Analysis of Stakeholders' participation in Agricultural Innovation Systems in the Oyo State of Nigeria

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Candidate's declaration

I, Christianah Mobolaji Fadiji declare that this research "Analysis of Stakeholders' participation in Agricultural Innovation Systems in Oyo State of Nigeria" is my work. It is hereby submitted for the degree of Doctor of Philosophy in Agricultural Economics and Extension at the North-West University, Mafikeng. This research study has not previously been submitted for any degree at the North-West University or any other institution.

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Christianah Mobolaji Fadiji May 2023

Dedication

This research is dedicated to my awesome husband; Olusola, lovely children; Toluwalope, Temiloluwa, and Tifeoluwa and amazing parents; Olugbemi and Olubunmi. Thank you so much for your moral, financial and emotional support because, without you, the successful completion of this research would have remained a mirage.

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Abstract

To solve the bottleneck of food insecurity while ensuring food sustainability as the nation's (Nigeria) population increases, agricultural innovation systems that are nonlinear, integrated, holistic, and trans-disciplinary which accentuate diverse stakeholder participation approaches are key factors that proffer a solution to the challenges.

This document evaluates the analysis of stakeholders' participation in agricultural innovation systems (AIS) in Oyo State of Nigeria. It specifically examines the involvement, interactions, interdependencies, and interrelationships amongst the array of diverse stakeholders in their linkage activities of agricultural innovation systems to improve productivity.

The data for this study were elicited by a pre-tested structured questionnaire from primary sources while a multi-stage sampling technique and purposive sampling method were used to select a sample size of 400 respondents which included farmers (222), extension agents (85), researchers (30), input dealers (33) and agro non-governmental organizations (30).

The IBM SPSS was used in analyzing the data obtained from study objectives using frequencies, percentages, cluster bar charts, means, and standard deviation. The stepwise binary logistic regression and the Chi-square were used to analyze the association between demographic characteristics of stakeholders and their participation in the linkage activities in AIS; demographic variables and factors influencing stakeholders' participation in the agricultural innovation system (AIS); as well as demographic variables and constraints facing stakeholders on their participation in the agricultural innovation system.

The results of the study revealed that the respondents were predominantly male, married and with a mean age of fewer 50 years while they had over 10 years of work experience and got their information mostly from workshops/ seminars through stakeholders' collaboration and personal experience.

The linkage activities in AIS amongst the stakeholders were strong while, the majority of them strongly agreed that stakeholders' collaborative relationship enhances their participation, knowledge generation, and effective communication strategy. Besides, they revealed the constraints they mostly faced in their participation in the agricultural innovation systems were limited resources, poor communication among stakeholders and inadequate finance among other existing constraints.

Likewise, from the Chi-square analysis, the variable "age" had dependency (at 5% level) on the participation in the linkage activities of AIS between the extension agents and input leaders, and between extension agents and farmers.

The logistic regression showed that the variable "currently studying for a higher degree" had a significant effect (at 5% level) on the participation in the linkage activities of AIS between farmers and researchers.

According to the results of the logistic regression, only farmers that posses a master's degree from the variable "highest educational qualification" had a significant effect (at 5% level) on the participation in the linkage activities of AIS between them and extension agents.

From the regression analysis, the independent variables that include the "highest educational qualification" and "source of information"(at a 5% level) had a significant impact on the factors that influence stakeholders' participation in AIS (the dependent variables).

To enhance large-scale production and commercialization, stakeholders should implement interactive, constructive, and comprehensive participatory approaches, with input from all participants in the value chain. An investment budget needs to be set aside for role player training necessary to improve capacity building and information sharing on agricultural innovation systems.

Enabling frameworks should be put in place to support relevant policies for stakeholder participatory techniques. In addition, strategic initiatives that encourage cooperation and collaboration should be implemented to strengthen relationships between stakeholders.

Keywords: Innovation Capabilities, Stakeholder Participatory Approaches, Stakeholder Participatory Models, Agricultural Innovation Systems, Enabling Environment, Value Chain

TABLE OF CONTENTS

List of Tables

Bar Chart

List of Figures

Lists of Acronyms

ADPs:	Agricultural Development Programmes
AIS:	Agricultural Innovation Systems
AKIS	Agricultural Knowledge and Information System
CRIN:	Cocoa Research Institute of Nigeria
DADP:	Diocesan Agricultural Development Programme
EADD:	East Africa Dairy Development
FADU:	Farmers Development Union
FAO:	Food and Agricultural Organization
FO:	Farmers' Organizations
IAR&T:	Institute of Agricultural Research and Training
ICT:	Information and communication technology
IITA:	International Institute of Tropical Agriculture
IP:	Innovation Platforms
LGAs:	Local Government Areas
NAERLS:	National Agricultural Extension and Research Liaison Services
NCRI:	National Cereal Research Institute
NGOs:	Non-Governmental Organizations
NIHORT:	National Institute for horticultural research
NISER:	Nigeria Institute for Social and Economic Research
NSPRI:	Nigeria Stored Products Research Institute

SPA: Stakeholder Participatory Approaches

SPM: Stakeholder Participation Models

EEAIS: Elements for Enhancing Agricultural Innovation Systems

CHAPTER ONE

1.0 Introduction

Agriculture has a great potential for stimulating economic growth, enhancing food security, and generating income in a nation such as Nigeria like most of the developing countries in the world (Omorogiuwa, Zivkovic et al. 2014, Matemilola 2017, Nwankpa 2017). The majority of her people are engaged in subsistence farming activities that are characterized largely by small-scale production resulting in low production (declination in productivity) (Ahikiriza, Wesana et al. 2021, Otoijamun, Kigozi et al. 2021, Kruse, Mensah et al. 2022) As such, agricultural development in Nigeria has generally been on a downward trend as the nation is faced with food insecurity, food price volatility and unsustainable food production (Brück and d'Errico 2019, Afolabi, Ayodele et al. 2021)

As a result, though a considerable percentage (above 50%) of the populace of this nation is involved in subsistence agriculture, nevertheless, the country keeps experiencing a food shortage, thereby perpetually spending her meagre national income on food importation in trying to feed her growing populate (Ayinde, Otekunrin et al. 2020). Thus, the situation call for continuous innovation, if the agricultural sector is to contribute meaningfully to the economic growth of the nation (Ankrah and Freeman 2022, Chinseu, Dougill et al. 2022, Toillier, Mathé et al. 2022).

In this regard, the agricultural innovation systems approach stresses that innovations are orchestrated through the stakeholders participatory approach (Hermans, Sartas et al. 2017, Davies, Maru et al. 2018, Anandajayasekaram 2019, Klerkx and Begemann 2020, Andersen and Wicken 2021). Stakeholder participatory strategies in agricultural innovation systems are crucial for the creation of projects, initiatives, programs, and policy interventions in low-income countries (Bank 2012, Hermans, Sartas et al. 2017, Zwane 2020). They offer a distinctive perspective on the engagement of the pluralism of stakeholders in the formulation, development, implementation, and evaluation of their envisioned needs for the best possible strategic development (Bank 2012, Hermans, Sartas et al. 2017, Zwane 2020).

1.1 Background to the Study

In most African economies, agricultural development is based on small-scale production for food security, food sustainability and economic growth (Juhro and Aulia 2019, Khalid Anser, Iqbal Godil et al. 2021). Although agriculture is fundamental to humanity in the provision of food, medicine, clothing, shelter, and raw material, thereby reducing hunger and poverty, nevertheless, in African economies, its development has been on smallholdings for food security and economic growth (Fasoyiro and Taiwo 2012, Ayinde, Otekunrin et al. 2020, Otekunrin 2022). In a developing country such as Nigeria, about 85% of her 212 million population rely on subsistence farming for their livelihoods (Michael 2020, Nwokoma, Obasi et al. 2022).

As a result of the inevitable downward trends of development in agriculture befalling the African nations, the agricultural innovation systems (AISs) are conceptualized as a social adaptive system in addressing the challenge (Schut, Kamanda et al. 2019, Tomich, Lidder et al. 2019, Zwane 2020). They comprise of interventions, interactions, interrelationships, interdependency and involvement of the multiplicity of stakeholders, organizations and institutions (Schut, Kamanda et al. 2019, Tomich, Lidder et al. 2019, Zwane 2020). The AISs are social logical systems for orchestrating knowledge, boosting competitiveness, generating technological output and innovative processes (Ngaboyisonga, Oduol et al. 2017, Hermans, Geerling-Eiff et al. 2019, Zwane 2020).

Conversely, agricultural innovation systems (AISs) involve the strategic and tactical interventions of stakeholders' collaborative mechanisms for knowledge generation and novelty (Schut, Kamanda et al. 2019, Tomich, Lidder et al. 2019, Zwane 2020). They play a vital role in economic development by integrating a wider network of stakeholders' collaboration processes. (Tolunay et al. 2014).This is through the initiatives of stakeholders by transforming their collective action into outcomes in agriculture (Anandajayasekaram 2019, Hermans, Geerling-Eiff et al. 2019, Schut, Kamanda et al. 2019). Thus, several authors in their recent studies have revealed that current agricultural innovation systems do not only see innovations to be developed by researchers only but rather by all role players (stakeholders) as the initiators and the decision-makers to effect the desirable change (Modirwa and Oladele 2017, Davies,

Maru et al. 2018, Hermans, Geerling-Eiff et al. 2019). The agricultural innovation systems (AISs) recognize the emergent and the logical interventions of the active dynamic relationship among various innovation platforms through their technical, social and institutional change as means to trigger the anticipated change in agricultural development (Douthwaite and Hoffecker 2017, Schut, Kamanda et al. 2019).

Similarly, AIS involves continuous interventions, interaction, coordination and prompt feedback mechanisms among the network of heterogeneous role players for the generation, adaptation and adoption of knowledge in facilitating technological output (Klerkx and Begemann 2020). This is contrary to previous perspectives that considered AIS as a linear process that begins with research (Tomich, Lidder et al. 2019, Zwane 2020).

As a result, the agricultural innovation systems concepts embrace the stakeholders' involvement mechanism which results in the collaboration among role players in the value chain (Chinseu, Dougill et al. 2022). It generates interventions that enable the stakeholders to creatively act in unison for enabling the change needed in bringing new products, new processes and new forms of organizations into use in the value chain (Bank 2012, Hermans, Sartas et al. 2017, Zwane 2020)

However, the agricultural innovation systems could be likened to an invisible orchestra that embraces the organizational and inter-disciplinary team works through the various engagements of stakeholders that explore a participatory approach through dynamic collaboration, strong linkage structure, effective communication strategy and active partnership for knowledge generation in value (Davies, Maru et al. 2018, Schut, Kamanda et al. 2019).

Consequently, Zwane (2020) and Hermans, Geerling-Eiff et al. (2019) affirm that AIS could be triggered by capacity building, fund availability, and an enabling environment for joint problem identification, joint problem solving, joint learning, joint training, joint implementation, joint monitoring, and joint evaluation. Similarly, the World Bank and other related studies affirmed that achieving food security in any economy of the world has to be rooted in agricultural innovation systems. Thus, the principles of stakeholders' mechanism for collaboration, synergism, and collectiveness among pluralism of innovation platforms which

include private, public sectors and their inter-disciplinarians have become a mainstay in AIS for boosting competitiveness and enhancing food sustainability (Hermans, Geerling-Eiff et al. 2019, Tomich, Lidder et al. 2019, Klerkx and Begemann 2020).

Therefore, the agricultural innovation systems concepts strategize on collaboration, partnership, linkages, communication and information accessibility among the networks of role players for increasing food security, food sustainability, food productivity and national income (Zwane 2020, Khalid Anser, Iqbal Godil et al. 2021). A lot of literatures highlighted that actors do not innovate in isolation in AIS but embrace stakeholders' mechanisms that are drawn from both private and public bodies to facilitate the pooling together of limited resources in achieving food sustainability (Hermans, Geerling-Eiff et al. 2019).

The agricultural innovation systems entail learning alliance network of dynamic heterogeneous stakeholders from both public and private sectors (such as researchers, extension workers, farmers' organizations, private firms, non-governmental organizations, input dealers, marketers and government policy-makers) for enhancing new knowledge, skills and new products along the value chain (Davies, Maru et al. 2018, Klerkx and Begemann 2020, Zwane 2020). According to Klerkx, Begeman, and Zwane (2020), several factors can affect how stakeholders interact with agricultural innovation systems. These include the social interaction patterns, communication modalities, and supportive environments (policies and infrastructure) which are significant for nutritional development.

The World Bank (2012) confirms that the level of stakeholders' collaboration determines their participation in agricultural innovation systems. This in turn influence their interactions, actions, reactions, and roles in the value chain. (Letsoalo and Oladele , Modirwa and Oladele 2017, Tomich, Lidder et al. 2019). Stakeholders ability to collaborate play the key roles to food sustainability and agricultural development of any nations (Letsoalo and Oladele , Modirwa and Oladele 2017, Tomich, Lidder et al. 2019).

The stakeholder participation approaches (SPA), stakeholder participation models (SPM), and elements for enhancing agricultural innovation systems (EEAIS) underscore the significance of the planning, developing and implementation of agricultural innovations for sustainable development (Eidt, Pant, and Hickey 2020). Agricultural innovation systems are vital for

improving food sustainability, driving innovation, and promoting agricultural development (Douthwaite and Hoffecker 2017, Zwane 2020). It highlights opportunities to address bottlenecks in sub-Saharan Africa (SSA) (Agbontale and Issa 2017, Froebrich, Ludi et al. 2020, Bentley, Naziri et al. 2021)

1.2 Statement of the Problem

Over the years, Oyo State of Nigeria had the highest number of agricultural research institutions in the country; yet, food sustainability, food security, and national development remain an illusion (Ogali 2017, Kasa, Izah et al. 2020, Atairet, Atairet et al. 2021).

Although research institutions are engines and producers of new knowledge, nevertheless, these institutions cannot single-handedly effect the needed changes in agricultural development but require voluntary willful participation of stakeholders from both public and private sectors (Tomich, Lidder et al. 2019, Klerkx and Begemann 2020, Zwane 2020, Andersen and Wicken 2021). The stakeholders include farmers' groups, agro-dealers, agro-based non-governmental organizations, researchers, financial institutions, extension agents and policymakers for achieving food sustainability and nutritional development (Tomich, Lidder et al. 2019, Klerkx and Begemann 2020, Zwane 2020, Andersen and Wicken 2021).

However, the issue of linkages, partnerships, collective actions and collaborative strategies become central and major structural performance criteria to ensure agricultural development for meeting the rising demand for food (Hermans, Geerling-Eiff et al. 2019, Isiordia-Lachica, Valenzuela et al. 2020, Zwane 2020).

In Nigeria, just like many developing countries, the poor linkages among actors remain a matter of great concern. The linkages fail due to inability to acknowledging the power of networking (Ngaboyisonga, Oduol et al. 2017). As a result, there has been no linkage mechanism to foster dynamic connections, mutualism, collaboration, reciprocal interdependence, and interconnection among actors to achieve common goals (Ngaboyisonga, Oduol et al. 2017). It limits access to new knowledge by causing poor interactions, weak alliances, an ineffective collaborative culture, inadequate communication, and poor feedback mechanisms.(Agbontale

and Issa 2017, Ifeanyieze, Nwarieji et al. 2017, Olufemi 2018, Klerkx and Begemann 2020, Zwane 2020).

Independence rather than interdependence is among the role players in the value chain. As a result, actions involving stakeholders frequently take place with little to no partnership, interaction, or communication between them (Ogunremi and Olaniran 2010, Agbontale and Issa 2017, Ifeanyieze, Nwarieji et al. 2017, Hermans, Geerling-Eiff et al. 2019). Poor inter-organizational interactions exist among players as a result of these factors (Bank, 2012). It ensures that those scientific findings won't be made accessible to farmers, and even if they are, farmers won't be able to employ them effectively (Ogunremi and Olaniran 2010, Agbontale and Issa 2017, Ifeanyieze, Nwarieji et al. 2017, Hermans, Geerling-Eiff et al. 2019).

Agbontale and Issa (2017) and Ifeanyieze et al. (2017) affirm that the weak linkage structures, frail partnerships, and poor collaboration among stakeholders in Nigeria have hampered the adoption of several innovations. It led the federal government to spend an annual amount of US $ 3 billion on food importation; thus, making her perpetually spend the lean foreign reserves, which would have been significant revenue for national development while GDP (Gross Domestic Product) from the agricultural sector has dropped by 31% (Egbetokun, Omonona et al. 2014, Agbontale and Issa 2017).

Consequently, enhancing nutritional security, food sustainability, and food production requires the integration of strong linkage structures and inclusive partnering among innovative platforms (stakeholders) in the value chain AIS (Davies, Maru et al. 2018, Hermans, Geerling-Eiff et al. 2019, Zwane 2020). The formation of strong linkages mechanisms among stakeholders for agricultural production in Nigeria is crucial in identifying the challenges and opportunities in reaching a consensus on a common vision for scaling up food production (Agbontale and Issa 2017, Tomich, Lidder et al. 2019).

Andersen and Wicken (2020), Letsoalo and Oladele (2019), and Tomich et al. (2019) assert the importance of collaboration and collective action of the role players to be the crucial tools for increasing productivity in their study on the determinants of willingness to participate in collective action among farmers in the Dzindi communal irrigation scheme, Limpopo province, South Africa.

Therefore, in achieving any innovation as regards agricultural development, it has to be hinged on a collaborative effort, collective action, inclusive partnership, and continuous participation from all the arrays of stakeholders who are actively involved in all the linkages activities starting from setting priorities, joint problem identification, joint problem solving, joint learning, joint training, joint evaluation of trials, joint implementation, joint monitoring, joint feedback mechanism and collective use of resources, together with interdisciplinary teamwork in AIS (Davies, Maru et al. 2018, Klerkx and Begemann 2020, Andersen and Wicken 2021).

Though several studies have identified weak linkages among researchers, extension agents, and farmers in Oyo State such as Ogunremi and Olaniran, (2010) who identified Research – Extension – Farmers Input Linkage (REFILS) mechanism as a means for creating a dynamic partnership, mutual relationship and reciprocal connection among them for achieving a common goal, however, this study did not involve all the stakeholders (innovation platforms) in agriculture. Oladele and Sakagami et al. (2006), and Agbontale and Issa (2017), highlighted the weak working relationship between researchers, extension agents, and farmers, which prevented farmers from adopting agricultural innovations in the form of products or processes (end users).

