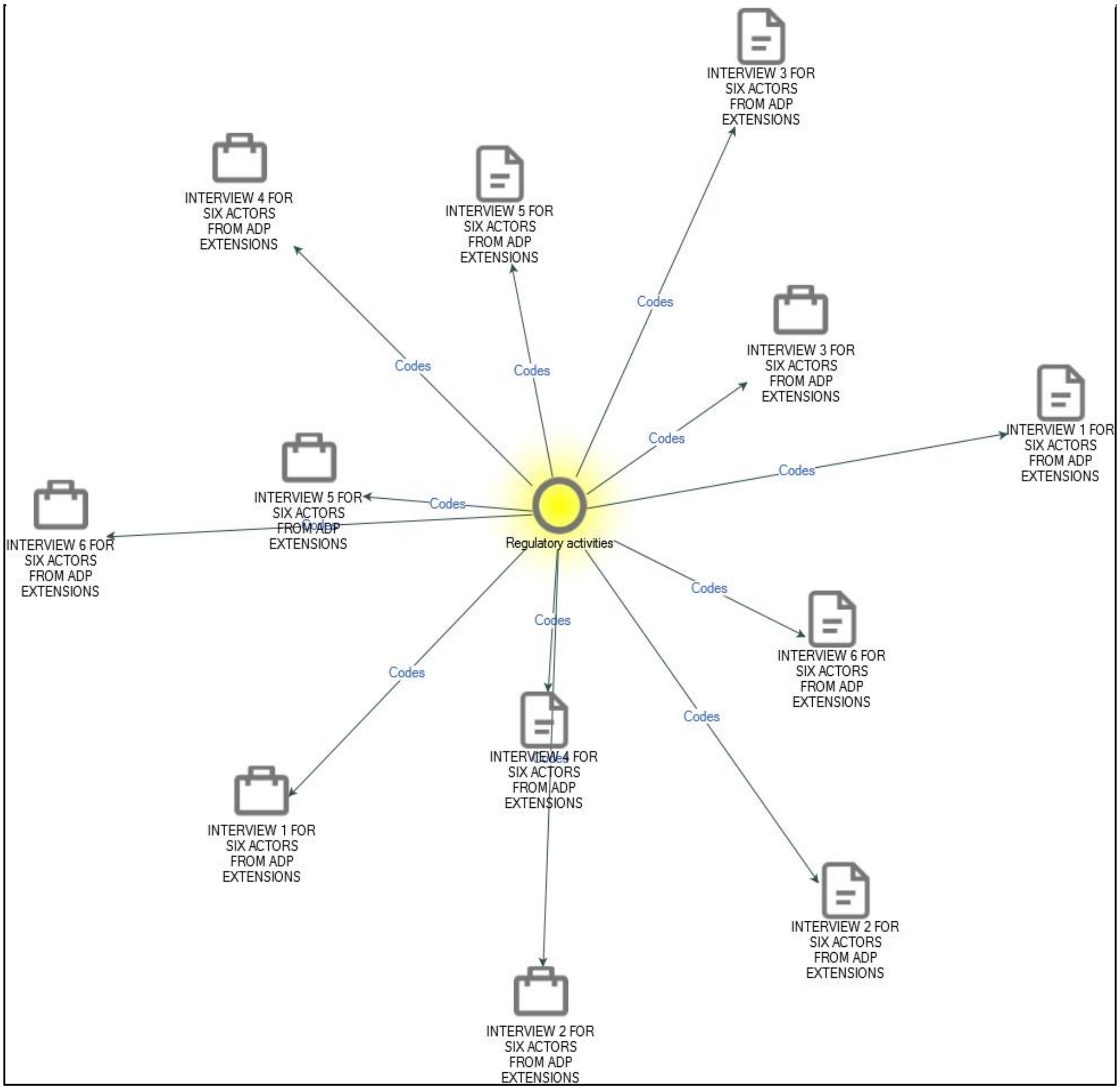
The relationship between the RIFAN members and ADP extension workers is cordial; this is identified from the comments by the ADP extension workers under the theme 'stakeholder activities', where respondents mentioned their involvement with most of the activities identified across the rice value chain.

Other stakeholders identified across the supply chain were the local marketers, vendors and distributors. The perception about the relationship with these stakeholders seemed good and worth building towards a sustainable supply chain for rice. One response to support this was: *"I* *have [a] good relationship with the local marketers who buy from me and improve our relationship through regular meeting[s]" (***RIFAN-LSF 2).**

The RIFAN-LSF commented that they supply their output to local rice collectors, while comments from the RIFAN SSF showed that they have meetings with other stakeholders that they interact with. Such meetings could be with their input suppliers, fellow RIFAN members who are also part of the rice value chain, large-scale rice farmers who are also RIFAN members, and ADP extension workers. From another response to 'interaction with other stakeholders' one of the RIFAN-LSF mentioned the use of phones in communication; this could be for placing orders for inputs with the suppliers or on supplying available outputs to the local collectors. Through their interactions within the RIFAN membership society, members have access to loans and input. Comments like: *"I get my seedlings and fertilisers from [the] open market plus [the] RIFAN program"* made by **RIFAN-SSF 4,** indicate a degree of collaboration with the RIFAN membership office, from which the members access seedlings and fertilisers. This was further mentioned when one of the respondents mentioned, *"I use resources such as manpower, machines, labourer, loan from [the] bank and cooperative."*

These responses align with the weighting of the 'perception' child node, and with the grandchild node of 'good relationship stance'. This is further seen in the weighting of the 'supply chain node' of 4.8%, with the child node of 'relationship with ADP extension workers' being 1.22% implying a good relationship with the RIFAN members. This already established perception which is a result of trust and cordiality can be a platform through which sustainable supply chain practices can be introduced to the members by the ADP extension office.

Figure 5-32: Diagram Exploring the Theme Regulatory Activities

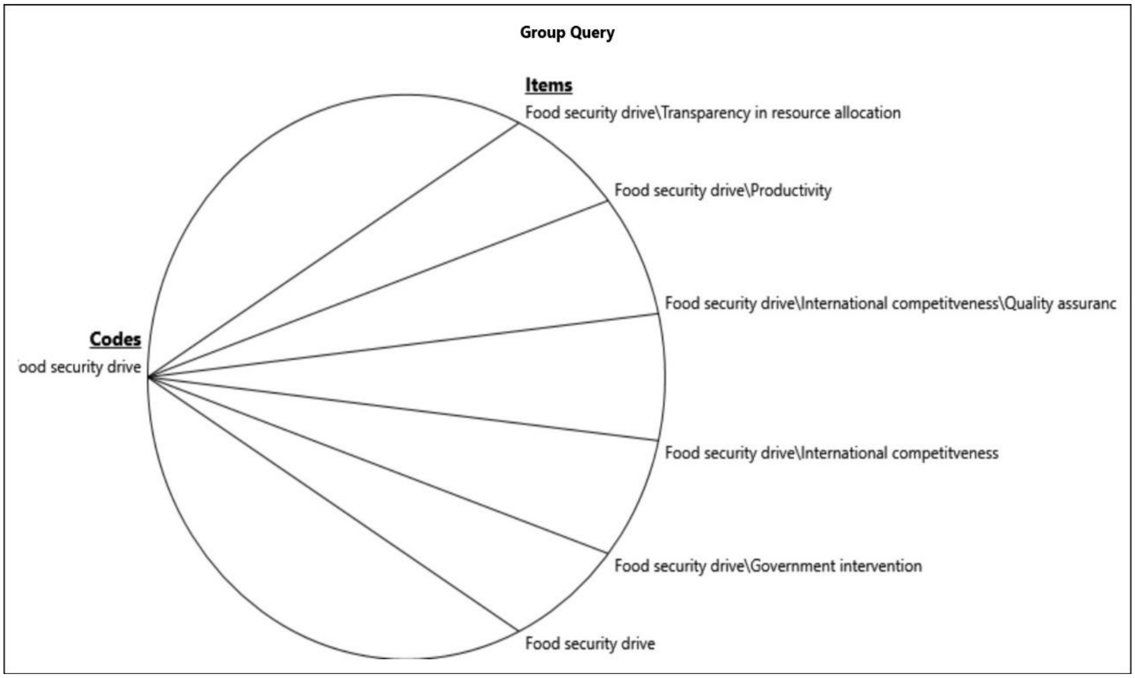


***Source*:** Emerged from Nvivo analysis

Food Security Drive

For this theme of 'food security drive' 28 references emerged out of six files, with a weightings of 2.85% of the document. The child node that emerged from this theme were: 'international competitiveness' with grandchild node of 'quality assurance', 'transparency in resource allocation', 'productivity', 'international competitiveness' and 'government intervention'. These are further depicted in Figure 5-33 below.

Figure 5-33: Nodes for the Theme of Food Security Drive (Nvivo 12 generated)



Source: Emerged from Nvivo analysis

Table 5-27: List of Codes Generated for Food Security Drive

Transparency in resource allocation
International competitiveness\quality assurance
Productivity

Source: Deduced Nvivo generated codes

The node 'transparency in resource allocation' is a measure of how food security can be attained through the allocation of the available resources to the RIFAN members.

In response to the question about transparency and quality assurance in resource allocation across the supply chain of rice, most of the respondents mentioned that there are no measures for ensuring transparency. Responses from themes such as 'stakeholder resources' and 'sustainable sourcing' already indicated that RIFAN members source their seedlings from the open market and have not supplied them by the government. For the node of 'productivity' most of the respondents could not state the rate of productivity, with one of them stating that "*the farmers in this region produce more than 5,000 tonnes of rice, and I don't think they meet international competition because they produce locally" (***ADP extension worker 2).** Another interesting comment indicated that "*the farmers in the region produce more than 2,000 tonnes yearly" (***ADP extension worker 3).**

These responses reflect that there are no records to capture the output of the RIFAN members, and further indicate that sustainable practises are not adopted in the rice value chain in this region, which constraints food security. It also means that RIFAN members are not well schooled in management.

The previous responses were further reinforced by comments made by other participants; for instance, RIFAN-SSF 11 mentioned "*I can increase my production through proper farm management*"**.** This response was like those from two other RIFAN-LSF. However, to acquire proper farm management skills, this may require that the RIFAN members have access first to basic primary education, and that ADP extension workers must also be trained in record keeping which is included in farm management.

The absence of quality assurance implies that the rice value chain in the region may not be ready to compete in the international market; this is also indicated by the insufficiency it still experiences in terms of rice production and supply.

5.3.5 Value chain model influencing the security of the sustainable food supply chain in the North Central region of Nigeria.

Table 5-28: Descriptive Information for Value Chain Model for Improved Value Chain for Food Security

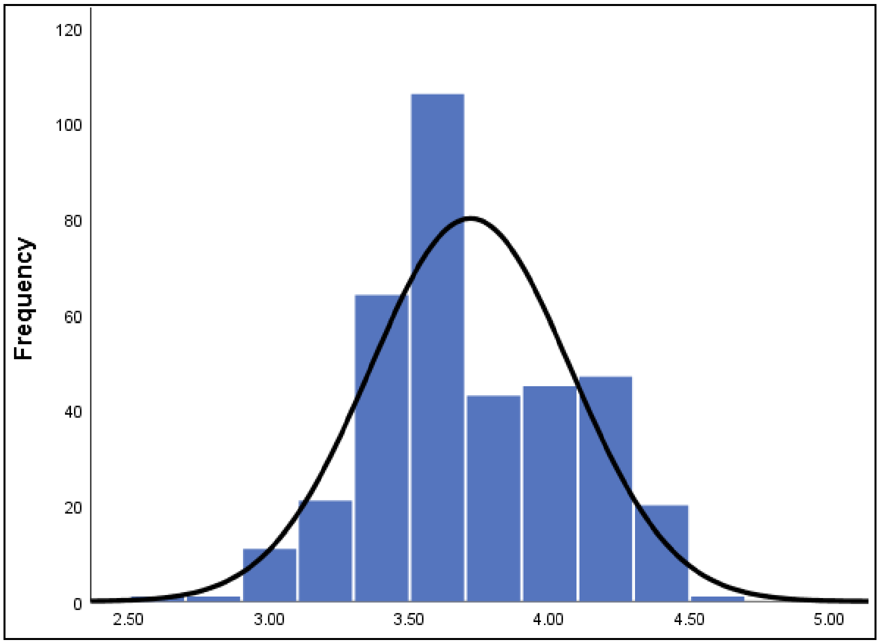
Item	N	Mean	Median	Std.deviation
Access to collectors	360	4.631	5.0	.5968
Stakeholder's communication	360	4.6250	5.0	.5073
Trained extension workers	360	4.589	5.0	.661
Loan repayment	360	2.7194	2.0	1.035
Financial transparency	360	2.02	2.0	.325

Source: Compiled by researcher from SPSS results

The existing value chain of rice in the Edu-Patigi region indicates that respondents had access to local rice collector (M=4.63), and that there was communication among stakeholders (M=4.63). Also, based on the knowledge and trust of the respondents and trust, the extension workers were well trained (M=4.59). This connotes that a vibrant value chain can be developed to improve food security in the region. Although respondents disagreed with loan repayment (M=2.72) due to high interest rate and lack of transparency in granting loans (M=2.02), a value chain model could be developed for rice towards achieving food security in this region. The estimated mean and median values of items are equal which depicts a symmetric distribution of scores, while the standard deviation shows that the responses were dispersed from the mean values, except for loan repayment.

5.3.5.1 Inferential statistics

Figure 5-34: Frequency Distribution for Improved Value Chain Model for Food Security



The mean, median, mode and standard deviation values of the respondents' perceptions of the adaptation of the value chain model influencing the sustainable food supply chain security in the North Central region of Nigeria were 3.71, 3.60, 3.60 and 0.358 respectively. The mean value was higher than the median and mode values, which were equal, thus suggesting that the distribution of the scores is positively skewed. This is consistent with the value of the coefficient of skewness of 0.124, which is positive. The coefficient of Kurtosis was -0.437. The negative Kurtosis is suggestive that the distribution of the scores associated with the respondents' view of the value chain model influencing the sustainable food supply chain security in the North Central region of Nigeria is platykurtic. The range value for this item is 2.00, which is small range value in comparison with the other range values, herein depicting small variability. Compared to the other variables, the respondents' value chain model influencing the sustainable food supply chain security in the North Central region of Nigeria were smaller which was also the same for standard deviation, thus indicating the variability in the values for the respondents' perceptions of this item.

A comparison of the statistics of all the variables indicates that the coefficients of variation were 10.81% for driving and restraining forces influencing the rice supply chain in the North central region of Nigeria,, 6.85% for activities of stakeholders and their resources that improved food security, 7.21%, for activities of stakeholders and their resources that improved food security on the underlying triple bottom line, 7.08% for sustainable supply chain management policy practices mitigate the food security risks and uncertainty, and for 9.65% the factors influencing the sustainable food supply chain security in the North Central region of Nigeria respectively. The implication is that the values for respondents' perceptions of the value chain model influencing the sustainable food supply chain security in the North Central region of Nigeria were dispersed. Nevertheless, the computed values of the coefficients of variations are suggestive that the data was generally not too dispersed from its respective means, thus indicating that the respondent's perception of the items had some reasonable degree of reliability. This outcome is without prejudice to the reliability of the instrument.

Table 5-29: Inferential test for Research Objective five

Parameter	N	Mean	Std.Dev	Std. Error Mean
Value_chain_model_sscm	360	3.7172	.35879	.01891

Table 5-30: Inferential Test (t calculated and p values) Research Objective five

	Test value = 3.5					
	T	Df	Sig. (2-tailed)	Mean difference	95% confidence interval of the difference	
					Lower	Upper
Value_chain_model_sscm	11.487	359	.000	.21722	.1800	.2544

An examination of respondents' perceptions of the factors influencing the sustainable food supply chain security in the North Central region of Nigeria revealed that the mean score associated with the respondents' perception was 3.717 with a standard deviation of 0.359 and a standard error mean of 0.014 (See Table 5-32). Against a test value of 3.5, this resulted in a mean difference of 0.217. A one sample t-test for significance of respondents' perception of these yielded a computed t statistic of 11.49 and a significant p value ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-33). Thus, rejects the null hypothesis that the factors influencing the sustainable food supply chain security in the North Central region of Nigeria are not significant. The implication is to infer that, at the 99% confidence level, that the factors influencing the sustainable food supply chain security in the North Central region of Nigeria are significant.

5.3.5.2 Qualitative analysis

Improved Rice Value Chain

For the theme of 'improved rice value chain', responses were collated from the three categories of stakeholders, and questions were designed to provide strategies for instituting a rice value chain model that can adopt sustainable supply chain management towards food security. Furthermore, this theme is linked to other themes such as stakeholders' activities, stakeholders' relationships, stakeholders' resources, and interaction with extension office. To aid in representing this linkage, the following nodes are collated across the stated codes

Table 5-31: List of Codes Generated for Improved Rice Value Chain

Code	coverage
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Governmental Intervention	1.07
Codes\\Food security drive\Transparency in resource allocation	0.61
Codes\\Interaction with extension office\Stakeholder's activity	0.71
Codes\\Stakeholders resources\Linked with (Activity of Stakeholder)	0.91
Codes\\Supply chain\Relationship with ADP extension workers	1.22
Codes\\sustainable resource utilization\Access to equipment and tools	1.63
Codes\\Sustainable sourcing\Quality of input	1.22
Codes\\Stakeholders relationship\Stakeholder Relationship Perception\Relationship Stance\Good Relationship	0.51

Source: Emerged from Nvivo analysis

Government intervention was a recurring child node that came up through the interactions with the respondents, weighing high (1.07%) in the theme stakeholders' activities. This validates the importance of the government to have an improved rice supply chain and aligns with several respondents' responses across the three categories of stakeholders; one of such comment was that *"Government should subsidize inputs for us so that we can improve our production capacity"* by **RIFAN-LSF 1.** This is similar to the response by **RIFAN-SSF 2,** who said that *"Government should train me in new technological way of farming."* Likewise, **ADP extension worker 2** mentioned that *"Nigeria can be self-sufficient in rice production and supply without importation by government assistance and support the farmers with farming input."*

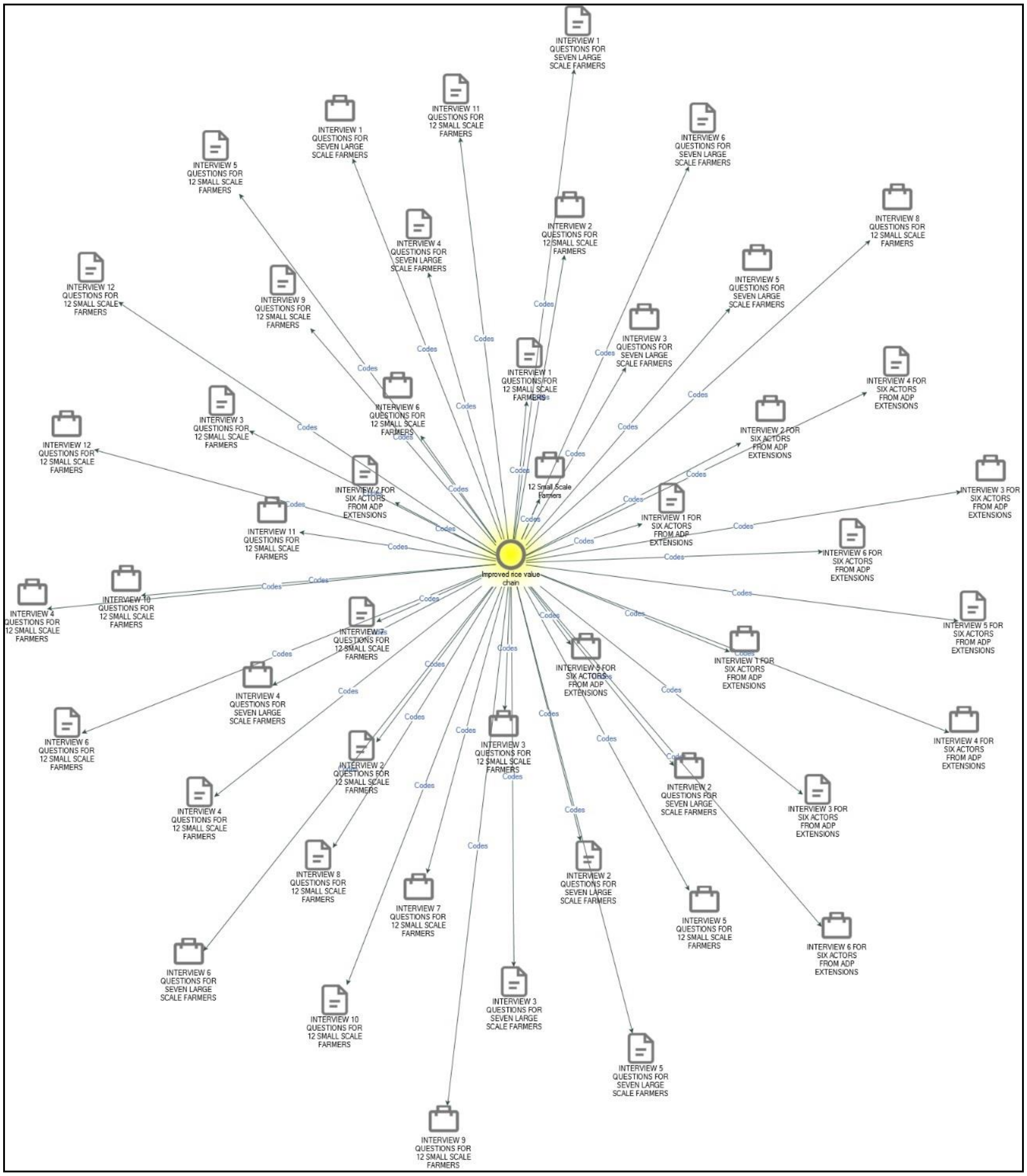
Participants identified government interventions in the form of subsidies on inputs, access to loans and credits, and training and technological development as enablers in improving the value chain. However, the absence of the supply of inputs, grading systems, ethical standards and policies on rice production and importation have negatively impacted the supply chain of rice; these are interventions by the government as a stakeholder that can improve the rice value chain.

The drive for sustainable supply chain management for rice requires that the government, as a stakeholder in the rice value chain empower the ADP extension workers (1.22% - the child node of 'relationship with ADP extension workers') who are also stakeholders in this to interact with the RIFAN members towards ensuring resource allocation and utilization. An improved rice value chain will depend on transparency in resource allocation, which will drive quality towards sustainable sourcing (1.22%). Comments from ADP extension workers demonstrated that RIFAN members have a good perception of them, and they are well accepted as they engage in their farming activities. This is seen from comments made by **ADP extension worker 3** who stated, *"I visit the rice farmers two times a month to train them, supervise their activities and give them technical advice."* This shows that a level of trust and commitment which are requirement for developing a sustainable supply chain has been developed by both categories of stakeholders towards one another. This can be leveraged to ensure that RIFAN members accept the introduction of sustainable practices across the value chain of rice.

Also, RIFAN members mentioned that they interact more amongst themselves through regular meetings, as well as and with local rice collectors and marketers of inputs; this implies that this platform can the enable flow of information among these categories of stakeholders. Furthermore, a medium for sustainable sourcing through quality assurance can be instituted. This could activate the 'return' dimension of the SCOR model.

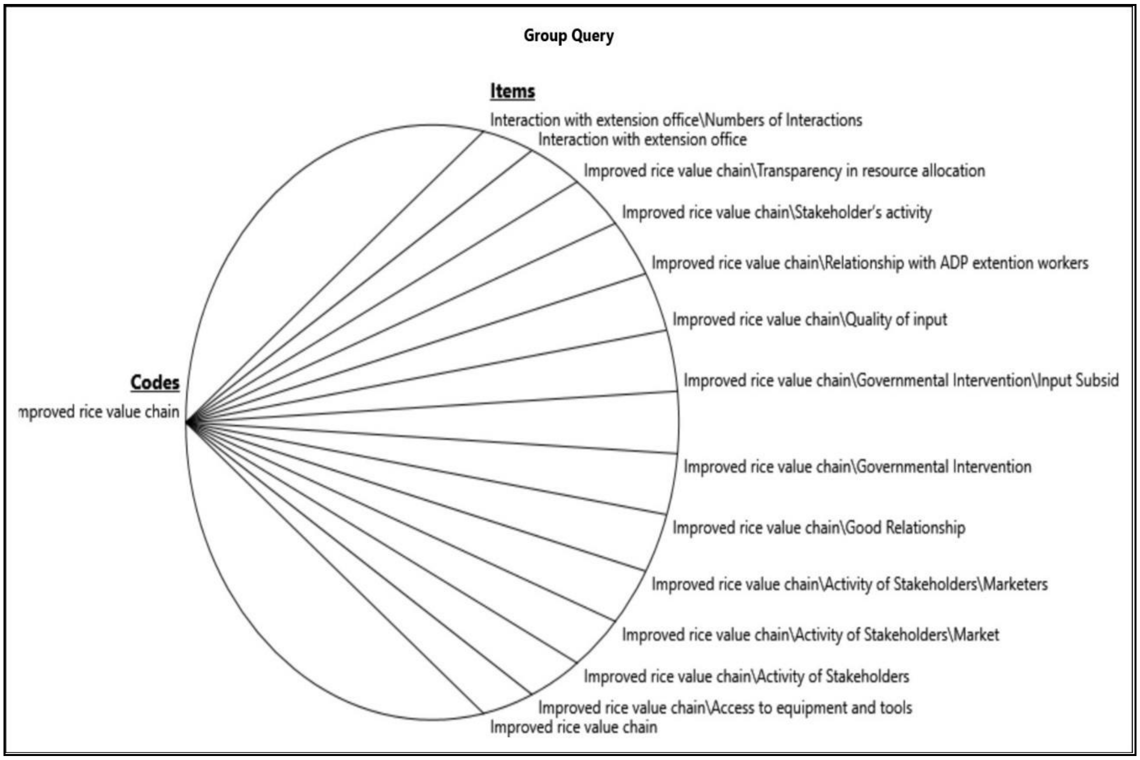
RIFAN members indicated their interest and willingness in adopting new techniques and technology in enhancing their production; this connotes a need for investment in equipment and infrastructure by the government. This support activity within the rice value chain will build a sustainable supply chain for rice in this region.

Figure 5-35: Diagram Exploring the Theme of Improved Rice Value



Source: Emerged from Nvivo analysis

Figure 5-36: Nodes for the Theme Improved Rice Value Chain (Nvivo 12 generated)



Source: Emerged from Nvivo analysis

5.4 Multivariate Analysis

This study performed regression and hierarchical regression analysis using a 6-point Likert-type scale from the survey research instrument items, with rice value chain as the dependent variable and two subjective items (sustainable supply chain management and competitive performance) as the independent variables. Respondents were asked to choose the degree to which they agreed with each statement with a scale which ranged from 1=strongly disagree to 6=strongly agree. The findings implied that the rice value chain (RSV) is dependent on sustainable supply chain management and competitive performance of rice.