Studies conducted before the creation of agricultural innovation systems include Ogunremi and Olaniran (2010) and Oladele and Sakagami et al. (2006), which have limitations as they only had Farmers, Extension agents, and Researchers as the study participant. Very few studies have researched the stakeholders' involvement in Nigeria's agricultural innovation system.

There is an overwhelming need to accord the agricultural innovation systems a priority in Oyo State, particularly in Nigeria. AIS is a new concept in agricultural extension and rural development field that has not received much attention from researchers. It is built on the premise of inclusive strategies for unpacking stakeholders' logic interventions and building interactive linkage through the open social systems for the knowledge generation, production of technological outputs, or new processes in crossing the immense hurdles of small-scale production while enhancing food security and a rapid sustainable agricultural development beyond the scope and approaches of previous studies.

Therefore , analyzing the participation of different heterogeneous stakeholders in the study area will lead to ways to strengthen linkage systems, develop effective collaborations and build capacities in terms of knowledge acquisitions in agricultural innovation systems by developing new approaches for engaging different stakeholders while the findings from this study would shed light on the involvement of stakeholders in the agricultural innovation systems in Oyo State of Nigeria with the following research questions.

1.3 Research Questions

i. What are the effects of socio-demographic factors of stakeholders on their level of participation in agricultural innovation systems?
ii. What is the stakeholders' perception of agricultural innovation systems?
iii. What are the participation levels of stakeholders in the linkages activities in agricultural innovation systems?
iv. What are the factors influencing the participation of stakeholders (farmers, extension agents, researchers, input dealers, and NGOs) in agricultural innovation systems (AIS)?
v. What are the constraints facing stakeholders (collaborators) in their level of participation in the agricultural innovation systems?

1.4 Research objectives

The research objectives of this study consist of both general and specific objectives.

1.4.1 General Objective

The general objective of this study is to analyze the stakeholders' participation in agricultural innovation systems in Oyo State of Nigeria.

1.4.2 Specific Objectives

The specific objectives of this study are designed to:

i. identify the socio-demographic characteristics of the stakeholders (farmers, extension agents and researchers, input dealers, and NGOs) in agricultural innovation systems

ii. analyze the stakeholders' perception of agricultural innovation systems

iii. ascertain the stakeholders' level of participation in the linkage activities of agricultural innovation systems (AIS)

iv. examine the factors influencing the participation of stakeholders (farmers, extension agents, researchers, input dealers, and NGOs) in the agricultural innovation system (AIS)

v. identify the constraints facing stakeholders (collaborators) in their participation in an agricultural innovation system

1.5 Hypotheses

Therefore the study attempts to test the following null hypotheses (H_0)

i. H_0 There is no significant relationship between stakeholders' socio-demographic factors and their level of participation in agricultural innovation systems.

ii. H_0 There is no significant difference in the stakeholders' perception and their level of participation in agricultural innovation systems.

iii. H_0 There is no significant relationship between stakeholders' socio-demographic variables and factors influencing their level of participation in agricultural innovation systems.

iv. H_0 There is no significant relationship between stakeholders' socio-demographic variables and constraints facing them in their participation in the agricultural innovation systems.

1.6 Significance of the Study

This study of analysis of stakeholders' participation in agricultural innovation systems in the Oyo State of Nigeria is significant for several reasons: Examining the socio-demographic factors of stakeholders to their participation in AIS in the study area will unleash the factors that favour or impede innovative processes, as a basis for making recommendations for

practice, research, and policy. Moreover , it will showcase the perception, and level of participation of various stakeholders in agricultural innovation systems towards enhancing the collaboration amongst the stakeholders. While, understanding the relative involvement of actors in agricultural innovation in the study area will bring the attitudinal behavioural disparities existing among them, which can be worked upon to provide the framework of solutions on how to proffer solution to the the challenges and how to scale up agricultural development in the state.

Furthermore, analyzing the participation of different heterogeneous stakeholders in the study area will lead to ways to strengthen linkages systems, develop effective collaborations and build capacities in terms of knowledge acquisitions in agricultural innovation systems by setting new approaches for engaging different stakeholders.

Finally it will provide an avenue to understand factors that are significant and non-significant in stakeholders' participation in agricultural innovation systems and thus provide a platform for building robust integrative and sustainable agricultural innovation systems.

1.7 Scope and Limitations of the Study

The study population comprises researchers in agricultural research institutes, farmers from the farmers' organizations, input dealers, extension personnel in extension agencies, and agro-based non-governmental organizations in Oyo state, Nigeria. The state consists of thirty-three (33) local government areas (LGAs) with four zonal agricultural development programs (ADPs) located at Ogbomosho, Oyo and Ibadan with headquarters in Saki. The study area has several agricultural research institutions.

Ultimately, the study identified the socio-demographic characteristics of stakeholders in the agricultural innovation systems, analyzed stakeholders' perception of the agricultural innovation systems, described stakeholders' level of participation in the agricultural innovation system, examined factors affecting stakeholders' participation, and identified the challenges facing stakeholders' involvement in the agricultural innovation systems. The study suggested ways of enhancing strong linkages, partnerships, and collaboration among actors in the value chain in the agricultural innovation systems.

However, this study was limited to data collected from the agricultural stakeholders only in the Oyo state of Nigeria owing to lack of funds making it difficult to envisage covering all the states in southwestern Nigeria. Another limitation was the bad road networking which made it a difficult task in accessing the farmers' communities that required a lot of hiking.

1.8 Definitions of Terms

The following terms are used in the study and their operational meanings are stated below:

- **Value chain**: these are the set of linked activities being carried out by heterogeneous actors in an organization for producing a new product or process.
- **Innovation capabilities**: these are the knowledge and skills for building and integrating internal and external resources in addressing difficulties in the value chain.
- **Farmers' organizations**: organizations consisting of farmers who are seeking production solutions.
- **Stakeholders**: they are groups of people, organizations and institutions having a share in a particular issue.
- **Innovation**: it is the production of goods and services which are new to the agricultural stakeholders.
- **Agricultural innovation systems**: it is the network of actors and organizations that bring new products, new processes, and new forms of organization into economic use altogether with the institutions and policies that affect their behaviours and performance.
- **Organizations;** are groups of actors (stakeholders) that collaborate over a sustained period. An organization can be either formal or informal.
- **Innovation platforms (IP):** are diverse groups of actors that voluntarily contribute knowledge and other resources to jointly develop or improve a social or economic process or product.

- **Agricultural extension agents** refer to the government or ministry of Agriculture staff whose responsibilities are for disseminating vital innovations to farmers to increase productivity.
- **Communication** is the exchange of information through verbal or non-verbal means.
- **Adoption** refers to agricultural stakeholders' decision to accept and apply new techniques.
- **Pluralism:** These are multiple stakeholders in the value chain.
- **Linkages:** these are the establishments of close working relationships among the network of role players, and organizations in the value chain for joint identification of problems, implementation, and provision of feedback mechanisms in the pursuit of commonly shared objectives to enhance the increase in productivity.

1.9 Chapter Summary

The chapter outlined various sections as follows: the background to the study that examines the concept of agricultural innovation systems, the role of stakeholders' mechanisms in the value chain, the importance of stakeholders' participation in the agricultural innovation systems on how it increases food production, income generation and nutritional security.

This chapter also discusses the elements that trigger development in agricultural innovation systems among stakeholders which include strong collaboration, active partnership, good linkages system, capacity building, good feedback mechanism, information availability, and accessibility amongst the networks of actors for improving and increasing nutritional development. Moreover this chapter delineates the research problem statement, the research questions, hypotheses, objectives, significance of the study, and definitions of the operational terms used in this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature by providing current trends of information while relating it to the topic considered thereby facilitating the best approach for the study.

The chapter also reviews the literature on the concepts of agricultural innovation systems, characteristics of agricultural innovation systems concepts, the agricultural innovation systems strategies and their complexity, stakeholders' participation models, engagement and integration of the collaborative stakeholder-participation model for this study, the significance of stakeholders mechanism in agricultural innovation systems concept, the principles for building stakeholders mechanism in the agricultural innovation systems, the elements for sustainability in agricultural innovation systems, the components of stakeholders mechanism in agricultural innovation systems concepts, the roles of stakeholders mechanism in agricultural innovation systems, the benefits of stakeholders' mechanism in agricultural innovation systems, the theoretical framework, and the conceptual frame of this study.

2.2 Agricultural Innovation Systems (AIS)

Over time, several approaches have been considered from the time immemorial as a way of identifying and solving agricultural problems. These solutions were aimed at increasing agricultural production, beginning with a linear model that was dominant from 1960 to 1970 in which innovations came from outside (sciences) and were proposed to farmers (Klerkx, Van Mierlo et al. 2012, Gamito and Madureira 2019, Bentley, Naziri et al. 2021).

Besides, the second model with a more holistic view was also developed in 1990 in 1970 which was the farming systems research perspective (FSR) to increase food productivity.The third is the agricultural knowledge and information system (AKIS)This emerged after 1990 from an extension perspective, and it was based on interactive learning with the consciousness of a broader institutional environment (Klerkx, Van Mierlo et al. 2012, Knierim, Boenning et al. 2015, Adolwa, Schwarze et al. 2017).

However, most recently, from the 2000s to the present, there has been a paradigm shift from all these previous approaches while a new model of the participatory concept known as agricultural innovation systems (AIS) which are holistic, transdisciplinary, non-linear complex adaptive systems involving the interactions, interdependencies, partnerships of arrays of heterogeneous actors for synthesizing knowledge, enhancing competitiveness and ensuring food sustainability are increasingly recognized as the mainstream to achieving agricultural development (Davies, Maru et al. 2018, Hermans, Geerling-Eiff et al. 2019, Klerkx and Begemann 2020).

The agricultural innovation systems have been concieved as a result of identifiable weaknesses of previous approaches, the emerging challenges, and the percieved need for society. Thus, the linear and conventional approaches have been considered dysfunctional while nonlinear approaches involving the participation of a multiplicity of inputs (actors) are necessary both in basic and applied research for generating multiple outputs which have been acknowledged to be thriving (Douthwaite and Hoffecker 2017, Zwane 2020).

Consequently, AIS which is a nonlinear innovations approach involving an interactive model of cylindrical learning of social interventions among diverse stakeholders for knowledge generations is critically important as the appropriate framework for synthesizing technological output and process for the agricultural development value chain (Juma 2015, Douthwaite and Hoffecker 2017, Eidt, Pant et al. 2020, Zahran, Kassem et al. 2020, Zwane 2020).

Accordingly, the agricultural innovation systems emerge as the transdisciplinary, holistic systems involving scientific, technological, organizational, financial, managerial and commercial processes of collaborations of the stakeholders beginning from joint problem recognition to mutually reinforcing learning activities to joint knowledge generation for improvements in the social and economic organization that lead to implementation in the value chain (Davies, Maru et al. 2018, Tomich, Lidder et al. 2019, Bentley, Naziri et al. 2021).

Moreover, Juma (2015) along with Tomich et al. (2019) as well as Davies et al. (2018) assert that agricultural innovation systems concepts are built on the premise of a combination of new ideas, knowledge, skills, information and different types of capabilities, and resources from the arrays of heterogeneous actors. Intervention of AIS begins by building trust and relationship

amongst stakeholders along the value chain for generating income, mitigating poverty and creating jobs.

Zwane (2020), and Tomich et al. (2019) confirm that AIS could be created by users themselves and they are not a one-way street from research to users while providing a platform where researchers could work closely with other stakeholders for knowledge generation while learning is at the core of agricultural innovation systems.(reference) Any change in the value chain would bring about improvements in social or economic organization, which also increases knowledge production.

Agricultural innovation systems go beyond knowledge creation, but also share knowledge and foster learning by integrating the individuals' capability, organizational capacity, and institutional capacity through their responsiveness to changing contexts and patterns of interaction in the value chain (Knierim, Boenning et al. 2015, Douthwaite and Hoffecker 2017, Gamito and Madureira 2019, Tomich, Lidder et al. 2019).

However, the collaboration relationship, communication strategy, interaction pattern, incentive provision, financial resources, enabling environments (policies and infrastructures), human resources, ready-made market, effective coordination, capacities development, the procurement cost of technological inputs and stakeholders' interest and felt need for inclusiveness do influence the planning, execution, adoption, implementation, and adoption process in AIS development (Davies, Maru et al. 2018, Gamito and Madureira 2019).

Thus, AIS form the essential concepts for small-holder farmers in developing countries in overcoming the hurdles in the quality and quantity of food production in a bid to have a rapid sustainable agricultural development (Douthwaite and Hoffecker 2017, Hermans, Geerling-Eiff et al. 2019, Tomich, Lidder et al. 2019).

2.2.1 The Agricultural Innovation Systems and Their Complexity

Many complex phases are involved in agricultural innovation systems, beginning with project planning, development, and implementation (Klerkx and Begemann 2020, Bentley, Naziri et al. 2021, Hoffecker 2021). Due to stakeholder differences, the process of planning, executing and evaluating innovations in agricultural value chains is inherently challenging (Klerkx and

Begemann 2020, Bentley, Naziri et al. 2021, Hoffecker 2021). Since innovations unfold in unanticipated ways, they cannot be fully anticipated or predicted (Klerkx and Begemann 2020, Bentley, Naziri et al. 2021, Hoffecker 2021).

All value chain participants must be aware of the complexity of the project's design and implementation because it integrates both logical frameworks and actor-based theories of change (De Bernardi and Azucar 2020; de Boon; Sandström et al. 2022). The development of a meaningful collaboration could be hampered by partners' disparities in terms of capability, expertise, resources, organizational strength, and negotiating ability (Rajalahti, Janssen, and Peu 2008). This makes innovation within a project structure fundamentally difficult (Rajalahti, Janssen, and Pehu 2008).

To ocherstrarate innovations in agricultural sector demand ultilization of existing knowledge through open communication arising from collaborations among stakeholsers (World Bank 2012). Unpredictability in AISs is brought about by the interconnectedness and complexity of stakeholder structures in agricultural innovation systems (De Bernardi and Azucar 2020; de Boon; Sandström et al. 2022). This can result in the systems developing co-evolutionarily and remarkable outcomes (De Bernardi and Azucar 2020; de Boon; Sandström et al. 2022).

Agriculture innovation systems are complex dynamic approaches to logic interventions that arise from innovation platforms (multiple actors) based on their interests and needs for producing a technological output or a new process that is beneficial to sustainable development, population livelihood, and nutritional advancement (Klerkx and Begemann 2020, Bentley, Naziri et al. 2021, Hoffecker 2021).

AIS concepts do not only provide a framework for analyzing complex relationships amidst heterogeneous actors but also capture essential components, the linkages amongst these components and the institutions and policies that constitute the enabling environment for innovation (Devaux, Torero et al. 2016, Douthwaite and Hoffecker 2017, Klerkx and Begemann 2020, Bentley, Naziri et al. 2021).

Eidt et al. (2020) and Klerkx and Begemann (2020) confirm that the involvement and inclusion of innovation platforms (stakeholders) in the East Africa Dairy Development (EADD) program in Kenya involves a complex process for joint knowledge generation and

collective learning for increasing smallholder dairy farmers' productions and their livelihood through their social capital increment. Zwane (2020) in his study discusses that the inclusion and integration of diverse stakeholders for maize production in Limpopo Province in the agricultural innovation system involves a complex collective stakeholder's talent pool for achieving food security.

A large body of literature that agricultural innovation systems are associated with complex social processes involving heterogeneous actors, different components and different organizations for generating knowledge, disseminating knowledge, and applying that knowledge to promote new processes and new products (Douthwaite and Hoffecker 2017, Zwane 2020). They require comprehensive strategies to unblock logical interventions from stakeholders and build interactive links through open social systems to stimulate changes (Agbontale and Issa 2017, Froebrich, Ludi et al. 2020, Bentley, Naziri et al. 2021).

2.2.2 The Principles for Agricultural Innovation Systems

Effective coordination, collaboration, and all-inclusive collective action are the fundamental keys to efficiently and effectively engaging various stakeholders in AIS which are highly important for enhancing food production (Rijswijk and Brazendale 2017, Gamito and Madureira 2019, Bentley, Naziri et al. 2021). Thus, efficacious coordination among role players in the value chain not only facilitates the flow of both indigenous and generic knowledge but also determines their propensity to innovate (Davies, Maru et al. 2018, Bentley, Naziri et al. 2021).

Consequently, coordination which can either emerge through impulsively voluntary action or deliberate interactions requires committed proficient leadership. This leadership shapes the organizational culture of the system through appropriate incentives, capacity buildings, available funds and enabling environment (Nettle, Klerkx et al. 2017, Zwane 2020).

Through effective coordination, stakeholders can cooperate by building coherence, setting consensus-based priorities, and generating knowledge and resources for generating, disseminating, adapting, and adopting technological processes and products among actors in AIS while reducing transaction costs, enhancing economies of scale and bringing local

knowledge closer to generic knowledge for large-scale production (Douthwaite and Hoffecker 2017, Davies, Maru et al. 2018).

However, lack of coordination can lead to poor communication, limitation of accessibility to new knowledge, weak institutional learning, limited financing for innovation, and frail research and training (Devaux, Torero et al. 2016, Nettle, Klerkx et al. 2017, Rijswijk and Brazendale 2017).

2.2.3 The Elements for Enhancing Sustainability in Agricultural Innovation Systems (EEAIS)

For agricultural innovation systems to be sustainable, they require some elements that include capacity development, enabling environment, good incentives, availability of funds, availability and accessibility of information (Anandajayasekaram 2019, Riaño, Manrique et al. 2019). These elements strengthen and promote development within the agriculture innovation systems by ensuring food sustainability, food security and economic growth. Accordingly, agriculture innovation systems that work better than conventional and linear approaches require significant investments in the capacity buildings for boosting food production (Douthwaite and Hoffecker 2017, Hermans, Geerling-Eiff et al. 2019, Eidt, Pant et al. 2020).

Capacity development is the process by which individuals, organizations, and societies acquire and management of skills and knowledge to improve their quality of life, achieve change, and enable food sustainability (Riaño, Manrique et al. 2019, Chinseu, Dougill et al. 2022). In AIS, capacity development is initiated by researchers or other stakeholders, and it is built through collaborative and inclusive learning (Zwane 2020). Workshops, seminars, farm visits, consultations, and reformations of curricula aimed at promoting food sustainability are among the activities (Aerni and Zou 2022)

The capacity developments (individual capacity, organizational capacity and institutional capacity) require significant investment in training and educating heterogeneous actors for knowledge acquisition (Baldanov, Kiminami et al. 2020, Aerni and Zou 2022). The innovation capabilities that depend on individual traits, collective learning mechanisms and organizational cultures trigger food productivity in AIS while a massive commitment to capacity

developments through role players' time and resources enhances food sustainability and boosts competitiveness (Aerni, Nichterlein et al. 2015, Baldanov, Kiminami et al. 2020). Individual capacity requires adequate investments in learning, training and education for strengthening stakeholders' mindsets in the value chain (Aerni, Nichterlein et al. 2015). Organizational capacity requires strong linkage structures and resources managerial activities, while institutional capacity needs a holistic approach to building human capacity through curricula reforms to enhance skill and knowledge acquisition necessary to achieve the desired change in AIS (Aerni, Nichterlein et al. 2015, Baldanov, Kiminami et al. 2020). However, the lack of capacity development results in knowledge deficiencies, and this, in turn, would lead to low agricultural productivity (Baldanov, Kiminami et al. 2020).

Favourable policies are integral for enabling environments that enable individuals, institutions, and organizations' capacities to thrive in AIS (Boon, Bawole et al. 2013, Pomareda 2016, Froebrich, Ludi et al. 2020). Therefore, conducive policies shape stakeholders' behaviours that not only stimulate innovation by providing the right resources but also bring about support structures (Lamprinopoulou, Renwick et al. 2014, Zwane 2020). Thus, there would be no sustainability in agricultural innovation systems without the involvement of policy-makers such as the government and stakeholders' coalition that would facilitate provisions of infrastructures in AIS (Froebrich, Ludi et al. 2020).

Good policies and supportive environments are important promoters of innovation capacity which would necessitate the adoption of innovation among stakeholders in the value chain (Coudel, Devautour et al. 2013, Aerni, Nichterlein et al. 2015, Badstue, Elias et al. 2020, Froebrich, Ludi et al. 2020). Most importantly, the participation of policy-makers in agricultural innovation systems ensures the provision of useful infrastructure and good policies that will trigger novelties. The provision of infrastructure enables innovations as it reduces costs of production and facilitates the transportation of agricultural products (Lamprinopoulou, Renwick et al. 2014, Pomareda 2016, Zwane 2020).

Boon and Edler (2018) assert the vital need for governments to invest powerfully in building infrastructure to increase the profitability, productivity and sustainability of agricultural produce. Therefore, the well-functioning enabling environments that comprise good policies

and infrastructure will trigger efficient and effective operations of stakeholders in AIS are vital for system sustainability (Pomareda 2016, Boon and Edler 2018, Edler and Boon 2018, Badstue, Elias et al. 2020).

Besides, incentives (reward systems) also play a crucial tool in triggering technology while the provision of incentive rewards such as recognition of team accomplishments motivate and catalyze the performance of role players in AIS (Materia 2012, Juma 2015). Likewise, stakeholders and government commitments to funding would facilitate the effectiveness and efficiencies of AIS for generating new products, new processes and new forms of organization (Devaux, Torero et al. 2018).

Since AIS is a cyclical learning process in which the subjects perceive the context through the available information, thus, availability and accessibility of information are crucial keys to achieving sustainability in AIS (Amonjenu and Wombo 2016). The information is such that facts perused and knowledge obtained to enhance learning play vital roles in AIS for synthesizing technological output, increasing agricultural production, improving marketing and achieving sustainability in agricultural development (Spielman, Davis et al. 2011, Amonjenu and Wombo 2016).

Information and communication technology (ICT), is all-inclusive sources of information that embraces both computer and telecommunications, is an enabler in AIS for collecting and organizing various forms of information to reduce transaction costs, scale-up innovations, increase agricultural production and competitiveness in the value chain (Rijswijk, Klerkx et al. 2018, Ingram and Maye 2020). It does help in bridging the information and communication gap that enables effective feedback mechanisms among the heterogeneous actors in the value chain (Bank 2012).

However, the information does not only enable stakeholders to make the right decisions regarding production, marketing and distribution but also plays a significant role in the development of human society by shaping their thinking, while, the provision of electronic–learning facilitates the effective functioning of the agricultural innovation systems (Bank 2012, Knierim, Boenning et al. 2015, Rijswijk, Klerkx et al. 2018, Ingram and Maye 2020).

Therefore, for AIS to be sustainable, investment in capacity development, funds availability (operating funds), good incentives, enabling environment and information and communication technology (ICT) through the availability and accessibility of information, are needed to harness and facilitate the development of knowledge and novelty among role players. Monitoring and evaluating are necessary for the value chain in AIS as they quantify the impact of interaction among networks of stakeholders (Bank 2012, Douthwaite and Hoffecker 2017, Rijswijk, Klerkx et al. 2018, Ingram and Maye 2020).

2.2.4 Characteristics of Agricultural Innovation Systems

Agricultural innovation systems are an all-encompassing trans-disciplinary approach which generates integrated learning through the societal collaboration of diverse actors that are adapting their strategies for collective action through learning alliances on changing system conditions for knowledge creation, sharing, application, and assessment towards achieving desired social and economic outcomes (Eidt, Pant et al. 2020, Jia 2021) (Juma, 2015; Rijswijk and Brazendale, 2017; Davies et al., 2018; Bentley et al., 2021; Hoffecker, 2021).As a result of close working relationships among a plurality of stakeholders, they mobilize and integrate existing knowledge while developing new practices and technologies tailored to the new local contexts (Douthwaite & Hoffecker, 2017, Klerkx & Begemann, 2020).

Agricultural innovation systems concepts are deeply rooted in science and political institutions, requiring multi-organizational approaches and do not solely rely on science for knowledge acquisition (research is not the exclusive source of knowledge), but rather acquire knowledge from partners, innovation platforms, various organizations, entrepreneurs, and institutions (Douthwaite & Hoffecker, 2017).

Agricultural innovation systems mobilize and integrate indigenous knowledge while developing new techniques and technologies for promoting sustainable agriculture by working closely with a variety of stakeholders and reforming existing institutions (Zwane, 2020).

Agricultural innovation systems thrive well when there are enabling environments, good incentive systems, availability, and accessibility of financial investments required to foster

partnership while they can be triggered in various ways which include market triggers, knowledge triggers, policy triggers and resource triggers (Froebrich, Ludi et al. 2020).

In addition, agricultural innovation systems provide platforms for defining topics for learning based on stakeholder needs and priorities, which are then used to identify joint problems where intervention begins through the development of close working relationships and trust among stakeholders in the value chain, thereby facilitating the development of an open research program on food sustainability (Toillier, Mathé et al. 2022).

2.2.5 The Components of Agricultural Innovation Systems

The components of agricultural innovation systems comprise the private sector, which is the farmers' group, agro-based dealers (input or output dealers), NGOs (non-governmental organizations), agro-industrial firms, financial institutions, transporters, post-harvest handlers, insurance and public sectors which are researchers, extension agents, policymakers, and meteorologist (Bank 2012, Salvini, Van Paassen et al. 2016, Eidt, Pant et al. 2020, Makate 2020). Thus, in both the private sector and public sector, the stakeholders collaborate through their collection actions while they generate outputs in the value chain (Anandajayasekaram 2019, Hermans, Geerling-Eiff et al. 2019).

2.2.5.1 The Role of Research in Agricultural Innovation Systems

The role of research is vital to agricultural innovation systems as it generates technologies (knowledge frontier), its engagements with other stakeholders in the value chain are crucial in achieving food security and agricultural development (Bank 2012, Lynam 2012, Eastwood, Klerkx et al. 2017, Ogunniyi, Oluseyi et al. 2017, Anandajayasekaram 2019, Faure, Blundo-Canto et al. 2020). There is a shift from research being the centre of innovation whilst the involvement of other stakeholders' inclusiveness in setting priorities, planning, programming, monitoring, executing and implementing, as well as evaluating their innovation agenda and ideas is paramount to the performance of the AIS concept (Bank 2012, Anandajayasekaram 2019, Faure, Blundo-Canto et al. 2020, Posner, Fenichel et al. 2020).

Research roles in the AIS concepts are not only to generate knowledge through basic and strategic research but also to translate the knowledge generated with other role players into

technological outputs and processes (Bank 2012). Thus, the close working relationship of researchers for partnering with other stakeholders enhances the performance of AIS by heightening technological outputs (Devaux, Torero et al. 2018, Anandajayasekaram 2019). The partnering of researchers with other stakeholders in AIS is pertinent for research reformation and funds procurement which trigger the technological outputs (Eastwood, Klerkx et al. 2017). Similarly, strengthening linkages of research with other innovation platforms is the key to facilitating the generation and adoption of technological outputs and processes in AIS (Douthwaite and Hoffecker 2017).

Bringing research closer to other stakeholders in the value chainis important as it builds strong ties for establishing a joint management system and systematically ensuring joint monitoring and joint evaluation in AIS. Therefore, researchers need to acquire skills to facilitate wide-ranging reforms to achieve food sustainability (Bank 2012). Moreover, the shift from research being in a central position to being an important constituent in the agricultural innovation system connotes that the agricultural innovation system embraces the totality, participation and interaction of other components inclusively in the value chain (Anandajayasekaram 2019, Zwane 2020). The researchers must acquire skills in negotiation and facilitation to perform as effectively as a partnership in the incremental process of innovation and development (Bank 2012). The performance of research in the agricultural innovation system is thereby heightened through partnerships and the ability to collaborate with other components for fostering food security (Douthwaite and Hoffecker 2017).

However, the research encounters some problems which include institutional change, policy change and lack of consensus on a strategic vision, weak linkage system, ineffective leadership and poor management (Bank 2012).

2.2.5.2 The Role of Agricultural Education in Agricultural Innovation Systems

Agricultural education is an important institution that creates capacity development and supplies intellectual resources in agricultural innovation systems through the systematic and integrative process of teaching, training and learning for knowledge and skills acquisition (Bank 2012). Thus, it is necessary for capacity building through comprehensive reformationand

practical oriented training for the development of individual traits necessary for making AIS thrive (Klerkx, Van Mierlo et al. 2012, Aerni, Nichterlein et al. 2015).

However, building integrative education and training systems that deepen comprehensive institutional reforms of curricula which serve diverse stakeholders in AIS requires a great deal of financial commitment and investment for creating capacity development while strengthening innovations (Bank 2012, Aerni, Nichterlein et al. 2015, Andersen and Wicken 2021).

As a result, adequate financial investments for long-term reforms in agricultural education improve and generate capacity building among role-players for improving, monitoring, and evaluating innovation while strengthening inputs, outputs, and impacts in the value chain with the overall aim of increasing food production in the agricultural innovation system. Thus, the absence of agricultural education creates a gap in the agricultural developmental growth of any nation (Aerni, Nichterlein et al. 2015, Klerkx and Begemann 2020).

2.2.5.3 The Role of Extension in Agricultural Innovation Systems

Extension forms an integral part of agricultural innovation systems which provide stakeholders with instructions and technical assistance along with information for stimulating the adoption of technology (Eastwood, Klerkx et al. 2017, Ogunniyi, Oluseyi et al. 2017, Chavas and Nauges 2020). Thus, the inter-dependency relationship and collaboration of extension agents with other stakeholders are paramount for the effectiveness and efficiency of improving productivity in the agricultural innovation system (Eastwood, Klerkx et al. 2017, Anandajayasekaram 2019).

Consequently, extension agents are encumbered with knowledge brokering services such as exchanging information, facilitating partnerships and building coalitions among stakeholders (Klerkx 2012). Besides, extension agents are increasingly important in providing, simplifying, clarifying and delivering research-relevant information and technologies to farmers in effective ways, while facilitating farmers' training on developed technologies (Eastwood, Klerkx et al. 2017, Anandajayasekaram 2019). They also provide advisory services and feedback mechanisms from farmers to researchers on the problems encountered while offering services

to farmers in helping them to be organized into functional units such as a farmers group, cooperative farmers' society, and commodity groups (Rijswijk and Brazendale 2017, Chavas and Nauges 2020).

Klerkx, (2020) opines that extension should move beyond transferring technology to farmers to connecting institutions, organizations and stakeholders by providing support and brokering knowledge for ensuring partnership in AIS. However, for extension to be relevant in AIS, it requires adequate investments in extension and advisory service, reformation of the extension systems, recognition of the need for new expertise, and provision of pluralism in extension service deliveries (Bank 2012, Klerkx and Begemann 2020).

2.2.5.4 The Role of the Farmers' Organization in Agricultural Innovation

The farmers' groups are the primary producers of commodities, and they are fundamental in agricultural innovation systems, while innovation is largely designed on their behalf to improve the quality and quantity of their yield (Zwane 2020). Hence, farmers' participation is so crucial and necessary in the planning and implementation of any innovation as it facilitates sustainable adoption of innovations than reaching out to individual farmers, while other role-players such as researchers, extension agents, non-governmental organizations and input dealers need to agree with farmers' priorities (Amonjenu and Wombo 2016).

Undoubtedly, farmers being organized into a functional organization bring about a strong negotiating power in the purchase of farm inputs, selling farm produce, helps in leveraging farmers' weight, and makes available the indigenous knowledge that can effectively be communicated within the value chain (Bank 2012).

It reduces the transaction cost of reaching out to individual farmers in the value chain while accessibilities of credit facilities are made possible through farmers' groups without paying a high interest rate (Baldanov, Kiminami et al. 2020).

2.2.5.5 The Role of Agro-dealers in Agricultural Innovation Systems

The engagements of agro-dealers are vital in the value chain because they meet the specific demand of the stakeholders of the value chain (Bank 2012, Ogunniyi, Oluseyi et al. 2017,

Hornum and Bolwig 2021). Thus, the agro-dealers contribute to the development, adaption, and adoption of innovation by providing farmers with affordable, accessible input supply systems and appropriate high-quality technologies to enhance yield (Bank 2012, Aerni, Nichterlein et al. 2015).

They do not only provide advisory services on the best way to use technologies to achieve favourable economic returns but improve the transfer of knowledge in ensuring the sustainability of agricultural development (Adebayo, Olagunju et al. 2016, Ogunniyi, Oluseyi et al. 2017). Also, they provide seeds, seedlings, breeds, fingerlings, feeds and fertilizers in the value chain (Bank 2012). The agro dealers' role varies based on the phases of agricultural development. For instance, in a nation where agriculture is developed, agro-dealers assume more complex roles compared to an underdeveloped agricultural nation. They could be strengthened by improving dealers' knowledge in the marketing of agricultural products and building the capacity of dealers (Bank 2012, Adebayo, Olagunju et al. 2016).

2.2.5.6 The Role of Market in Agricultural Innovation Systems

Market accessibility plays a vital role in influencing the performance of stakeholders for enhancing their livelihood and diversifying productions (Lamprinopoulou, Renwick et al. 2014, Anandajayasekaram 2019, Chavas and Nauges 2020). Thus, markets are critically important in creating links between innovations and development, but, are not sufficient for them while they require other institutions to work with, such as education, research and service delivery (Lamprinopoulou, Renwick et al. 2014). Certainly, market-led agricultural development relies more strongly on the collective actions of stakeholders in the value chain (Anandajayasekaram 2019).

Effective marketing increases production and agricultural development by enabling actors in the agricultural innovation system to benefit from economies of scale while highly competitive markets do arise from the collaboration of actors in the value chain (Lamprinopoulou, Renwick et al. 2014, Schut, Klerkx et al. 2015).

Consequently, agricultural innovation systems are articulated by the market while market information systems not only provide information on markets' prices but also analytical

information on market intelligence. However, for scaling up agricultural productions, market integration is crucial in the value chain (Bank 2012, Anandajayasekaram 2019).

2.2.5.7 The Role of Agro-based Non-governmental Organizations in Agricultural Innovation Systems

Non- governmental organizations are not only effective vehicles in agricultural innovation systems for delivering agricultural support services, facilitating the supply of inputs into the management process, transferring technology and alleviating poverty but, also play a quality services delivery in agricultural development for networking information among actors and fostering participation for achieving sustainability in agricultural innovation system while also offering an advisory services in the value chain (Eidt, Pant et al. 2020, Romero-Riaño, Guerrero-Santander et al. 2021).

The non-governmental organizations that are non-profit making voluntary interest-based organized cooperative groups (or institutional groups) are independent of the government. The government's primary objectives are purely humanitarian rather than commercial (Bank 2012). Their dynamic development performance processes are paramount as they express farmers' views that otherwise might not be heard through their consultative, participatory approaches with other actors in the value chain (Eastwood, Klerkx et al. 2017).

However, their effective collaboration and strategic partnership with other stakeholders are paramount to ensuring food security (Lewis, Kanji et al. 2020). Some of the challenges of non-governmental organizations include the following: financial constraints, lack of efficient leadership, limited strategic perspectives, limited technical capacities, limited organizational capacities, and limited managerial and weak linkages with other actors in development (Eidt, Pant et al. 2020, Lewis, Kanji et al. 2020).

2.2.5.8 The Role of the Policies in Agricultural Innovation Systems

The good policy mixes are significant and integral for achieving innovations in AIS as they trigger the participation and mobilize collaboration of stakeholders, and facilitate the implementation of the program through the formulation of appropriate policies (Badstue, Elias et al. 2020, Froebrich, Ludi et al. 2020). Thus, it legitimizes and facilitates the support of the

government for stakeholders' activities in the value chainand governs the stakeholders' operations in the value chain (Boon, Bawole et al. 2013).

The policies that support innovation are not the outcome of a single policy but of a set of policies that work together in generating technological outputs and processes (Froebrich, Ludi et al. 2020). The fiscal policies are needed in AIS for the promotion of the agricultural innovation systems in the area of financing (Badstue, Elias et al. 2020). Thus, policies support investment in innovation, enhance innovative competencies of the organization and strengthen linkages within the innovation system (Badstue, Elias et al. 2020).

Moreover, appropriate policies facilitate the creation of infrastructure and enabling environments that support innovations (Bank 2012). This, brings about an enabling environments to help in promoting and catalyzing innovations by providing both supportive structures and good resources in achieving technological products and processes in agricultural innovation systems (Klerkx, Van Mierlo et al. 2012, Badstue, Elias et al. 2020, Lewis, Kanji et al. 2020).

2.2.5.9 The Role of Financial Institutions in Agricultural Innovation Systems

Financial institutions are increasingly important in actualizing any development in the agricultural innovation systems as their engagements in the value chain are significant in filling the amounts needed by the stakeholders in AIS (Aerni, Nichterlein et al. 2015).