Pearson correlation analysis was performed, and it showed a significant relationship between the variables. It also examined the variance in the RVC as explained by each of the independent variables by using the hierarchical regression method.

5.4.1- Response to Research Question 3

H_{03}: Sustainable supply chain management (SSCM) will not influence the competitive performance (CP) of rice value chain network

H_{a3}: Sustainable supply chain management (SSCM) will influence the competitive performance (CP) of rice value chain network

Table 5-32: Descriptive Statistics

	Mean	Std.dev	N
RVC	3.6038	.29276	360
SSCM	3.9131	.24693	360
CP	3.5229	.42738	360

Source: Field Survey Result (2022)

Table 5-33: Correlation Coefficient Matrix of Rice Value Chain, Supply Chain Management and Competitive Performance

Correlations		RVC	SSCM	CP
Pearson correlations	RVC	1.000	0.536	0.170
	SSCM	0.536	1.000	0.232
	CP	0.170	0.232	1.000
Sig. (1-tailed)	RVC	.	.000	.001
	SSCM	.000	.	.000
	CP	.001	.000	.
N	RVC	360	360	360
	SSCM	360	360	360
	CP	360	360	360

Source: Field Survey Result (2022)

Table 5-34: Correlation Analysis for Rice Value Chain, Supply Chain Management and Competitive Performance

Variables measured again RVC	Pearson Correlation ®	Sig. Value	Level of Sig.	Remark
SSCM	0.536^{**}	0.000	$P<0.01$	Significant and positive relationship
CP	0.170^{**}	0.001	$P<0.01$	Significant and positive relationship

** Correlation is significant at the 0.01 level (2-tailed)
Source: field survey (2022)

Table 5-34 depicts the existing relationship between rice value chain, supply chain management and competitive performance. From the simple correlation analysis displayed above, it was noticed that significant correlations exist among each of the variable (items). This implies that there is a significant relationship between rice value chain, sustainable supply chain management and competitive performance with a correlation coefficient of 0.536 and 0.170 at 0.000 and 0.001 levels of significance, respectively. This, thus, indicates that a significant relationship exists between rice value chain, sustainable supply chain management and competitive performance. Therefore, the study suggests that the null hypothesis should be rejected thus, indicating that Sustainable supply chain management (SSCM) has significant influence on the competitive performance (CP) of rice value chain network should be accepted.

Table 5-35: Model Summary

Model summary									
					Change statistics				
Model	R	R Square	Adjusted R square	Std. Error of the estimate	R square change	F change	df1	df2	Sig. F Change
1	.536[a]	.287	.285	.24758	.287	144.000	1	358	.000
2	.538[b]	.289	.285	.24754	.002	1.110	1	357	.293
a. Predictors: (Constant), SSCM									
b. Predictors: (Constance), SSCM, CP									

Source: Field Survey Result (2022)

The summary model provides an explanation of the variance of the dependent variable (RVC) due to the independent variable in a hierarchical manner (SSCM, CP). The coefficient determination (R square) of SSCM shows a value of 0.287, which is 28.7% when expressed in percentage. This shows that 28.7% of the variation in RVC is caused by variations in SSCM in the first model and by SSCM and CP in the second model. Also, the R square change of 0.287, which is 28.7%, was the same as the R square of SSCM which is the parameter which was identified. This implies that it has no effect on the independent parameter (SSCM).

Table 5-36

ANOVA[a]						
	Model	Sum of squares	df	Mean square	F	Sig
1	Regression	8.826	1	8.826	144.000	.000[b]
	Residual	21.943	358	.061		
	Total	30.770	359			
2	Regression	8.894	2	4.447	72.577	.000[c]
	Residual	21.875	357	.061		
	Total	30.770	359			

a. Dependent variable: RVC
b. Predictors: (Constance), SSCM
c. Predictors: (Constance), SSCM, CP
Source: Field Survey Result (2022)

Interpretation of results: The ANOVA table depicts that the F value of model 1 was 144.000 at a .000[b] significance level. The results of the F test indicate that the linear regression model is a good fit to the data.

Table 5-37

Coefficients[a]								
	Model	Understand coefficients		Standardized coefficient			Collinearity statistics	
		B	Std.error	Beta	T	Sig.	Tolerance	VIF
1	(constant)	1.119	.207		5.393	.000		
	SSCM	.635	.053	.536	12.000	.000	1.000	1.000
2	(Constant)	1.054	.216		4.874	.000		
	SSCM	.622	.054	.524	11.430	.000	.946	1.057
	CP	.033	.031	.048	1.054	.293	.946	1.057

a.Dependent variable: RVC
Source: Field Survey Result (2022)

The coefficient table reveals the statistically significant contribution displayed in the simple model showing the degree to which the variables used in the model are related to the response (dependent) variable as seen in the significant column in the table and checking to identify multicollinearity in the model.

From the results in the table, it can be deduced that there is a statistically significant relationship between sustainable supply chain management and competitive performance; where two models; were generated and inserted differently as additional variables.

The model shows that SSCM has a coefficient of 0.536, which means that a unit increase in RVC will cause a 53.6% increase in RVC while a unit decrease in SSCM will cause a 53.6% decrease in RVC the calculated t statistic of 12 and the associated significant probability ($P < 0.01$) indicate a statistically significant relationship between SSCM and RVC.

The result of model 2 with the with SSCM and competitive performance as the predictors shows that only SSCM had a statistically significant relationship with RVC while CP does not have a statistically significant relationship, based on the p-values. In this model, the coefficients of SSCM and CP are 0.622 and 0.033 *respectively*. These indicate that a unit change in SSCM will cause a 62.2% variation in RVC while a unit change in CP will cause a 3.3% change in RVC. The calculated t statistic and the associated significant probability are 11.43 ($p < 0.01$) and 1.054 1.054 1.054(0.293) for SSCM and CP respectively. Thus, we reject the null hypothesis of no significant relationship between SSCM and RVC, but we do not reject the null hypothesis that there is no significant relationship between CP and RVC. Thus, while there is a significant relationship between SSCM and RVC, there is no statistically significant relationship between CP and RVC. This implies that the mediation of the relationship between SSCM and RVC with CP is not significant.

Table 5-38: Summary of research hypothesis and result of test

Null hypothesis	Result status
H_{a1}: Sustainable supply chain management (SSCM) will influence the competitive performance (CP) of rice value chain network	Accept

5.4.1.1 Regression Analysis

Problem

To examine the extent to which sustainable supply chain management influences the competitive performance of rice value chain network.

Hypothesis

H_1: There is a significant impact of sustainable supply chain management on competitive performance of rice value chain network.

Table 5-39

Hypothesis	Regression Weights	Beta Coefficient	R^2	F	p-value	Hypothesis Supported
H_1	SSCM ⟶ CP	.244	.103	41.114	0.001	Yes

Note *p < 0.05. CP: Competitive performance of rice value chain network, SSCM: Sustainable supply chain management

Table 5-40

Variable Entered/ Removed[a]			
Model	Variable entered	Variable removed	Method
1	SSCM[b]		enter

a. dependent variable: CP
b. all requested variables entered.

Table 5-41: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.321[a]	.103	.101	3.44289

Predictors: (Constant), SSCM

Table 5-42

ANOVA[a]						
	Model	Sum of squares	df	Mean square	F	Sig
1	Regression	487.347	1	487.347	41.114	<.001[b]
	Residual	4243.542	358	11.853		
	Total	4730.889	359			

a. Dependent variable: CP
b. Predictors: (Constance), SSCM
Source: Field Survey Result (2022)

Table 5-43

Coefficients[a]						
	Model	Understand coefficients		Standardized coefficient		
		B	Std.error	Beta	T	Sig.
1	(constant)	11.882	2.529		4.698	<.001
	SSCM	.244	.038	.321	6.412	<.001

The hypothesis tests if there is any significant relationship between sustainable supply chain management and competitive performance of rice value chain (RVC) network. The dependent variable CP was regressed on SSCM to test the hypothesis H_1. The results indicate a statistically significant relationship between SSCM and CP, with the calculated t and associated significant probability of 6.412 ($p < 0.01$), the null hypothesis of no significant relationship is rejected, thus indicating that there is a statistically significant relationship between SSCM and CP. The calculated F (1, 358) of 41.114, $p < 0.001$, which indicates that the overall significance of the model is good. The $R^2 = .103$ depicts that 10.3% of the variation in CP is explained by variations in SSCM. Table 5-41 shows the summary of the findings.

5.5 Multi-criteria Decision Making (MCDM) Fuzzy- Analytical Hierarchy Process (F-AHP)

Responses from the questionnaires administered to and collected from RIFAN members were adopted for the MCDM F-AHP approach used in this study. Twenty-one items which focused on decision making activities of the stakeholders, were extracted from the responses. A weighting was assigned using the 6-point Likert rating scale, which ranged from 1 (strongly disagree) to 6 (strongly agree). Appendix 36 displays the assessment, standard values and corresponding fuzzy number with inverse values for the respondents. The corresponding assessment using the Satty scale and triangular fuzzy scale is shown in appendix 37 while the average weight criterion (Mi) and normalized weight criterion of each of the assessments are displayed in Appendix 38. Appendices 39 to 53 show the corresponding assessments of the environmental, economic, and social criteria for each of the five respondents.

The three level Decision Hierarchy for Choice for Sustainable Supply Chain of Rice is displayed in figure 5-36. While the fuzzy-AHP MCDM model presented the weights and rankings from the responses obtained from RIFAN members, where a consistency ratio below 0.1 was deemed acceptable.

Table 5-44: Overall Rating of the Environmental Criteria for the Five Respondents

Criterion	Weight	Rank
Water Usage	0.349	1
Land usage	0.168	2
Weed management	0.128	4
Processing method	0.140	3
Power usage	0.055	6
Grain wastage	0.049	7
Seed selection	0.082	5

Table 5-44 presents the results for the environmental dimension. From this result, water usage had a weight of 0.349, which will not be accepted.

The weight for decisions on land usage and processing methods will be accepted. Land usage, which weighed 0.168, was measured by how often land was treated after each harvest; the response indicates that this sustainable practice was well embraced. The processing method measures the kind of method adopted in processing the output. The result was 0.140 which implies that RIFAN members still adopted manual farming and processing method and not more advanced technologies in the production process. Weed management which weighed 0.128, was ranked fourth, which implying that the decisions on usage of chemicals as mentioned by SRP, were applicable.

Chemicals such as NPK were used to manage weed although the recommended proportion is not measured in this research. Power usage and seed selection weighed 0.082 and 0.055 respectively; these values are < 0.1, which indicates that low attention was given to decisions on the choice of seedlings and power usage. RIFAN members indicate that they use fuel because there was no good supply of electricity. The weight of seed selection implies that members got seeds from unverified suppliers, such seedlings in turn affected productivity and the poor quality of the grains.

Table 5-45: Overall rating of the Economic Criteria for the Five Respondents

Criterion	Weight	Rank
Supplier diversity	0.349	1
Transparency	0.028	7
Quality input	0.102	5
Loan repayment	0.049	6
Adoption of new technology	0.21	2
Financial decisions	0.108	4
Profitability	0.129	3

Results for the economic dimension are presented in Table 5.45. Considering the acceptable weights of <0.1, supplier diversity and adoption of new technology with weights of 0.349 and 0.21, respectively, will therefore not be accepted. This implies that the rice farmers have diverse suppliers of input. This is not healthy as these suppliers are not regulated. This criterion was linked to quality inputs which weighed 0.129. According to Arouna et al., (2021, p. 6), a structure was developed to ensure seedlings and fertilizers were rightly sourced; this was aimed at improving productivity and ensuring traceability within the supply chain of rice. The weight for the adoption of new technology implies the willingness of the rice farmers to adopt this towards improving their productivity and profitability. Profitability ranked third with a weight of 0.129; the RIFAN members indicated that they made enough profit to employ more people. This criterion is linked to the job creation criterion of the social dimension with a weight 0.247. Job creation is a social development sub-dimension of the social dimension of sustainability. Although the cost incurred on labour negatively impacted the profitability, the rice farmers still employed more labour especially because of the manual method of rice farming and processing. According to SRP an estimate of the profit was calculated from the rice produced. Farmers should be taught record keeping of sales and expenditure with the aim of improving their profitability.

Decisions on finances ranked fourth; this criterion denotes the cost incurred on input, labour, equipment and transport; it also includes the decision to get loans and credit. Its weights were 0.108, which implies that it is germane to the productivity of the rice farmers. SRP described productivity based on grain yield and labour. The productivity of grain yield gives the estimated productivity of grain harvested without the adjustment to the moisture content. With this understanding a farmer is aware of the difference in the harvest in various seasons and can compare them. Meanwhile, labour productivity gives an estimate of a farmer's productivity, which is a function of the number of people involved in cropping on a field at a given time. The farmer is able to understand that the application of various management practices contributes to the quantity of grain that the labour of each person produces.

Loan repayment and transparency weighed <0.1, which is an indication that decision-making about both is low or not prioritized. Loan repayment weighed 0.049; this corroborates with Ayuba et al., (2020, p. 45), who mentioned that the RIFAN members in that region scheme their way out of repaying loans obtained through the Anchor Borrower Scheme. Transparency, weighed 0.028, which is the lowest amongst the criteria; this implies that there are no measures in place to check corruptible practices across the existing value chain. This is also linked with the quality assurance criterion of the social dimension which verifies that ADP extension workers check the grains before passing them on to the market. The criteria weighed 0.063 which is <1, this is an indication that such decisions were not prioritized.

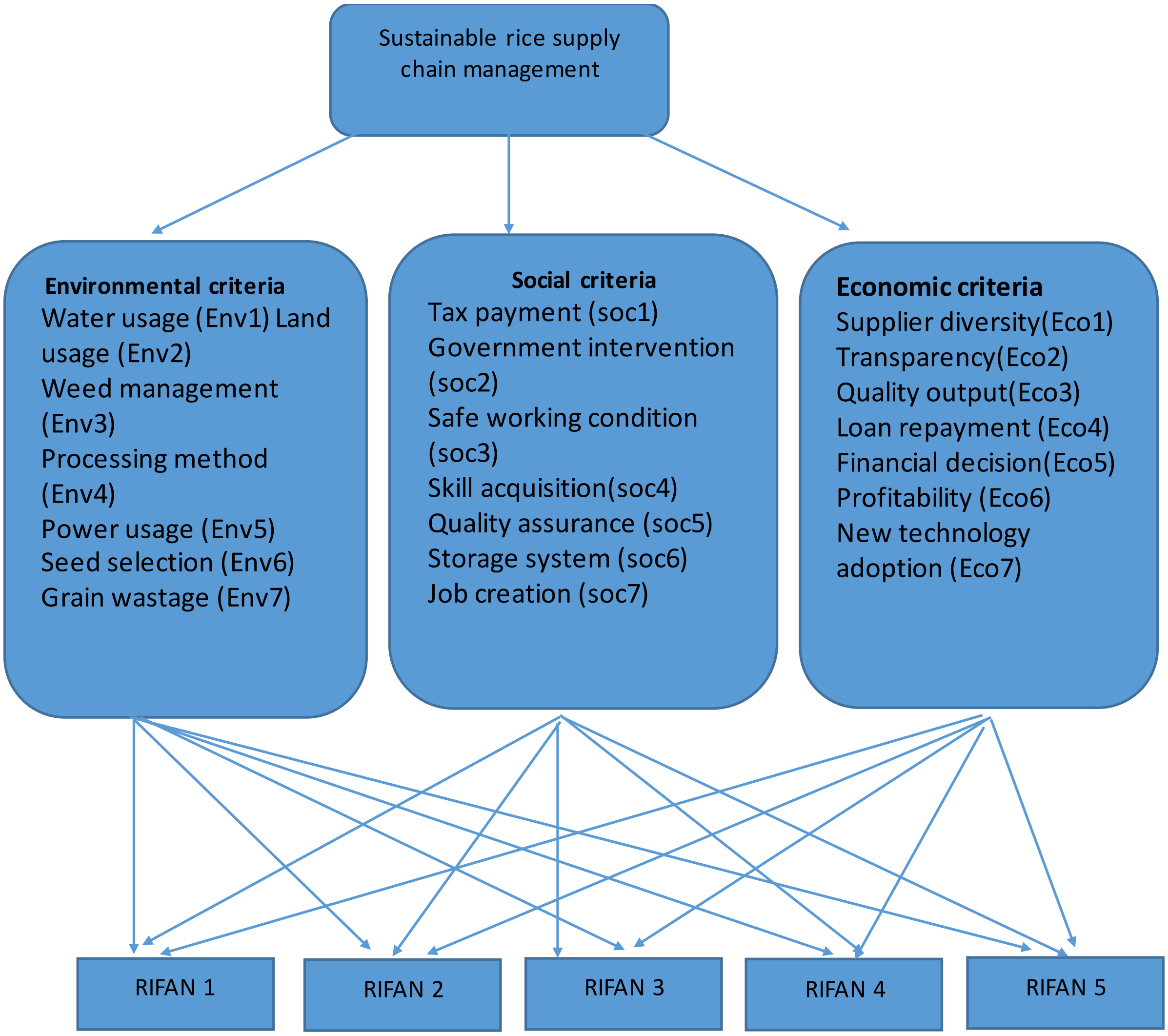
Table 5-46: Overall rating of the Social Criteria for the Five Respondents

Criterion	Weight	Rank
Quality assurance	0.063	6
Storage system	0.129	3
Job creation	0.247	2
Skill acquisition decision	0.115	4
Safe working environment	0.323	1
Government intervention	0.057	7
Tax payment	0.067	5

Table 5-46 displays the results from the social dimension. With the acceptance weight of >1, safe working environment and job creation weighed 0.323 and 0.247, respectively. This denotes that RIFAN members within the regions prioritized safe working conditions especially insofar as attacks from Fulani herds men. The manual processing methods requires more labour, which led to an increase in labour demand and jobs created within the community. Storage system weighed 0.129, as RIFAN members indicated that this was not available within these regions; as such, no measures had been taken towards building silos in the drive for food security. Skills acquisition decision weighed 0.115, which implies a level of willingness by the RIFAN members to improve their skills if provided with the opportunity.

Tax payment, quality assurance and government intervention weighed <0.1; this is an indication that they were not prioritized decisions for the respondents while there were no platforms to enable tax payment and quality assurance. Quality assurance should be a means of checking produce for colour, stones and brokenness. A good platform for quality assurance would aid the competitiveness of rice from those regions on the international market. Government intervention weighed 0.057 which implies that there were no policies guiding the activities of the RIFAN members across the rice value chain.

Figure 5-37: A three level Decision Hierarchy for Choice for Sustainable Supply Chain of Rice



Source: Author

5.6 Section C

In this section, the qualitative and quantitative data analysis is further compared for methodological triangulation

5.6.1 Comparison of Qualitative and Quantitative Data Analysis (Methodological Triangulation)

From the qualitative data and quantitative data collected, certain areas of triangulation were discovered.

5.6.1.1 The Effects of the Driving and Restraining Forces Influencing the Rice Supply Chain in the North Central Region of Nigeria.

The effects of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria were explored by Research Question One and supported by the outcome of the qualitative analysis. Restraining forces such as high cost of labour, and equipment, use of old rice farming techniques, poor funding, and pest invasion, were forces identified. To improve the rice supply chain, driving forces such as the adoption of technology and new rice farming techniques were proposed. Also training on farm management skills such as book-keeping, use of equipment, improvement in literacy level of RIFAN members and reduction in labour cost, will aid the rice supply chain. Government intervention was seen as a major influence on the rice supply chain. This could be through policy on rice production, subsidies for rice farmers, and provision of large farming equipment such as planters, harvester and tractors. Furthermore, subsidies on inputs such as seedlings and fertilisers, and access to loans for an enlarged capacity can positively influence the rice supply chain. The quantitative analysis indicated that the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria are significant (see Table 5-3, Table 5-4, 5-5, and 5-6).

5.6.1.2 How the Activities, Decisions of Stakeholders and Their Resources Improve Food Security on the Underlying Triple Bottom Line.

Research Question Two investigated how the activities, resources and decisions related to TBL can improve food security. With the outcome of the qualitative analysis, the activities of stakeholders were identified using the SCOR model, and the available resources were checked for alignment with the TBL dimension. Training, visits and monitoring provided by the ADP extension officers were identified as a stakeholder's activity that can improve food security. Government as a stakeholder could improve food security through interventions using financial resources, and the provision of equipment through the extension office. Using quantitative data for the fuzzy AHP MCDM model, the decision-making of stakeholders was weighed against the TBL; the outcome indicated that the adoption of and prioritisation of TBL practices in the decision making of stakeholders would improve food security. The quantitative analysis indicated that the activities of stakeholders and their resources significantly improved the food security aspect of the underlying triple bottom line in the North central region of Nigeria (see Table 5-10, Table 5-11, Table 5-12, Table 5-13, and Table 5-14).

5.6.1.3 Influence of Sustainable Supply Chain Management on the Competitive Performance of Rice Value Chain Network.

Research Question Three was developed to identify the influence of sustainable supply chain management on the competitive performance of the rice value chain network. The outcome from the qualitative analysis showed that the major competitor of the rice value chain network was the international market. It also identified that sustainable supply chain management would influence the competitive performance of rice. Factors such as ethical standards, quality assurance platforms and regulatory practices for RIFAN members and rice farmers would improve the competitive performance of rice value chain network. The outcome of the hierarchical regression revealed that sustainable supply chain management (SSCM) would influence the competitive performance (CP) of rice value chain network (see Table 5-33, Table 5-39). The quantitative analysis further indicated that sustainable supply chain management significantly influenced the competitive performance of the rice value chain network. (see Table 5.34, Table 5-39, Table 5-40).

5.6.1.4 Strategic Role of Sustainable Supply Chain Management Policy Practices to Mitigate the Food Security Risks and Uncertainty.

Research Question Four was developed to investigate strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty. The results of the qualitative analysis showed that adoption of sustainable practices would improve food security. Factors such as sustainable sourcing, sustainable resource utilisation, transparency in resource allocation, monitoring and evaluation, silos, and focus on employee welfare and security would all mitigate the food security risk, and uncertainty. However, the quantitative analysis indicates that sustainable supply chain management policy practices did not significantly mitigate the food security risks and uncertainty (see Tables 5-24, Table 5-25, and Table 5-26).

5.6.1.5 Value Chain Model Influencing the Sustainable Food Supply Chain Security in the North Central Region of Nigeria.

Research Question Five was developed to check the influence of the value chain model on the sustainable supply chain and food security in the North Central region of Nigeria. The outcome from the qualitative data identified that factors of the value chain model, such as stakeholder relationships which can be built on existing communication structure among stakeholders, as well as transparency and communication among stakeholders, influenced the sustainable food supply chain towards food security in the North Central region of Nigeria. The quantitative analysis also showed that the factors considered in the value chain model which influenced the sustainable food supply chain security in the North Central region of Nigeria were significant.

5.7 Summary of Chapter

The focus of this chapter was on the analysis and presentation of the qualitative data collected through semi-structured interviews, and the quantitative data collected through a structured questionnaire. Nvivo and thematic analysis were adopted for identifying themes and getting meanings from unstructured data in line with the research questions. Quantitative data was analysed using descriptive statistics, and further presented using bar charts and pie charts. Inferential statistics was used to test the research questions and hierarchical regression was used for Research Question Three. The fuzzy AHP-MCDM approach was also used for research question two. Methodological triangulation was carried out by comparing the outcomes of the qualitative data with those of the quantitative data.

The results showed that the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria were significant. Also, the activities of stakeholders and their resources improved the food security aspect of the underlying triple bottom line in the North Central region of Nigeria. Data analysis further revealed that sustainable supply chain management significantly influenced the competitive performance of the rice value chain network, and that the factors considered in the value chain model significantly influenced the sustainable food supply chain security in the North Central region of Nigeria are significant. While the qualitative analysis showed that sustainable supply chain management policy practices did indeed significantly mitigate the food security risks and uncertainty, however, the quantitative analysis indicated that these practices did not significantly mitigate the food security risks and uncertainty.

In the next chapter, the findings from the study will be discussed in-depth.

CHAPTER 6

DISCUSSION OF RESULTS

6.1 INTRODUCTION

This study aimed to develop a model for sustainable supply chain management among rice farmers towards ensuring food security in the North Central region of Nigeria.

To achieve this, there is a need to establish the linkage between the findings from the study, the literature reviewed, and the research objectives. The literature review based on the operationalised constructs and theoretical frameworks aided in the interpretation of the results. The focus of this chapter is on the discussion of the findings as they relate to the data analysis presented in Chapter five of this study. This chapter also provides an explanation of the extent to which the research findings align with the proposed model, which is aimed at the adoption of SSCM for the rice value chain towards a drive towards food security.

This chapter constitutes the empirical research component of the study based on the responses from 384 participants. It is divided into four sections; section one is a discussion on the demographics of the respondents and themes generated from thematic analysis section two focuses on discussion of the results based on each research objective by linking thematic analysis which emerged from the responses from the 24 interview respondents (three categories of stakeholders) with results from the inferential and multivariate analysis; section three discusses the descriptive statistics, finally, section four explains whether the research objectives were achieved and research question answered.

6.2 Section

6.2.1 Quantitative Approach

6.2.1.1 Demographic Statistics of Respondents

Section one of the survey instrument was designed to collect information with respect to the demographic profile of respondents, and to link their activities and experiences as they influence the rice value chain. The activities of respondents were planting of rice, harvesting, preparation of land, processing of paddy, and storage of grains. Five per cent of respondents indicated that they performed four of these activities namely land preparation, rice planting, harvesting and processing of paddy, 76% were involved land preparation, planting of rice, and harvesting, while

19% perform just two of the activities which were ground preparation and planting. Responses from the qualitative data were analyzed by adopting the SCOR model for grouping of the activities of respondents. The gender distribution indicated that the sector was male dominated with 99% male and 1% female, with few of the females being employers, contractors and employee s or apprentices. This corroborates with responses from the qualitative data and analysis, where participants mentioned that the women involved in the rice value chain were responsible for chasing birds.

With regards to the number of years of experience, 67% of respondents indicated that they had over 10 years of experience as stakeholders in the rice value chain, while 53% had between 7-10 years of experience in activities performed there. This could be seen from in the age of the respondents, with 34% over 45 years of age, 50% between 36-45 years of age, and just 16% respondents were between the ages of 18-35. The National Youth Policy (NYP, 2009, p. 6) described youths in the Nigerian contexts as male and female citizens between the age of 18 and 35 years of age who are charactierised by innovativeness, energy, optimism, creativity and ambition. Based on this definition, the youth population who are RIFAN members is smaller than the older. The youths are generally characterized with strength, agility, innovativeness and creativity, and were not well represented among the respondents; this may well have affected the productivity of rice across the region and the adoption of new techniques and technology. An insightful statistic is that 81% of the respondents were owners and 10% were employees. The owners engaged with the activities of partners (8%), contractors (14%), employees (34%), and apprentices (44%). Meanwhile, 51% of the respondents were in Edu while 49% were in Patigi.