Consequently, they provide financial services for enhancing agricultural development through the provision of credit facilities and loans in the value chain (van Rooyen, Ramshaw et al. 2017). Also, meteorologists play a prominent role in providing weather-based information to stakeholders for effective production in agricultural innovation (Bank 2012)

2.3 Stakeholder Participatory Approaches (SPA)

Many of the existing studies have conceptualized that the development of any project requires the involvement of actors (stakeholders) in taking initiatives in decision-making processes through their collective action, collaboration framework and joint learning for facilitating the

community development process and enhancing sustainable agricultural development (Leeuwis, Pybaurn et al. 2002, Eidt, Pant et al. 2020, Gyan 2021). Stakeholder participation approaches (SPA) embrace the involvement of role players in the decision-making process for the planning and implementation of project development while harnessing their resources in achieving their physical, social and economic objectives (Boon, Bawole et al. 2013, Van Waart, Mulder et al. 2015, Blundo-Canto, Devaux-Spatarakis et al. 2020).

Consequently, involving the stakeholders in the developmental activities of a project forms an integral part of participatory developmental approaches while requiring a great commitment in labour and time on their parts (Van Waart, Mulder et al. 2015). Thus, the participation of actors determines the success of any project and plays a significant role in the decision-making process for identifying, planning and implementing, monitoring and evaluating on the development of projects (Sartas, Van Asten et al. 2019). The importance of stakeholders' participation (SP) in a programme cannot be undermined as it has become imperative for ensuring who decides on the definition of the problem for the planning and implementation process (Sartas, Van Asten et al. 2019, Eidt, Pant et al. 2020).

Undoubtedly, the participation of actors is paramount for harnessing the collective talent pool of role players for project planning and executing the process of project development. While the active involvement of stakeholders for any project is paramount for enhancement of project development, it has not been without enormous hurdles (Sartas, Van Asten et al. 2019, Raman 2020, Gyan 2021). Thus, actors deserve the thrill that enables them to work collectively and collaboratively to ensure food sustainability while contributing to the issue at hand. Cornwall (2008) and Leeuwis et al. (2002) differentiate the various types of participation as follows

- Passive participation is a form of participation where the decision on the definition of the problem and implementation and initiatives is solely taken by the project management while other actors are being told of the decision made.
- Consultation participation is a type of participation where the decision and initiative on the definition of problems are carried out by the external agents (professionals) while they are not oblique in any way in sharing other actors' opinions or interventions.

- Material incentives participation is a type of participation where actors contribute their resources in the form of labour in obtaining material incentives in return such as food while having ended the incentives; such practices can no longer be prolonged.

- Functional participation is a form of participation where the major decisions and interventions are made by external agents for project execution while other actors are being organized into functional groups in participating in the projects.

- Interactive participation is a type of dynamic, systemic, interdisciplinary and multidimensional participation where shared decision and resource contribution is made from the initiatives and interventions from the active and full involvement of actors that are part of a consensus on jointly identifying of a problem, jointly problem solving, jointly learning, jointly financing of projects, and jointly implementation in contributing to the issue at stake.

2.3.1 Stakeholders Participation Models (SPM)

According to Sartas et al. (2019) as well as Eidt et al. (2020) for any development to be sustainable or a project to be successful, they necessitate the active involvement and full engagement of heterogeneous stakeholders. This is pertinent for collective democratization processes, effective management of resources, and joint skilled-oriented learning while reaching a consensus on the planning and implementation of their felt need.

The literature has shown that engaging and fostering stakeholder participation models (SPM) in a project or program have been increasingly recognized for enabling novelties, enhancing production and achieving sustainable development (Sartas, Van Asten et al. 2019, Eidt, Pant et al. 2020, Ondeko 2020, O'Brien, Phelan et al. 2021). According to Ondeko (2020) who states that the stakeholder participation models denote a particular approach to engaging stakeholders in the planning and implementation of their felt needs into organizational goals in creating effective strategic development.

The literature has it that there are different approaches to stakeholder participation models (SPM). While applying any of these models, it must be carefully chosen as it can impede or facilitate the development of the value chain. Many studies stress the advantages of several

stakeholder participation models (SPM) while ignoring their limitations. Consequently, Ondeko, (2020) opines that participation models include the top-down stakeholder-participation model; the bottom-up participation model; the collaborative stakeholder-participation model; and the contractual stakeholder-participation model which are as follows:

- A top-down stakeholder-participation model is an approach in which decision-making and interventions in the planning and implementation processes of the project are initiated by the experts (top actors) while other actors follow their governance in the value chain. This model does not give room for other actors to dialogue in the decision-making process.

- The bottom-up stakeholder participation model is an approach in which interventions and decisions made on the felt needs emanate from local actors while other actors in the value chain provide support, there was a shift from top-down to bottom-up in the mid-twentieth century.

- A collaborative stakeholder-participation model is an approach in which interventions and decision-making emanate from the multiplicity of stakeholders who share their mutual requirements in reaching a consensus in the value chain. This model fosters cooperation, partnership and collaboration by engendering knowledge generation, joint learning and collective effort. Nevertheless, this model is not without its challenges as the assemblage of stakeholders does come with conflict, though such emergent conflict can be resolved.

- A contractual stakeholder-participation model is a type of model in which interventions and decision-making are undertaken and defined by the project owner solely (influential stakeholder) while other stakeholders participate in the program.

- A consultative stakeholder-participation model is an approach in which the social actor makes the key decisions while wielding influence on other actors in the value chain.

- A collegiate stakeholder-participation model is an approach in which decisions and initiatives are made on consensus by different stakeholders who work together in partnering with one another in the planning and implementation of a project.

2.3.2 Engaging and Integrating Models

Agricultural innovation systems embrace and accentuate the stakeholders' participatory approach in achieving novelties and co-evolutions, the bottom-up participation model, collaborative stakeholder-participation model and collegiate stakeholder-participation model are therefore required for this study (Blundo-Canto, Devaux-Spatarakis et al. 2020, Okul and Nyonje 2020). The engagement and integration of the bottom-up participation model, collaborative stakeholder-participation model and collegiate stakeholder-participation model in this study are pertinent and beneficial as the interventions and initiatives arising from a plurality of stakeholders (farmers, extension agents, researchers, input dealers, and NGOs in the study area) in the open social system. This platform brings all the actors together in setting priority while sharing and discussing their challenges and opportunities for affecting desired changes which include knowledge production, generation of value-added products, and processes in the value chain (Okul and Nyonje 2020). Thus, decision-making emanates from every actor which includes farmers, extension agents, researchers, input dealers and NGOs while their voices are taken into recognition (Turner, Klerkx et al. 2017).

Turner et al. (2017) assert that agricultural innovation systems are the co-development systems comprising wide range of partners, entrepreneurs, innovators, multi actors for dynamic participation and active partnership in which new ideas can either be initiated by local stakeholders (bottom-up) and facilitated by external actors (top-down) in which no single actors dominate for creating societal impact. The agricultural innovation concepts have to be the predominant change narrative for setting goals in orchestrating the agricultural development for both local and global institutions through international funders (Food and Agriculture Organization FAO) and Consultative Group on International Agriculture Research CGIAR) for creating technological output (Turner, Klerkx et al. 2017).

Therefore, this study is built on the bottom-up participation model, collaborative stakeholder-participation model and collegiate stakeholder-participation model which involve well-established involvements, interrelationships, interactions, and interdependencies among heterogeneous stakeholders for contributing to the issue at stake through the new form of communications for orchestrating knowledge.

The participation and engagement of the diversity of stakeholders' participatory approach in AIS contribute immensely to setting priorities in generating knowledge and fostering learning through the collaboration and collective actions of actors. This is while engaging various actions and reactions regarding their requirements to use the resources at their disposal to enhance technological products or processes through their joint problem identification, joint problem solving, joint learning, joint training, joint financing of projects, joint evaluations of trials, joint shared use of resources, joint provision of advisory support, joint extension services, joint use of subject matter specialists for a service provider, joint implementation, joint feedbacks mechanism, joint monitoring, joint research activities, joint management capacity and joint evaluations (Blundo-Canto, Devaux-Spatarakis et al. 2020).

2.3.3 The Significance of Stakeholders' Mechanism in Agricultural Innovation Systems

Agricultural innovation systems aim to offer value-added products and technological outputs through the inclusion of stakeholders' partnerships. They recognize the importance of collective actions, mutual participation, effective communications and feedback structure among the heterogeneous stakeholders in the organizational governance for generating knowledge, technological processes and products in the value chain that have the potential to eliminate virtually all the hurdles the smallholder farmers are experiencing in developing communities (Turner, Klerkx et al. 2017, Blundo-Canto, Devaux-Spatarakis et al. 2020). The stakeholder mechanism in agricultural innovation systems is a process that brings all actors together to contribute to the issue at stake through the new form of communication for orchestrating knowledge through their joint decision-making. In setting priorities based on their felt needs by collective learning, joint problem identification, solving problems together, conducting surveys, evaluating trials jointly, providing advisory support to each other, implementing, generating feedback structures, monitoring, managing, evaluating and financing projects together, as well as sharing resources through their collective actions and reactions to achieve innovation through economies of scale in scaling up production (Klerkx & Begemann, 2020, Zwane, 2020).

Therefore, the stakeholders' mechanism arises from the dynamism, collaboration, interaction, interrelationship, interdependency and voluntary cooperation among the multiplicity of actors

in AIS who are actively committed to knowledge sharing, learning alliance, capacity building, and all forms of networking for growing, processing, packaging, marketing, distributing and consuming agricultural products (Anandajayasekaram 2019, Eidt, Pant et al. 2020).

Consequently, their involvement is vital for building a coalition and synthesizing harmonious synergy intended for the generation, dissemination, and adaptation of knowledge and adoption of a technological output or a new process for novelty in ensuring nutritional security, economic growth and livelihoods improvement (Bank 2012, Turner, Klerkx et al. 2017).

Nevertheless, the stakeholders' mechanism requires systemic dynamic approaches for engaging different stakeholders in identifying a common felt need and facilitating the implementation of their need through their concerted effort (Blundo-Canto, Devaux-Spatarakis et al. 2020). Thus, partnerships among stakeholders are achieved by utilizing one another's comparative advantage through leverage without ignoring other strength (Aerni, Nichterlein et al. 2015). The stakeholders' mechanism is an important factor in influencing the shapes and the direction of innovation processes through the collaboration of the network among actors for developing relationships that are based on democratic principles of transparency for increasing technology, productivity and marketability in AIS (Eastwood, Klerkx et al. 2017, Andersen and Wicken 2021) Effective coordination is a fundamental requirement in AIS for building a coalition among stakeholders (innovation platform) that emerges spontaneously or deliberately from active interactions in the value chain (Boon and Edler 2018, Zwane 2020).

This effective coordination requires a committed and capable leadership that would shape the organizational culture within the AIS while a lack of efficacious coordination results in limiting access to new knowledge, weak organizational learning, and weak articulation for training (Nettle, Klerkx et al. 2017, Rijswijk and Brazendale 2017).

Embracing the collective actions of stakeholders' interventions for the identification of opportunities, assessing the challenges involved and accessing the social, human and capital resources in AIS would improve productivity (Devaux, Torero et al. 2016).The propensity to innovate is determined by active relationships, effective collaboration, efficacious coordination and the collective actions of stakeholders in AIS (Bentley, Naziri et al. 2021). Thus,

stakeholders' interdependencies, interactions, involvements and inter-relationships do enhance not only productivity but also increase marketability (Anandajayasekaram 2019).

Besides, increasing the innovation process in AIS requires the strengthening of linkages among the stakeholders' which include farmers, researchers, extension agents, non-governmental organizations, input dealers and other relevant stakeholders in setting priorities for the innovations agenda in the value chain (Eidt, Pant et al. 2020).

2.4 Enumerating the Benefits of Stakeholders' Mechanism in the Agricultural Innovation System

First and foremost, Devaux, et al. (2016) observe that the active involvement of stakeholders in AIS has become integral for enhancing sustainable growth in agriculture by necessitating rapid diffusion, adoption, development of knowledge and technological output. Hence, AIS brings farmers closer to other role players, thereby synthesizing harmonious synergy for mitigating poverty, facilitating large-scale production, and generating income.

The involvement of diverse heterogeneous stakeholders as role players in AIS not only facilitates active interaction, strong linkages, effective communications and dynamic relationships among the arrays of actors in the value chain but also generates knowledge and technological output which aim at orchestrating agricultural development (Hermans, Geerling-Eiff et al. 2019).The collaboration of diverse heterogeneous stakeholders influences the decision-making process on their felt needs while helping them to navigate their directions through their close interactions, strong linkage mechanisms and effective communications that would trigger high productivity for achieving economic development (Klerkx 2020).

Similarly, knowledge and skill generation from the array of role players in AIS would help them in identifying their challenges and opportunities by setting priorities in contributing to the issue at stake and reaching consensus through dialogues for new ideas in facilitating large-scale production (Klerkx, Van Mierlo et al. 2012). Thus, the stakeholders' mechanism builds coherence, dialogues and consensus in setting priorities, and implementation for the achievement of nutritional security, food sustainability and economic growth (Anandajayasekaram 2019).

Furthermore, the AIS bring about a forum where stakeholders can give their opinions regarding their felt needs in the process of planning and implementing any technology (Ingram, Gaskell et al. 2020). Therefore, the stakeholders' participation in agricultural innovation systems allows them to voice their needs, thereby creating demand-driven needs in the process of designation and implementation of a technological output or a new process (Klerkx and Begemann 2020).

More so, the involvement of innovative platforms facilitates large-scale production and high marketability through the close working relationships of farmers' groups with other actors by building a coalition for co-development AIS while influencing their decision and direction of production, market formation and resource mobilization (Devaux, Torero et al. 2018, Ingram, Gaskell et al. 2020).

Lastly, the stakeholders' collaboration in AIS does not only help them in managing the risks associated with production and marketability but also facilitates leverage for increasing their productivity while resulting in radical economic improvement (Bank 2012).

Hence, it leads to drastic improvements in upgrading the indigenous knowledge in agriculture through a better leveraging of human and capital resources (Klerkx and Begemann 2020). Thus, the significance of stakeholders' mechanisms in agricultural innovation systems can never be overemphasized as it enhances competitiveness and food sustainability (Eastwood, Klerkx et al. 2017).

2.5 Theoretical Frameworks

In order to develop empirical work for this study, it has to be based on some theories. The theoretical foundation for this research is drawn from psychology, sociology and economics. Thus, the theories and their relevancies are discussed which include:

- The theories based on evaluations
- The middle-range theories
- Economics theories include evolutionary and industrial economics theory, the new growth theory, and the institutional economic theory

2.5.1 The Theories based on evaluations

The theory-based evaluations are logic models that explain the designation, development and evaluation of interventions in conceptualizing analytical models which were first coined by Chen and Rossi in 1980 (Brousselle and Buregeya 2018). However, Chen and Rossi (1989) suggested a manifesto tenant of black box programs in 1989 with no theory while the black box is the space between the actual input and the expected output of a program (Brousselle and Buregeya 2018, Barrett, D'Errico et al. 2020).

The theories based on evaluations are theories based on the propositions of the logic of social interventions within a mechanism for producing outcomes (Hoffecker 2021). Thus, these theories explain how the logic of social interventions is expected to produce outcomes (results) that take into account the mechanisms through which they produce outcomes. By offering solutions to overcome the hurdles associated with some inventions, we have contributed to addressing the inherent complexity associated with those inventions (Douthwaite and Hoffecker 2017, Koleros, Mulkerne et al. 2020).

Co Douthwaite and Hoffecker (2017) assert that this theory aims at accessing the change at every stage of the theory to test the linkages while generating outcomes within a system through the logical interventions of the individuals involved within the context in which it is implemented. Brousselle and Buregeya (2018) with Koleros et al. (2020) confirm that the theories-based evaluations have solved a lot of complexities associated with systems of institutions and organizations.

However, there have been a lot of theories-based evaluations with different variations (Blamey and Mackenzie 2007). As a result, one of the theories-based evaluations was considered for this study which included a realistic evaluation. In 1997, Pawson and Tilley (the sociologists) were the proponents of realist evaluation which found its roots in the perspective of the theories-based evaluation while this realistic evaluation has been increasingly proven to be thriving (Douthwaite and Hoffecker 2017). Thus, the realist evaluation stated that for any intervention to be successful, it has to depend on the underlying mechanism at play in that specific context in generating the output (Douthwaite and Hoffecker 2017).

Mechanism + interventions = outcome

Thus, the main evaluations for realistic evaluators are largely concerned with what works, for whom it is working and in what circumstances and respects it is working (Pawson, 2013). Pawson and Tilley (1997) affirm that the mechanisms thrive when the interventions come through the stakeholders' collective actions and joint reactions for output generation. They further explain that it is not only interventions that synthesize output within a context, but also through the joint resources of the role player (Douthwaite and Hoffecker 2017, Barrett, D'Errico et al. 2020, Koleros, Mulkerne et al. 2020).

However, in the AIS concepts, the mechanisms that would trigger knowledge generation which in turn results in a technological product or process in the value chain include stakeholders' collaboration, enabling environments, capacity developments, investment of time and personal resources, and role players discharging their duties effectively and efficiently within the system (Douthwaite and Hoffecker 2017, Koleros, Mulkerne et al. 2020).

Accordingly, the concept of agricultural innovation systems falls within a realist evaluation and could be attributed to theories-based evaluations as AIS are complex social logic interventions involving stakeholders' mechanisms for generating knowledge and technological outputs as their outcomes (Koleros, Mulkerne et al. 2020). In spite of this, theories-based evaluations support this research by providing a link between it and other studies (Koleros, Mulkerne et al. 2020).

Therefore, AIS are complex systems of social logic interventions, interactions, interrelationships, and interdependency of stakeholders' coalition mechanism for knowledge generation to enhance technological output or processes with the overarching aim of improving agricultural productivity (Douthwaite and Hoffecker 2017, Koleros, Mulkerne et al. 2020). Thus, the stakeholders' mechanism plays a significant role in AIS for identifying their cogent needs and pooling their resources together while requiring the investment of time and resources on their part toward achieving technological output (Schut, Kamanda et al. 2019).

2.5.2 The Middle Range Theories

In 1968, the middle-range theories were developed by an eminent sociologist named Robert K Merton whose aims were to integrate theory with empirical research as an approach to sociological theorizing (Chiffoleau and Loconto 2018). The middle-range theories were built on the social phenomena of interrelationships among concepts which try to explain all social behaviour with a given systematic set of assumptions that lie between generated hypotheses for enhancing knowledge (Douthwaite and Hoffecker 2017).

The theory is thus based on the scientific study of organizations and organizational behaviour (Hoffecker 2021).

Robert Merton in l968 postulates that middle-range theory fills the sociological blanks, while the middle-range theories have the features listed below (Lee 2021).

- It is concerned with each phenomenon, rather than attempting to address all social issues.
- It creates linkages that foster relationships.
- Its abstract may be turned into straightforward assumptions that could be tested.
- It has a limited set of assumptions and hypotheses that are testable hypotheses.

Thus, the middle-range theories offer backdrops for the concept of agricultural innovation systems for the creation of knowledge through the involvement and engagement of various stakeholders, institutions and organizations for generating technological output and technological processes for enhancing agricultural development.

2.5.3 Economics Theories

Some economic theories described how innovations have become the key drivers of economic growth (Guinet, Jean et al. 2009). Guinet, Jean et al. 2009 state that following the Evolutionary Theory, New Growth Theory, Institutional Economics Theory, and Industrial Economics Theory, investments in knowledge accumulation among networks of individuals have an increasingly important role to play in achieving new technologies and human capital.

The agricultural innovation systems are the buildup of the learning process involving the interrelationships, and the partnerships of the networks of actors and organizations from both private and public sectors that are governed by policies (Röling 2009, Carayannis and Grigoroudis 2016, Lundvall 2016).This policy either promote or impede the performance of innovation while AIS stress the importance of coordination and complex interdependencies within firms, enterprises, institutions and organizations as a means for designing and producing the goods and services that are new to them (Röling 2009, Carayannis and Grigoroudis 2016, Lundvall 2016).

Consequently, AIS interventions which are initiated by the array of stakeholders and their initiatives are based on their felt needs and common interest through their joint implementation while they are committed to investment in capacity development (human resources), operational funds and conducive policies (enabling environment) (Guinet, Hutschenreiter et al. 2009, Aerni, Nichterlein et al. 2015).

However, all the aforementioned theories provide frameworks that appear promising theories for the analysis of stakeholders' participation in agricultural innovation systems in the Oyo State of Nigeria. This is because this study is focusing on the social logical interventions, collaborations, interrelationships and interdependency of the role players (stakeholders) for knowledge generation and with the overall aim of increasing agricultural production.

Thus, since AIS are social, institutional and technical changes occurring from the participation of the interdependent stakeholders having collective learning in achieving new things, products, and practice, thus all the highlighted theories apply to this study.

2.6 Conceptual Framework of the Study

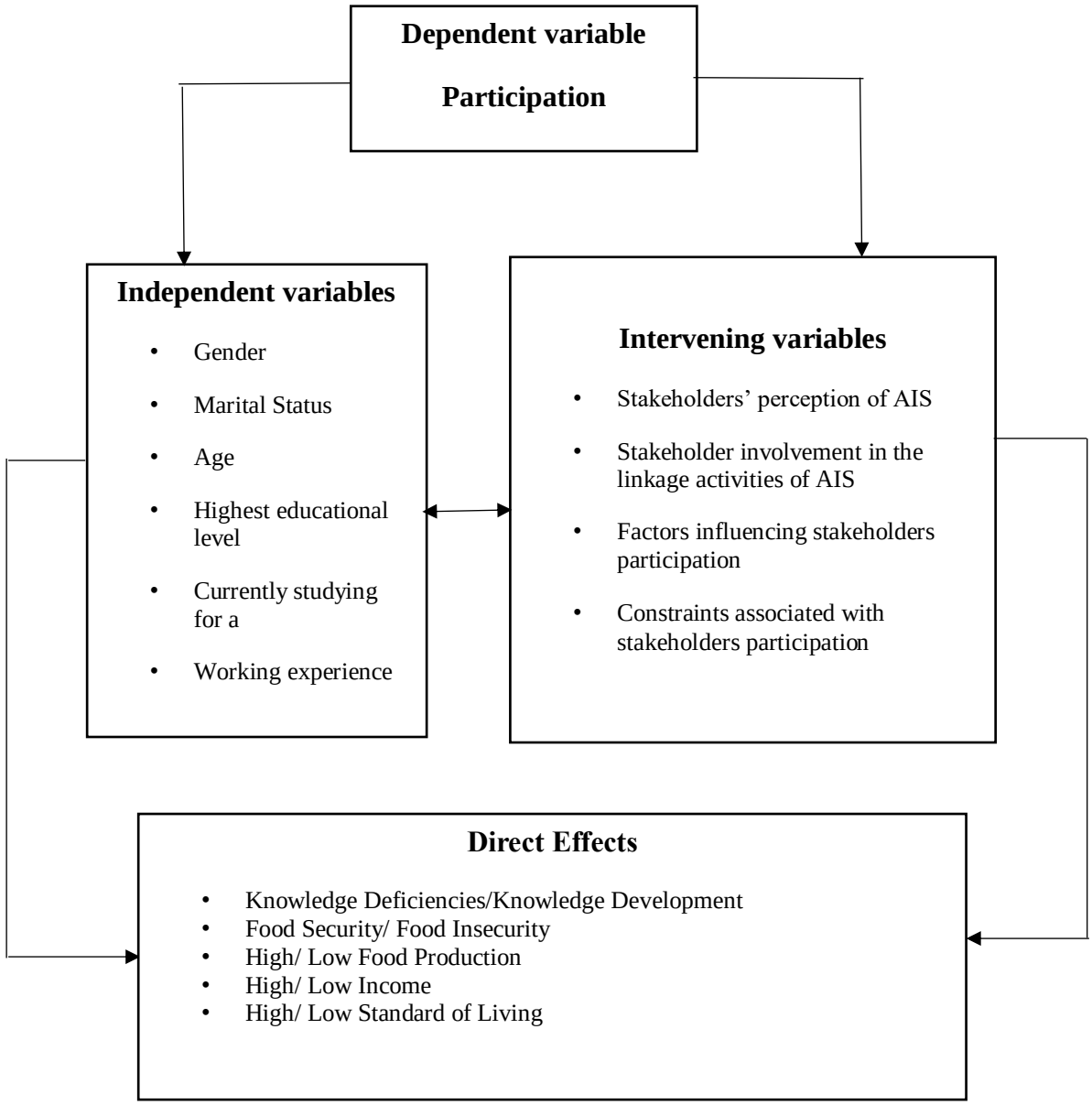


Figure 2.1: Conceptual Framework of the study (Analysis of stakeholders and their participation in AIS). Source: Author

The conceptual framework for this study is divided into three segments which include independent, dependent variables and intervening variables that show the relationship between independent, dependent variables and intervening variables.

The independent variables in this study are the stakeholders' socio-demographic factors which include gender, marital status, highest educational level, currently studying for a higher degree, working experience and source of information. These stakeholders' socio-demographic factors are capable of influencing their participation in the agricultural innovation system. Consequently, the involvement of innovation platforms (role-players) in agricultural innovation systems is brought about by the socio-demographic factors which will, in turn, determine their productivity.

The dependent variable for this study is the participation in the linkage activities of AIS among stakeholders (this explains the stakeholders' willingness and their disposition towards participating in agricultural innovation).

The intervening variables are the variables that explain the relationship between the independent variables and the dependent variable. Thus, the intervening variables have an indirect influence on the participation in AIS for enhancing an increase in productivity among stakeholders. These variables include stakeholders' perception, stakeholder involvement in the linkage activities of AIS, factors influencing stakeholders' participation and constraints associated with stakeholders' participation. They are crucial for building synergistic relationships necessary for stakeholders in participating in AIS.

2.7 Chapter Summary

This chapter has reviewed pieces of literature on agricultural innovation systems beginning with the introduction, the concepts of agricultural innovation systems, characteristics of agricultural innovation systems concepts, the significance of stakeholders mechanism in agricultural innovation systems concept, the elements for sustainability in agricultural innovation systems, the components of stakeholders mechanism in agricultural innovation systems concepts, the roles of stakeholders mechanism in agricultural innovation systems, the benefits of stakeholders' mechanism in agricultural innovation systems, while this chapter concludes by reviewing related theories and presenting the conceptual framework for the study.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodological approaches used in collecting and analyzing data. It also covers the study area, the study population, research design, sample procedure, sample size, the instrument for data collection, validity and reliability of the instrument, analyses of data and ethical considerations.

3.2 Study Area

The study was conducted in Oyo state southwestern part of Nigeria, with its capital at Ibadan. The agricultural sector forms the basis of the overall development thrusts in the state. It is bounded in the north by Kwara state in the west by Ogun state and partly by the Republic of Benin, in the east by Osun state, and in the south by Ogun state (Adekunle, Ilori et al. 2020). The ecological zone of this area ranges from the rainforest in the South around Ibadan to the mangrove forest. The rainfall ranges from 2 500 to 3 000 mm per annum which is distributed from April to October with a spell of the dry season between late July and early August. The average daily temperature ranges between 25 °C (77 °F) and 35 (95 °F) almost throughout the year. The climate in the state favours the cultivation of crops such as maize, yam, cassava, plantains, cocoa, palm produce, cashew, cocoyam and vegetables. The state consists of thirty-three (33) local government areas (LGAs) with four zonal agricultural development programmes (ADPs) located at Ogbomosho, Oyo, Ibadan\ Ibarapa with headquarters in Saki. The study area has a distribution of agricultural research institutions namely; the International Institute of Tropical Agriculture (IITA), National Cereal Research Institute (NCRI) Ibadan, Nigeria Institute for Social and Economic Research (NISER), Institute of Agricultural Research and Training (IAR&T) Ibadan, Cocoa Research Institute of Nigeria (CRIN), National Institute for Horticultural Research (NIHORT) Ibadan, Nigeria Stored Product Research Institute (NSPRI) Ibadan, National Agricultural Extension and Research Liaison Services (NAERLS).

Keys

Zonal (ADPs)
Oyo
Ogbomosho
Ibadan
Ibarapa
Saki

Five zonal agricultural development programmes (ADPs)

Figure 3.1: Map of Oyo State Nigeria Source: (Nigerian Muse, 2010)

3.3 Research Design

The study used a descriptive survey design and a quantitative method in its analytical approach. This method was used because the set of predetermined questions was used to collect data from the sample of the study population. The data collected from the respondents were quantitative in line with the specific research objectives of the study. Also, the quantitative research method is more reliable and objective as it enables respondents to express themselves in a direct manner. It also reduces and restructures complex problems to limited numbers (Powell 2020).

3.4 Study Population

The study population consists of all researchers in an agricultural research institute, all farmers from the farmers' groups or organizations, all input dealers, all extension personnel in extension agencies, and all agro-based non-governmental organization in Oyo state of southwestern Nigeria.

Farmers' organizations (FO): they are the primary producers of the commodities in the agricultural innovation system.

Input dealers: they contribute to the development, adaption, and adoption of innovation by providing farmers with affordable, accessible input supply systems (fertilizers, herbicides, tools, and farm machinery) and appropriate high-quality technologies to enhance better yield.

Extension personnel in extension agencies: simplify, clarify and deliver research information and technologies to farmers in effective ways.

Agro-based non-governmental organizations: facilitate the supply of inputs, the transfer of technology and delivery of agricultural support services into the management process

Researchers in the agricultural research institutes: four out of nine research institutes existing in Oyo state namely NCRI NIHORT, IAR&T and FRIN. were selected for this study.

Extension Agents (from ADP)

The population of the extension agents in the study area comprises four ADP zones and the four zones were made up of the population for the study area which includes Ibadan\ Ibarapa, Oyo, Ogbomosho, and Saki inclusive with extension agents of the NAERLS office.

Farmers from the Farmers' Groups or Organizations

In Oyo State of Nigeria, 20 farmers' groups were registered with ADP and this constituted the population for the study. These are the group that meet regularly to discuss and adopt innovations. Each group consisted of 20 to 25 farmers making a total number of 500 members.

Agro-based Non-governmental Organizations

Oyo state of southwestern Nigeria has two agro-based non-governmental organizations namely Diocesan Agricultural Development Programme (DADP) and Farmers Development Union (FADU), and these two constitute the population for this study.

Input dealers

The study population of the study includes all the input dealers in Oyo state of southwestern Nigeria

3.5 Sample Procedure and Sample Size

400 respondents made up the study's overall sample size, of which 222 farmers were drawn at random from a population of 500 farms. A sample of 85 extension workers was randomized from a total of 170 extension workers. From a population of 80 researchers, 30 researchers were randomly chosen as the sample size.The population of 330 input dealers, 33 input dealers were randomly chosen as the sample size. 30 agricultural non-governmental organisations were chosen at random from a total of 300 agricultural non-governmental organisations.

3.5.1 Farmers from the Farmers' Group

According to the Agricultural development project 2012, the Oyo state of Nigeria has four zones which include Ibadan\ Ibarapa, Oyo, Ogbomosho, and Saki.

In Oyo State, though there were many farmers' groups in the study area, only 20 groups were registered with ADP with each group having 20 to 25 members (Adesoji and Tunde 2012). Thus, a population of 500 farmers was considered for the study. According to Yamane (1967), the sample size can be calculated as n = N\ 1+ N (e) 2. Thus, the sample size formula was used and 222 farmers were obtained as the sample size.

Sample size n = N\ 1+ N (e) 2

The margin error is 5% (0.05)

n = sample size,

N= total population size of the farmers was 500,

e = margin of error (confidence interval)

n = 500\ 1 + 500 (0.05)2 = 222

3.5.2 Researchers in the Agricultural Research Institute

Out of the nine research institutes that exist in the study area, four were chosen using a purposive sample technique that were mostly agriculturally oriented (NCRI NIHORT, IAR&T, and FRIN). The sample size of 30 researchers was randomly selected from the four selected research institutes of population size of 80.

3.5.3 Extension Agents

A simple random sampling technique was used to select the extension agents from the four agricultural development zones in the study area.

A sample size of 85 extension agents was randomly chosen, representing 50% of the 170 extension agents present in Oyo State. These regions included Ibadan, Saki, Oyo, and Ogbomosho zones, each of which included 56, 42, 40, and 32 extension agents (Alaka and Ashimolowo 2015). (Alaka and Ashimolowo 2015).

Table: 3.1 Extension agents

Zones	Population size	Sample size (50%)
Ibadan	56	28
Saki	42	21
Oyo	40	20
Ogbomosho	30	15
Total	170	85

3.5.4 Input Dealers

A simple random sampling technique was used in selecting the input dealers in the study area. They are the groups that supply farmers with fertilizers, herbicides, tools and farm machinery, etc. Ten per cent (10%) of the input dealers' population size in the study area was randomly selected from the list of 330 input dealers in ADP zones to form a sample size of 33.

3.5.5 Agro-based Non-governmental Organizations

Ten per cent (10%) of the non-governmental organizational population of 300 in the study area were randomly selected from the two local non-governmental organizations namely the Diocesan Agricultural Development Programme (DADP, and Farmers Development Union (FADU) to have a sample size of 30. The agro-based non-governmental organizations provide agricultural support services, technological transfer and effective adaptation of innovation to farmers.

3.6 Validity and Reliability of the Instrument

The validity of an instrument is the degree to which the instrument for the data collection measures what it is supposed to measure. For this study, the content validity was employed while the content of the instrument was determined by the experts. The researcher gave copies of the developed questionnaire to three experts in the researcher's field for content validation to ensure that the items on the questionnaires that were developed for the study represented what it intends. The corrections made by the experts were added to the instrument (questionnaire).

The reliability of an instrument refers to the consistency of an instrument to measure what it is supposed to measure within a study (Singh, Vik et al. 2011). A Split – half reliability was used for this study while the test on the questionnaire was divided into two halves and administered to the respondents. Therefore, the correlation between the two test results was determined. This was done by dividing the test into two halves which included the odd items in one half and the even item in the other half. The correlation coefficient of 0.86 between the two sets was calculated and since it was close to one that means the instrument has given an internal consistency to the test.

It can be calculated by r total test 2r split half/1 + r split half = 2 x actual correlation between halves of instrument /1 + actual correlation between halves of the instrument.

3.7 Instrument for Data Collection

The data used in this study were obtained from primary sources by using two sets of instruments in obtaining information. The open-ended and structured questionnaires were used in eliciting information from respondents in which the respondents were provided with a list of alternatives to be chosen from. The researcher used this type of questionnaire because it helps respondents in giving specific and direct answers to questions asked without going beyond the stipulated research objectives. Secondly, the interview schedule was used alongside to create a more direct, personal relationship between the interviewer and the respondents. It also helps in interacting with respondents who are illiterate, especially farmers.

However, the researcher trained research assistants for administering and interpreting the question items contained in the questionnaire to ensure that the respondents understood perfectly the contents of the questionnaire.

The questionnaires were categorized as stated below:

Section A: Stakeholders' socio-demographic factors were measured as follows

Respondents were asked to indicate their gender: Male was assigned 1; Female was assigned 2.

Respondents were asked to indicate their marital status which was categorized and scored as follows: Single (assign 1), Married (assign 2), Divorced (assign 3) and Widowed (assign 4).

Respondents were asked to indicate their age(s) in years.

Respondents were asked to indicate their highest educational qualification, which was categorized and scored as follows: Certificate (assign 1), Diploma (assign 2), Degree (assign 3), Masters (assign 4) and PhD (assign 5).

Respondents were asked to specify if they are currently studying for a higher degree which was scored as No (assign 1) and Yes (assign 2).

Respondents were asked to state their working experience (in years)……..

Respondents were asked to specify the type of stakeholders they are in agricultural innovation systems concepts which were categorized as follows:Farmers (assign 1), Extension agents (assign 2), Researchers (assign 3), Input dealers (assign 4), and Agro non-governmental organization (assign 5).

Respondents were asked to indicate their sources of information which were coded as follows: Family (assign 1), Friend (assign 2), Traditional Rulers/community leaders (assign 3), Bulletin, magazines and newspapers (assign 4), Radio Broadcast (assign 5), TV Broadcast (assign 6), Internet (assign 7), and Workshop/seminar through stakeholders' collaboration and personal experience (8).

For section B, the stakeholders' perception of knowledge of AIS agricultural innovation systems was measured by administering a test comprising of 8 variables in AIS was rated on a 2-point scale by assigning 1 for false (assign 1) and 2 for true (assign 2). The stakeholders' perception of agricultural innovation systems includes the following questions:

AIS is the mainstream of orchestrating agricultural development

AIS stresses collective learning by synthesizing harmonious synergy among stakeholders

AIS integrates education and training as parts of its components and brings about unlimited access to new knowledge

Stakeholders' collaboration in AIS enhances the improvement of the livelihoods of the populace and the achievement of viable economic growth.