This study focused on the adoption of sustainable practices for improving the supply chain of rice in the North Central region of Nigeria towards attaining food security. In view of this, the educational level of respondents indicated that the respondents had the ability to comprehend and adopt sustainable practices. In fact, 68% had above a secondary school leaving certificates, while 27% had a primary school educational level.

6.2.1.2 Responses from stakeholders

Responses from the three categories of stakeholders were further grouped into 13 themes which will be discussed below. The themes are further linked to the research objectives and research questions. A part of the theme Stakeholders' activities and the theme adoption of sustainable supply chain answered research question one. Another part of the Stakeholder's activities and Stakeholder resources focused on research objective two. The themes for research objective three are sustainable resource utilization, sustainable sourcing and rice value chain competitiveness. Themes such as Government intervention, stakeholder's relationship, regulatory activities and food security drive are the themes generated for research objective four. While for research objective five, the themes generated are improved rice value chain which is further linked to the themes on interaction between farmers and extension officers, stakeholder's relationships and the theme on stakeholder's resource.

6.3 Section

6.3.1 Establish the challenges influencing the rice supply chain in the North Central region of Nigeria and establish driving forces for such.

To this end, the restraining and driving forces of this objective needed to be identified.

The results of the statistical analysis that emerged from the descriptive analysis depicted that a certain percentage of respondents agreed that poor pricing (M=4.85) followed using old farming techniques (M=4.5), both had median values of 5.0; this confirmed that the central points were the most significant restraining forces influencing the rice value chain. Poor pricing was due non-existence of a general fixed pricing or grading system for produce, which was common among other farmers. As a driving force, respondents were asked about the willingness to adopt new techniques (M=5.48) and new technology (M=5.31); these ranked the highest insofar as the driving forces, as well as above the first two restraining forces. Results about the restraining forces further indicated that the loss of output to pests and rodents (M=3.11) was ranked third. This was confirmed by the responses from the qualitative data collected and analysed, where participants identified bird chasing/ scaring as an important activity within the rice value chain. The fourth and fifth restraining forces were existing rice policies (M=2.5) and stability of policies (M=2.53) for the rice value chain. Respondents disagreed that they knew of such policies, indicating that there were no existing policies to improve rice value chain. This response aligned with the responses of the participants from the interviews. Aside from poor pricing, respondents opined that the pricing system (M=2.25) was distorted, especially since there was no monitoring body; therefore, respondents sold their produce at any price to big buyers or local rice collectors. Poor pricing and no centralised pricing system affected the profitability of respondents.

The availability of technological equipment (M=2.1) and its adoption ranked third lowest. Despite the importance of technology for improving productivity, respondents seemed happy with the manual system of rice production, especially since such technological equipment was not available. However, when looking at the adoption of new technology and techniques as a driving force for the rice supply chain, respondents agreed that training sessions organised by the government (M=4.71) and skills development sessions (M=4.39) could aid the level of productivity and improve the rice value chain. This could be facilitated by the ADP extension workers, especially since responses from the participants of the interviews mentioned that they had good relationship with the formers. Also, responses from the interviews with the ADP extension workers showed that monitoring the RIFAN members was a part of their activities; it was also evident that they had the willingness to improve in their knowledge, which would thereafter be passed onto the RIFAN members. Respondents disagreed that there was good transport system (M=1.99), that is, the road infrastructure which linked the farms to the market was bad. Also, respondents disagreed that there was the existence of storage facilities (M=1.93) for excess rice grains.

Respondents agreed that transparency among stakeholders (M=4.36) was a driving force that could improve the supply chain of rice. Stakeholders across the value chain of rice included the government, input suppliers, buyers (local rice collectors), input manufacturers, financial institutions, technology providers, RIFAN members, and ADP extension workers. Transparency among these stakeholders would improve the quality of inputs (M=1.06) provided by manufacturers and suppliers. Also, it would help to monitor the access to these inputs (M=3.74) and the allocation of resources (M=2.82) such as loans, grants and other equipment. Transparency among stakeholders would further influence the pricing system of output through regulatory practices, to improve the profitability of rice for RIFAN members.

The themes generated from the interview via thematic analysis in relation to this research objective one are:

Stakeholders' Activities

This theme was aimed at understanding the activities in the rice value chain and the linkages between the stakeholders as the activities of each stakeholder across it rice can influence their costs or profits (Soullier et al., 2020, p. 4). The report by GAIN (2019, p. 11) found that there may be different types of rice value chains, because each stakeholder may choose to add value at different stages, for instance some may add value at the storage, transportation, and packaging stage, or even in the choice of variety to plant. Tinh, et al, (2020, p. 385) identified the activities of rice processors as de-husking, removal of rice bran and polishing; small-scale processors only deal with rice consumed daily while the medium and large-scale ones deal in the process of de-husking. Meanwhile, Soullier et al, (2020, p. 4) added that some processors may add value by upgrading the quality of rice, through pre-cleaning, drying, stone-picking, cleaning, weighing, hulling, separating, whitening, grading and bagging. Understanding these activities is aimed at identifying the challenges or restraining forces across the rice value chain and the driving forces that can improve the activities of stakeholders across the rice value chain.

Table 6-1: Environmental and Social Dimension of Activities of Stakeholder

Node	Child nodes	Grandchild nodes
TBL-1 Environment (node) (ENV)	Natural resources (ENV -1)	FADAMA land selection, application of 2,4-D, application of NPK fertilizer, land preparation and selection of nursery, bund creation to control water, application of chemical and pesticides
	Green processing, packaging and transport (ENV-3)	monitoring and inspection by ADP, waste caused by birds and rodents, transportation
TBL – 3 Social (node) (SOC)	Social development (SOC-2)	health and safety of workers e.g. training on use of pesticides

Source: Author

The environmental and social dimension of the TBL identifies and relates to the activities of the stakeholders across the rice value chain, to verify the adoption of sustainable practices. Part of the activities of the ADP extension worker, according to SRP, should be the assessment of soil and the efficient use of the NPK fertilizer and the 2,4-D chemical. None of the participants mentioned this, yet all of the respondents mentioned the application of the NPK fertilizer and 2,4-D chemical. NPK stands for Nitrogen, Phosphorus, and Potassium, and it is used to improve soil fertility, in this case, to increase the quantity of rice produced (Sadimantara, et al., 2022, p.1). Sustainable Rice Platform (SRP, 2020, p. 5) recommends efficiency in the usage of these nutrients to avoid the release of excessive nitrogen into the environment. Nitrogen is a required fertilizer in rice production, but uncontrolled usage can cause global warming, depletion of fossil, acidification, and air pollution (Tayefeh, et al, 2018, p. 1). Sadimantara, et al, (2022, p. 1) recommend the application of organic fertilizer, such as manure from animals and other residue from plant litter alongside this inorganic fertilizer, to reduce the harm.

This is relevant in discussing the environmental dimension of the triple bottom line which encourages green processing. The SRP is of the view that efficiency in the use of NPK is measured by the grain yield per unit of nitrogen input. Where the value >1, this means there is an efficient use of N and improved grain yield. If A < value, this means there is possible release of excess N into the environment, and the productivity of the P fertilizer applied compared to the amount of grain yield. Where P-fertilizer is the phosphorus use efficiency which is measured by grain yield per unit and an overtime increase in the soil is desirable. The Responses of the extension workers implied that they were not involved in the activities of the rice farmers, yet there was no mention of monitoring the application of the required amount of 2,4-D, and glyphosate chemicals, which are used for weed management. This could be due to the lack of information and knowledge about sustainable practices that can be adopted to improve rice production. This denotes that to efficiently introduce sustainable practices across the value chain of rice, the extension workers who interact with the rice farmers and can break down the requirements for the latter should receive orientation about sustainable practices that can be employed in rice farming to develop a working supply chain management for rice.

Further responses from ADP extension workers indicated that the output of rice farmers was not monitored. Tansay, et al., (2021, p. 3) agreed with the use of 2,4-D and glyphosate chemical although their excessive application in rice paddy fields can negatively impact the environment and affect the growth of rice as well as the primary producers. This indicates that the adoption of sustainable practices is absent in this area, and there is a need to introduce these in developing the supply chain management of rice towards improving food security in this region.

Another activity is the construction of rice beds to control the flow of water. This activity ensures the efficient use of water for preparing the land for and preventing soil erosion and is indicated as a sustainable practice that must be adopted towards building sustainable supply chain management in rice production.

In addition, the ‘scaring of birds’ is another major activity worthy of mention as part of the activities across the rice value chain. This activity indicates that rice farmers are faced with the problem of pest invasion which may reduce the productivity and profitability of rice. Rice farmers hire workers who are responsible for scarring birds, through shouting, waving, drumming, or using catapult (Segun, et al., 2018, p. 186) or mobile scarecrow (Roy, et al., 2021, p. 1). Segun et al., (2018, p. 185) added that the Global Rice Science Partnership (GRiSP) mentioned that birds are the second hindrance to rice production in Africa, and 15% of the rice produced all around the globe is lost to pest in which including bird.

Authors such as Chikezie, et al., (2022, p. 254), Roy et al., (2021, p. 1) recommended the adoption of technology; with Chilezie et al., proposing the use of Wireless Sensor Network Technology, which consumes limited energy and can preventing/ control birds and other animals through an automated buzzer activation mechanism. This technology also has the function of irrigating farmland by automation through-out the year, while also applying pesticides for the control and prevention of disease; it further applies fertilizers and other herbicides through automated application for the control and prevention of weeds. Segun et al., (2018, p. 185-187) proposed smart farming, a technologically controlled concept for farming management that allows the optimization and monitoring of the processes involved in agriculture; while Roy et al., (2021, p. 3) proposed the use of Unmanned Aerial Vehicles (UAVs). The adoption of technology will improve the productivity of rice farmers; this is indicated in the SRP as improved livelihood of rice farmers, which is measured in terms of profitability, productivity, and labour productivity.

A common problem mentioned by all the respondents was ‘*cost of labour’*. This is in line with the discussion by Nawaz, et al., (2022, p. 2), who submitted that activities involved in preparing a nursery for transplantation often demanded up to 250-350 hours of manpower per hectare; this equals an increase in labour cost which eventually reduces the profit. Labour productivity is measured by the SRP based on grain yield, which is the estimated productivity of grain harvested without the adjustment to the moisture content. With this understanding the farmer is aware of the differences in the harvests from various seasons and can compare them. Labour productivity provides an estimate of the farmer’s productivity, which is a function of the number of people involved in cropping on the field at a given time. Through the application of various management practices, the farmer is able to understand that productivity can be measured by the quantity of grain that the labour of each person produces.

According to one of the ADP extension workers, "*The production rate of the rice farmers is on the average between 2,000 tons to 5,000 tons yearly across the region"*; this value is yearly the weekly and monthly values could not be provided. This shows a poor record keeping and monitoring system by the ADP extension office. The cost incurred on labour and on sourcing inputs is high while the rice farmers still use the manual method of farming.

Also, the cost of hiring tractors and purchasing tools is high, which in addition to cost of labour, affects the level of profitability. Several of the respondents mentioned that with good machinery and equipment, the level of production would increase. The small-scale rice farmers and some of the large-scale ones still use manual tools, which limits their level of productivity. To increase rice productivity, which positively impacts profitability, some of the respondents proposed "*training on farm management, acquiring skill to improve rice farming and there was a willingness to adopt new technology"*.

The activities of the RIFAN members could improve if the ADP extension workers were well trained. In line with this, responses from some of the ADP extension workers who are also part of the rice value chain proposed "*the need for adopting innovativeness in rice production by the extension office"*. This means that there is a need for the government to invest in training workers with new methods of rice production.

Rodent invasion was a major problem for the rice grown in Vietnam's Makong River Delta, Mishra et al., (2022, p. 8) identified two approaches that solved the problem and increased both the yield and income of the farmers. One was community-based action which involved ensuring hygienic conditions within the community and the second was the community trap barrier systems (CBTS) which required that fences made of plastic be installed and rat traps set around them. These methods are both environmentally and economically sustainable and could be adopted to increase the productivity of the farmers in the Edu and Patigi region.

Adoption of Sustainable Supply Chain

This theme identified the extent to which existing sustainable supply chain practices were employed in their activities and resource utilization. The relevant subthemes from the generated nodes were waste disposal, transportation, employee welfare, social development, available financial resources, job creation, available machinery and available utilized resources. RIFAN members who often generate waste from husking mentioned that *"waste generated are used in poultries and do not constitute pollution in the community*". This is a practice that was adopted within the community, although a more sustainable practice would be to use waste such as straw for renewable energy. About the transportation of produce, respondents mentioned "*the use of vehicle for transportation which runs on fuel"*. For this, fuel consumption will further increase the cost of production. A sustainable supply chain is one that pays attention to the welfare of employees; this was identified in SRP 2020 (p. 8) as a labour condition which ensures that employee be trained in safety instructions and first aid, availability of health services within the community, and safe location.

Responses from the RIFAN members indicated that a few of them still used hoes and cutlasses for farming; an adoption of sustainable practices here would imply that members use modern equipment such as planters, harvesters, tractors, and threshers in the process of producing rice grain. This would improve the productivity and profitability of the RIFAN members. Although job creation was on the increase, the workers did not have access to equipment to enhance their productivity. This is in line with the works of Addison, et al., (2022, p. 1) who mentioned that the agricultural sector in general contributes to 70% of jobs created in rural households in Ghana. For this node, sustainable practices were not adopted, as members and their workers still used a crude method of farming which had not improved their productivity.

Table 6-2: Environment and Economic Dimension of Supply Chain

TBL (node)	Child node	Grandchild node
TBL-1 Environmental (node) (ENV)		
	Resource/ equipment efficiency (ENV-2)	Use of farm equipment such as tractors, willowers, and threshers
	Green processing, packaging and transport (ENV-3)	Monitoring and evaluation of use of resources by ADP extension workers, good storage facility, waste disposal, and management
TBL – 2 Economic (node) (ECO)	Sustainable sourcing (ECO-1)	Increase supplier/ stakeholder diversity, transparency, provision of inputs by government, other sources of inputs, trust and confidentiality among stakeholders
	Supporting supply chain practices (ECO-2)	Development of rice farming skills, introduction of new technology, access to equipment (tractors, threshers, and planters, farm management knowledge / practices
	Social development (SOC-2)	Employment creation, training and development by ADP extension workers
	Regulatory (SOC-3)	Government subsidy on inputs

Source: Author

The resources utilized such as fertilizers and seedlings were sourced by the RIFAN members themselves. This implies that the farmers just purchased what is available from different suppliers without verifying the quality of such inputs. The variety of inputs and fertilizers used affects the output, but this was not taken into consideration by the government and the extension workers. One of the essential aspects of CARD/NRDS is to ensure that seedlings are verified and rice farmers have access to a variety of these seedlings, which will improve their output and its quality (Futakuchi et al., 2021, p. 4) The adoption of sustainable practices in resources utilization will improve productivity, ensure traceability, improve quality of output and ensure the competitiveness of grains on the international market. Also, an improved variety of seedlings and use of equipment will increase productivity through which food security can be ensured. A sustainable supply chain for rice value chain can also be achieved through transparency, trust, and confidentiality among the stakeholders across the value chain of rice, as well as through training and development of ADP extension workers.

The TBL dimension that can be adopted for this theme is as shown in Table 6-2 above

6.3.2 Impact of stakeholders' activities, decision, and resources on improve food security, and the effect of this on the underlying triple bottom line.

The descriptive statistics from Table 5-25-Table 5-27 categorised the activities and resources available to stakeholders across the TBL dimension, which consist of environmental, economic and social. Land preparation (M=4.91) was indicated to be the most practiced activity across the rice value chain, while from the economic dimension, quality input (M=4.81) was ranked the highest, from the social dimension job creation (M=3.81) ranked higher than all the other items in that category. Other activities in the environmental dimension were weed management (M=4.97), water usage (M=4.92), harvesting method (4.86), and drying method (4.81) which ranked higher than other items. This indicates that respondents ranked these activities as being of utmost importance. This prioritization was in line with the responses gathered from the participants in the interviews where the activities of the stakeholders were identified and grouped using SCOR as follows: (a) Plan: land selection and land preparation, (b) Source: application of chemicals (c) Make: planting, making bund control, harvesting, gathering, threshing, winnowing, scaring of bird (d) Deliver: bagging, processing, and marketing. Respondents agreed that they use of certified inputs (M=4.58), especially those with labels from certified suppliers; however, the source of the inputs was not verified by the government. This corroborates with responses from the interview's participants, who mentioned that inputs were bought from the open market, and different suppliers or buyers.

However, contrary to these statements, the ADP extension worker mentioned that government did provide inputs such as seedlings and fertilisers to RIFAN members through the office. For crop management, the ADP extension workers, whose role included the monitoring of the activities of RIFAN members through farm visits. This explains the involvement of the extension workers across the rice value chain. The use of natural fertilisers (M=4.23); confirmed the statement made in the interviews by RIFAN members, who mentioned the use of both N-P-K fertilizers and natural fertilisers. Another activity in the environmental dimension was seed preparation (M=3.58), which ranked the ninth highest. This activity requires that planter treats seeds before planting them ensure a healthy output is produced, as soil erosion (M=3.20) is a common environmental challenge, however, interview participants mentioned that RIFAN members created water beds for controlling water and avoiding pollution within the community.

Despite the importance of measuring the moisture content (M=2.76) of rice after harvest, respondents did not agree that this activity took place. For the supply of electricity (M=2.0), respondents agreed that they used diesel and fuel due to the absence of a central electricity supply by an approved power supplier.

Buyer diversity (M=4.53) ranked second highest in the economic dimension of the TBL categorisation of activities and resources available to stakeholders. Respondents agreed that there were diverse buyers to whom they sold their output. However, linking this to the issue encountered with the pricing system, respondents sold output to any available buyer or local rice collector at any price at which it was demanded. According to the qualitative data collected from the ADP extension workers, the output of all the rice farmers in the region was between 2,000 and 5,000 tonnes per year. This is an indication that respondents lacked record keeping which made it difficult to monitor their rate of productivity. Respondents agreed that they were able to afford inputs (M=3.45) to increase output; nevertheless, there is need to use a variety of seedlings to have variety of output which could improve the competitiveness of the rice grains on the international market. The profitability rate (M=3.36) was due to the ability of the respondents to employ more workers; however, interview participants mentioned a high labor cost which led to a reduction in the profit made. The issue with the pricing system could also have affected the profitability of respondents.

Access to funds such as loans and grants was a major resource required to improve the rice supply chain, to which participants mentioned poor access and high interest rates on loans obtained. This relates to the responses from interview participants who mentioned that loans could be obtained from banks to buy equipment and machines towards improving productivity, but that high interest was incurred on these loans. This aligns with the respondents who disagreed with having access to equipment and machines (M=2.34) and as a result, most activities were executed manually.

With regards to other items pertaining to the social dimension of TBL, knowledge acquisition had (M=3.52), respondents showing the respondents' willingness to acquire new knowledge, especially farm management knowledge, new techniques, and use of new technical tools with the aim of improving productivity. To achieve this, it would require the participation of ADP extension workers, especially since a good relationship exist between both sets of stakeholders.

Good healthcare (M=2.83) and a safe working environment (M=2.73) are resources needed by the respondents, as these were not available. Although, respondents from Edu had a safe working environment, those from the Patigi region were faced with attacks from herdsmen. Unfortunately, the government as a stakeholder in the rice value chain has not been able to provide adequate security. Tax payment (M=2.11) is a form of corporate social responsibility of citizens, but respondents did not have platforms for the payment of tax.

The theme used stakeholder theory for defining the supply chain and value chain of rice in the north Central region of Nigeria. To achieve this, the SCOR model was adopted in categorizing the activities of the stakeholders which were further aligned with triple bottom line and sustainable practices. As such, the activities of the rice supply chain were described by the participants are the following:

a) Plan: land selection and preparation,

b) Source: application of chemical

c) Make: planting, making bund control, harvesting, gathering, threshing, winnowing, and scaring of birds)

d) Deliver: bagging, processing, bagging, and marketing

Return could be triggered by poor quality of rice from the rice farmers, and supplier, of input, which could be monitored by the ADP extension office, but out of the activities mentioned, the return activity was not executed. The adoption of sustainable practices puts in place the KPIs from the SCOR model. The performance metrics are reliability, cost of labour employed during the activities, and cost of inputs such as fertilizer and seedlings, which should be monitored by ADP extension workers.

Stakeholders' Resources and Government Intervention

The aim of this theme is to adopt resource dependency theory in identifying the resources available to the RIFAN members, such as people and equipment, which they can leverage across the rice value chain. This was identified through the questions such as *'Who are other people you interact with during the process of production?'*; this question was aimed at identifying the stakeholders that RIFAN members interacted with and to whom they also supplied output as well as the resources that could be harnessed from the stakeholders. The other question was focused on identifying the resources, such as equipment and machinery, used for production and the problems encountered. Another question was aimed at identifying the resources that could be harnessed from the government as a stakeholder in the rice value chain, to improve productivity.

In the previous discussion with the ADP extension workers, they mentioned that RIFAN members got inputs from different suppliers aside from the government. Although previous policies mentioned the supply of varieties of rice seedling and certified fertilizers and chemical, as the responsibility of the government through the extension office, the opposite was the case as farmers had to source inputs from various sources, some verified or others not. Some of the responses from the participants were that they had implored the government to provide input at subsidized rates. The availability and efficiency of resources of stakeholders were linked to government intervention, which was a recurring theme from the three categories of stakeholders. Gomez, et al., (2022, p.2) identified some of the government interventions in the rice value chain, as the provision of infrastructure such as road and irrigation systems, development of policies such as export policies, tax incentives, investment in research and development, and regulations such as laws for seeds and input usage. An instance of government intervention aimed at improving rice production was mentioned by Addison et al., (2022, p. 2) in their research in Ghana, where they observed that the local government in the local government area provided subsidies for rice farmers to adopt new methods of rice cultivation.

A lack of policies for the rice value chain within the region indicates neglect by the government. Although in the past, there had been some kind of intervention by the government, for instance, there was a ban on the importation of rice by different regimes of government which was aimed at boosting rice production. Unfortunately, this was not sustained because Nigeria as a country is not self-sufficient in rice production. For instance, Eliw, et al., (2022, p. 496) stated that in Egypt, the government intervened in rice productivity through the development of varieties of rice which were high yielding; this intervention placed responsibility on the need to invest in research and development. Also, the Egyptian government promoted the services of extension workers through technology transfer (Eliw, et al., 2022, p. 496). Currently, the Anchor Borrower Program is an intervention by the government to improve rice productivity; for rice stakeholders to benefit from this intervention, there will be a need to ensure transparency. Also, for government intervention to drive rice productivity and improve food security, there must be a corruption free system that will ensure policies are applied to the letter.

Resources available to RIFAN members were inputs, machinery, equipment, human resources, and financial resources. For instance, participants identified that "*the resource[s] the government as a stakeholder can provide [are] resources such as input, loan, linkage to financial institution and market linkage".* In line with this, research by Bich.et al., (2022, p. 2) found that countries like Vietnam were able to improve their productivity through access to tractors and combine harvesters; they also have access to structured credits offered by either commercial banks or banks of agriculture. Improved interaction with the government as a stakeholder in the rice value chain through the office of the extension workers could improve the access to inputs for the RIFAN members which in turn will impact their productivity, reduce costs and improve their livelihoods through profitability.

Profitability can be achieved through a reduction in resources such as land, water, and labour employed across the value chain of rice. Akter, et al., (2019, p. 1) are of the view that interacting factors such as adoption of technology, environmental forces and institutional forces can also impact the total cost of production which eventually reduce the profitability of rice farmers. Also, factors such as the adoption of modern technology for rice production, use of available resources and fertility of the land have varying influences on the degree of profitability (Akter et al., 2019, p. 1). Based on the measurement details and indicators by the SRP, profitability is an indicator of an improved livelihood of rice farmers and gives an estimate of the profit made from the rice produced. RIFAN farmers should be taught the record keeping of sales and expenditure with the aim of improving profitability. The TBL dimension applicable for this theme is as stated below, where the sustainable practice is adopted from the practice metrics of the SCOR model. The rice value chain must adopt practices that promotes a good value system and do not violate human rights; moreover, it must encourage transparency and avoid corrupt practices.

Table 6-3: Stakeholders' Resources and Government Intervention

Nodes	Child nodes	Grandchild nodes
TBL – 2 Economic (ECO)	Sustainable sourcing (ECO-1)	Provision of inputs by government, other sources of inputs and fertiliser, selection of nursery site and preparation,
	Support supply chain practices (ECO-2)	Development of rice farming skills, introduction of new technology, access to loans, government policies on importation of rice, government policies for rice farmers, access to equipment (tractors, threshers, and planters), infrastructural development, farm management knowledge / practices, monitoring and evaluation of use of resources by ADP extension workers
	Improved livelihood (ECO-3)	Production per year, productivity per number of workers, profitability
TBL-3 Social (SOC)	Regulatory (SOC-3)	Government subsidy on inputs, government policies on rice farming, government policy on quality of rice produced, ethical standards

Source: Author

The TBL dimension identified other resources such as government policies for farmers and on importation, infrastructural development, knowledge of farm management and farm practices, and monitoring and evaluation by the ADP extension office. Provision of these resources by the identified stakeholders will improve the productivity and profitability of RIFAN members. The efficiency in output (rice production) is impacted by the measure to which input and the resources available such as technical efficiency, input usage and technology are utilised based on the available technology for profitability (Wijaya, et al., 2022, p. 49). Implicitly, access to resources through government intervention will improve the productivity of RIFAN members, which will in turn improve their livelihood.

Proper farm management was identified by one participant as a medium for increasing rice productivity and competitiveness; the SRP opines that teaching farmers proper record keeping of sales and expenditure will aid in the improvement of their profitability. Also, proper farm management can be further introduced through the adoption of block chain technology, which enables quality assurance, traceability, strengthens trust among stakeholders, and aids consistency across the supply chain of rice, through the adoption of a standard traceability identifier (Yakubu, et al., 2022, p. 3). Although this management of the supply chain of rice is effective, it is limited in that it is not cost effective for the category of rice farmers in this study and will require that the stakeholders have a higher literacy level. Adoption of the SCOR model, which consists of plan, source, make, deliver, and return, will aid in proper farm management of the rice value chain. While the ADP extension office monitors the planning and sourcing of inputs, other stakeholders such as which are the farmers are involved in planning, sourcing, making, delivering, returning, and enabling. Return could happen due to poor quality of rice from the rice farmer or poor input from suppliers.

6.3.3 Extent to which sustainable supply chain management influences the competitive performance of the rice value chain network

The descriptive statistics from Table 5-28 examined the influence of sustainable supply chain management on the competitive performance of the rice value chain. It identified the factors that can improve the competitive performance of rice. Respondents agreed that there was a demand for output (M=5.95), which denotes that output was good quality (M=4.82); however, participants mentioned that there were no quality checks on output for cleanness, stonelessness, moisture content, and the level of brokenness of grains. The diversity of suppliers of input (M=4.5) and information about suppliers (M=4.56) were factors that could improve the quality of inputs and output to improve the competitiveness of rice; unfortunately, information about suppliers were not a concern to respondents, which explains why inputs were sourced from any supplier in the market.

The themes generated from the interview for this research objective are further discussed.

Sustainable Resource Utilization

The identified sub-themes for this theme are access to equipment and tools, the activities of stakeholders, improved productivity, job creation and labour productivity. ADP extension workers identified the productivity per annum across the region as between 2,000 and 5,000 tons, with the definition by the SRP (2020, p. 14) of labour productivity among rice farmers is the total number of days worked per kilogram of rice produced per hectare. Labour productivity could not be measured as defined by SRP, and the reason for this could be a poor accountability or management system both by the ADP extension workers and RIFAN members. RIFAN members opined that "*improvement in the activities executed by various stakeholders will improve productivity*". The existing value chain runs on subsistence farming, which is the use of crude resources and equipment, but the adoption of sustainable resources will impact the productivity of workers.

RIFAN members who owned up to three hectares of land were considered large-scale farmers while, those with less land usage were seen as the small-scale ones. This corroborates with research by Bich, et al., (2022, p. 2) who mentioned that in countries like Vietnam, large-scale farmers are rice farmers whose land usage is over 3 hectares; such farmers were able to improve their productivity through access to tractors and combine harvesters. Similarly, Addison, et al., (2022, p. 2) opined that rather than expanding land usage for rice production, the adoption of technology for agriculture would increase rice productivity. As such, the adoption of technological innovation in rice production will improve food security in the North Central region of Nigeria.

The above authors further mentioned instances of the improvement in the supply chain of rice in Ghana, Ethiopia and Mozambique, through the adoption of technology across the rice value chain. In Ghana technology and technological innovation were adopted among rice farmers in the rural areas; this increased the productivity and incomes of farmers, improved food security, and reduced poverty in the region. The jobs created in the community can be leveraged by migrating from the subsistence structure to the use of modern equipment in order to improve the productivity of workers. Also, productivity will be able to be measured when RIFAN members learn management practices and record-keeping skills (SRP, 2020, p. 9) this can be possible once RIFAN members acquire a basic literacy level which will impact data management, learning and self-improvement. The applicable TBL dimension is as seen Table 6-3.

Table 6-4: Sustainable Resource Utilization

TBL (node)	Child node	Grandchild node
Environmental	Resource/ equipment efficiency (ENV-2)	Use of farm equipment such as tractors, willowers, threshers, and planters
Economic	Supporting supply chain practices (ECO-2)	Access to equipment (tractors, threshers, and planters), farm management and record keeping knowledge / practices, improved literacy level
	Improved livelihood (ECO-3)	Production per year, productivity per number of workers, profitability, land usage per worker

Source: Author

Sustainable Sourcing and Regulatory Activities

This theme aims at improving food security through the identification of problems faced by the different categories of stakeholders while providing solutions to aid in the sustainable sourcing of inputs for the rice supply chain. Some of the problems that the RIFAN members identified were the cost incurred on employees, pest invasions, herds-men invasions, cost of processing and access to quality inputs.

The solutions were mostly focused on interventions by the government through the introduction of ethical standards, a grading system, and subsidies on inputs and other resources. Sustainable sourcing ensures that the inputs used for planting such as seedlings, fertilisers, land itself and other equipment meet an ethical standard. Also, access to funding and grants could be regulated by the government, with the aim of ensuring that RIFAN members have access to interest free-loans or grants. This aligns with Soullier et al., (2020, p. 4) who are of the view that policies should be targeted towards providing improved inputs and larger farm space for planting for small household rice farmers. A good example of this instance mentioned by the authors was in drive towards increasing food security in West Africa, where policymakers formulated policies to curb the importation of rice under the Coalition for African Rice Development. Also, the policies were made to attract investors to improve rice milling by investing in technologies such as industrial or semi-industrial milling technology with the aim of increasing the production capacity and producing grains that were clean, with acceptable levels of moisture and of good quality.

Another problem identified was the invasion of farmlands by the Fulani herds-men who are rivals for land usage, water, and grazing land (Ojo, 2022, p. 105). This problem is a prevalent occurrence in Nigeria especially, in the six states of the North Central regions of the country which are Kogi, Kwara, Benue, Nasarawa, Niger, and Pleatue states (Mustapha, 2022, p. 21; Ojo, 2022, p. 103). Failure by the government as a major stakeholder in the conflict, has resulted in violence between farmers and herdsmen leading to the destruction of farms and the environment. Despite government policies on industrialisation, land usage and urbanisation, the RIFAN members still experienced this challenge. To address this issue, authors like, Olagbemiro, et al., (2022, p. 83) proposed the adoption of a resilient strategy which requires intervention from the government; (Ojo, 2022, p. 112) recommended community policing system, and a government campaign for regulated ranching which should portray the relevance of all stakeholders without discrimination.

Rice Value Chain Competitiveness

The child nodes for this theme are competitors, ethical standards, international competitiveness, regulatory intervention, and access to financial resources.

Participants identified importers of rice from the foreign market as the competitors to the locally produced rice. Although the RIFAN members did not produce enough to sustain the local demands for rice to meet the food security requirement, mentioned that through interventions from the government and access to financial resources, the quality and quantity of rice produced in this region could meet international standards, thereby making the value chain competitive. It was also mentioned that there were no ethical standards and regulatory interventions set in place towards rice production in this region; however, it is the responsibility of the government to engage with stakeholders across the rice value chain in developing ethical standards and regulatory interventions to improve its competitiveness.

The competitiveness of rice from the Edu-Patigi region is not guaranteed at the international market as responses from the ADP extension workers mentioned that quality assurance which is a major requirement at the international market was not in place. Babatunde, et al., (2019, p. 142) identified post-harvest losses as the cause of the poor competitiveness of the rice produced in the Edu-Patigi local government area. Quality assurance is aimed at checking for the quality of rice insofar as stonelessness, sizes, colour, and aroma. The authors opined that post-harvest losses which can either be quantitative or qualitative, are major causes of food insecurity; while quantitative losses are caused by a reduction in volume, qualitative losses are caused by changes in the colour, aroma, taste, appearance, and size of rice. These factors also reduced the productivity and profitability of the RIFAN members.

The competitiveness of the value chain of rice from the Edu-Patigi region is also affected by the variety of rice seed planted; this resonates with Sollier et al., (2020, p. 4) who submitted that the problems with the competitiveness of the rice value chain were inconsistency in variety, low quality of grains and high rate of broken grains, which contributed to poor yield and food insecurity. Addison et al., (2022, p. 2) mentioned that the adoption of a new variety of rice in

Asia improved the output of rice and food security; also, the use of the CARD/NRDS variety by rice farmers in Uganda and Yunnan province of China, improved the food security drive, reduced poverty levels among farmers, and increased their income level.

Ethical standards could be developed for the rice value chain to ensure competitiveness by adopting the SCOR model. Using this output of each stakeholder across the value chain of rice is benchmarked against certain criteria. For instance, inputs such as fertilisers and seedlings must be supplied by certified suppliers otherwise; such inputs will not be accepted. This view is in line with Lambrechts (2020, p. 406) who mentioned the need for the adoption of ethics in sourcing, production, and services rendered across a business; this ensures a fair wage system in the community and prevent slavery and child labour.

Some common issues associated with rice farmers that were found in a study carried out on rice growers in Bangladesh by Islam, et al., (2021, p. 178) were a lack of support and regulatory programmes such as subsidies on inputs, poor policies on market regularisation, delayed access to quality seedlings, and poor access to credit facilities. These are similar problems to the ones mentioned by the participants in this research. Access to financial resources or credit facilities will impact the income of RIFAN members in that community, because as the level of productivity increases, food security improves and so does the quality of output.

6.3.4 The plans, strategic policies, and practices put in place to mitigate food security risks and uncertainty

In the drive towards food security, the adoption of sustainable supply chain management could play a strategic role especially when enabled by factors such as government subsidies. This enabling factor (M=4.78) ranked the highest. This was reiterated by responses by interview participant who mentioned the need for subsidies on inputs and equipment in order to increase the productivity of rice. Other government interventions (M=4.72), some of which the interview participants agreed with included training and development, provision of technical tools, policies on rice production and importation, improved policies sourcing of input, provision of infrastructure such as good road networks, and functional and equipped health centres, instituting regulatory activities on the pricing system, introduction of ethical standards and policies for handling herdsmen invasion. Respondents were neutral about the existence of processing facilities (M=3.51) which may have been because the quantity of paddy was not sufficient and could be manually processed. However, processing facilities would enable the timely production of clean grains while reducing their level of brokenness. The construction of silos and storage facilities is required to store excess grains towards food security, however, respondents disagreed that these exist (M=2.14). This was because all rice grains produced were sold and the government did not have structures to enable food storage in silos- a way to get farmers buy-in could be to pay them higher amount for every portion of grain stored in silos. Respondents disagreed that there was the presence of monitoring and evaluation of output (M=2.03). The presence of a team responsible for these under the ADP extension office would bring an understanding and encourage the adoption of sustainable practices. The team would also develop criteria for quality checks and benchmarks for output.

Themes generated from the interview in line with the research objective are further discussed.

Interaction among Stakeholders, Rice Supply Chain and Stakeholders' Relationships

This theme is aligned to the Research Objective Two of this study, where employs resource dependency theory is employed to identify the resources available to each stakeholder, and how these can be leveraged to improve productivity. The focus of the theme is to identify the interactions and relationship between the ADP extension workers and the RIFAN farmers, to enable an effective rice supply chain.

Responses from the ADP extension workers expressed that *"the workers as stakeholders have [a] good network with the other stakeholders across the rice value chain and understand the resources available or required for the execution of their rice production related activities"*; this means that if the ADP extension workers are well trained and informed, they can contribute to the supply chain management of the rice value chain. An example is in the context of Bangladesh which is the largest producer of rice in the world; there, the extension offices provide credit facilities to farmers who adopt modern technology to improve their productivity through which the country achieves self-sufficiency in the production of rice (Akter et al., 2019, p. 1).

Part of the services of the extension workers is training and a technical advisory service which the office provides through frequent visits to the farm sites of the RIFAN members. Through these visits, the extension workers mentioned that they trained RIFAN members and ensured practical application of the knowledge taught. Also, from the responses from the RIFAN members, it was observed that there was a good relationship between themselves and the extension workers; this could be leveraged to develop a vibrant rice supply chain, which is enabled by transparency, communication, and trust. Participants one and three did this by visiting the farmers twice every month, while participants five and six visited thrice monthly and the other two visits as often as they could. Also, the extension office was responsible for providing inputs to the rice farmers who had to visit for collection. The procedure for collection was not structured, such that it enabled poor accountability and aided corrupt practices among the extension workers. The sourcing of fertilisers and inputs was not monitored by the government, and no specific measures were stated to verify the quality of the inputs.

The responses from the stakeholders implied that the ADP extension workers interacted closely with the rice farmers to ensure that trainings were adopted properly. However, there is a need for up-to-date knowledge for the ADP extension workers, on recent methods and use of new technology. This could be the reason participant one suggested that *"rice production could be increased in the region by adapting new technology".* Since the extension office is responsible for training the rice farmers, it becomes the first point of call to learn new technology and sustainable practices which will further be passed onto the rice farmers to aid in productivity of and ensure food security in the rice supply chain.

The adoption of the service of extension workers is required for advisory support and transfer of knowledge to rice farmers (Wehmeyer., et al., 2022, p. 2). Gomez, et al., (2022, p. 2) opined that agricultural extension is one of the responsibilities of the government as a stakeholder across the rice value chain. Extension services will equip rice farmers with the right farming technology and skills while introducing sustainable practices that can increase the yield of rice (Wehmeyer et al., p. 224). Unfortunately, the extension workers did not understand sustainable practices. This was evident from the responses with regards to monitoring of output, where some participants said, "*no one can police anybody"*, by which they meant that nobody had the time to monitor anyone's productivity.

Table 6-5: Interaction among Stakeholders, Rice Supply Chain and Stakeholders' Relationship

Node	Child node	Grandchild nodes
TBL-1 Environmental (ENV)	Natural resources (ENV -1)	Land preparation and selection of nursery,
TBL-3 Social (SOC)	Social development (SOC-2)	Training and development by ADP extension workers, training on use of pesticides
TBL 2 Economic	Sustainable sourcing (ECO-1)	Allocation of inputs and fertilisers supplied by government, ensuring trust, transparency and confidentiality among stakeholders

Source: Author

Connor, et al., (2021, p. 88) studied the change in the livelihood of rice farmers in Myanmar after the adoption of sustainable practices and observed that there was an increase in profitability, which is a function of an increase in output and reduction in the cost of labour; although rice farmers only accepted practices that were least expensive, the efforts by the government and other developmental projects aided the sustainable production of cereals such as rice, thereby improving the livelihood of rice farmers.

The TBL dimension applicable for this theme is as stated below, where the sustainable practice is adopted from the practice metric of the SCOR model. The rice value chain must adopt practices that promote a good value system and do not violate human rights; it must further encourage transparency and avoid corrupt practices.

Food Security Drive

This theme identifies the enabling forces for and against food security, and how the adoption of a sustainable supply chain could improve the competitiveness of the rice produced in the North Central region of Nigeria.

The set of indicators for food security adopted for this study were availability, accessibility, stability, and utilization. However, to drive these, it is expected that the government, through the office of the extension workers, should ensure availability and accessibility of inputs and fertilisers to the rice famers at a subsidised rate, but it came as a surprise that this was not the case. Inegbedion, et al., (2018, p. 4) stated that the ADP was established with the aim of ensuring the productivity and profitability of farmers in local communities through infrastructural development and the establishment of crop and farm input distribution centres, under the supervision of ADP extension workers from the ADP facility office. Contrary to this proposition, responses from the participants were that rice farmers in the Edu and Patigi local government areas had to source their inputs although ADP extension workers "*provide advisory services for RIFAN members.*"

There is the need for the government to empower the ADP extension office with seedlings and fertilizers, so that rice farmers can access these at a subsidized rate. Sustainable practices can then be adopted across the rice supply chain, to ensure accessibility and availability of inputs to the rice farmers. Through this structure, the extension office can verify the quality of inputs provided to the RIFAN members to ensure effective and efficient utilisation.

One of the participants mentioned one of the platforms created by the government to drive food security was by "*creating a loan facilitating platform for the rice farmers through the ADP extension workers, and further validated by their membership with RIFAN*". The platform is called the Anchor Borrower's Program, which is a value chain platform that links the agricultural value chain with the financing value chain. Part of the requirement is that farmers must be members of a commodity association to be beneficiaries of loan. The program increased the level of income of participants in the Edu-Patigi local government area by 1% (Ayinde et al, 2018, p. 31); Ayuba et al., (2020, p .47) further added that the effectiveness of the program requires the dedicated participation of extension workers, the adoption of technology for rice farmers, and improvement in the technical efficiency and educational proficiency of the rice farmers.

From the point of view of the extension workers, "*the rate of productivity of the rice farmers is little compared to what is expected to maintain self-sufficiency in rice production as a means of ensuring food security*". The estimated yearly production amount provided by one of the ADP extension workers was between 2,000 and 5,000 tons of rice across the whole region. The monthly quantity could not be provided, indicating that the rice farmers did not have the capacity to produce yearly and that the ADP workers do not keep records of rice production. Participants also mentioned that "*they were certain if the rice produced meets international standard.*" This response places a responsibility on the government to create a performance metrics of the SCOR's process reference model which benchmarks the quality of output which the extension workers must be familiar with. This will activate the 'RETURN' segment of the SCOR model which implies that rice output that does not meet the stated quality is returned to the rice farmer, right from the point of the quality check by the ADP extension workers. Such checks could be for the texture, colour, stones and breakage of grains.

Table 6-6: TBL Dimension for Food Security Drive

Node	Child node	Grandchild nodes
TBL – 2 Economic (ECO)	Sustainable sourcing (ECO-1)	Increase supplier/ stakeholder diversity, transparency, provision of input by government, other sources of inputs, trust, transparency and confidentiality among stakeholders, selection of nursery site and preparation, adoption of rice processing technology
	Support supply chain practices (ECO-2)	Access to loans, farm management knowledge / practices, training of RIFAN members and extension workers on use of new technology, monitoring and evaluation of use of resources
	Improved livelihood (ECO-3)	Production per year, productivity per number of workers, profitability
TBL-3 Social (SOC)	Regulatory (SOC-3)	Government subsidy on inputs, government policies on rice farming, government policy on quality of rice produced, ethical standards
	Consumer need (SOC-1)	Assessment of grains by extension workers, availability of silos and storage system, inspection of silos by ADP extension workers

Source: Author

The SRP (2020, p. 8) mentioned that as part of the drive for food security, silos and storage systems must be provided for storing excess grains, which ensures the availability and accessibility of rice at any time. Although the participants mentioned that "*there are no silos and storage systems for storing grains*" the issue is that they did not produce enough to validate the existence of silo or storage system. To increase the productivity of RIFAN members in this region, Yusuf, et al., (2021, p. 2) proposed a migration from the crude, non-hygienic and product-wasting system of processing rice to the adoption of rice processing technologies, such as paddy cleaners, rice polishers, and rice graders. Also, Soullier ((2021, p. 4) recommended the use of semi-industrial or industrial milling technologies which perform functions like pre-cleaning, drying, picking of stones, weighing, hulling, separation, whitening, grading, and bagging. This would increase the productivity and income of RIFAN members; it would improve the competitiveness of the rice from the region; and rice sufficiency towards food security drive.

The TBL dimension applicable to this theme is as stated in Table 6-7 above, where the sustainable practice is adopted from the practice metric of the SCOR model. The rice value chain must adopt practices that promotes a good value system and do not violate human right; it must further encourage transparency and avoid corrupt practices.

6.3.5 Improved rice value chain model influencing the security of the sustainable food supply chain in the North Central region of Nigeria.

Improved Rice Value Chain

This theme is built on other themes such as stakeholders' activities, stakeholders' relationship, stakeholders' resources, and interactions with extension office, it is further developed with the child nodes of government relationship, transparency in resource allocation, activity of stakeholders, relationship with ADP extension workers, access to equipment, and relationship among stakeholders. The aim is to develop an improved rice value chain which use sustainable supply chain management.

Responses from the stakeholders indicated that the value chain of rice in this region was just about buying and selling. As mentioned earlier, seedlings and fertilisers were sourced from open markets without verified sources; government as a stakeholder in the value chain was not involved in the activities of the other stakeholders as required; the ADP extension workers only interacted with the RIFAN members when there was the need to train them, but none of the ADP workers mentioned that they themselves were trained; and RIFAN members mentioned that "*they just sell their produce to the rice collectors at the local level without any quality check or grading system."* Some of these problems corroborate with, Soullier et al., (2020, p. 2) who mentioned that in the existing traditional value chain of the rice produced in West Africa the rice collectors and buyers in the local market did not have quality checks or criteria against which to benchmark the grains produced; furthermore, the moisture level and rate of impurities were not checked before collection from the RIFAN members. This was obvious in the existing value chain of the RIFAN members in the Edu-Patigi local government area, as the ADP extension workers mentioned that "*there is no platform for checking both inputs and outputs across the rice value chain*".

Obviously, the ADP extension workers had a good relationship with the RIFAN members; this could be leveraged by the government to build a sustainable supply chain for the rice value chain. To build an efficient sustainable supply chain, Zimon, et al., (2019, p. 220) mentioned that there is a need for a good relationship among stakeholders across the supply chain. This has a tendency of reducing the risk associated with the environmental and economic dimensions of sustainability and enabling the development of a sustainable supply chain. The above authors further mentioned that introducing sustainable supply chain management practices in food security as part of the SDGs would ensure that entrepreneurs, in this case the RIFAN members and stakeholders across the value chain develop strategies for an efficient, resilient, and ethical rice supply chain.

In addition, responses from the RIFAN members showed that there was a level of trust with the ADP members, and, likewise, the ADP members mentioned that they are committed to the RIFAN members. Trust and commitment are strong forces to build a resilient supply chain. Government as the stakeholder with the regulatory ability, could leverage this already existing trust and commitment to introduce sustainable practices to the stakeholders, especially the ADP workers who interact directly with the RIFAN members. Since responses from the RIFAN members indicated their willingness to innovate and adopt new of technology, the government should make available new equipment and machines as well as improved inputs, to improve the productivity level. This is in line with Gomez et al., (2022, p. 2) and Wehmeyer et al., (2022, p. 224) who mentioned that government has the responsibility of providing extension services for farmers, through the office of the extension workers who are well trained and equipped; this office is thereafter saddled with the task to update their knowledge and transfer the same to the farmers.

To have an improved rice value chain, transparency must exist in the activities of stakeholders in it, such as sourcing of inputs, resource allocation, collection of output, and training and development of both ADP workers and RIFAN members. To run a structure of transparency for the rice supply chain, therefore, Sunmola & Burgess (2023, p. 1257) suggested the need to adopt technologies such as blockchain technology, especially for sourcing inputs. The authors described that transparency in the supply chain implied the level to which stakeholders across it had access to it, and shared knowledge and information about the product, in a manner that did not disrupt the supply chain. Adopting blockchain technology across the activities of stakeholders in the rice value chain would provide information about the input suppliers, prices, quality and quantity of inputs, standards and specifications of inputs, relevant standards organisations that suppliers belong to, and relevant certificates. This would further drive traceability, thereby making monitoring and evaluation easy for ADP workers, especially with the introduction of SCOR. It would also enable traceability of loans and grants given to RIFAN members by financial institutions.

An improved value chain for food security can thrive by stakeholders having access to improved information sharing, and there being communication with other stakeholders, trust, and transparency in resource allocation and a friendly loan repayment structure. Respondents agreed that they had access to local rice collectors (M=4.65), however, earlier discussions have indicated that they just sold output at any price due to the absence of a price regulatory body. Communication among stakeholders (M=4.63) could be leveraged to facilitate the adoption of the knowledge of sustainable practices for the rice supply chain by the ADP extension workers, which could eventually be transferred to RIFAN members through training. Respondents trusted the current knowledge and technical-know-how of the extension workers (M=4.59), therefore, government as a stakeholder could retrain this ADP extension workers to facilitate knowledge transfer to other stakeholders. Although some respondents had access to loans and grants for expansion, the repayment of loans was low (M=2.72) because of high interest rates. Also, transparency in allocation of financial resources (M=2.02) was low, however, a structured monitoring team could ensure transparency in access and use of financial resources.

6.4 Section

6.4.1 Inferential Statistical Analysis

The adoption of inferential statistics provided adequate information about the relationship between variables, while the statistical *t-test* determined the statistically significant relationships between the variables. To further investigate the research objectives, exploratory research questions were developed, and the bivariate test was carried out by using hypothetical statements.

A one sample *t-test* for the significance of respondents' perceptions of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria, yielded a computed *t statistic* of 3.72 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-33). Thus, the null hypothesis that the driving and restraining forces influencing the rice supply chain in the North central region of Nigeria are not significant was rejected. The implication is to infer that, at the 99% confidence level, the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria are significant.

A one sample t-test for significance of respondents' perceptions of how the activities of stakeholders and their resources improved the food security on the underlying triple bottom line yielded a computed t statistic of 6.792 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level (See Table 5-33). Thus, the null hypothesis that the activities of stakeholders and their resources improving food security on the underlying triple bottom line are not significant was rejected. The implication is to infer that, at the 99% confidence level, that the activities of stakeholders and their resources improve food security on the underlying triple bottom line in the North Central region of Nigeria are significant.

A one sample *t-test* for the significance of respondents' perceptions of the extent to which sustainable supply chain management influenced the competitive performance of the rice value chain network yielded a computed t statistic of 35.09 and a significant *p -value* ($P<0.01$), thus indicating that the test was significant at the one per cent level (see Table 5-33). Thus, reject the null hypothesis that sustainable supply chain management influence on the competitive performance of rice value chain network is not significant. The implication is to infer that, at the 99% confidence level that sustainable supply chain management significantly influences the competitive performance of the rice value chain network.

A one sample *t-test* for the significance of respondents' perception of the extent to which sustainable supply chain management policy practices mitigated the food security risks and uncertainty yielded a computed t statistic of -4.873 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level (see Table 5-33). Thus, reject the null hypothesis that sustainable supply chain management policy practices mitigating the food security risks and uncertainty. The implication is to infer that, at the 99% confidence level that sustainable supply chain management policy practices do not significantly mitigate the food security risks and uncertainty.

A one sample *t-test* for the significance of respondents' perception of the factors influencing the sustainable food supply chain security in the North Central region of Nigeria, yielded a computed t-statistic of 11.49 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level (see Table 5-33). Thus, reject the null hypothesis that the factors influencing the sustainable food supply chain security in the North Central region of Nigeria are not significant. The implication is to infer that, at the 99% confidence level, that the factors influencing the sustainable food supply chain security in the North Central region of Nigeria are significant.

6.5 Discussion of Research Objectives

6.5.1 Research Objective 1

Research Objective one was to establish the effects of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria. The force field approach by Lewis was employed to identify these forces.

The restraining forces identified in the survey and the interviews across the three categories of stakeholders were poor access to funds, poor transportation system, bird invasions, lack of modern training, use of small tools and equipment, poor data management system, poor financial literacy system, poor monitoring and evaluation structure, lack of quality assurance system, and lack of transparency in the distribution of resources such as loans and grants. These are in line with the works by Babatunde et al., (2019, p. 143) who mentioned that some of the constraints faced by the stakeholders across the rice supply chain in Edu and Patigi local government areas of Kwara state were poor manpower, poor transport system, high cost of processing and inability to adopt modern technology, poor data system, and lack of storage infrastructure. The survey also corroborates with the findings from a study by Islam et al., (2021, p. 178) who identified similar issues associated with rice growers in Bangladesh as lack of support and regulatory programs such as subsidies on input, poor policies on market regularization, delayed access to quality seedlings, and poor access to credit facilities. These forces were also factors restraining the food security drive in the Edu and Patigi region.

The driving forces tested included introduction of technology such as artificial intelligence, drones and blockchain technology, structured and acceptable grading systems, transparency across the value chain, introduction of quality control across the rice value chain, provision of silos by different local governments, interventions from research institutions, and improved logistics structures. This is in line with the NATIP agenda, which is aimed at harnessing the untapped and available resources in Nigeria through the adoption of 21st century knowledge, technology and innovation in agriculture with the aim of ensuring food and nutrition security. Also, Chikezie, et al., (2022, p. 254) and Roy et al., (2021, p. 1), recommended the adoption of technology as a driving force in the rice value chain; furthermore, Yakubu, et al., (2022, p. 3) mentioned that transparency and trust across the value chain will influence its performance especially using traceability identifier.