AIS is the tool for the generation, dissemination, adaptation of knowledge, and adoption of a technological output or a new process

AIS stress on the application of knowledge and skills from different sources among stakeholders will strengthen the linkage system for the novelty in achieving large-scale production.

AIS serves as a means of generating income, creating jobs, and mitigating poverty.

AIS brings about a forum where researchers work closely with other stakeholders in knowledge generation.

For section C, respondents were given twenty-five (25) lists of linkage activities variables to determine how often they participated in AIS linkage activities and were rated as often O (assign 3), rarely R (assign 2), and never N (assign 1). The linkages activities in AIS include the following: joint problem identification, joint problem solving, joint learning, joint training, joint surveys, joint evaluation of trials, setting priorities, knowledge generation, contribution to the issue at stake, provision of advisory support, joint extension services, joint use of SMS for service providers, the joint implementation, joint feedback, joint monitoring, workshop and demonstration together with field visits, joint research activities, dissemination of

knowledge and information, financing of projects and shared use of resources, attendance of seminar and workshop, maintenance of the project, report publications, reward system, management capacity, and in evaluation exercise.

For section D, the respondents were asked to indicate the factors influencing their participation in AIS were measured by administering 17-factor variables to the respondents which were rated on a 5-point scale of strongly agree SA (assign 5), agree A (assign 4), undecided U (assign 3), disagree D (assign 2) and strongly disagree SD (assign 1). The factors influencing stakeholders' participation in AIS include

- Knowledge sharing brings about stakeholders' participation in AIS
- The cost of procuring technological inputs affects stakeholders' participation in AIS
- Investments in capacity development and operating funds are essential to harness the stakeholders' participation in AIS.
- Active coordination among stakeholders promotes participation in AIS
- Ready-made markets trigger stakeholders' participation in AIS
- Human resources facilitate stakeholders' participation in AIS
- Availability of infrastructure enhances stakeholders' participation in AIS
- Conducive policies create an enabling environment for stakeholders' participation in AIS
- Availability of funds triggers stakeholders' participation in AIS
- The provision of good incentives for stakeholders motivates their participation in AIS
- Stakeholders' pattern of interaction in AIS affects their participation
- Stakeholders' interest and the need felt for inclusiveness in the AIS implementation process trigger their involvement

- Stakeholders' attitude influence their involvement
- Effective communication strategy enhances stakeholders' participation in AIS
- Stakeholders' attitude toward AIS influences their involvement in the system
- Knowledge generation triggers stakeholders' participation in AIS
- Stakeholders' collaboration enhances their participation in AIS

Finally, for section E, the constraints being faced by stakeholders in their participation in the agricultural innovation system were measured on a 2-point scale of No (assign 1) and Yes (assign 2), with 26 constraints variables administered to respondents. These constraints include the following : Limited resources, Weak or poor communication among stakeholders, inadequate farmer participation in innovation meeting, Unawareness of the existing innovation, Inaccessibility to information on new technologies, Inadequate finance for technologies, Inappropriate technologies, Unclear project scope, Conflict of ideas and roles among stakeholders, Different expectation, Stakeholders distrust, Dearth of interest, Status among stakeholders, Poor management, Remote and dispersed farmers residence, Difficulties in contacting key decision makers when matters arises, Lack of time, No consultation, Inadequately skilled staff, Professional bias, Job tenure of researchers, Job tenure of extension agents, Qualification of extension agents, Inadequate research staff, Insufficient extension staff, Poor administration of research and extension institutions, Political issues influencing research and extension, Absence of recognition and complement from colleagues, Distance between research centres and extension offices.

3.8 Analyses of Data

A descriptive and inferential statistical analysis of the structured questionnaire data was conducted after coding the data collected from the respondents. The descriptive statistical analysis includes percentages, frequency distribution, means and standard deviation for describing the variables. This approach was employed to provide a fundamental descriptive framework of all-inclusive explanatory variables considered.

The quantitative data obtained from the structured questionnaire was processed by the statistical package for social sciences (SPSS). The IBM SPSS was used in analyzing the data obtained from study objectives which included:

- Identify the socio-demographic characteristics of the stakeholders (farmers, extension agents and researchers, input dealers and NGOs) in agricultural innovation systems
- Analyze stakeholders' perception of AIS
- Ascertain the stakeholders' participation in the linkage activities of AIS
- Examine the factors influencing the participation of stakeholders (farmers, extension agents, researchers, input dealers and NGOs) in the agricultural innovation systems (AIS)
- Identify the constraints facing stakeholders (collaborators) in their participation in the agricultural innovation systems

The inferential statistical analyses used in the study were the Chi-square and Stepwise binary logistic regression. They were used in analyzing the relationships between the dependent variables and independent variables.

Consequently, the choice of using the Stepwise binary logistic regression for the analysis was because almost all aggregate variables for the stakeholders' participation in the linkage activities of agricultural innovation systems (AIS) had two categories (rarely and often) though initially, it was in three categories (often, rarely and never). Thus, the variable was converted to binary code where 0 = rarely and 1= often.

The Chi-square was used to analyze the association between demographic characteristics (independent variables) of stakeholders and their participation in the linkage activities in AIS (dependent variables).

The stepwise binary logistic regression was used for analyzing the relationship between demographic variables (independent variables) and the factors influencing the stakeholders' participation (dependent variables).

Also, the stepwise binary logistic regression was used for analyzing the relationship between demographic variables (independent variables demographic variables) and the constraints facing stakeholders (collaborators) in their participation in the agricultural innovation system (dependent variables).

Thus, this was done to determine the independent variables that contributed significantly to explaining variation in the dependent variable. The hypotheses which were stated in the null forms (H_0) were used in determining the relationshipas stated below:

- There is no significant relationship between stakeholders' socio-demographic variables and their participation in AIS.
- There is no significant difference in the stakeholders' perception and their participation in AIS.
- There is no significant relationship between stakeholders' demographic variables and factors influencing their participation in the AIS.
- There is no significant relationship between stakeholders' demographic variables and constraints facing stakeholders in their participation in AIS

Thus, the empirical model for determining the stakeholders' participation in agricultural innovation systems was specified as follows with the stepwise binary logistic regression

$$y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \beta 5x5 + \beta 6x6 + \beta 7x7 + \varepsilon$$

Where y = participation in agricultural innovation system which was the dependent variable (response variable or outcome variable)

$\beta 0$= constant term,

Where x1= Gender

Where x2= Marital status

Where x3= Age in years

Where x4= Highest Educational qualification,

Where x5= Currently studying for a higher degree

Where x6= Working experience in years

Where x7 = Source of information

Where x8 = Religion

Where ε = error term,

Where x1, x2, x3, x4, x5, x5, x6, x7, and x8 were the predictor variables (independent variables)

Thus all the listed predictor variables provided information on the association of the dependent variable (outcome variable)

Hence, the independent variables for this study are gender, marital status, age, educational level, currently studying for a higher degree, working experience, source of information, and religion.

The participation in agricultural innovation system was the dependent variable (response variable or outcome variable).

3.9 Ethical Considerations

The researcher sought clearance from the North-West University (NWU) Research Ethics Regulatory Committee (IRERC) as well as National and International laws and regulations regarding the researcher's field of study. The Research Ethical Clearance was requested from the NWU Institutional Ethics committee and an Ethics clearance certificate was issued (Appendix …).

Similarly, the researcher observed the highest possible codes of conduct before, during and after the survey. When collecting information from respondents, the researcher ensured that no prejudices, sentiments, biases, emotional or preferential treatment were used; all information gathered from respondents and organizations was focused on the research objective.

Furthermore, the respondents' identities were not requested before, during and after the research. Therefore, the information elicited from study findings would not be linked to any respondents during the research exercise while having the right to withdraw from the research exercise at any time.

During the research, the participants were not exposed to any physical or psychological risks that might affect them. All through the study, the researcher ensured the welfare of the respondents was well taken care of. The study was neither injurious nor engaged in any harmful task that could affect the health and interest of the respondents. Thus, the researchers observed the highest possible codes of conduct throughout the study were: anonymity and confidentiality, voluntary participation, informed consent, beneficence and non-maleficence.

3.10 Chapter Summary

This chapter discussed the research methodology used in collecting and analyzing data. It also covered the study area, the study population research design, sampling procedure and sample size, the instrument for data collection, validity and reliability of the instrument, analyses of data, and ethical considerations.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter comprised of the presentations, discussions, and interpretations of the result of the study on the analysis of stakeholders' participation in agricultural innovation systems in the Oyo State of Nigeria. This was done along with the background of the stated objectives and was analyzed with both descriptive and inferential statistics. While some four hundred (400) questionnaires were sent out to the respondents ((farmers, extension agents and researchers, input dealers and NGOs), three hundred and ninety-four (394) responses were collected.

The following results are presented and discussed under the following headings: the socio-demographic characteristics of stakeholders in agricultural innovation systems; the stakeholders' perception of agricultural innovation systems; the stakeholders' participation in the linkages activities in agricultural innovation systems; the factors that enhance stakeholders' participation in agricultural innovation system (AIS) and the constraints faced by stakeholders to their participation in agricultural innovation systems were analyzed with frequency, percentages, mean and cluster bar charts.

This chapter also presents the relationship between stakeholders' socio-demographic factors and their participatio in agricultural innovation systems. The stakeholders' perception of knowledge of AIS and their participation in agricultural innovation systems, as well as the relationship between stakeholders' socio-demographic characteristics, perception and factors that enhance stakeholders' participatio in agricultural innovation system which were all analyzed with the inferential analysis Chi-square and stepwise regression analysis.

Table 4.1 The socio-demographic characteristics of the respondents in AIS (farmers, extension agents and researchers, input dealers and NGOs)

Variables		Farmers (220)	Extension agents (84)	Researchers (30)	Input dealers (30)	NGOs (30)

Gender						
	Male	193 (88.1%)	60 (71.4%)	22 (73.3%)	16 (53.3%)	26 (86.7%)
	Female	27 (11.9%)	24 (28.6%)	8 (26.7%)	14 (46.7%)	4 (13.3%)
Marital Status						
	Single	21 (9.5%)	18 (21.4%)	4 (13.3%)	4 (13.3%)	1 (3.3%)
	Married	187 (85.0%)	66 (78.6%)	26 (86.7%)	24 (80%)	29 (96.7%)
	Divorced	8 (3.6%)	-	-	1 (3.3%)	-
	Widowed	4 (1.8%)	-	-	1 (3.3%)	-
Religion						
	Christianity	103 (46.8%)	43 (51.2%)	14 (46.7%)	16 (53.3%)	21 (70%)
	Muslim	112 (50.9%)	41 (48.8%)	16 (53.3%)	14 (46.7%)	8 (26.7%)
	Traditional	5 (2.3%)	-	-	-	1 (3.3%)
Highest Educational Qualification						
	Certificate	105 (47.7%)	-	-	-	-
	Diploma	53 (24.1%)	16 (19.0%)	-	10 (33.3%)	7 (23.3%)
	Degree	56 (25.5%)	43 (51.2%)	8 (26.7%)	20 (66.7%)	21 (70%)
	Master	6 (2.81%)	24 (28.6%)	16 (53.3%)	-	2 (6.7%)
	PhD	-	1 (1.2%)	6 (20.0%)	-	-
Are you currently studying for a higher degree?						
	No	178 (80.9%)	48 (57.1%)	5 (16.7%)	22 (73.3%)	19 (63.3%)

	Yes	42 (19.1%)	36 (42.9%)	25 (83.3%)	8 (26.7%)	11 (36.7%)
Source of information						
	Family	25 (11.36%)	-	1 (3.3%)	-	-
	Friends	10 (4.5%)	-	1 (3.3%)	-	-
	Traditional/ community leader	18 (8.2%)	-	1 (3.3%)	-	-
	Bulletin, magazine and newspapers	10 (4.5%)	-	-	-	-
	Radio broadcast	20 (9.1%)	-	-	-	-
	Internet	8 (3.6%)	-	-	1 (3.3%)	-
	Workshop/ seminar	129 (58.6%)	84 (100%)	27 (90%)	29 (96.7)	30 (100%)

Figures in parenthesis are percentages

Source: Data of respondents from field survey, 2021

4.1 The socio-demographic characteristics of the respondents in AIS (farmers, extension agents and researchers, input dealers and NGOs)

4.1.1 Gender

Table 4.1 presents socio-demographic characteristics of the respondents that participated in agricultural innovation systems of Oyo State of Nigeria (this included: farmers, extension agents and researchers, input dealers, and NGOs).

It shows that 88.1% of farmers were male and 11.9% were female, 71.4% of extension agents were male and females were 28.6%, 73.3% of researchers were male and females were 26.7%, 53.3% of input dealers were male and 46.7% were female while 86.7% of NGOs were male and 13.3% were female. This indicates that the majority of the respondents (farmers, extension agents, researchers, input dealers, and NGOs) were male. The findings of this study reveal that the predominant gender in the study was male which agrees with the findings of Adesoji et al. 2012 as well as Onemolease and Oriakhi (2011) where the majority of their respondents were male. Thus, gender defines the role ascribed to men and women in any given society (The World Bank, 2012).

4.1.2 Marital Status

Table 4.1 shows that most of the respondents surveyed in this study were married with a percentage of 85.0% for farmers, 78.6% for extension agents, 86.7% for researchers, 80.0% for input dealers, and 96.7% for NGOs. This finding agrees with Jibowo (1992) together with that of Dire et al. (2016) that married people make up the highest proportion of any society.

4.1.3 Religion

The study reveals in table 4.1 that farmers' religion was 50.9%, 46.8%, 2.3% for Muslim, Christians and traditional religion respectively while 51.2% of extension agents were Christians, 53.3% of researchers were Muslim, 53.3% of input dealers were Christian and 70.0% of NGOs were Christian. This indicates that stakeholders in AIS in the study area were predominantly Muslim and Christian while the percentage of the traditional religion respondents was very low.

4.1.4 Highest Educational Qualification

The Highest educational qualification is shown in table 4.1. 47.7 % of farmers had a certificate, 51.2% of the extension agents had a degree, 53.3% of the researchers had a Master's degree, 66.7% of input dealers had a diploma and 70.0% of NGOs had a degree. Thus, it is an indication that each respondent has at least some level of education which is believed to have influenced and broadened their knowledge and skills for boosting agricultural development.

4.1.5 Currently Studying for a Higher Degree

Farmers, extension agents, researchers, input dealers, and NGOs that are currently studying for higher degrees in table 4.1. are 19.1%, 42.9 %, 83.3%, 26.7%, and 36.7% respectively. The findings imply that most of the researchers were currently studying for a higher degree, some of the extension agents were currently studying for a higher degree while other respondents which include farmers, input dealers, and NGOs had low percentages. Thus, studying for a higher degree not only increases the knowledge, skill, and understanding of stakeholders but also is a requirement for promotions and job earnings.

4.1.6 Source of Information

Table 4.1 presents respondents source of information. This study reveals that most of the respondents got their information from workshops/seminars through stakeholders' collaboration and personal experience with 58.6%, 100%, 90%, 96.7%, and 100% for farmers, extension agents, researchers, input dealers and NGOs, respectively. This implies that almost all the stakeholders in the study area got their information through workshops/ seminars through stakeholders' collaboration and personal experience.

Table 4.2: The respondents' age in years and working experience of the respondents in years (The remaining demographic characteristics of the stakeholders)

Variable	Research subjects	N	Minimum	Maximum	Mean	Std deviation
Age in Years	Farmers	220	20.00	58.00	43.8091	9.80867
	Extension agents	84	23.00	58.00	40.9167	8.83750
	Researchers	30	28.00	58.00	44.1667	8.37518
	Input dealers	46	3.00	75.00	41.6522	13.09829
	NGOs	41	40.00	60.00	49.7805	5.70312
Working experience in years						
	Farmers	220	2.00	30.00	11.7773	6.04779
	Extension agents	84	2.00	33.00	11.4048	6.74692
	Researchers	30	2.00	25.00	10.4000	5.96310
	Input dealers	46	3.00	39.00	12.7826	9.30212
	NGOs	41	5.00	25.00	13.2439	4.69457

Source: Data of respondents from field survey, 2021

4.2 The respondents' age in years and working experience of the respondents in years (The remaining demographic characteristics of the stakeholders)

4.2.1 Age in Years

Table 4.2 shows the age in years and working experience in years of the respondents which were both measured in mean since they were continuous variables. The respondents stated their age in years while the mean ages were calculated for each respondent which includes 43.8 for the farmers, 40.9 for extension agents, 44.2 for researchers, 41.7 for input dealers, and 49. 8 for NGOs. These results show that stakeholders that participated in agricultural innovation systems in the study area were mostly young people. This implies that respondents were full

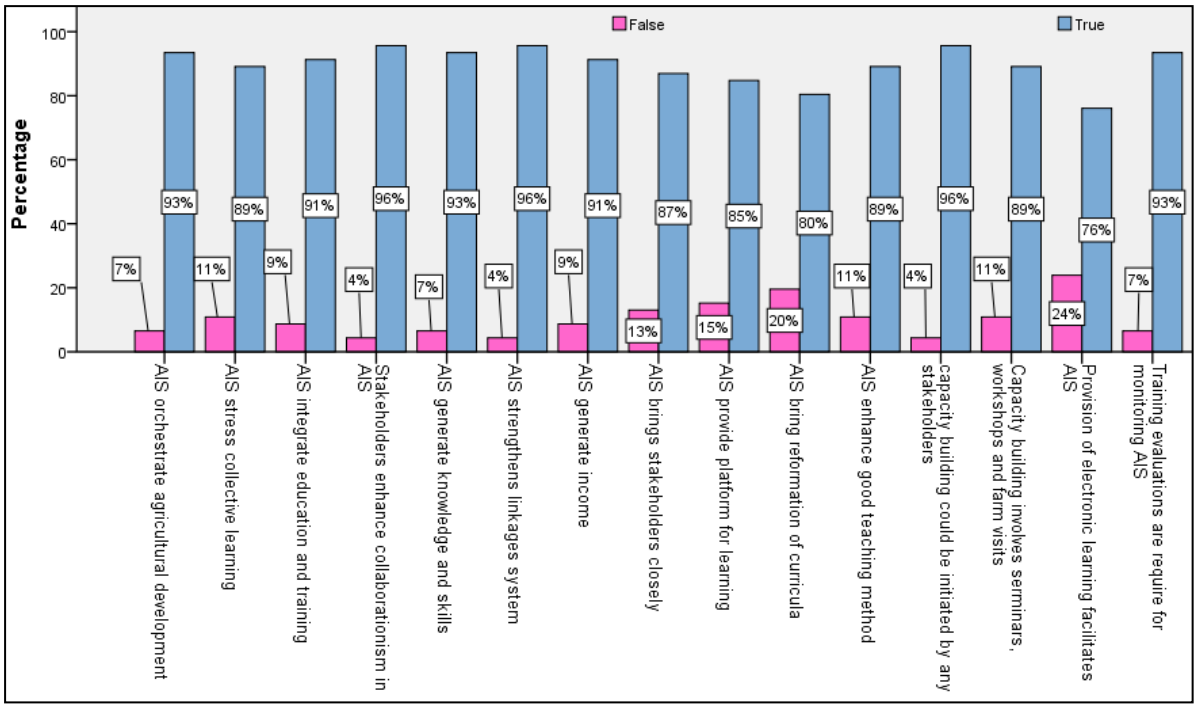
of vigour which had a positive influence on their collaboration and involvement in agricultural innovation systems for enhancing food security and increasing food production. This study is in agreement with the study of Adesoji and Tunde (2012), who established that the age of the respondents affected their linkage activities in their study.