The thematic analysis from the qualitative data and one sample *t-test* helped to answer the research question, thereby achieving Research Objective One. The qualitative data revealed that there are forces restraining the rice supply chain, and driving forces that can be introduced which positively influence the rice supply chain. The outcome of the one sample *t-test* for the significance of respondents' perceptions of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria, yielded a computed *t statistic* of 3.72 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level. The implication is that the driving and restraining forces influencing the rice supply chain in the North central region of Nigeria are significant.

The outcome of the interviews and the quantitative data collected, suggests that RIFAN members were faced with forces that have limited the productivity of the rice supply chain, causing the region to be faced with food insecurity. It further revealed that the adoption of driving forces would improve the performance of the rice supply chain towards attaining food security.

6.5.2 Research Objective 2

Research Objective Two was to determine how the activities, decisions of stakeholders and their resources improved the food security on the underlying triple bottom line. Stakeholders' theory and resource dependency theory were used to address this research objective. Fuzzy AHP-MCDM was further used to determine the weight of the alignment of stakeholders to sustainable practices using the TBL dimension. Through the SCOR model, the activities of stakeholders were categorised based on the outcome of the interview. This result is consistent with the opinion of Rodríguez Mañay et al., (2022, p. 4), namely, that the SCOR model aids in the identification and understanding of the activities and responsibilities of stakeholders at each stage across the value chain. The qualitative data further revealed how the available resource of one stakeholder influenced the activity and productivity of another; these resources and activities were further categorized according to the TBL dimensions, which are environmental, economic and social and were consistent with SRP performance indicators v2.1 (SRP, 2020, p. 7). The outcome of the quantitative data using the fuzzy AHP-MCDM was able to weigh the decision-making of stakeholders in alignments with TBL, and the adoption of sustainable practices in activities. This is in line with the results from Mastrocinque et al., (2022, p. 11), in which it was found the fuzzy AHP-MCDM was a model for decision-makers and stakeholders for sustainable supply chain management.

A one sample *t-test* for the significance of respondents' perception on how the activities of stakeholders and their resources improved food security on the underlying triple bottom line yielded a computed t statistic of 6.792 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level. The implication is to infer that, at the 99% confidence level, the activities, resources of stakeholders and alignment of the decision making with triple bottom line dimension have the tendency to improve food security

6.5.3 Research Objective 3

Research Objective Three was to examine the extent to which sustainable supply chain management influenced the competitive performance of rice value chain network.

Thematic analysis of the qualitative data, a one sample *t-test* and hierarchical regression helped in achieving this research objective. From the qualitative data, it was noted that factors such as government intervention, regulatory activities, sustainable sourcing and adoption of sustainable supply chain management could improve the competitive performance of the rice value chain network. This aligns with Sollier et al., (2020, p. 4) who stated that the problem of the competitiveness of rice value chain are inconsistency in variety, low quality of grain, and high rate of broken grain, which contributes to the poor yield and food insecurity.

Government intervention includes initiating policies for rice production and rice producers such as providing research and development centres, access to equipment, and subsidies and grants to rice farmers, and establishing ethical systems to monitor the output. This would also influence the sourcing of inputs because sustainable practices would be adopted at every stage of the rice value chain. This corroborates with Lambrechts, (2020, p. 405) who mentioned the need for the adoption of ethics in the sourcing of inputs. This is buttressed by the study by Bich et al., (2022, p. 2) in which government intervention through a structured credit system offered through banks and access to equipment in Vietnam resulted in an increase in productivity. Sustainable sourcing also involves the use of varieties of rice grains to have a variety of outputs which will facilitate competitiveness of rice from that region. Addison et al., (2022, p. 2) validate this by stating the result of the adoption of varieties of rice in Asia increased the productivity of rice farmers.

A one sample *t-test* for significance of respondents' perceptions of the extent to which sustainable supply chain management influenced the competitive performance of the rice value chain network, yielded a computed *t statistic* of 35.09 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level. This implies that at the 99% confidence level, sustainable supply chain management significantly influences the competitive performance of the rice value chain network. Also, from the simple correlation analysis for depicting existing relationship between the rice value chain, supply chain management and competitive performance, it was noticed that correlations existed among each of the variable. This implies that there is a significant relationship between rice value chain, sustainable supply chain management and competitive performance, with correlation coefficients of 0.536 and 0.170 at 0.000 and 0.001 levels of significant respectively. This, thus, indicates that a moderate relationship exists between the rice value chain, sustainable supply chain management, and competitive performance. This implies that sustainable supply chain management (SSCM) will influence the competitive performance (CP) of the rice value chain network.

The outcome of the interviews and quantitative data collected and analysed implies that the adoption of sustainable practices will impact the competitive performance of rice produced from that region, which will in turn improve the profitability and standard of living of rice farmers. This corroborates with the outcome of the study by Connor et al., (2021, p. 88) on the rice farmers in Myanmar after sustainable practices were adopted; it was observed that there was an increase in rice farmers' productivity and profitability.

6.5.4 Research Objective 4

The fourth research objective was to establish the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty.

A thematic analysis and *t-test* were employed in achieving this objective of study. The themes that emerged from the analysis for this were government intervention, sustainable sourcing, regulatory activities, rice supply chain and sustainable utilization of resources, which were based on the indicators set by the United Nations (FAO, 2019, p.69) that are availability, accessibility, stability and utilisation. Also, parameters such as government subsidy, government intervention, access to processing facilities, and monitoring and evaluation were measured to test the research question. The role of government intervention in the adoption of sustainable supply chain management towards food security was evident from both the interview and survey data collected. It is worth mentioning that the other parameters were rooted in government intervention. For instance, to ensure the sustainable sourcing of inputs, the government will need to provide a new variety of input. This resonates with the study by Addison et al., (2022, p. 2) who mentioned the use of rice varieties in Asia and CARD/NRDS by farmers in Uganda and Yunnan province of China, which resulted in an increase in the productivity of rice farmers, increased level of income for rice farmers, and improved food security.

To ensure that sustainable resources provided are sustainably utilised, the government through the office of the extension workers would monitor the activities and usage of input and evaluate with outputs. Also, to increase productivity, which will enable food security- in terms of availability and accessibility, rice farmers require access to rice processing facilities, which will enable agility in production. Such facilities can be provided by the government. This aligns with Soullier, et al., (2020, p. 2) who found that the rice value chain can be improved by instituting policies to enlarge the processing capacity of rice through the provision of semi-industrial or industrial milling technology which performs functions like pre-cleaning, drying, picking of stones, weighing, hulling, separation, whitening, grading, and bagging. Yusuf et al., (2021, p. 2) further proposed the use rice processing technologies such as paddy cleaners, rice polishers and rice graders. To enable the accessibility indicator of food security, SRP (2020, p.8) identified the need for silos for storing grains, however, results from both the interviews and quantitative data indicate that there was no provision for this.

The outcome of the one sample t-test for the significance of respondents' perceptions of the extent to which sustainable supply chain management influenced the competitive performance of the rice value chain network yielded a computed t statistic of -4.873 and a significant *p-value* *($P<0.01$)*, thus indicating that the test was significant at the one per cent level (see Table 5-33). The implication is that, at the 99% confidence level, sustainable supply chain management policy practices do not significantly mitigate the food security risks and uncertainty.

6.5.5 Research Objective 5

The Research Objective was to develop the value chain model influencing the sustainable food supply chain security in the North Central region of Nigeria.

A thematic analysis and *t-test* were employed to attain the stated objective. Themes such as stakeholders' relationships, interactions with extension workers, and government intervention emerged. Also, parameters such ass access to rice collectors, stakeholders, communication, training, financial transparency, and loan repayment were measured. Some of the interventions required by the government to improve the rice value chain were the provision of infrastructure such as good road network, security system, research facilities and health care services. This corroborates with the findings by Gomez, et al., (2022, p. 2) where authors identified some of the interventions of the government in the rice value chain as the provision of infrastructure such as road and irrigation system, development of policies such as export policies, incentives for tax, investment in research and development and regulations such as laws for seeds and input usage. An instance of government intervention aimed at improving rice production was mentioned by Addison et al., (2022, p. 2) in their research in Ghana, where they observed that the government in the local government area provided subsidies for rice farmers to adopt new methods of rice cultivation.

An improved value chain can thrive on the contributions of the extension worker especially through knowledge transfer. This is underpinned in the study by Eliw., et al., (2022, p. 496) where it was noted that the Egyptian government promoted the services of extension workers through technology transfer. In agreement with, Gomez.et al., (2022, p. 2) and Wehmeyer et al., (2022, p. 224) mentioned that the government has the responsibility of providing extension services to farmers through the office of the extension workers, who are well trained and equipped; this office is thereafter saddled with the task to undertake knowledge and transfer to farmers. Results from the interviews and quantitative data revealed that extension workers had a good relationship with the rice farmers, and respondents were willing to adopt new techniques and technology. This strength should be leveraged by training the extension workers on relevant sustainable practises, who will thereafter train the rice farmers.

Engaging with and attracting the youth into rice farming is of great importance, especially because the youth population across Nigeria is over 64 million with less than 10% of them in active employment- (43% youth unemployment, and 21% of the youth are underemployed), while and less than 48% of them are female (National Bureau of Statistics - NBS, 2019, p. 107; NBS 2023; Fasakin, et al., 2022, p. 1). Duyen, et al., (2021, p. 116) stated that to encourage the participation of youths and women in agriculture there must be equal access to resources and information available, while Olanrewaju et al., 2021, p. 2) suggested the need for policies by the government to enable such access. Fasakin et al., (2022, p. 2) mentioned that 69% of youths in Nigeria reside in the rural area and opine that the engagement of these youths in agriculture will foster sustainable employment.

Olanrewaju, et al., (2021, p. 2) argued that these youths are constrained by factors such as poor access to credit especially because they do not have collateral to obtain loans; however, the introduction of the Anchor Borrower Program (ABP) was introduced to encourage the participation of youths in agriculture. The engagement of youths in rice cultivation will be of great value to them because rice is a common staple food in Nigeria that is highly preferred by consumers (Fasakin et al., (2022, p. 2). The contribution of the youths towards economic development and productivity, will result in a reduction in poverty levels and an increase in well-being because they possess the strength, mind, willingness to acquire new knowledge and innovative nature which will encourage them to try new techniques (Duyen et al.,2021, p. 116).

To have an improved value chain, transparency must exist in the activities of stakeholders in the rice supply chain such, as the sourcing of inputs, resource allocation, collection of output and training and development of both ADP workers and RIFAN members. To run a structure of transparency for the rice supply chain therefore, Sunmola et al., (2023, p. 1257) suggest the need to adopt technology such as blockchain technology especially for the sourcing of inputs. Authors described that transparency in the supply chain implies the level to which stakeholders across it have access, shared knowledge and information about products in a manner that does not disrupt the supply chain.

A one sample *t-test* for significance of respondents' perceptions of the factors influencing the sustainable food supply chain security in the North Central region of Nigeria yielded a computed t statistic of 11.49 and a significant *p-value* ($P<0.01$), thus indicating that the test was significant at the one per cent level (see Table 5-33). Thus, reject the null hypothesis that the factors influencing the sustainable food supply chain security in the North Central region of Nigeria are not significant. The implication is that, at the 99% confidence level, the factors influencing the sustainable food supply chain security in the North Central region of Nigeria, are significant

To build an efficient sustainable supply chain, Zimon, et al., (2019, p. 220) stressed that there is a need for a good relationship among stakeholders across the supply chain. This has a tendency of reducing the risk associated with the environmental and economic dimensions of sustainability and enabling the development of a sustainable supply chain. The above authors further mentioned that introducing sustainable supply chain management practices for food security as part of the SDGs will ensure that entrepreneurs, in this case the RIFAN members and stakeholders across the value chain develop strategies for an efficient, resilient, and ethical rice supply chain.

6.6 Summary of Chapter

This chapter presented an in-depth discussion of the findings from the research in line with the literature review, research objectives and research question of the study. The empirical research focused on the data analysis and interpretation. Through this, the research questions were answered serving as meaningful contribution to the body of knowledge. The discussion was centered on the outcome from the statistical analysis presented in the previous chapter. The research findings revealed that there are restraining and driving forces that influence the rice supply chain. Also, an understanding was developed of the activities and resources of stakeholders and the extent to which decision-making aligned with the triple bottom line influenced the rice value chain. The study found a significant relationship between the competitive performance of the rice value chain and sustainable supply chain management. The findings further revealed that there is no significant relationship between supply chain management and food security, however, the adoption of sustainable supply chain management for the rice value chain could improve food security in the North Central region of Nigeria. The study also found that an improved value chain model can influence the sustainable food supply chain towards food security in the North Central region of Nigeria.

CHAPTER 7

Recommendation and Conclusion

7.1 Introduction

This study aimed at developing a conceptual framework for a sustainable supply chain towards managing the food security of rice in the North Central region of Nigeria. The study sought to understand the challenges across the supply chain of rice as a major staple crop in the North Central region of Nigeria especially from the perspectives of the stakeholders in the rice value chain. It also sought to understand how the adoption of sustainable practices across the supply chain could improve the value chain and ensure food security in the region.

7.2 Objectivity and Statement of Problem

The statement of problem of this study expressed the challenges in the supply chain of rice for attaining food security. Despite the consumption of rice as a major staple crop in the region, the supply chain has not been able to ensure self-sufficiency in rice production and meet the competitive demands for rice on the international market. Due to the emergence the Sustainable Development Goals with one of the aims being zero hunger, the adoption of sustainable practices in the supply chain of rice could aid food security and the competitiveness of the rice produced in the North Central region of Nigeria. The literature review extensively researched on sustainability using the triple bottom line, which was further aligned with the supply chain for rice and the rice value chains of other countries and regions where rice is a major tool and has been used to drive food security. These provided an understanding of the challenges of the rice supply chain and an overview of the activities of stakeholders across the rice value chain. The study focused on the adoption of sustainable supply chain of rice towards attaining food security and the improvement of the competitive performance of rice produced from the region. The five research objectives stated the purpose of the study and the research questions aligned with the appropriate research methodology for answering these. The empirical research findings showed the specific inferences that contribute to practical solutions for the supply chain of food crops at large. Although the focus of this study was on the rice supply chain in the Edu-Patigi local government area, a region in the North central region of Nigeria, it also, provided an understanding of the supply chain of the other food crops in Nigeria.

The respondents and participants of the study were stakeholders across the rice value chain such as the extension workers, large-scale rice farmers and small-scale rice farmers. Most of the participants had over 10 years of experience in the rice value chain, which gave validation to the valuable information gathered that can improve the sector. The extension workers as stakeholders in the value chain provided relevant information and insight on behalf of the government, while the RIFAN members also gave on-the-ground insight and experience regarding the value chain. The study discovered that the adoption of a sustainable supply chain for an improved rice value chain could leverage the interactions between these two categories of stakeholders, alongside other parameters which can be enabled through government intervention to improve the value chain of rice in the region. To this end, the next sections discuss the empirical findings and recommendations will be made.

7.2.1 Empirical Analysis of Sustainable Supply Chain

The evidence from the empirical research of this study indicates that the stakeholders across the rice supply chain were unaware of being involved in adoption of sustainable practices in some aspects of their activities in the rice value chain. For instance, insofar as the environmental dimension of sustainability, 54% used natural resources as ferterlizers and 58% used inputs with certified labels, however, the sources of inputs were not verified. In terms of land preparation, which is a sustainable practice towards ensuring quality output, less than 50% of the respondents implemented this. Regarding the measurement of the moisture content of rice, 73% of the respondents did not engage in this. Although this should be the responsibility of the monitoring team, in this case the ADP extension workers, 94% of respondents did not monitor their of output. In terms of water usage, sustainable practice was in place, and 57% of respondents did not experience erosion; this could be because water beds which ensure a sufficient supply of water flow were constructed for rice planting. Despite the availability of water, some participants indicated the need for irrigation especially during the dry season. With respect to the availability of an electrical supply and the usage of fuel, 98% of the participants did not have access to supply of electricity.

In terms of the processing of grains, it was discovered that respondents still used the manual system, which affected both the quantity and quality of the rice supply chain. With 75% of respondents indicating that they harvested rice grains manually and 86% drying rice grains manually, this puts into question the quality of the output and denotes that the quantity produced could be processed manually. Also, a large majority of respondents (80%) agreed that they needed equipment to improve their productivity, which according to Soullier et al., (2020, p. 4) would ensure the wholeness of the process. Although over 84% respondents mentioned that the output was of good quality, there was no monitoring and evaluation team across the rice supply chain to check the quality of outputs such as the whiteness, stonelessness, odour, color and brokenness of the grain.

The study further discovered that sustainable practice was adopted for weed and crop management. Ninety-seven per cent of participants engaged in weed management with the use of chemicals and 58% took part in crop management with the assistance of the ADP extension workers.

In terms of the economic dimension, factors such as cost, time, profitability, productivity, and the sustainable sourcing of inputs and their utilization were considered. Responses from the interview participants indicated a high cost was incurred in the process. Some of the costs mentioned were on equipment and labour. Although 53% of the respondents agreed that they made sufficient profit, which allowed them to employ more workers, over 60 % disagreed that they had access to financial grants, which means there is the need for more funds. Considering the time spent on the activities across the rice value chain, interview participants mentioned that farmers in the region produced between two thousand and five thousand metric tonnes yearly, which is little compared to what is required for consumption and sales. The manual system of processing is a major setback for the stakeholders, as most of the respondents (70%) still used the manual farming technique.

The adoption of equipment such as planters, harvesters, and tractors will improve production. The small-scale farmers used between one and three hectares of land, while the large-scale farmers were described as those who used three hectares and above for planting rice; although rice farmers in this region indicated that they used more than two hectares of land for rice planting, the available land space was not well utilized. The challenge is obviously not the availability of land, but its efficient utilization as an available resource. The rate of productivity was not commensurate with the level of productivity, as the profits made had not improved the standard of living of the respondents, and the yearly output did not justify the time invested. It was further discovered that sustainability was not evident in the sourcing of inputs. This is because almost all the respondents (99%) agreed that they sourced inputs from the open market, while 75% of them agreed that quality check platforms were not available. The input suppliers in the markets were not verified, and the quality of the inputs was not up to standard. This was seen in the output as farmers did not use high yielding variety of seeds. It should become the responsibility of the NGOs and government to provide high-yielding varieties of rice seedlings to rice farmers, just as was done in Ghana, Brazil, India and Bangladesh. With the aid of the ADP extension office, the suppliers of inputs could be accessed to ensure that the right input is supplied. The use of a variety of inputs, especially seedlings, would improve the quantity and quality of the rice produced in the region. Empirical findings indicate that sustainability is not evident in the economic dimension of the rice supply chain.

The social dimension considers factors such as safe working conditions, social responsibility, job creation, access to good healthcare service, and knowledge and skill acquisition. Respondents (63%) agreed that they enjoyed safe working conditions, although this was dependent on the location, with a larger percentage of the respondents enjoying such conditions being from the Edu area of the region. This shows that those in Patigi faced attack from herdsmen. The research further discovered that most respondents (89%) did not pay taxes as a social responsibility because no platform was structured for this. With regards to good healthcare services, many respondents (51%) agreed that these would improve livelihoods; it is the responsibility of the government to ensure that well-equipped and functional healthcare services are provided in the local government areas. With the aim of increasing the productivity of the rice supply chain to attain food security, many respondents (56%) were willing to acquire new skills and knowledge. It was discovered that 69% of the respondents still used old techniques of rice farming, which were time consuming and less efficient, however, they were willing to adopt new technology and innovative ways of improving productivity. This indicates the willingness of respondents to accept sustainability towards an improved rice supply chain. It is noteworthy to mention that 70% of respondents were able to provide jobs within the community. This sustainable practice was aimed at improving the livelihood of the community at large. The empirical findings indicate that sustainable practices were only evident in the social dimension of sustainability; as such, the rice supply chain requires structured and monitored sustainable practices to enable more productivity towards ensuring food security.

In a nutshell, the empirical findings indicate that the adoption of a sustainable supply chain using the triple bottom line dimensions, would improve the rice supply chain towards attaining food security in the Edu-Patigi region.

7.2.2 Empirical Analysis of Rice Value Chain and Stakeholders' Activities

In this empirical research, the stakeholders of the rice value chain in the Edu-Patigi region consisted of the ADP extension workers, small-scale farmers, large-scale farmers, input sellers, and the local rice buyers or collectors. Responses from the interview participants indicated that inputs were mostly sourced from the open market, with 60% of respondents having adequate information about the suppliers. Although the ADP extension workers mentioned that the government provided inputs to rice farmers, 54% of respondents did not agree with this view. While the role of the ADP extension workers across the rice value chain involves monitoring the activities of rice farmers, 57 % of respondents agreed that they used the support of extension workers to ensure good management of their crops and to control pests and disease. With regards to the monitoring of output, 70% of respondents disagreed that they measured the moisture content of the rice produced, while 74% disagreed that they did quality checks on the output; these activities should be part of the role of the ADP extension workers. Also, ADP extension workers mentioned that the output of rice farmers was not checked to ensure its quality. However, respondents agreed that the extension officers performed a training and development role and the former further indicated that a good relationship existed between the rice farmers and extension workers; this could further foster a platform for training and the adoption of new skills.

With regards to the activities of government as a stakeholder in the rice value chain, 70% of respondents disagrees that there exists stable policies instituted by the government to improve the rice value chain. Also, as part of the role of the government to ensure social responsibility through the creation of platforms for tax payments, 88% of respondents do not have access to such platforms to exercise their corporate social responsibility through tax payments.

The study further revealed that the activities in the production of rice were mainly through manual labour. Seventy per cent of respondents still used old farming techniques, with 85% indicating that they use manual processes in their activities. Respondents identified the activities in which they were involved, which were categorized using the SCOR model.

Insofar as land preparation, 87% of respondents indicated that they always prepared the land after each harvest for another planting. Moreover, participants responded that they used chemicals for weed management, and 47% of respondents prepared their seeds before planting them to ensure a good quality of output. Thirty-nine per cent of respondents agreed that they made of bunds to prevent erosion, by controlling the flow of water, while 75% still used manual techniques for harvesting the output. Bird scaring was an activity in the rice value chain in this region because of the invasion of birds, which caused the loss of grains especially before harvest. Interview participants mentioned that some rice farmers had to use the support of family members to perform this activity, or they had to scare these birds themselves. Most of the respondents indicated that they had buyers to sell their grains to. Interview participants mentioned that waste generated from rice production, such as rice straw and husk, were given to poultry.

Return could be triggered due to a poor quality of rice from rice farmers or poor grain varieties from suppliers of inputs; these could be monitored by the ADP extension office. However, from the activities mentioned, the return activity was not enabled. The adoption of sustainable practices puts in place the KPIs from the SCOR model. The performance metrics are reliability, cost of labour employed during the activities, and cost of inputs such as fertilizers and seedlings, which should be monitored by the ADP extension workers.

7.2.3 Empirical Analysis on the Adoption of Technology for Food Security

Empirical findings from the study indicate that the adoption of technology across the rice value chain will improve its productivity and competitiveness; however, 77% of respondents indicated that these were not available to them. These technologies are to replace manual farming and ensure the mechanization of processes such as land tillage, planting, and harvesting. Participants mentioned that land, which is a resource for food security, was not adequately utilized, and this was due to the high costs of labour incurred. With the availability and access to high-powered equipment, the available land can be used more effectively for rice farming, which in effect would increase the quantity of rice produced. With regards to respondents' willingness to adopt technology to improve productivity, 99% were willing to do so. Aside from technologies required for planting and harvesting, there is the need for those that can perform functions such as pre-cleaning, drying, cleaning, stone picking, weighing, hulling, separating, whitening, bagging, and grading. Such technology will improve the quality of rice grains and can be used for large quantity of paddy, thereby increasing the quantity of rice produced.

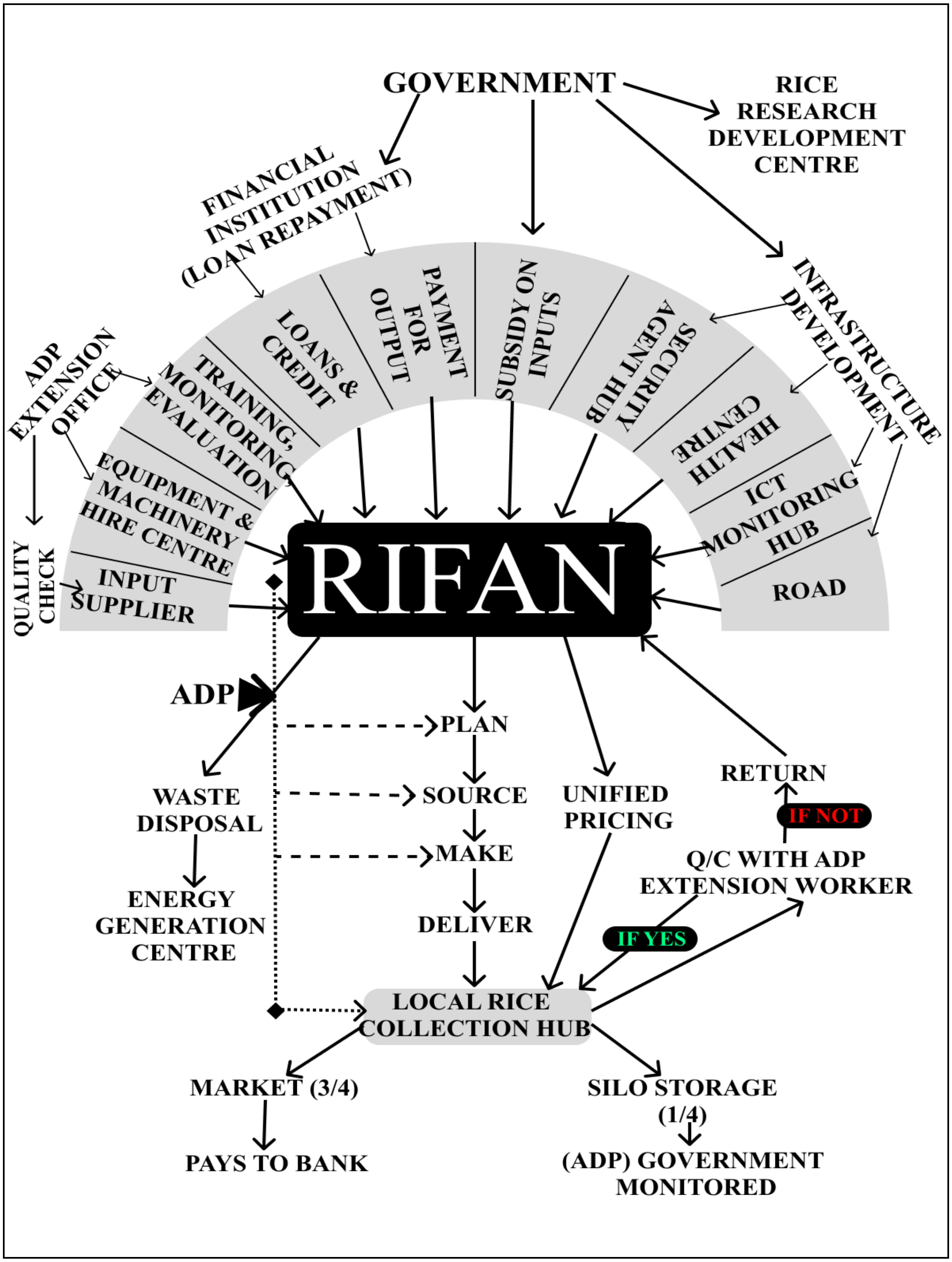
Another form of technology required to improve the rice value chain is one that can curb bird invasions. Participants identified bird scaring as a major activity in the process of growing rice; this activity is needed to reduce both pre-harvest and post-harvest losses. The use of technology to overcome this will require technological hubs, however, this demands investment from private participants or the government. To ensure the availability of rice, there is the need for traceability and transparency across the rice value chain; this can be realized with technological applications that ensure the availability of data and aid in decision making among stakeholders. These will further enable access to information on resource availability and enable the monitoring of the use of such resources provided to the stakeholders. The adoption of technology will also provide stakeholders with hands-on information for decision-making towards productivity, for instance, information on weather can help rice farmers make decisions on planting and harvesting. Other stakeholders can also be provided with information on the quality of inputs available and aboutthe suppliers of these.

7.2.4 Empirical Analysis for Government Intervention

In this empirical study, the intervention by the government, which is a stakeholder across the rice value chain, has been identified as key in the adoption of a sustainable supply chain in the rice value chain, to ensure food security through using rice as a staple food crop. Government intervention enables the adoption of sustainable practices by the main stakeholders across the value chain, while also integrating the participation of other relevant stakeholders that are required to improve activities such as research and development, information technology, and communication across the supply chain. Through government intervention, sustainable resources can be provided through grants and subsidies. Effective usage of these resources can be monitored through the ADP extension offices. Output can be further benched marked against certain requirements to ensure its quality. Through government intervention, policies can be implemented to encourage youth participation, especially with the introduction and adoption of technology.

The findings from the study indicated that 84% of respondents were over 36 years of age, which means that the younger and more vibrant population were not interested in theis sector; however, the adoption of technology through government intervention could attract the participation of the youth. The findings also revealed that the rice value chain had very low female participation at 1%, which indicates a gender imbalance; one of the participants mentioned that the role of women was mainly to scare or chase birds away. Therefore, with the introduction of technology and government intervention, female participation in the rice value chain could improve. With over 70% of respondents agreeing that they needed access to good roads and healthcare services, a part of the government's interventions to improve the rice value chain towards food security, should be the provision of infrastructural facilities such as good roads, healthcare centres, and research and development centres to foster the productivity of rice farmers.

Figure 7-1: Sustainable Supply Chain Management model for Rice Value Chain



Source: Author

7.3 Recommendation for this Study

This study has answered the stated research questions from the literature review. Given the research findings which emerged from the scientific components of the study, Figure 7-2 captures the value chain model and recommendations for the adoption of sustainable supply chain management for the food value chain, towards food security in North Central region of Nigeria. These recommendations are based on the empirical findings of the study regarding how a sustainable supply chain in the rice value chain can influence food security in the North Central region of Nigeria.

To achieve this, the empirical findings from the study identified three important stakeholders, which are the rice farmers (RIFAN members), government, ADP extension officers, and financial institutions.

7.3.1 Government

The empirical findings of the study reveal the gap caused by the absence of the participation of the government as a stakeholder across the rice value chain. The participation of government is linked to the activities of other stakeholders and is fourfold, namely, infrastructural development, research and development, resource supply, and policy creation and implementation. The needed infrastructure consists of the following: information and communications technology (ICT) monitoring hubs, security hub, healthcare centres, and good road networks.

The effective use of ICT will require the engagement of engineers, data scientists, and artificial intelligence specialists. Engineers facilitate the provision of technological equipment to improve quality, while the service of data scientists' aids rice farmers in having precision in their decision-making, through the provision of customized and user-friendly mobile applications on mobile devises. The decisions that farmers make is wide ranging, but some of these are on weather, planting and harvesting, pricing, variety of seedlings to plant, fertilizer to use, loan and interest on such loans, grants, adoption of sustainable practices, techniques to use at various phases of rice farming, and use of suitable tools for productivity. These decisions among others can be aided using tools and applications provided by data scientists and artificial intelligent specialists.

The information and communications technology hubs would link the activities of stakeholders through block chain technology and enable their monitoring to ensure transparency using mobile technology devices. The hubs will facilitate supplier information with regards to the quality of the inputs supplied, their prices and the details of their source. This information would especially be provided to the ADP extension office, which approves the supply of inputs and distributes these to rice farmers. The team there would also create a platform for quality checks for the output delivered by the farmers. Furthermore, automated farming equipment such as drones, robots, Wireless Sensor Network technology, and buzzer activation mechanisms for scaring birds, can be introduced and monitored by the team. Drones can be provided for monitoring activities such as the state of the health of rice crops, application of fertilizers.

Some of the responsibilities of the research and development centres would be the identification of suitable high-yielding varieties of seeds specifically for the region, the right fertilizer for the sustainable use of land and to improve productivity, and proper soil monitoring and management. The team would also collaborate with the data scientists on the ICT team for data collection on soil usage and management. The security hub would engage the services of security personnel to protect farmers especially against attacks from herdsmen. Also, a good and well-equipped health facility could be provided in the region to cater for the well-being of farmers and the community. A good road network must be provided to ensure an affordable transportation system and ease of access to and from the farms, for the activities of stakeholders.

To ensure the quality and quantity of the output, the government has the responsibility of facilitating the supply of resources such as technological equipment, human resources, an enabling working environment, and rice seedlings fromhigh-yielding varieties (HYV); these wouldensure productivity and aid in job creation all year round. The availability of high-yielding varieties could be facilitated through research and development, to ensure the right variety of seeds that thrive in specific regions, regardless of the season of the year. Also, another resource that should be facilitated by the government is the establishment of equipment hire centres, especially for mechanized equipment such as planters, tillers, harvesters, and tractors, which small-scale farmers may not be able to afford. Such equipment would be provided for hire by the government. The government could encourage private investors to provide such centres, but these should be offered to rice farmers at economical rates; this could be put into place through subsidies from the government towards ensuring that rice production costs are reduced. To ensure that rice farmers have access to resources, mobile applications or technology that notify users about the details of available resources should be provided.

Policy creation and implementation towards the adoption of a sustainable supply chain for an improved value chain for food security, remain the responsibility of the government. As much as possible, policies towards the reduction of imported inputs, such as fertilizers and variety of rice seedlings, and the encouragement of local input providers should be enacted, as well as policies on access to input, access to loans and grants, a sharing system for sales and storage of rice grains, and training and development. Policies that will control the activities and ensure the adoption of sustainable practices should be adopted. Economic incentives such as tax reductions and subsidies on resources should be implemented for stakeholders such as rice farmers, and equipment input manufacturers. Policies for the distribution of resources, the monitoring of their usage, and the final output must be implemented.

To this end, a monitoring team must be created across the ADP extension offices, and officers must be trained on the acceptable requirements for output. The monitoring of resource usage would be enabled by a technology-driven platform that provides data about who collected inputs and the corresponding output produced. In addition, policies for the sales and storage of rice produced towards food security, must be enacted. This further requires the setting-up of data-enabled community silos where one third of the rice produced would be stored, and farmers can be paid the same amount as the prices fetched for the remaining two thirds that is sold. These silos would be monitored by the ADP extension offices under the supervision of the Federal Ministry of Agriculture and Rural Development.

7.3.2 ADP Extension Office

This office should be empowered by the government towards driving the adoption of sustainable practices across the rice value chain. The present roles of the office are to provide extension services through the monitoring of the activities of the rice farmers at the local level. This framework shows that the office is a link between the government and other stakeholders across the rice value chain. The ADP extension office should also be responsible for ensuring in-depth training on sustainable practices to rice farmers, facilitate transparency in the distribution of inputs and traceability in their supply, and further ensure that the output of rice farmers meets a set of specifications before approval for sale or storage. The government needs to facilitate the training of the ADP extension workers towards the acquisition of sustainable practices in the rice supply chain, such as on the use of sustainable resources as specified by the research and development team. Also, the extension workers would be trained on the use of equipment, the technology-driven platforms created by the ICT team, and sustainable avenues for grants and resource acquisition. Since the role of the team includes the monitoring and evaluation of output and the rice value chain using the SCOR model, the extension officers would acquire the skills for identifying the requirements that would enhance the quality assurance of output. The existing relationship between the rice farmers and the extension workers, which has been built on trust, loyalty, and confidentiality, can be leveraged to ensure good labour conditions and to train and develop the RIFAN members towards learning about the new technology and techniques, farm management skills, efficiency in the use of resources such as nitrogen and phosphorus, water productivity, biodiversity, use of mobile applications, and platforms for a sustainable supply chain for an improved rice value chain.

7.3.3 Financial Institution

Financial institutions should provide RIFAN members with loans and credit and pay them for their output supplied to the silos. This would be an arrangement between the government and financial institutions towards encouraging RIFAN members to store a portion of their rice produced for food security. To ensure the efficient use of resources and repayment of loans given to rice farmers, financial institutions should be given access to the platforms or portfolio of each rice farmer, to monitor the use of financial resources provided and to create a suitable repayment structure for them. The arrow in Ffigure 7-2 indicates a notification from the ADP extension office, which certifies the output supplied by a rice farmer and approves payment from the bank. Funds provided for rice farmers would mainly cover costs incurred on labour, purchase of inputs, transportation of output, and hire of equipment.

7.3.4 RIFAN Members

The other the categories of stakeholders would provide sustainable resources in the rice supply chain towards improving the rice value chain. The activities of the rice farmers would be monitored through the adoption of the SCOR model, to ensure the effective and efficient use of the resources provided.

The planning phase of the activities of the rice farmers consists of activities such as land selection and preparation, so the sustainable practices required at this phase would be to ensure suitability of land for the planting of a selected variety of rice seedlings. Rice farmers would provide an assessment to check for the presence of pests, beneficial organisms, and use of pesticide. Also, an estimate of the use of pesticide applied per area of land used for rice farming would be recorded. With regards to water required for irrigation, a high quality of water must be used, therefore the source of water must be free from contamination.

For inputs such as seedlings, fertilizers, and chemicals required, rice farmers would need to ensure that inputs are sourced from designated and government-approved centres or suppliers; this is to ensure the use of quality inputs that must be used in the right quantity. There is the need for efficiency in the use of the nitrogen and phosphorus make-up of the chemicals used; the ADP team would guide users on this. Rice farmers must be encouraged to use both organic and inorganic fertilisers.

The making phase consists of activities such as planting, bed control to control the flow of water, weeding, harvesting, gathering, winnowing, and the scaring of birds

7.3.5 Waste Renewal/Energy Generation Centre

To ensure the adequate use of waste generated from rice, such as the straw and husk, a community waste renewal centre should be established as part of the value chain to drive environmental sustainability. This centre would be involved in the generation of electricity from waste gathered from rice, such that the rice-growing communities can have access to clean and sustainable energy. This would reduce the costs incurred by households on electricity, enable a regular and constant supply of power, and ensure the consumption of clean electrical energy. This would further drive job creation aside from engagement in rice production within the communities.

7.4 Limitation and Delimitation of Study

The research adopted a convergent mixed methods research design for data collection and analysis. Both qualitative and quantitative data was collected concurrently. Qualitative data was collected purposively through in-depth interview with the three categories of stakeholders, and quantitative data was collected using a questionnaire. Comparing results from both the qualitative and quantitative data collected and analysed, showed the need for the adoption of a sustainable supply chain for the rice value chain towards food security in Nigeria. With the assistance of the ADP extension officers, the researcher was able to meet participants, while the ADP extension workers assisted in assembling the RIFAN members and guided some of them, who could not read or write, in comprehending and filling the survey instrument (questionnaire); this enabled the participants to answer the questions to the best of their knowledge. The study also indicated consistency in the internal reliability of the instrument. The limitation of this study was the sample population which was limited to just two local government areas among the rice producing states in the North Central region of Nigeria. An option for future research would be to use exploratory sequential mixed methods, where the outcome from the qualitative data collected through the interviews of the different categories of stakeholders, would inform the questions for the quantitative data. Although the model developed from the study can be applied to other food crops in Nigeria, the outcome from the research cannot be generalized to other rice-producing regions in Nigeria. This is because of the variance in the rice supply chain, rice cultivation, and the programmes adopted in different states towards food security. These limitations would be the basis for future research in exploring a sustainable supply chain for other food crops available in Nigeria, towards ensuring food security in the country.

7.5 The Value and Future of the Study

This contribution of this study to other research areas is multidimensional. The effective implementation of the outcome can enhance future research if such studies focus on this specific field or its stakeholders. The study contributes to supply chain management and the body of knowledge, generally, by conceptualizing the SCOR framework with the TBL framework, towards attaining food security in the North Central region of Nigeria. The study explored theoretical models and literature on supply chain management, the rice value chain, and sustainability, while empirical research was used for the scientific aspect of the study, with the aim of answering the research questions towards meaningfully contributing to the existing body of knowledge.

The empirical results showed the restraining forces influencing the supply chain of rice in the North Central region of Nigeria, and how the identified driving forces could improve the supply chain of rice towards food security. The empirical research indicates that, despite the demand for rice as a major staple food in Nigeria, stakeholders across the rice supply chain are struggling with productivity and profitability, which also results in food insecurity.

Stakeholder theory and Resource Dependency theory provided an understanding of the resources available to stakeholders, and their activities across the rice value chain; these theories also aided in the adoption of the triple bottom line model for sustainability across the rice supply chain for improving food security. The empirical findings revealed that the rice value chain runs on manual and outdated techniques; however, adopting sustainability across the rice value chain would enhance the activities of stakeholders, and help to effectively utilize the available resources in the drive for food security in Nigeria.

Evidence that emerged from the analysis of the data revealed that the adoption of a sustainable supply chain, could influence the rice value chain in the North Central region of Nigeria towards food security. This analysis identified the role and contribution of different stakeholders across the rice supply chain. It further identified technology as a major driver in the adoption of a sustainable supply chain for the rice value chain towards food security in Nigeria. Therefore, outcomes from this research can help supply chain professionals in collaboration with data scientists, to develop specific technological tools and mobile applications for small-scale rice farmers to improve their productivity. Also, supply chain professionals can introduce sustainability into the agricultural sector using the SCOR model. The study's outcomes will further help stakeholders adopt technology for sustainable decision-making and utilization of resources. The research shows the role of the government as a stakeholder in the rice value chain, offering insights to embrace and implement policies on the adoption of sustainable practices across the value chain, towards food security and the competitiveness of rice from Nigeria. Future research should look at the contributions of other stakeholders in the rice value chain, and how their activities can improve the value chain towards food security. Findings from the research can help in redesigning the value chain of rice in Nigeria. The proposed rice value chain can be tested and replicated on other food crops for improving food security in Nigeria.

7.6 Saturation and Triangulation

The point at which respondents were no longer providing new information about the subject, was identified by the researcher as data saturation. This is in line with authors like Fusch & Ness (2015, p. 1408) and Saunders et al. (2007, p. 499), who submit that data saturation is the point during data collection and analysis, when the researcher did not get new and relevant data from the respondents, there is no more allowance for further coding/analysis, and the study has sufficient information to reproduce itself. On average, saturation is often reached at the 13th interview (Mwita, 2022, p. 415). The researcher identifies depth in the information provided in comparison with initially drafted themes and documents the process to notice when no new and relevant information was provided. Saturation further assures the researcher the validity and credibility of the information provided by the respondents.

Data triangulation was adopted in this study, along with time triangulation, where data was collected at different times about the same phenomenon. The qualitative data was gathered first, after which the quantitative data was collected by drawing inference from the qualitative data (interviews) using questionnaire. Also, space triangulation was used because data was collected from different locations, namely, the Edu local government, Patigi local government, and ADP offices. Meanwhile, person triangulation was also used, in which data was collected from large-scale rice farmers, individual rice farmers from an association (RIFAN), and ADP extension workers. Methodological triangulation was adopted in this study by using both qualitative and quantitative data; this is further discussed below.

7.6.1 The Effects of the Driving and Restraining Forces Influencing the Rice Supply Chain in the North Central Region of Nigeria

The effects of the driving and restraining forces influencing rice supply chain in the North Central region of Nigeria, were explored by Research Question One. The outcome of the qualitative analysis indicates that restraining and driving forces did indeed influence the rice supply chain in the North Central region of Nigeria. Restraining forces such as high cost of labour and equipment, use of old rice farming techniques, poor funding, and pest invasions were identified. To improve the rice supply chain, driving forces such as the adoption of technology and new rice farming techniques, were proposed. Also, the training of farmers on farm management skills such as bookkeeping, use of equipment, improvement in literacy levels of RIFAN members, and reduction in labour cost would aid the rice supply chain. Government intervention was seen as a major influence on the rice supply chain. This could be through policy on rice production, subsidies for rice farmers, and provision of large farming equipment such as planters, harvesters, and tractors. Also, subsidies on input such as seedlings and fertilisers and access to loans for an enlarged capacity, could influence the rice supply chain. The quantitative analysis indicated that the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria, were significant (see Table 5-28 and Table5- 29).

7.6.2 How the Activities, Decisions of Stakeholders and Their Resources Improve the Food Security Aspect of the Underlying triple Bottom Line

Research Question Two investigated how the activities, resources, and decision-making related to the TBL can improve food security. With the outcome of the qualitative analysis, the activities of stakeholders were identified using the SCOR model, and the available resources were vetted against the TBL dimension. Training, visits, and monitoring provided by the ADP extension officers were identified as that stakeholder's activities that could improve food security. Government as a stakeholder could improve food security through interventions on financial resources, and provision of equipment through the extension office. Using quantitative data in the fuzzy AHP MCDM model, the decision-making of stakeholders was weighed against the TBL, and the outcome indicated that the adoption and prioritization of TBL practices in the decision-making of stakeholders would improve food security. The quantitative analysis indicated that the activities of stakeholders and their resources to improve the food security aspect of the underlying triple bottom line in the North central region of Nigeria, were significant (see Table 5-28 and Table5- 29).

7.6.3 Influence of Sustainable Supply Chain Management on the Competitive Performance of the Rice Value Chain Network

Research Question three was developed to identify the influence of sustainable supply chain management on the competitive performance of the rice value chain network. The outcome from the qualitative analysis showed that the major competitor of the rice value chain network was the international market. It also identified that sustainable supply chain management would influence the competitive performance of rice. Factors such as ethical standards, quality assurance platforms, and regulatory practices for RIFAN members and rice farmers would improve the competitive performance of the rice value chain network. The outcome of the hierarchical regression revealed that Sustainable Supply chain management (SSCM) would influence the competitive performance (CP) of the rice value chain network (see Table 5-33). The quantitative analysis indicates that sustainable supply chain management significantly influenced the competitive performance of the rice value chain network (see Table 5-28 and Table 5-29).

7.6.4 Strategic Role of Sustainable Supply Chain Management Policy Practices to Mitigate the Food Security Risks and Uncertainty

Research Question Four was developed to investigate the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty. The result of the qualitative analysis on the role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty, showed that the adoption of sustainable practices would improve food security. Factors such as sustainable sourcing, sustainable resource utilisation, transparency in resource allocation, monitoring and evaluation, silos, and focus on employee welfare and security would mitigate the food security risks and uncertainty. However, the quantitative analysis indicated that sustainable supply chain management policy practices did not significantly mitigate the food security risks and uncertainty (see Table 5-28 and Table 5-29).

7.6.5 Value Chain Model Influencing the Security of the Sustainable Food Supply Chain in the North Central Region of Nigeria

Research Question Five was developed to check the influence of the value chain model on the sustainable supply chain and food security in the North Central region of Nigeria. The outcome from the qualitative data identified the factors for the value chain model as stakeholder relationships, which can be built on the existing communication structure and transparency among stakeholders, to influence the sustainable food supply chain towards attaining food security in the North Central region of Nigeria. The quantitative analysis showed that that the factors considered in the value chain model that influence the security of the sustainable food supply chain in the North Central region of Nigeria, were significant.

7.7 Conclusion of Study

This research was aimed that developing a model for the adoption of a sustainable supply chain in the rice value chain, towards attaining food security in the North Central region of Nigeria. Responses were provided for the research questions from the qualitative and quantitative data analyses, which led to robust empirical findings for the research objectives, and from these, the following conclusions were derived.

7.7.1 Conclusion One

The research revealed that the retraining and driving forces identified through the literature review, influenced the rice supply chain in the North Central region of Nigeria. For instance, restraining forces such as the non-adoption of technology, poor pricing, lack of storage facilities, use of old techniques of rice farming, loss of output to birds, non-existence and instability of policies for rice farmers, and poor transport system impeded the rice supply chain. The findings also revealed that driving forces such as transparency among stakeholders and in allocation of resources, supply of input by government, access to and acceptance of training and development on the use of new techniques and technology, could enhance the rice supply chain. In this way, Research Objective One, which looked at the effects of the driving and restraining forces influencing the rice supply chain in the North Central region of Nigeria, was achieved.

7.7.2 Conclusion Two

Research Objective Two was aimed at understanding how the activities of stakeholders and their resources, determined the improvement of the food security aspect on the underlying triple bottom line. To achieve this, the research examined the activities of each category of stakeholders, who were the ADP extension workers, large-scale rice farmers, and small scale rice farmers. The research further looked at how sustainable practices were adopted in executing activities and in the allocation of resources, using the fuzzy-AHP MCDM model. The empirical findings indicated that the stakeholders had little knowledge of sustainable practices. However, the result indicated that adequate knowledge of the underlying triple bottom line, which is linked to sustainability, wouldimprove food security in the North central region of Nigeria. This answered Research Question Two on how the understanding of the activities of stakeholders and their resources, could improve the food security aspect of the underlying triple bottom line.

7.7.3 Conclusion Three

Research Objective Three was aimed at examining the extent to which sustainable supply chain management influenced the competitive performance of the rice value chain network. Data analysis revealed that there was a significant relationship between sustainable supply chain management and the competitive performance of the rice value chain. The empirical findings showed that the adoption of Sustainable Supply Chain Management (SSCM) would influence the competitive performance (CP) of the rice value chain network. This outcome achieved this research objective. By the same token, the hierarchical regression model revealed that SSCM would influence the competitive performance (CP) of the rice value chain network.

7.7.4 Conclusion Four

This conclusion was inferred from Research Objective Four, which was aimed at establishing the strategic role of sustainable supply chain management policy practices to mitigate the food security risks and uncertainty. The outcome of the qualitative data analysed revealed that the adoption of sustainable supply chain policies for the adoption of sustainable practices, would mitigate food security risks and associated uncertainties; however, inferential statistics showed that sustainable supply chain management policy practices did not significantly mitigate these.

7.7.5 Conclusion Five

Lastly, Research Objective Five was to develop the value chain model influencing the security of the sustainable food supply chain in the North Central region of Nigeria. The outcome from the data analysed revealed that the value chain model developed, would influence the sustainable supply chain for food security in the North Central region of Nigeria. The model revealed the influence of technological adoption, through government intervention, as a tool to drive sustainable practices across the food value chain, and how this would improve food security in the North Central region of Nigeria.

7.8 General Conclusion

The findings from this research have provided elaborate information on sustainable supply chain management and the adoption of sustainable practices, which are based on the Triple Bottom Line, towards the improvement of the rice value chain in the drive to attain food security. The aggregate impact of the three dimensions of the Triple Bottom Line, which are the environmental, economic, and social dimensions, was to ensure a supply chain for rice towards food security in Nigeria. The Sustainable Development Goals were unveiled in 2016 by the United Nations, consisting of 17 goals and 160 targets that must be achieved by 2030. The second goal on the list is to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture. One aim of this goal is that by 2030, the productivity and income of small-scale food producers such as women, indigenous people, family farmers, and pastoralist should double. These people must have access to land, resources, inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment. Also, the goal is aimed at ensuring that by 2030, there is sustainability in the systems of food production, and agricultural practices for improved productivity are employed, to ensure a sustainable ecosystem, drive a resilient adaptation structure for changes in the climate, droughts, flooding, and other natural disasters, and improve the quality of soil and land. This SDG that targets zero hunger formed the basis of this research, which was aimed at developing a model for the value chain of rice, which is a staple food in the North Central region of Nigeria and other countries/regions in the world.

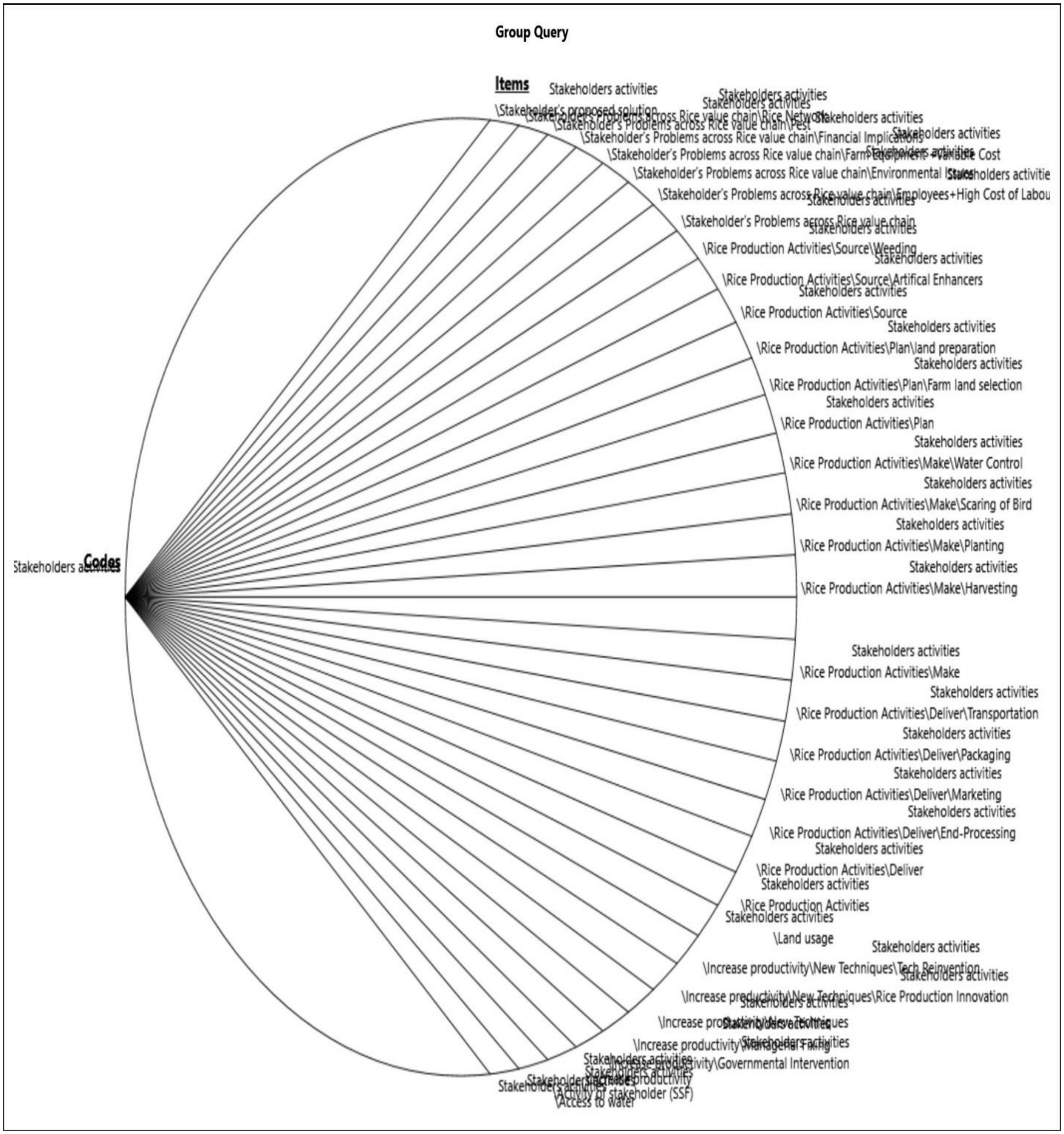
The study identified certain challenges facing stakeholders across the rice value, which may hinder the achievement of the set goals and target, especially in the North Central region of Nigeria, by focusing on two rice-cultivating local government areas in the region, namely, Edu and Patigi in Kwara State. The study focused on the participation of three categories of stakeholders in the rice value chain, which were ADP extension workers, and large- and small-scale rice farmers who were members RIFAN. Qualitative data was collected from 24 respondents across the three categories through interviews, while quantitative data was collected through questionnaires from 360 participants who were small-scale rice farmers. The qualitative data was analyzed using Nvivo and thematic analysis. The quantitative data was analyzed using SPSS from which descriptive and inferential statistics were obtained. The outcomes of the analyses formed the empirical research-based findings. The study confirmed the challenges that stakeholders across the rice value chain are faced with, which further hinder food security in the region; solutions were proposed, and the research questions answered.