4.2.2 Working Experience in Years

Table 4.2 presents the stakeholder's working experience in years which were measured as the mean. The working experiences in years in means were 11.8, 11.4, 10.4, 12.8, and 13.2 for farmers, extension agents, researchers, input dealers, and NGOs respectively. This indicates that all the respondents had over 10 years of experience in their job designations which showed them to be experienced.

4.3 The Stakeholders' Perception of knowledge in Agricultural Innovation Systems

Figure 4.1 Stakeholders' Perception of knowledge in Agricultural Innovation Systems



Source: Data of respondents from field survey, 2021

The above cluster bar chart in Figure 4.1 shows the aggregate stakeholders' perception of knowledge AIS. This indicates that the respondents predominantly (farmers, extension agents, researchers, input dealers, and NGOs) had a high percentage of over 70% on the eight (8) knowledge perception variables in AIS . Respondents answered "true" to all the knowledge perception questions which include AIS brings about agricultural development, AIS stresses collective learning, AIS integrates education and training, stakeholders participation enhance collaboration in AIS, AIS strengthens linkage system, AIS generates income, AIS brings stakeholders closely, AIS provides a platform for learning, AIS brings reformation of curricula, AIS enhances good teaching method, capacity building involves seminars, workshops and farm visits, provision of electronic learning facilitates AIS, and training evaluations are required for monitoring AIS.

This shows that all the participants in this study believed that agricultural innovation systems were crucial to the creation of new knowledge that triggered agricultural development.

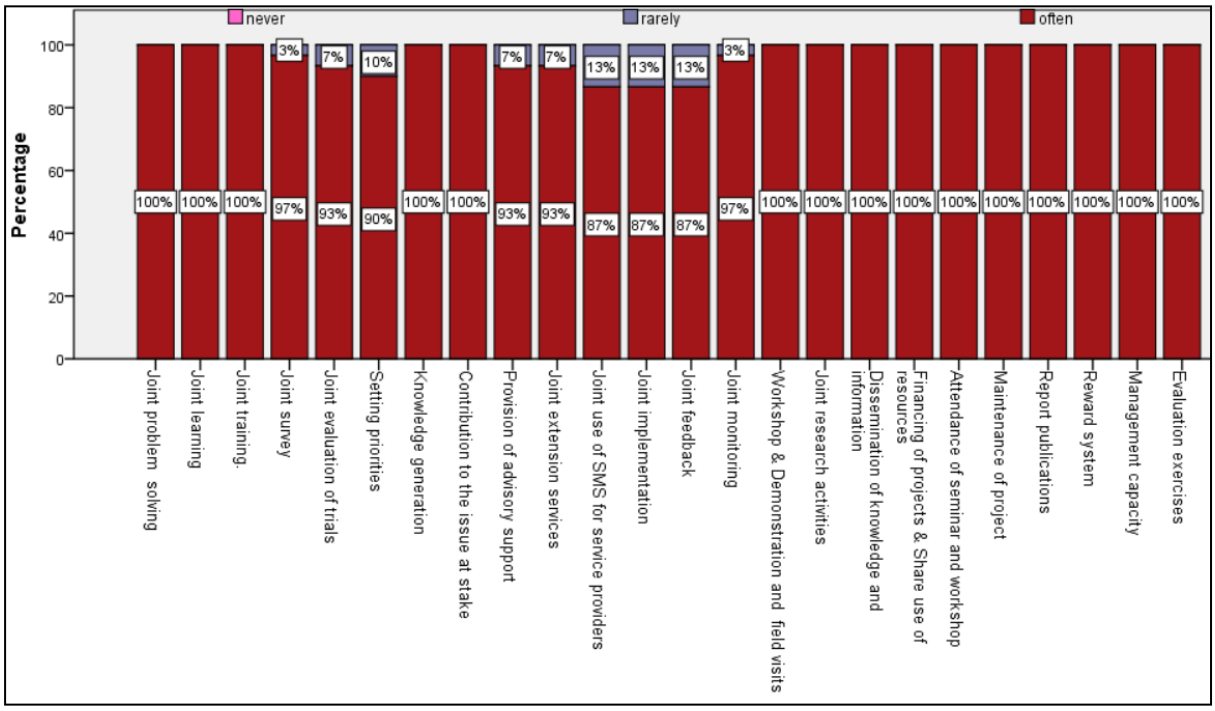
Some studies which include Ahmet et al. 2014, Bernard et al. (Year) and Philipp et al. 2015 hold a similar view that agricultural innovation systems do not only provide a platform for knowledge generation but also foster collective learning among heterogeneous stakeholders for enhancing sustainable food security.

4.4 The participation in the linkage activities of AIS among stakeholders

This was done to ascertain stakeholders' strength of collaboration and involvement in the linkages activities of AIS among stakeholders in the study area.

4.4.1 The participation in the linkages activities of AIS between Farmers with Researchers

Figure 4.2: The participation in the linkages activities of AIS between Farmers with Researchers



Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.2 shows the participation in the linkages activities of AIS between the farmers and researchers. It reveals that the farmers and researchers often participate in joint problem identification at 100%, joint problem-solving at 100%, joint learning at 100%, joint training at 100%, a joint survey at 97%, joint evaluation of trials at 93%, setting priorities by 90%, knowledge generation at 100%, contribution to the issue at stake by 100%, provision of advisory support at 93%, joint extension services at 93%, joint use of SMS for service providers, the joint implementation at 87%, joint feedback by 87%, joint monitoring by 97%, workshop and demonstration and field visits at 100%, joint research activities by 100%, dissemination of knowledge and information by 100%, financing of projects and share use of resources by 100%, attendance of seminar and workshop by 100%,

maintenance of project by 100%, report publications by 100%, reward system by 100%, management capacity by 100%, and in evaluation exercise by 100%.

This demonstrates that farmers and researchers took an active part in the connection operations. If this keeps up, their strong cooperation will continue to support the adoption of new technologies and the expansion of production.

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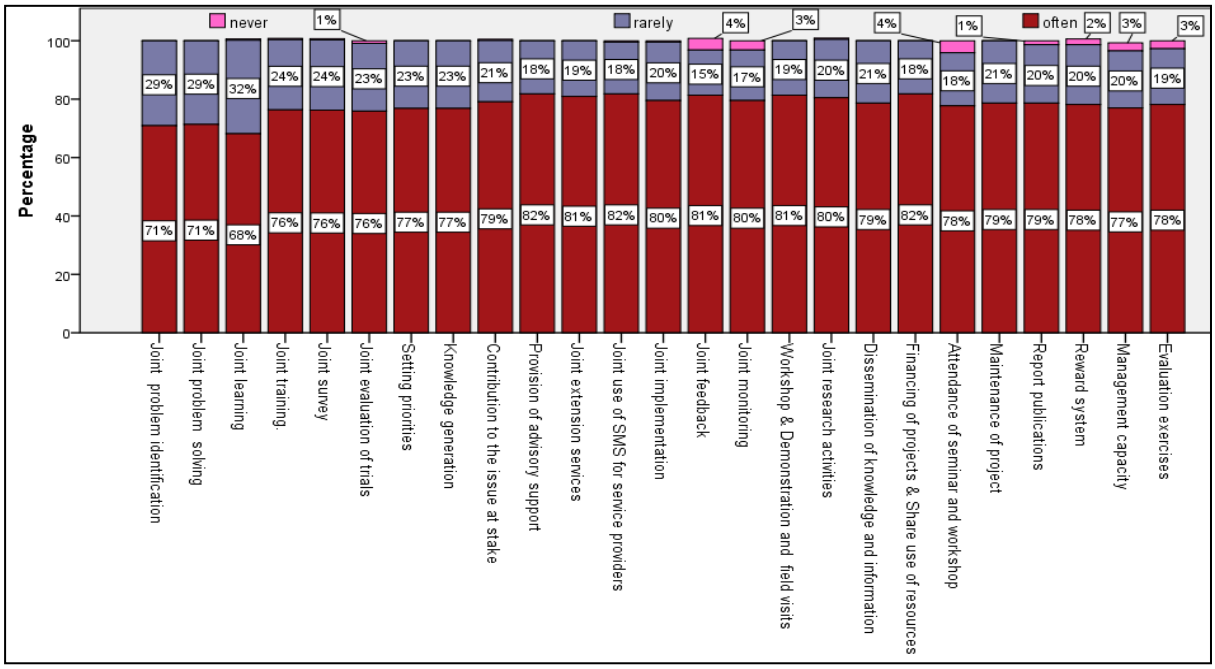
4.4.2: The participation in the linkages activities of AIS between Farmers and NGOs

Figure 4.3: The participation in the linkages activities of AIS between Farmers and NGOs



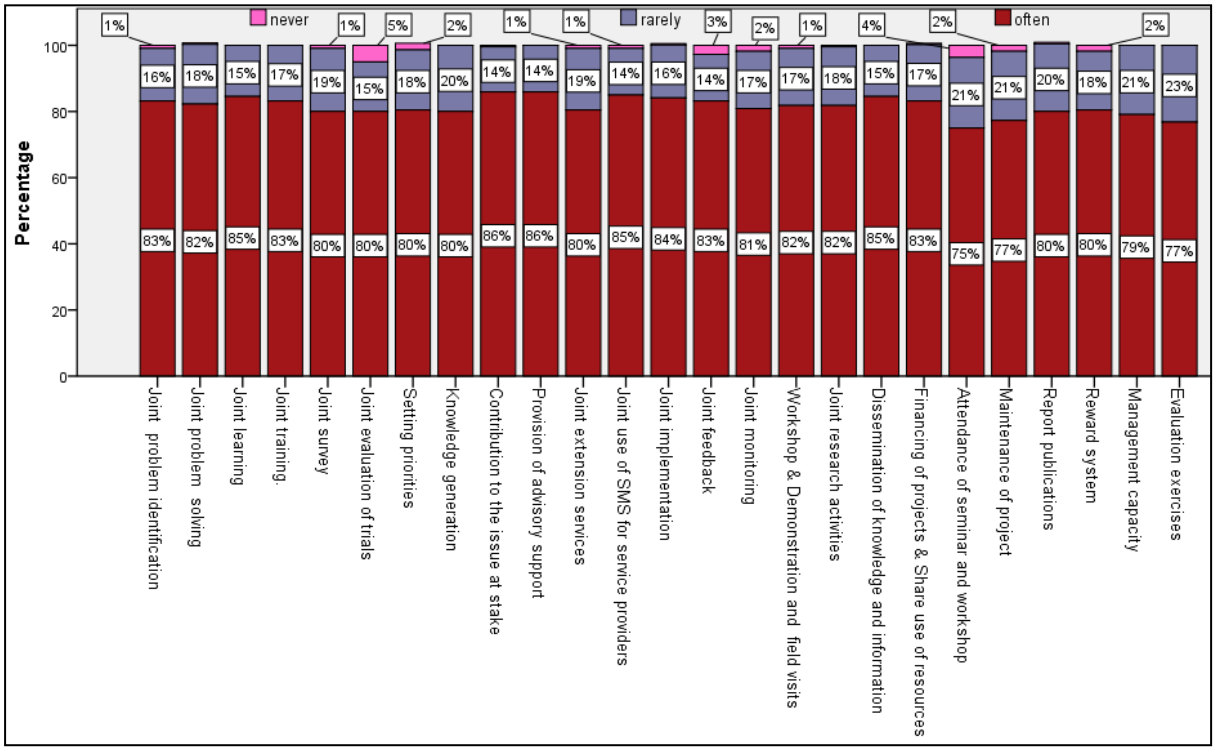
Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.3 indicates the participation in the linkages activities of AIS between the farmers and NGOs. It reveals that the farmers and NGOs often participate in joint problem identification, joint problem solving, joint learning, joint training, a joint survey by joint evaluation of trials, setting priorities, knowledge generation, contribution to the issue at stake, provision of advisory, joint extension services, joint use of SMS for service providers,

joint implementation, joint feedback, joint monitoring, workshop and demonstration, field visits, often participate in joint research activities, dissemination of knowledge and information, financing of projects and shared use of resources, attendance of seminars and workshops, maintenance of the project, report publications, reward system, management capacity, and evaluation exercise at 71%, 71%, 68%, 76%76%, 76%,77%, 77%, 79%, 82%,81%,82%,80%, 81%,80%,81%, 80%,79%, 82%, 78%, 79%, 79%, 79%, 78%,77% and 78% respectively. Thus, this is an indication that the strength of the relationship between farmers and NGOs is strong, while such might have triggered knowledge generation, collective learning and better productivity.

4.4.3: The participation in the linkage activities between Farmers, Researchers and Extension agents

Figure 4.4: The participation in the linkage activities between Farmers, Researchers and Extension agents

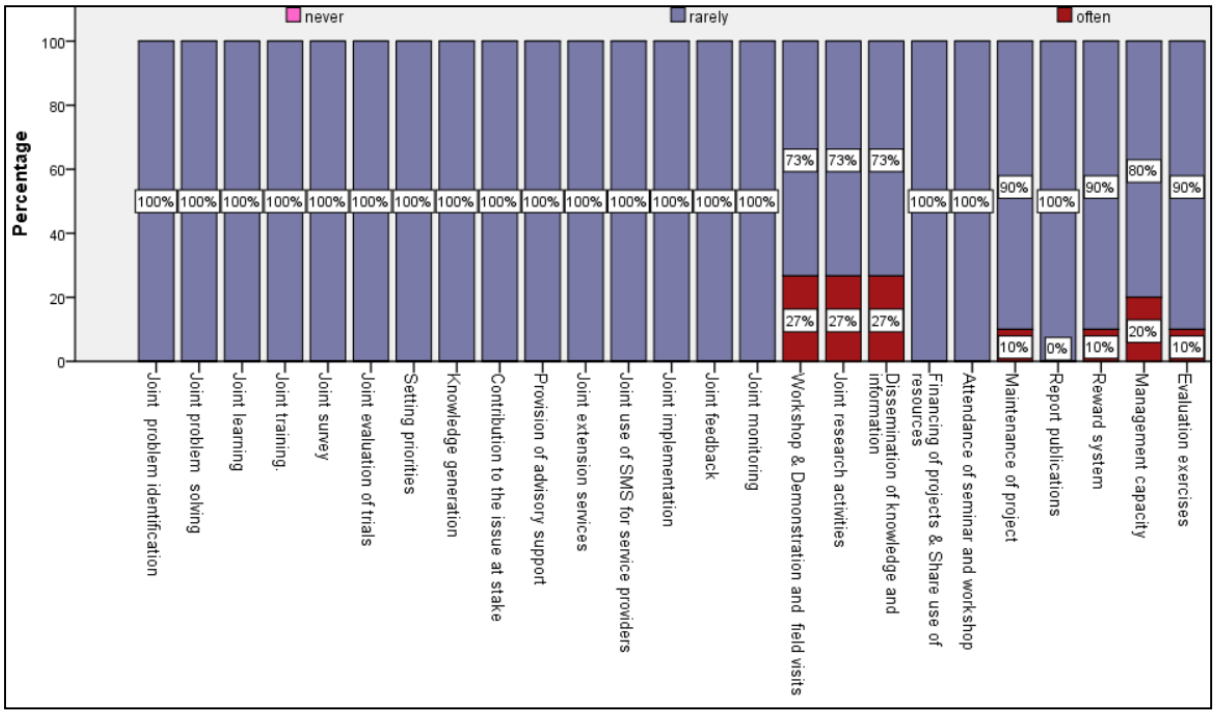


Source: Data of respondents from field survey, 2021

The cluster bar graph in Figure 4.4 depicts how farmers, researchers, and extension agents participated in AIS's linkages activities. According to the results, 75% to 86% of farmers, extension personnel, and researchers participated in AIS's linkages activities. It suggests that farmers, researchers, and extension personnel collaborate in some way on AIS connection efforts. The three players' ability to work together more effectively would make it easier for farmers to receive information and technical support. It will boost agricultural development-related productivity, competitiveness, and marketability.