The study confirmed the high dependence of rice stakeholders, especially the rice farmers, on the manual technique of rice cultivation, which leads to low productivity and profitability across the supply chain of rice, as well as food insecurity. Also, the causes for the poor acceptance and competitiveness of rice from the region were revealed; this cut across rice cultivated and produced in Nigeria in general. The study further revealed how the roles of each stakeholder and their relationships could improve the rice value chain, while a sustainable supply chain could improve the activities and decision-making of stakeholders in the rice value chain. It further identified the critical role of technology and government intervention in the adoption of a sustainable supply chain, for an improved rice value chain towards food security. The government should be expected to provide sustainable inputs, infrastructure such as roads, research and development centres, and a good healthcare system; it should also enact policies towards the improvement of stakeholders' activities, and the adoption of sustainable practices that can ensure transparency in resource allocation and traceability of such activities. This study further revealed the role of financial institutions and the critical role of extension workers in driving the adoption of a sustainable supply chain for an improved rice value chain.

Moreover, the research proposed a technologically driven value chain model that will demand the employment of the service of data scientists, artificial intelligence professionals, blockchain, and mobile applications that can be developed for rice farmers, to improve communication among stakeholders, give access to information on resources, traceability, transparency, and ensure a good platform for pricing; such mobile applications can enable the monitoring of activities and decision-making of stakeholders. Finally, the adoption of sustainable supply chain management in the value chain of rice can improve food security in North Central region of Nigeria, if stakeholders join a technology driven value chain.

APPENDIX A – TABLES AND FIGURES

Appendix 1: Group query diagram for stakeholder's activities



Appendix 2: Generated codes for Stakeholders activities

Codes Stakeholders activities	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Stakeholders activities					
Codes\\ Stakeholders activities \Rice Production	14	14	13	13	3

Activities\Plan\Farm land selection					
Codes\\ Stakeholders activities \Rice Production Activities\Plan\land preparation	31	31	22	22	6.62
Codes\\ Stakeholders activities \Rice Production Activities\Source\Weeding	43	43	23	23	9.19
Codes\\ Stakeholders activities \Rice Production Activities\Source\Artificial Enhancers	67	67	23	23	14.32
Codes\\ Stakeholders activities \Rice Production Activities\Make\Water Control	15	15	15	15	3.21
Codes\\ Stakeholders activities \Rice Production Activities\Make\Planting	30	30	21	21	6.41
Codes\\ Stakeholders activities \Rice Production Activities\Make\Scaring of Bird	15	15	15	15	3.21
Codes\\ Stakeholders activities \Rice Production Activities\Make\Harvesting	55	55	22	22	11.75
Codes\\ Stakeholders activities \Rice Production Activities\Deliver\End-Processing	3	3	2	2	0.64
Codes\\ Stakeholders activities \Rice Production Activities\Deliver\Packaging	37	37	22	22	7.91
Codes\\ Stakeholders activities \Rice Production Activities\Deliver\Marketing	14	14	12	12	2.99
Codes\\ Stakeholders activities \Rice Production Activities\Deliver\Transportation	21	21	20	20	4.49

Appendix 3: Generated codes for Stakeholders activities (B)

Codes Stakeholders activities	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Stakeholders activities/increase productivity					
Codes\\ Stakeholders activities \Increase productivity\New Techniques\Rice Production Innovation	5	5	5	5	1.06%
Codes\\ Stakeholders activities \Increase productivity\New Techniques\Tech Reinvention	6	6	6	6	1.28
Codes\\ Stakeholders activities \Increase productivity	3	27	3	22	0.64
Codes\\ Stakeholders activities	4	4	4	4	0.85

\Increase productivity\Governmental Intervention					
Codes\\ Stakeholders activities \Increase productivity\Managerial Fixing	6	6	6	6	1.28
Codes\\ Stakeholders activities \Increase productivity\New Techniques	3	14	3	14	0.64
Codes\\ Stakeholders activities \Increase productivity\New Techniques\Rice Production Innovation	5	5	5	5	1.07
Stakeholders activities/problems					
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain	3	44	3	23	0.64
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain\Employees+High Cost of Labour	12	12	12	12	2.56
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain\Environmental Issues	3	3	2	2	0.64
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain\Farm Equipment +Variable Cost	14	14	14	14	2.99
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain\Financial Implications	6	6	6	6	1.28
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain\Pest	5	5	3	3	1.07
Codes\\ Stakeholders activities \Stakeholder's Problems across Rice value chain\Rice Network	1	1	1	1	0.21
Codes\\ Stakeholders activities \Stakeholder's proposed solution	3	34	2	23	0.64
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Artificial Water Supplies	2	2	2	2	0.43
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Considerate Equipment Price	2	2	2	2	0.43
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Financial Assistance	1	1	1	1	0.21
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Governmental Intervention	5	16	5	16	1.07
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Governmental Intervention\Input Subsidy	11	11	11	11	2.35

Codes\\ Stakeholders activities \Stakeholder's proposed solution\Labour Cost Reduction	5	5	5	5	1.07
Codes\\ Stakeholders activities \Stakeholder's proposed solution\Production Cost Reductions	1	1	1	1	0.21

Appendix 4: Generated codes for food security

Codes Food security drive	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Food security drive\Government intervention	6	6	6	6	0.61
Codes\\Food security drive\International competitiveness	5	10	5	5	0.51
Codes\\Food security drive\International competitiveness\Quality assurance	5	5	5	5	0.51
Codes\\Food security drive\Productivity	6	6	6	6	0.61
Codes\\Food security drive\Transparency in resource allocation	6	6	6	6	0.61

Appendix 5: Generated codes for theme government intervention

Codes Government intervention	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Government intervention\Availability of output	6	6	6	6	0.61
Codes\\Government intervention\Government intervention	6	6	6	6	0.61
Codes\\Government intervention\Grading system	6	6	6	6	0.61

Appendix 6: Generated codes for theme interactions with extension office

Codes Interactions with extension office	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Interaction from extension office\Access to resources	7	7	6	6	0.71
Codes\\Interaction with extension office\Available resources	7	7	6	6	0.71
Codes\\Interaction with extension office\Numbers of Interactions	7	7	6	6	0.71
Codes\\Interaction with extension	7	7	6	6	0.71

office\Stakeholder's activity					

Appendix 7: Generated codes for theme regulatory activities

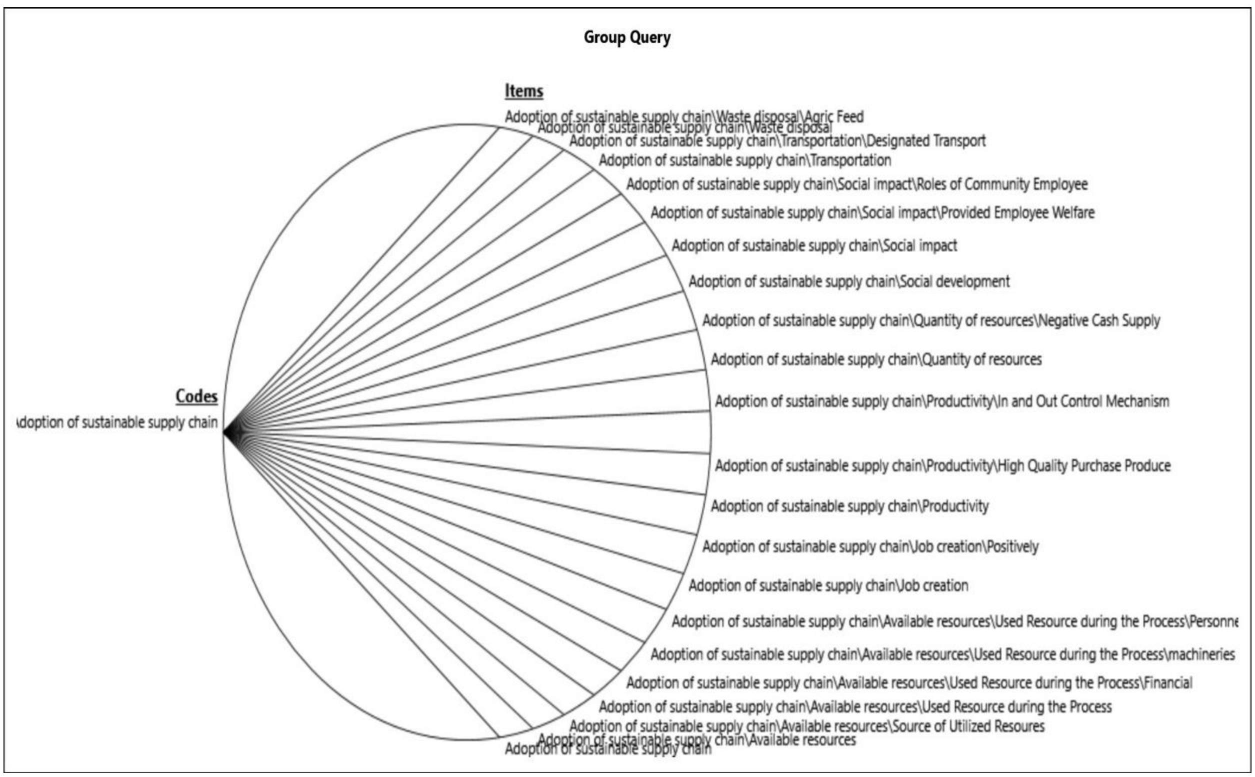
Codes Regulatory activities	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Regulatory activities\Ethical standards	9	9	6	6	0.92
Codes\\Regulatory activities\Food availability	7	7	6	6	0.71

Appendix 8: Generated codes for theme Adoption of sustainable supply chain

Codes Adoption of sustainable supply chain	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Adoption of sustainable supply chain\Available resources	1	26	1	6	0.10
Codes\\Adoption of sustainable supply chain\Available resources\Source of Utilized Resources	6	6	6	6	0.61
Codes\\Adoption of sustainable supply chain\Available resources\Used Resource during the Process\Financial	6	6	4	4	0.61
Codes\\Adoption of sustainable supply chain\Available resources\Used Resource during the Process\machineries	6	6	5	5	0.61
Codes\\Adoption of sustainable supply chain\Available resources\Used Resource during the Process\Personnel	7	7	5	5	0.71
Codes\\Adoption of sustainable supply chain\Job creation	1	6	1	6	0.10
Codes\\Adoption of sustainable supply chain\Job creation\Positively	5	5	5	5	0.51
Codes\\Adoption of sustainable supply chain\Productivity	1	6	1	6	0.10
Codes\\Adoption of sustainable supply chain\Productivity\High Quality Purchase Produce	3	3	3	3	0.31
Codes\\Adoption of sustainable supply chain\Quantity of resources	1	5	1	5	0.10
Codes\\Adoption of sustainable supply chain\Quantity of resources\Negative Cash Supply	4	4	4	4	0.41
Codes\\Adoption of sustainable	6	6	6	6	0.61

supply chain\Social development					
Codes\\Adoption of sustainable supply chain\Social impact\Provided Employee Welfare	5	5	5	5	0.51
Codes\\Adoption of sustainable supply chain\Social impact\Roles of Community Employee	2	2	2	2	0.20
Codes\\Adoption of sustainable supply chain\Transportation	1	6	1	6	0.10
Codes\\Adoption of sustainable supply chain\Transportation\Designated Transport	5	5	5	5	0.51
Codes\\Adoption of sustainable supply chain\Waste disposal	1	7	1	6	0.10
Codes\\Adoption of sustainable supply chain\Waste disposal\Agric Feed	6	6	5	5	0.61

Appendix 9 Group query diagram for theme Adoption of sustainable supply chain



Appendix 10: Generated codes for theme rice value chain competitiveness

Codes Rice value chain competitiveness	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage

Codes\\Rice value chain competitiveness\Access to financial resources	6	8	6	6	0.61
Codes\\Rice value chain competitiveness\Competitors	1	6	1	6	0.10
Codes\\Rice value chain competitiveness\Competitors\external businesses	5	5	5	5	0.51
Codes\\Rice value chain competitiveness\Ethical standards	1	6	1	6	0.10
Codes\\Rice value chain competitiveness\Ethical standards\Inexistence	5	5	5	5	0.51
Codes\\Rice value chain competitiveness\International competitiveness\Government Intervention	2	2	2	2	0.20
Codes\\Rice value chain competitiveness\International competitiveness\Production Improvement	3	3	3	3	0.31
Codes\\Rice value chain competitiveness\Regulatory intervention	6	7	6	6	0.61
Codes\\Rice value chain competitiveness\Regulatory intervention\Effect of Governmental Polices	1	1	1	1	0.1

Appendix 11: Generated codes for theme stakeholder's resources

Codes Stakeholder's resources	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Stakeholders resources\Activity of Stakeholders	1	6	1	6	0.10
Codes\\Stakeholders resources\Activity of Stakeholders\Market	4	4	4	4	0.41
Codes\\Stakeholders resources\Activity of Stakeholders\Marketers	1	6	1	6	0.51
Codes\\Stakeholders resources\Available Equipment	1	14	1	6	0.11
Codes\\Stakeholders resources\Available Equipment\Heavy machinery	8	8	5	5	0.82
Codes\\Stakeholders resources\Available Equipment\Simple Tools	5	5	5	5	0.51
Codes\\Stakeholders resources\Government Intervention	1	11	1	6	0.11
Codes\\Stakeholders	3	3	3	3	0.31

resources\Government Intervention\Financial Linkage					
Codes\\Stakeholders resources\Government Intervention\Market Linkage	1	3	1	3	0.11
Codes\\Stakeholders resources\Government Intervention\Produce Sustainability	1	1	1	1	0.11
Codes\\Stakeholders resources\Government Intervention\Subsidy creation	3	3	3	3	0.31
Codes\\Stakeholders resources\Linked with (Activity of Stakeholder)	1	9	1	6	0.10
Codes\\Stakeholders resources\Linked with (Activity of Stakeholder)\Clients	2	2	2	2	0.20
Codes\\Stakeholders resources\Linked with (Activity of Stakeholder)\Fellow Farmers	6	6	5	5	0.61
Codes\\Stakeholders resources\Problems in Production	1	9	1	6	0.10
Codes\\Stakeholders resources\Problems in Production\Cost of Acquisition	3	3	3	3	0.31
Codes\\Stakeholders resources\Problems in Production\Running Expenses	5	5	5	5	0.51
Codes\\Stakeholders resources\Productivity and profitability	1	6	1	6	0.10
Codes\\Stakeholders resources\Productivity and profitability\Negative	5	5	5	5	0.51

Appendix 12: Generated codes for theme improved rice value chain

Codes Improved rice value chain	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Improved rice value chain	12	12	12	12	1.22

Appendix 13: Generated codes for theme rice supply chain

Codes Rice supply chain	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\ rice supply chain\access to input	12	12	12	12	1.22
Codes\\ rice supply chain\Access to Loans	11	11	11	11	1.12

Codes\\rice supply chain\Relationship with ADP extension workers	12	12	12	12	1.22
Codes\\rice supply chain\supply of produce	13	25	12	12	1.22

Appendix 14: Generated codes for theme sustainable resource utilisation

Codes Sustainable resource utilisation	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\sustainable resource utilization\Access to equipment and tools	12	28	12	12	1.22
Codes\\sustainable resource utilization\Access to equipment and tools\Efficiency of equipment\Hire	4	4	4	4	0.41
Codes\\sustainable resource utilization\Activity of stakeholders	12	12	12	12	1.22
Codes\\sustainable resource utilization\Improved productivity	13	13	12	12	1.33
Codes\\sustainable resource utilization\Job creation	12	12	12	12	1.22
Codes\\sustainable resource utilization\Labour productivity	13	13	12	12	1.22

Appendix 15: Generated codes for theme sustainable sourcing

Codes Sustainable sourcing	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Sustainable sourcing\Government intervention	12	12	12	12	1.22
Codes\\Sustainable sourcing\Grading system	12	12	12	12	1.22
Codes\\Sustainable sourcing\Quality of input	12	12	12	12	1.22
Codes\\Sustainable sourcing\Problems faced by stakeholder\Employee Cost	2	2	2	2	0.20
Codes\\Sustainable sourcing\Problems faced by stakeholder\Financial Reasons	1	1	1	1	0.10
Codes\\Sustainable sourcing\Problems faced by stakeholder\Herdsmen	6	6	6	6	0.61
Codes\\Sustainable sourcing\Problems faced by stakeholder\Pest	5	5	5	5	0.51
Codes\\Sustainable sourcing\Problems faced by	12	12	12	12	1.22

stakeholder\Process Cost					

Appendix 15: Generated codes for theme stakeholder's relationship

Codes Stakeholder's relationship	Number of coding references	Aggregate number of coding references	Number of items coded	Aggregate number of items coded	coverage
Codes\\Stakeholders relationship\Marketing and distribution	1	6	1	6	0.10
Codes\\Stakeholders relationship\Marketing and distribution\local marketers	1	1	1	1	0.10
Codes\\Stakeholders relationship\Marketing and distribution\local Vendors	4	4	4	4	0.41
Codes\\Stakeholders relationship\Stakeholder Relationship Perception	1	11	1	6	0.10
Codes\\Stakeholders relationship\Stakeholder Relationship Perception\Means of Improving SH relationship	1	5	1	5	0.10
Codes\\Stakeholders relationship\Stakeholder Relationship Perception\Relationship Stance\Good Relationship	5	5	5	5	0.51

Appendix 16: Activity (units) of participants

Options	Percent	Valid percent	Cumulative percent
Two options	18.9	18.9	18.9
Three options	76.4	76.4	95.3
Four options	4.7	4.7	100.0
Total	100.0	100.0	

Source: Author's own compilation

Appendix 17: Statistics for question 'which of the following do you do?

N	Valid	360
	Missing	0
Mean		6.8583
Median		7.0000
Std. Deviation		.46545
Skewness		-470
Std. Error of skewness		.129

Appendix 18: Gender

	Percentage
Male	94.2

Female	0.6
Prefer not to say	5.3
Total	100.0

Source: Author's own compilation

Appendix 19: Statistics for gender

N	Valid	341
	Missing	19
Mean		1.0059
Median		1.0000
Std. Deviation		.7647
Skewness		13.000
Std. error of skewness		.132

Appendix 20: Respondent's years of involvement in rice farming

	Frequency	percentage
Less than 1 year	0	0
1-3 years	0	0
4-6	1	0.3
7-10	118	32.8
Over 10 years	237	65.8
Total response	356	98.9
Missing value	4	1.1
Total	360	100

Source: Author's own compilation

Appendix 21: Statistics on year of involvement

N	Valid	356
	Missing	4
Mean		4.6629
Median		5.0000
Std. Deviation		.47929
Skewness		-769
Std. error of skewness		.129

Appendix 22: Statistics for employment status

	Frequency	percentage
Owner/ employer	290	80.6
Employee	35	9.7
Apprentice	0	0
Contractor	0	0
Total	325	90.3
Missing	35	9.7
Total	360	100

Source: Author's own compilation

Appendix 23: Statistics for employment status

N	Valid	325

	Missing	35
Mean		1.1077
Median		1.0000
Std. Deviation		.31047
Skewness		2.543
Std. error of skewness		.135

Appendix 24: Number of workers in different categories

	Frequency	Percent	Valid percent	Cumulative percent
Partner	28	7.8	7.8	7.8
Employee	122	33.9	33.9	41.7
Apprentice	160	44.4	44.4	86.1
Contractors	50	13.9	13.9	100.0
Total	360	100.0	100.0	

Source: Author's own compilation

Appendix 25: Statistics for categories of employees

N	Valid	360
	Missing	0
Mean		2.6444
Median		3.0000
Std. Deviation		.81505
Skewness		-132
Std. error of skewness		.129

Appendix 26: Distribution of Location

location	Frequency	Percentage
Patigi	173	48.1
Edu	181	50.3
None	0	0
Total	354	98.3
Missing value	6	1.7
Total	360	100.0

Source: Author's own compilation

Appendix 27: Statistics for location

N	Valid	354
	Missing	6
Mean		1.5113
Median		2.0000
Std. Deviation		.5006
Skewness		-045
Std. error of skewness		.130

Appendix 28: Distribution of educational qualification of participants

	Frequency	percentage
Primary	97	28.3
O'level	147	42.9
OND	33	9.6

HND	29	8.5
Bsc	36	10.5
Msc	1	0.3
PhD	0	0
Total	343	95.3
Missing value	17	4.7
Total	360	100

Source: Author's own compilation

Appendix 29: Statistics for educational qualification

N	Valid	343
	Missing	17
Mean		2.31
Median		2.0000
Std. Deviation		1.27
Skewness		.97
Std. error of skewness		.132

Appendix 30: Age of participants

Years	Frequency	Percentage
18-25	13	3.6
26-35	43	11.9
36-45	181	50.3
46 and above	123	34.2
Total	360	100.0

Source: Author's own compilation

Appendix 31: statistics for age of participants

N	Valid	360
	Missing	0
Mean		3.15
Median		3.00
Std. Deviation		.7647
Skewness		-750
Std. error of skewness		.129

Appendix 32

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1	I have access to use of technological such as drones, spraying taps, robots and machineries or tools I don't have to operate manually	27 (7.5%)	276 (76.7%)	51 (14.2%)	5 (1.4%)		
2	There is a generally fixed pricing or grading system for my produce which is common among other farmers	53 (14.7%)	170 (47.2%)	130 (36.1%)	5 (1.4%)		1 (0.3%)
3	There is transparency between me and	1 (0.3%)	5 (1.4%)	20	171	162	

	other farmers that I interact with (e.g. rice planters, harvesters, ground preparers, processors or owners of warehouse or storage facilities)			(5.6%)	(47.6%)	(45%)	
4	The government through extension workers provide me with quality fertilizers and seedlings/ tractors or planters/ irrigation that helps me produce quality rice.		31 (8.6%)	65 (18.1%)	172 (47.9%)	32 (8.9%)	59 (16.4%)
5	There local government provides sufficient storage facilities for storing paddy/rice	29 (8.1%)	326 (90.6%)	3 (0.8%)			1 (0.3%)
6	There is good transportation system such as road and vehicle to move our produce from one place to another	99 (27.5%)	187 (51.9%)	63 (17.5%)	2 (0.6%)	8 (2.2%)	
7	The government organize trainings for us on how to improve production		1 (0.3%)	1 (0.3%)	259 (71.9%)	98 (27.2%)	
8	I always have access to seedlings and fertilizers made available by the government anytime I need them		56 (15.6%)	60 (16.7%)	165 (45%)	78 (21.7%)	
9	The policies made by the government on rice production improves my productivity and profitability	24 (6.7%)	203 (56.4%)	56 (15.6%)	61 (16.9%)	15 (4.2%)	
10	The policies of the government on rice production is stable and favourable	24 (6.7%)	252 (70.0%)	11 (3.1%)	60 (16.7%)	12 (3.3%)	
11	There is transparency in allocation of resources and inputs	12 (3.3%)	233 (64.7%)	10 (2.8%)	15 (4.2%)	89 (24.7%)	
12	Through trainings and introduction of new machineries by the government, I've developed new systems of farming		18 (5.0%)	32 (8.9%)	160 (44.4%)	89 (24.7%)	60 (16.7%)
13	I still use my old methods and equipment for farming		26 (7.2%)	1 (.3%)	82 (22.8%)	236 (65.6%)	14 (3.9%)
14	I am willing to learn new system of farming as long as it will increase my production				1 (.3%)	183 (50.8%)	175 (99.7%)
15	I am willing to embrace new technologies as long as it improves my productivity		1 (0.3%)		2 (0.6%)	240 (66.7%)	116 (32.2%)
16	I lose most of my produce to pests, rodents and the likes	5 (1.4%)	103 (28.6%)	103 (28.6%)	145 (40%)	2 (0.6%)	1 (0.3%)
17	Because I don't know what is going on in the big cities about rice, I just sell at any price the big buyers want		14 (3.9%)	36 (10.0%)	17 (4.7%)	214 (59.4%)	78 (21.7%)

Appendix 33

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
18	I use natural fertilizers for planting		47 (13.1%)	31 (8.6%)	76 (21.1%)	203 (56.4%)	2 (0.6%)

19	I use farmer-produce seeds or certified labelled seeds		1 (0.3%)	4 (1.1%)	142 (39.4%)	207 (57.5%)	4 (1.1%)
19	I treat my seeds before planting to avoid diseases in seedlings and crops and improve quality of my crops	1 (0.3%)	128 (35.6%)	47 (13.1%)	83 (23.1%)	43 (11.9%)	57 (15.8%)
20	I measure the moisture content of rice grain that I harvest or obtain from harvesters	5 (1.4%)	248 (68.9%)	14 (3.9%)	11 (3.1%)	81 (22.5%)	
21	I always prepare the land after each harvest		6 (1.7%)	2 (0.6%)	37 (10.3%)	256 (71.1%)	57 (15.8%)
22	To ensure water management I construct field channels to avoid excessive flow of water from or to the field		22 (6.1%)	1 (0.3%)	13 (3.6%)	269 (74.7%)	53 (14.7%)
23	I ensure weed management so that I can have prevent losses and have good quality grain		1 (0.3%)	14 (3.9%)		335 (93.1%)	9 (2.5%)
24	To ensure good management of crops extension officers help in controlling pests and disease		11 (3.1%)	44 (12.3%)	103 (28.6%)	192 (53.5%)	9 (2.5%)
25	I harvest and thresh grains manually			3 (0.8%)	71 (19.8%)	255 (71.0%)	30 (8.4%)
26	After harvest, I sun dry my grains on mats and pavement		9 (2.5%)	1 (0.3%)	45 (12.5%)	295 (81.9%)	9 (2.5%)
27	Inputs and fertilizers are easily available and affordable	10 (2.8%)	72 (20.0%)	98 (27.2%)	102 (28.3%)	77 (21.4%)	
28	I can afford to employ more workers to increase my productivity		19 (5.3%)	60 (16.7%)	250 (69.4%)	30 (8.3%)	
29	I trust the quality of grains I get from the harvesters/ I trust the quality seedlings and other inputs I get from suppliers		5 (1.4%)	2 (0.6%)	48 (13.3%)	304 (84.4%)	
30	I make good sufficient profit/ well paid after my activity as a land prepare, planter, harvester, processor or plant		95 (26.5%)	71 (19.7%)	163 (45.3%)	30 (8.3%)	
32	Government provides a good platform for payment of taxes	4 (1.1%)	318 (88.8%)	29 (8.1%)	5 (1.4%)	2 (0.6%)	
33	I have different suppliers I get grain from/ that I supply grains to			3 (0.8%)	163 (53.3%)	192 (53.3%)	
34	I have access to improve my skills and knowledge often		32 (8.9%)	126 (35.2%)	182 (50.8%)	18 (5%)	
35	I have access to good machineries and equipment that increase my level of productivity	11 (3.1%)	268 (74.4%)	28 (7.8%)	52 (14.4%)		
36	I have access to good financing opportunities such as access to loans and credit facilities	3 (0.8%)	207 (57.5%)	11 (3.1%)	63 (17.5%)	74 (20.6%)	
37	I increase my productivity often		5 (1.4%)	69 (19.2%)	250 (69.4%)	32 (8.9%)	1 (0.3%)
38	I and others working for/ with me have access to good hospitals	2 (0.6%)	184 (51.1%)	94 (26.1%)	32 (8.9%)	47 (13.1%)	
39	The environment I work is safe and not under any attack of animals or herdsmen	26 (7.2%)	203 (56.4%)	29 (8.1%)	41 (11.4%)	58 (16.1%)	
40	There is good supply of electricity so I use less fuel daily	123 (34.2%)	119 (33.1%)	103 (28.6%)	10 (2.8%)		
41	I don’t experience soil erosion and pollution	1 (0.3%)	139 (38.6%)	66 (18.3%)	93 (25.8%)	60 (16.7%)	

Appendix 34

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
42	I easily get my inputs from different suppliers		3 (0.8%)	4 (1.1%)	141 (39.2%)	211 (58.6%)	
43	The inputs I get are of good quality and makes me have good and quality rice grains		8 (2.2%)	90 (25.0%)	258 (71.7%)	2 (0.6%)	1 (0.3%)
44	I get information easily about other sources of supplier		4 (1.1%)	9 (2.5%)	127 (35.5%)	217 (60.3%)	1 (0.3%)
45	I am able to easily transport and deliver my produce to buyer	6 (1.7%)	111 (30.8%)	78 (21.7%)	148 (41.1%)	13 (3.6%)	3 (0.8%)
46	My produce has good quality so it is highly demanded by buyers				20 (5.6%)	337 (93.6%)	2 (0.6%)
47	The extension office often check for the quality of my rice grain before I sell them	7 (1.9%)	263 (73.1%)	70 (19.4%)	14 (3.9%)	5 (1.4%)	

Appendix 35

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
48	There are set policies, rules and regulations guiding set by the government for the activities of rice farmers	5 (1.4%)	339 (94.2%)	11 (3.1%)	1 (0.3%)	1 (0.3%)	
49	The government grant rice farmers loans grants and subsidies to improve rice production		6 (1.7%)	3 (0.8%)	56 (15.6%)	293 (81.4%)	
50	The government provide and train rice farmers with the use of new technological tools that can improve productivity		12 (3.3%)	3 (0.8%)	57 (15.8%)	288 (80%)	
51	There is good storage system for rice grains after processing	25 (6.9%)	273 (75.8%)	51 (14.2%)	10 (2.8%)	1 (0.3%)	
52	There is easy access to processing and threshing facilities	2 (0.6%)	83 (23.1%)	28 (7.8%)	221 (61.4%)	24 (6.7%)	1 (0.3%)
		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
53	There is easy communication between those I supply to and those I get inputs from			1 (1%)	136 (37.8%)	220 (61%)	3 (.8%)
54	I easily access the local rice grain collectors to market my processed grains		6 (1.7%)	2 (.6%)	113 (31.4%)	237 (65.8%)	2 (.6%)

55	The interest rates on loans from the bank are easily repayable	8 (2.2%)	210 (58.3%)	40 (11.1%)	79 (21.9%)	23 (6.4%)	
56	There is transparency in making grants, loans and funds available to rice farmers	11 (3.1%)	333 (92.5)	14 (3.9%)	1 (.3%)	1 (.3%)	
57	The extension workers are well trained and have good understanding of the rice production process		11 (3.1%)	1(.3%)	114 (31.7%)	233 (64.7%)	1 (.3%)

Appendix 36: Assessment, the standard values, corresponding triangular fuzzy number with the inverse values.

Definition	Standard values	Fuzzy number	Inverse values of the fuzzy number
Disagree	1	1,1,1	1/1,1/1,1/1
Slightly agree	3	1,3,5	1/5,1/3,1/1
Agree	5	3,5,7	1/7,1/5,1/3
Strongly agree	7	5,7,9	1/9,1/7,1/5
Extremely agree	9	7,9,11	1/11,1/9,1/7
Intermediate values	2,4,6,8	(1,2,4),(3,4,5)(5,6,7)(7,8,9)	(1/4,1/2,1/1),(1/5,1/4,1/3),(1/7,1/6,1/5),(1/9,1/8,1/7)

Appendix 37: Ccorresponding assessment using Satty scale, and Triangular fuzzy scale

Assessment	Weighting	Importance intensity (Satty Scale)	Triangular fuzzy scale	Triangular fuzzy reciprocal
Slightly Agree	30	3	2, 3, 4	¼,1/3,1/2
Agree	50	5	4,5,6	1/6,1/5,1/4
Slightly Agree	30	3	2,3,4	¼,1/3,1/4
Disagree	10	1	1,1,1	1,1,1
Slightly Agree	30	3	2,3,4	¼,1/3,1/2
Agree	50	5	4,5,6	1/6,1/5,1/4
Disagree	10	1	1,1,1	1,1,1

Appendix 38: Averaged weight criterion (Mi) and Normalized weight criterion (Ni) of each of the assessment

Rating	Mi	Ni	Rank
R1	0.048	0.045	6
R2	0.096	0.089	4
R3	0.167	0.155	3
R4	0.096	0.089	4
R5	0.239	0.221	2
R6	0.057	0.053	5
R7	0.377	0.349	1
Total	1.080		

Appendix 39: Corresponding assessment of respondent 1 on Environmental Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Water usage	0.349	1
C5	Land usage	0.221	2
C3	Weed management	0.155	3
C2	Processing method	0.089	4
C1	Power usage	0.045	6
C6	Grain wastage	0.053	5
C4	Seed selection	0.089	4

Appendix 40: Corresponding assessment of respondent 1 on Economic Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Supplier diversity	0.349	1
C1	Transparency	0.045	6
C2	Quality input	0.089	4
C6	Loan repayment	0.053	5
C5	Adoption of new technology	0.221	2
C4	Financial decisions	0.089	4
C3	Profitability	0.155	3

Appendix 41: Corresponding assessment of respondent 1 on Social Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C1	Quality assurance	0.045	6
C3	Storage system	0.155	3
C5	Job creation	0.221	2
C4	Skill acquisition decision	0.089	4
C7	Safe working environment	0.349	1
C2	Government intervention	0.089	4
C6	Tax payment	0.053	5

Appendix 42: Corresponding assessment of respondent 2 on Environmental Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Water usage	0.349	1
C2	Land usage	0.089	4
C3	Weed management	0.155	3
C5	Processing method	0.221	2
C6	Power usage	0.053	5
C1	Grain wastage	0.045	6
C4	Seed selection	0.089	4

Appendix 43: Corresponding assessment of respondent 2 on Economic Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Supplier diversity	0.349	1
C1	Transparency	0.045	6
C2	Quality input	0.089	4
C6	Loan repayment	0.053	5
C5	Adoption of new technology	0.221	2
C3	Financial decisions	0.155	3
C4	Profitability	0.089	4

Appendix 44: Corresponding assessment for respondent 2 on Social Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C1	Quality assurance	0.045	6
C2	Storage system	0.089	4
C5	Job creation	0.221	2
C3	Skill acquisition decision	0.155	3
C7	Safe working environment	0.349	1
C6	Government intervention	0.053	5
C4	Tax payment	0.089	4

Appendix 45: Corresponding assessment for respondent 3 on Environmental Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Water usage	0.349	1
C5	Land usage	0.221	2
C2	Weed management	0.089	4
C3	Processing method	0.155	3
C1	Power usage	0.045	6
C6	Grain wastage	0.053	5
C4	Seed selection	0.089	4

Appendix 46: Corresponding assessment for respondent 3 on Economic Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Supplier diversity	0.349	1
C1	Transparency	0.045	6
C2	Quality input	0.089	4
C6	Loan repayment	0.053	5
C5	Adoption of new technology	0.221	2
C3	Financial decisions	0.155	3
C4	Profitability	0.089	4

Appendix 47: Corresponding assessment for respondent 3 on Social Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C1	Quality assurance	0.045	6
C2	Storage system	0.089	4
C7	Job creation	0.349	1
C3	Skill acquisition decision	0.155	3
C5	Safe working environment	0.221	2
C6	Government intervention	0.053	5
C4	Tax payment	0.089	4

Appendix 48: Corresponding assessment for respondent 4 on Environmental Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Water usage	0.349	1
C2	Land usage	0.089	4
C3	Weed management	0.155	3
C5	Processing method	0.221	2
C1	Power usage	0.045	6
C6	Grain wastage	0.053	5
C4	Seed selection	0.089	4

Appendix 49: Corresponding assessment for respondent 4 on Economic Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Supplier diversity	0.349	1
C6	Transparency	0.053	5
C2	Quality output	0.089	4
C1	Loan repayment	0.045	6
C3	Adoption of new technology	0.155	3
C4	Financial decisions	0.089	4
C5	Profitability	0.221	2

Appendix 50: Corresponding assessment as carried out by 4th respondent, Social Criteria, Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C2	Quality assurance	0.089	4
C3	Storage system	0.155	3
C5	Job creation	0.221	2
C4	Skill acquisition decision	0.089	4
C7	Safe working environment	0.349	1
C1	Government intervention	0.045	6
C6	Tax payment	0.053	5

Appendix 51: Corresponding assessment for respondent 5 on Environmental Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Water usage	0.349	1
C5	Land usage	0.221	2
C2	Weed management	0.089	4
C3	Processing method	0.155	3
C4	Power usage	0.089	4
C1	Grain wastage	0.045	6
C6	Seed selection	0.053	5

Appendix 52: Corresponding assessment for respondent 5 on Economic Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C7	Supplier diversity	0.349	1
C2	Transparency	0.089	4
C3	Quality input	0.155	3
C1	Loan repayment	0.045	6
C5	Adoption of new technology	0.221	2
C6	Financial decisions	0.053	5
C4	Profitability	0.089	4

Appendix 53: Corresponding assessment for respondent 5 on Social Criteria for Normalized weight criterion and the corresponding rank

Rating	Criteria	Ni	Rank
C2	Quality assurance	0.089	4
C3	Storage system	0.155	3
C5	Job creation	0.221	2
C4	Skill acquisition decision	0.089	4
C7	Safe working environment	0.349	1
C1	Government intervention	0.045	6
C6	Tax payment	0.053	5

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APPENDIX B- INTERVIEW SCHEDULE

Information Sheet and Consent to Participate in Research

Date: 06 October 2021

Greeting,

My name is Adenike Oluyemi Bello from the School of Management, Information Technology and Governance of the University of KwaZulu Natal (UKZN). My contact details are +27739388879 and 219096260@stu.ukzn.ac.za. My Supervisor's contact details are: Dr. Thokozani P Mbhele +27312607524 and mbhelet@ukzn.ac.za

You are being invited to consider participating in a study that involves research in Sustainable Supply Chain towards Managing Food Security of Rice in the North Central Nigeria (former title: Improving food security through Sustainable Management of Rice Supply Chain in North central region, Nigeria). The purpose of this survey is to solicit for information from rice farmer stakeholders regarding rice supply chain. The information and ratings will help us identify forces for and against rice supply chain and aid ensuring sustainability supply chain of rice with the aim of ensuring food security in the North central region of Nigeria. The study is expected to enroll 385 participants, 25 actors will be interviewed and questionnaire will be administered to 360 rice farmers. It will involve the following procedures: answering some questions verbally or filling of questionnaires provided and returning same to the researcher once you complete filling it. The duration of your participation if you choose to enroll and remain in the study is expected to be between 10-15 minutes.

The study does not involve any risk or discomfort. This study will provide no direct benefits to participants, but I hope to identify forces for and against rice supply chain and aid ensuring sustainability supply chain of rice with the aim of ensuring food security in the North central region of Nigeria. The results of this questionnaire are intended to contribute to expanding body of academic knowledge and provide information on ensuring sustainability in the supply chain of rice in Nigeria.

This study (will be) has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number HSSREC/00003546/2021).

In the event of any problems or concerns/questions you may contact the researcher at +27739388879 or 219096260@stu.ukzn.ac.za or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Your participation in this research is voluntary and by participating, you are granting the researcher the permission to use your response. Also you may withdraw participation at any point, and in the event of refusal/withdrawal of your participation you will not incur penalty or loss of treatment. There will be no monetary gain from participating in this study. Your anonymity will be maintained by the researcher and he School of Management, Information Technology and Governance and your response will not be used for any other purpose aside this study.

Both electronic and hard copy data will be securely stored during the study and archived for 5 years and will be destroyed after then.

If you have any questions or concerns about been a part of the study, please feel free to contact myself or my supervisor with the contacts stated above.

Kind regards,

[redacted]

Adenike Oluyemi Bello

CONSENT

I………………………………………………………….have been informed about the study entitled Sustainable Supply Chain towards Managing Food Security of Rice in the North Central Nigeria (Improving food security through Sustainable Management of Rice Supply Chain in North central region, Nigeria) by Adenike Oluyemi Bello.

I understand the purpose and procedures of the study.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any of the benefits that I usually am entitled to.

I have been informed no compensation is available in the process of the study.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher.

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

____________________ ____________________

Signature of Participant **Date**

A. Interview questions for seven large scale farmers

Questions in line with RQ1	a. Can you explain to us the activities of in rice production? b. Which of these do you engage in? c. What problems do you encounter during this process of rice production?? d. How can these problems be solved? e. How can your production of rice increase?
Questions in line with RQ2	a. Who are the other people you interact with during the process of production? b. What machineries or equipment do you use? c. What problems do you encounter with them? d. Do you think what you produce is sufficient for marketing and distribution? e. Who do you supply your produce to? f. What do you think the government can do to improve your production capacity?
Questions in line with RQ3	a. Who are your competitors? b. What do you think can improve your participation in the

	international market? c. What are the government policies guiding your production and how do they impact on your production? d. Are there ethical standards set by the government to guide your activities e. Do you have access to loans and credit facilities?
Questions in line with RQ4	a. What resources do you utilize during this process and how/ where do you get them from? b. Do you enjoy sufficient supply of such? c. How do you ensure quality in your inputs and your outputs? d. What do you do with the waste? e. How do you transport your produce? f. Does your production affect the community negatively? g. How many people within this local community do you provide jobs for and what roles do they play? h. What welfare scheme do you provide for them?
Questions in line with RQ5	a. What does the relationship across your stakeholders look like and how can you improve it so as to improve productivity? b. How do you ensure smooth distribution of your produce?

B. Interview questions for 12 small scale farmers

Questions in line with RQ1	a. Can you explain to us the activities of in rice production? b. Which of these do you engage in? c. What problems do you encounter during this process of rice production? d. How can these problems be solved? e. How can your production of rice increase? f. What is the size of your farm land? g. Do you have regular supply to water supply?

Questions in line with RQ2	a. What is your weekly production capacity? b. How many people are working with you? c. Who are those you interact with during this process? d. What equipment and machineries do you use? e. How do you get them? f. How do you think you can improve your production capacity?
Questions in line with RQ3	a. How do you get your seedlings and fertilizers? b. Do you have access to loans from the bank? c. What does ADP (extension officers) do for you? d. Who do you supply your produce to? e. How do you move your produce to those you supply to?
Questions in line with RQ4	a. What is the quality of seedlings and fertilizers you use? b. What are the challenges you face in rice farming? c. Is there a stable grading system or price you sell to the big farmers? d. What help is the government offering to ensure you increase your production?
Questions in line with RQ5	a. How do you think you can improve your interactions with other stakeholders you relate with so that your production can improve?

C. Interview questions for six actors from ADP extension

Questions in line with RQ1	a. Can you explain to us the activities of in rice production? b. Which of these do you engage in? c. What problems do you encounter during this process of rice production? d. How can these problems be solved? e. How can your production of rice increase?

Questions in line with RQ2	a. What does ADP play in rice farming in this region? b. How often do you interact with them? c. What resource does your office provide these farmers to improve their productivity? d. What is the procedure for accessing resources (both by your office and for the farmers)
Questions in line with RQ3	a. How does your office ensure transparency in providing resources for these farmers? b. What measures does the government through you office put in place to ensure seedlings and fertilizers are of good quality? c. What is the capacity of rice produced within this region on weekly/ monthly basis? d. Do you think rice produced in this region meets up to the international standard? e. How do you ensure this?
Questions in line with RQ4	a. What policies guide rice production for farmers in this region? b. Are there storage facilities like silos to store grains? c. Are there particular grading systems for sales?
Questions in line with RQ5	a. How does your office monitor and regulate the activities of these farmers to ensure they meet up with ethical standards? b. How do you ensure ethical standards across the whole rice value chain c. How do you think Nigeria can be self-sufficient in rice production and supply without importation?

APPENDIX C- QUESTIONNAIRE

UNIVERSITY OF KWAZULU-NATAL

College of Law and Management Studies

School of Management, information technology and Governance

Voluntary Questionnaire (English version)

Doctor of Philosophy (PhD)- Supply Chain Management Research Dissertation

Researcher: Adenike Oluyemi Bello +27739388879 219096260@stu.ukzn.ac.za

Supervisor: Dr. Thokozani P Mbhele +27312607524 mbhelet@ukzn.ac.za

Title: **Sustainable Supply Chain towards Managing Food Security of Rice in the North Central Nigeria (formerly titled: Improving food security through Sustainable Management of Rice Supply Chain in North central region, Nigeria)**

The purpose of this survey is to solicit for information from rice farmer stakeholders regarding rice supply chain. The information and ratings will help us identify forces for and against rice supply chain and aid ensuring sustainability supply chain of rice with the aim of ensuring food security in the North central region of Nigeria. This questionnaire should take 10-15 minutes to complete. In this questionnaire you will be requested to indicate what is applicable to you, so there are no right or wrong answers. If you desire to make a comment, please feel free to write on the booklet and it will be appreciated if you attempt all questions as honest as possible.

Thank you for participating.

Section A (Demographic information section)

1. Which of the following do you do

plant/grow rice	harvest rice	prepare the ground	process rice paddy	storage/ warehouse

2. Your gender

Male	Female	Prefer not to say

3. How long have been doing it

Less than 1 year	1-3 years	4-6	7-10	Over 10 years

4. Which of the following are you?

Owner/ employer	Employee	Apprentice	contractor

5. If you are the owner, how many of the following do you have?

	Less than 5	6-10	11-20	Over 20
Partner				
Employee				
Apprentice				
contractor				

6. Which of these is your location

Patigi	Edu	None of the mentioned

7. What is your level of education?

Primary	O'level	OND	HND	Bsc	Msc	PhD

8. Age group

18-25	26-35	36-45	46+

Section B

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
	Driving forces						
1	I have access to use of technological such as drones, spraying taps, robots and machineries or tools I don't have to operate manually						
2	There is a generally fixed pricing or grading system for my produce which is common among other farmers						
3	There is transparency between me and other farmers that I interact with (e.g. rice planters, harvesters, ground preparers, processors or owners of warehouse or storage facilities)						
4	The government through extension workers provide me with quality fertilizers and seedlings/ tractors or planters/ irrigation that helps me produce quality rice.						
5	There local government provides sufficient storage facilities for storing paddy/rice						
6	There is good transportation system such as road and vehicle to move our produce from one place to another						
7	The government organize trainings for us on how to improve production						
	Restraining forces						
8	I always have access to seedlings and fertilizers made available by the government anytime I need them						
9	The policies made by the government on rice production improves my productivity and						

	profitability						
10	The policies of the government on rice production is stable and favourable						
11	There is transparency in allocation of resources and inputs						
12	Through trainings and introduction of new machineries by the government, I've developed new systems of farming						
13	I still use my old methods and equipment for farming						
14	I am willing to learn new system of farming as long as it will increase my production						
15	I am willing to embrace new technologies as long as it improves my productivity						
16	I lose most of my produce to pests, rodents and the likes						
17	Because I don't know what is going on in the big cities about rice, I just sell at any price the big buyers want						

Section C

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
18	I use natural fertilizers for planting						
19	I use farmer-produce seeds or certified labelled seeds						
19	I treat my seeds before planting to avoid diseases in seedlings and crops and improve quality of my crops						
20	I measure the moisture content of rice grain						

	that I harvest or obtain from harvesters						
21	I always prepare the land after each harvest						
22	To ensure water management I construct field channels to avoid excessive flow of water from or to the field						
23	I ensure weed management so that I can have prevent losses and have good quality grain						
24	To ensure good management of crops extension officers help in controlling pests and disease						
25	I harvest and thresh grains manually						
26	After harvest, I sun dry my grains on mats and pavement						
27	Inputs and fertilizers are easily available and affordable						
28	I can afford to employ more workers to increase my productivity						
29	I trust the quality of grains I get from the harvesters/ I trust the quality seedlings and other inputs I get from suppliers						
30	I make good sufficient profit/ well paid after my activity as a land prepare, planter, harvester, processor or plant						
32	Government provides a good platform for payment of taxes						
33	I have different suppliers I get grain from/ that I supply grains to						
34	I have access to improve my skills and knowledge often						
35	I have access to good machineries and equipment that increase my level of productivity						

36	I have access to good financing opportunities such as access to loans and credit facilities						
37	I increase my productivity often						
38	I and others working for/ with me have access to good hospitals						
39	The environment I work is safe and not under any attack of animals or herdsmen						
40	There is good supply of electricity so I use less fuel daily						
41	I don’t experience soil erosion and pollution						

Section D

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
42	I easily get my inputs from different suppliers						
43	The inputs I get are of good quality and makes me have good and quality rice grains						
44	I get information easily about other sources of supplier						
45	I am able to easily transport and deliver my produce to buyer						
46	My produce has good quality so it is highly demanded by buyers						
47	The extension office often check for the quality of my rice grain before I sell them						

Section E

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree

48	There are set policies, rules and regulations guiding set by the government for the activities of rice farmers						
49	The government grant rice farmers loans grants and subsidies to improve rice production						
50	The government provide and train rice farmers with the use of new technological tools that can improve productivity						
51	There is good storage system for rice grains after processing						
52	There is easy access to processing and threshing facilities						

Section F

		Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
53	There is easy communication between those I supply to and those I get inputs from						
54	I easily access the local rice grain collectors to market my processed grains						
55	The interest rates on loans from the bank are easily repayable						
56	There is transparency in making grants, loans and funds available to rice farmers						
57	The extension workers are well trained and have good understanding of the rice production process						

APPENDIX D- GATEKEEPER'S LETTER

KWARA AGRICULTURAL DEVELOPMENT PROJECT
KWARA STATE GOVERNMENT

RE: PERMISSION TO CONDUCT RESEARCH WITH RICE FARMER AND STAKEHOLDERS AT PATIGI AND EDU EXTENSION

I Salami S.T, the Managing Director of Kwara State Ministry of Agricultural and Rural Development, Agricultural Development Program(ADP) Patigi and Edu Extension agree that Adenike Bello, a doctoral research candidate at the University of KwaZulu Natal, with student number 219096260 will conduct a research study with rice farmers and stakeholders at ADP Patigi/Edu extension as she carries out her research with title: **Improving Food Security through Sustainable Management of Rice Supply Chain in North Central Region, Nigeria**.

I have read the information sheet and give permission to the researcher to collect the necessary data for the study. In the study, selected rice farmers and ADP extension workers will be interviewed at convenient places and other farmers within the selected local government area will be given a questionnaire to fill in.

Participation in this study is entirely voluntary and no information that may identify the identified stakeholders will be included in the research report.

I hereby consent that the rice farmers and stakeholders of the above mentioned extension to participate in this research.

Name: Salami S. Tunde

Date: [redacted]

Signatu[redacted]

Gsm/Contact Number: 08038345874
kwadp2@gmail.com

Old Jebba, Road, Ilorin Kwara State
Telegram: GOV. ILORIN
www.kwarastate.gov.ng

KWARA STATE GOVERNMENT

APPENDIX E- LETTER FROM THE LANGUAGE EDITOR

LANGUAGE INSTITUTE

St Charles College,
Harwin Road,
Scottsville
Pietermaritzburg 3201
Tel: 083 593 2855
admin@kznlanguageinstitute.com
www.kznlanguageinstitute.com

Registration number: 131 804 NPO

Certificate of editing 22 November 2023

Name: Adenike Oluyemi Bello

Title: Sustainable Supply Chain Towards Managing Food Security of Rice in North Central Nigeria.

This serves to confirm that the above document was edited substantively by members of the KZN Language Institute's professional English language editing team. The document was returned to the author with tracked changes and comments intended to correct errors and to clarify meaning. It was the author's responsibility to attend to these changes.

[redacted]

Ms J. Kerchhoff

Director of the KwaZulu-Natal Language Institute

KZN Language Institute – Transforming Words

APPENDIX F- ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

11 November 2021

Adenike Oluyemi Bello (219096260)
School Of Man Info Tech & Gov
Westville Campus

Dear AO Bello,

Protocol reference number: HSSREC/00003546/2021
Project title: Sustainable supply chain towards managing food security of rice in the north central Nigeria.
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 20 October 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 11 November 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

____

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

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