4.4.4: The participation in the linkages activities of AIS between Researchers and NGOs

Figure 4.5: The participation in the linkages activities of AIS between Researchers and NGOs



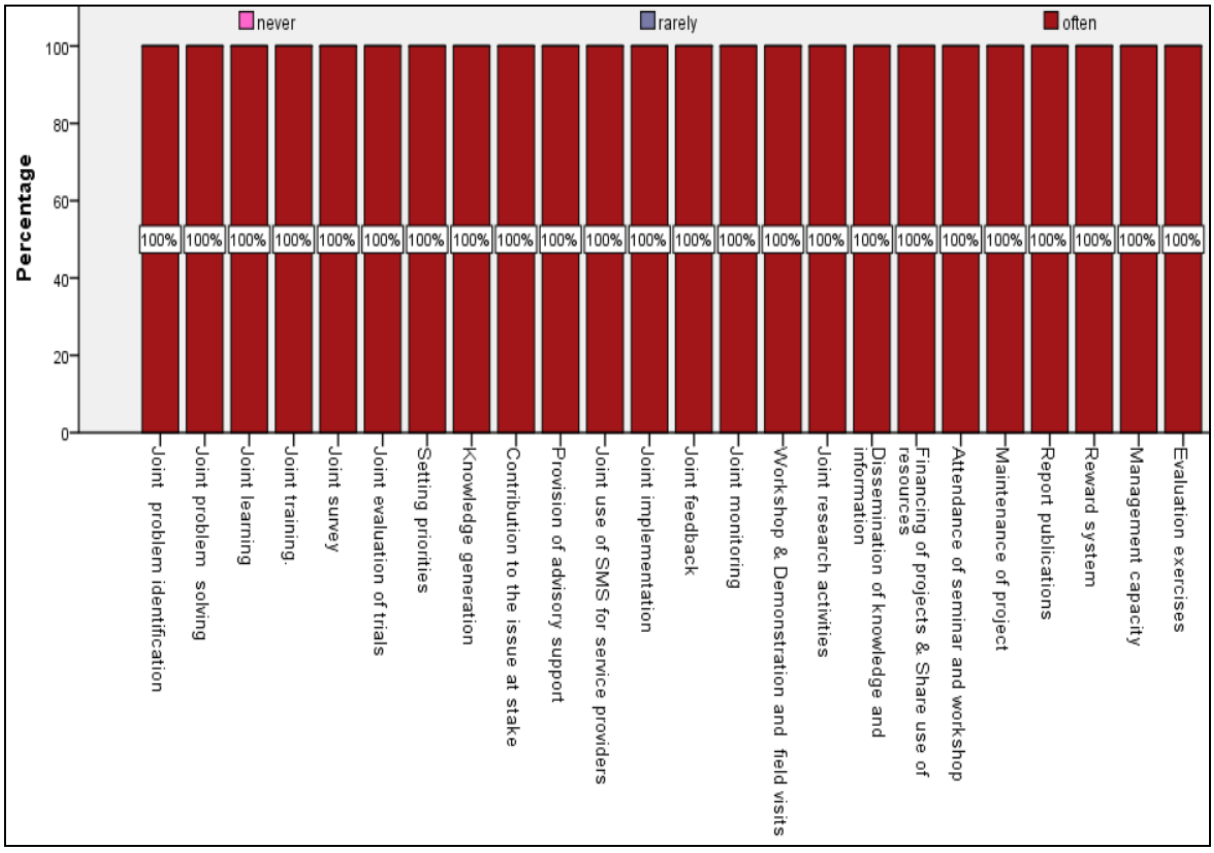
Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.5 presents the findings from the participation in the linkages activities of AIS between the researchers and NGOs. It was revealed that the researchers and NGOs rarely participate in all the linkage activities over 70%. This suggests that there is a weak relationship between researchers and NGOs. This might be because the NGOs are working

closely with farmers for enhancing agricultural innovation systems. Probably, if the relationship between the researchers and NGOs is improved upon, this would boost food production.

4.4.5: The participation in the linkages activities of AIS between the researchers with extension agents

Figure 4.6: The participation in the linkages activities of AIS between the researchers and extension agents



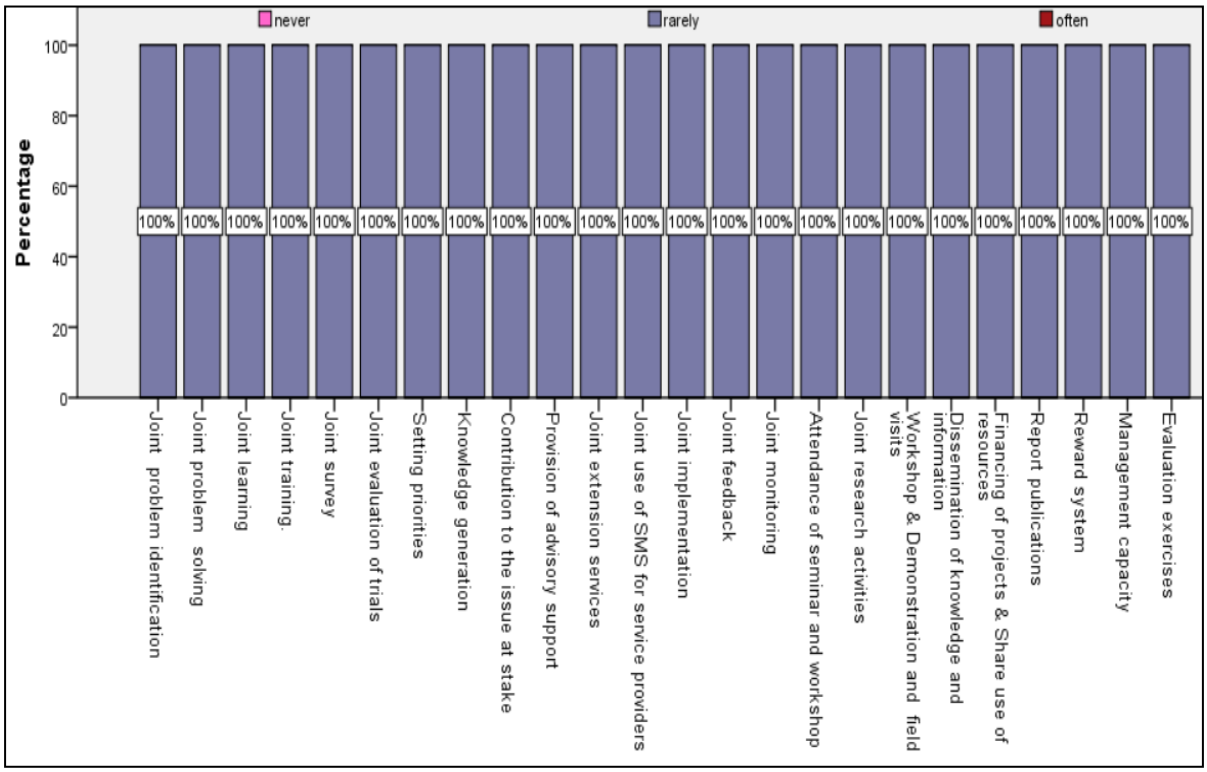
Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.6 presents the participation in the linkages activities of AIS between the researchers and extension agents. It shows that the researchers and extension agents often participate in all the linkage activities at 100%. This suggests that there is some harmonious synergy and strong collaboration between researchers and extension agents in the

linkage activities for agricultural development and improving the livelihood of the populace through generating, disseminating, adapting and adopting knowledge for innovations in AIS.

4.4.6: The participation in the linkages activities of AIS between Researchers with Input Dealers

Figure 4.7: The participation in the linkages activities of AIS between Researchers with Input Dealers



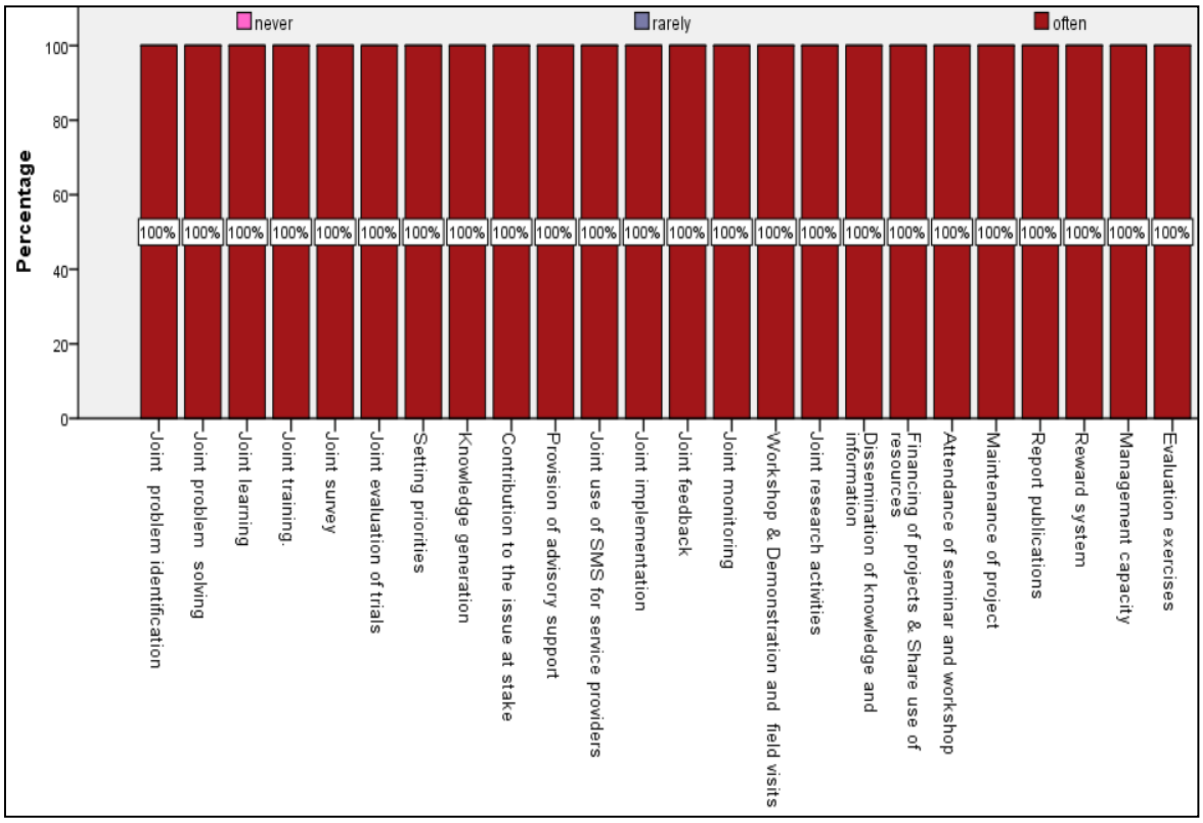
Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.7 shows the participation in the linkages activities of AIS between the researchers and input dealers. It indicates that the researchers and input dealers rarely participated in all the linkage activities at a 100%. It suggests that the strength of the

relationship between researchers and input dealers is weak; such might be that the researchers are dealing directly with extension agents and farmers.

4.4.7 : The participation in the linkages activities of AIS between extension agents with researchers

Figure 4.8: The participation in the linkages activities of AIS between extension agents with researchers

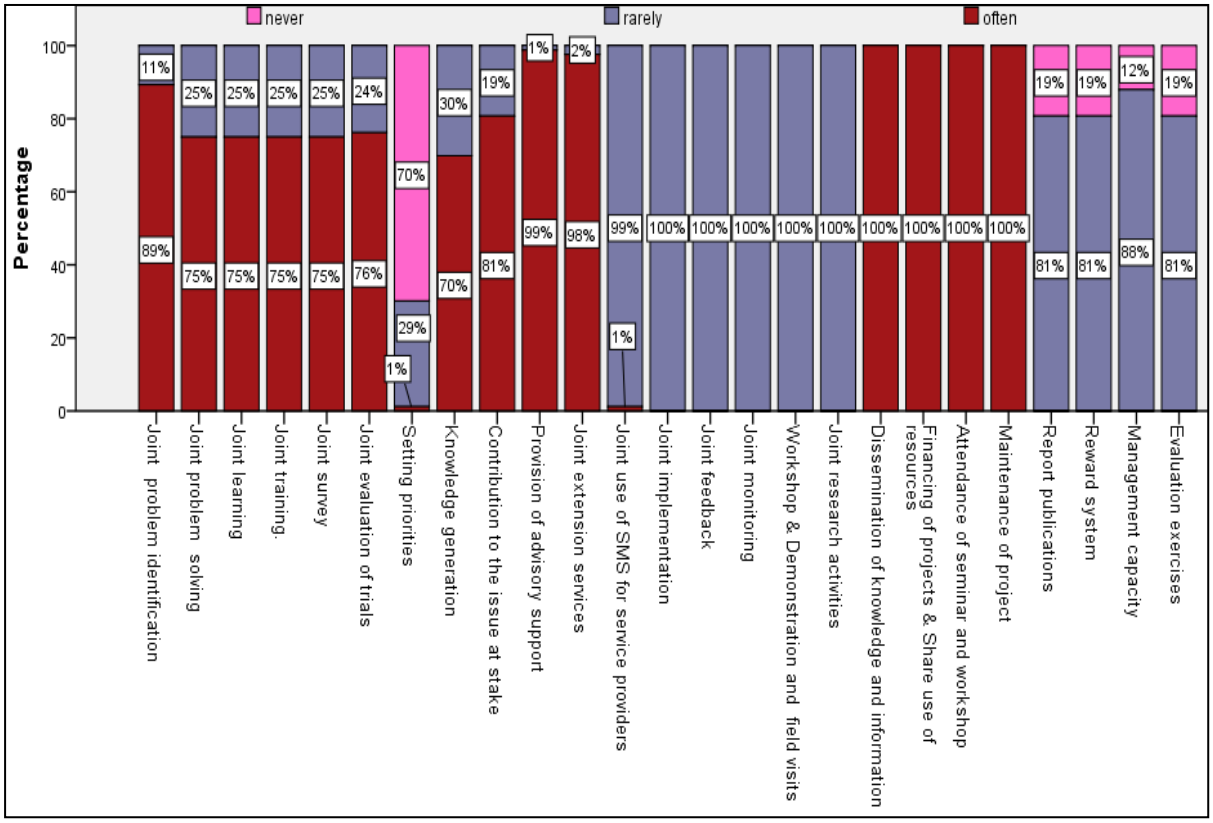


Source: Data of respondents from field survey, 2021

The Cluster bar chart in Figure 4.8 shows the participation in the linkages activities of AIS between the extension agents with researchers. It suggests that the extension agents with researchers often participated in all the linkage activities at a 100%. It is an indication that the strength of the relationship between extension agents with researchers was vigorous, which suggests that the extension agents will be able to meet the needs of farmers since there is a dynamic relationship between the extension agents with researchers for the flow of innovations.

4.4.8: The participation in the linkages activities of AIS between extension agents and researchers

Figure 4.9: The participation in the linkages activities of AIS between extension agents and researchers

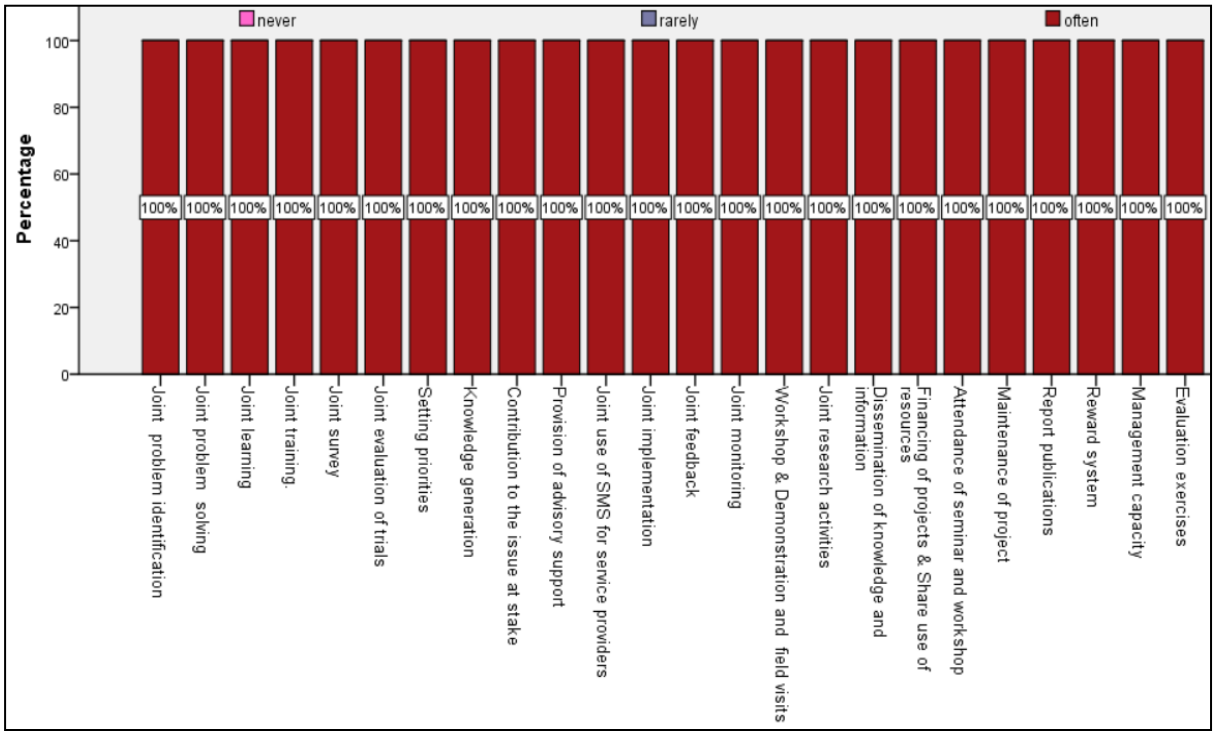


Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.9 shows the participation in the linkages activities of AIS between extension agents and NGOs. This is an indication that extension agents and NGOs did participate in some linkage activities of AIS, and that includes joint problem identification at 89%, joint problem solving by 75%, joint learning at75%, joint training at 75%, a joint survey at 75%, linking evaluation of trial at 75%, knowledge generation by 70%, contribution to the issue at stake by 81%, provision of advisory support by 99%, joint extension services by 98% while they rarely participated in other linkage activities of AIS.

4.4.9: The participation in the linkages activities of AIS between the NGOs with farmers

Figure 4.10 The participation in the linkages activities of AIS between the NGOs with farmers



Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.10 depicts the participation in the linkages activities of AIS between the NGOs and farmers. It implies that there is 100% participation in the linkages activities of AIS between the NGOs and farmers. This suggests that both actors (NGOs and farmers) were actively collaborating for achieving viable economic growth. It shows that the two non-governmental organizations considered for this study had harmonious synergies and strong linkage mechanism for knowledge generation and novelty for ensuring food sustainability.

Figures 4.2 to figures 4.10 present, the stakeholders' (farmers, extension agents and researchers, input dealers, and NGOs) participation in the linkage activities of the agricultural innovation system.

It was shown that stakeholders' participation in linkage activities in agricultural innovation systems among the stakeholders varied. The collaboration between some actors were strong while others were average and weak. Therefore, there is a need for improvement on the strength of linkage activities of AIS.

Thus, it is observed from the study that the participation in linkage activities in AIS between extension agents and farmers, farmers and researchers, researchers and farmers, extension agents and researchers, researchers and extension agents and extension agents and researchers, farmers and NGOs as well as farmers and farmers and inputs dealers was strong.

This is in agreement with the study of Adesoji and Tunde (2012) on the evaluation of the linkage system of Research Extension-Farmers in Oyo State Nigeria which posited that the linkage system among researchers, extension agents, and the farmers was strong, while contrary to this study, Oladele et al. (2006) on the study of Research–extension–farmer linkage system in Southwestern Nigeria revealed that weak linkages were existing between research, extension, and farmers which did affect food security and food sustainability.

Correspondingly, Zwane (2020) asserts that for any nation in the world to achieve sustainability in food security requires active participation, dynamic partnership and strong collaboration of multi-stakeholders in the agricultural innovation system.

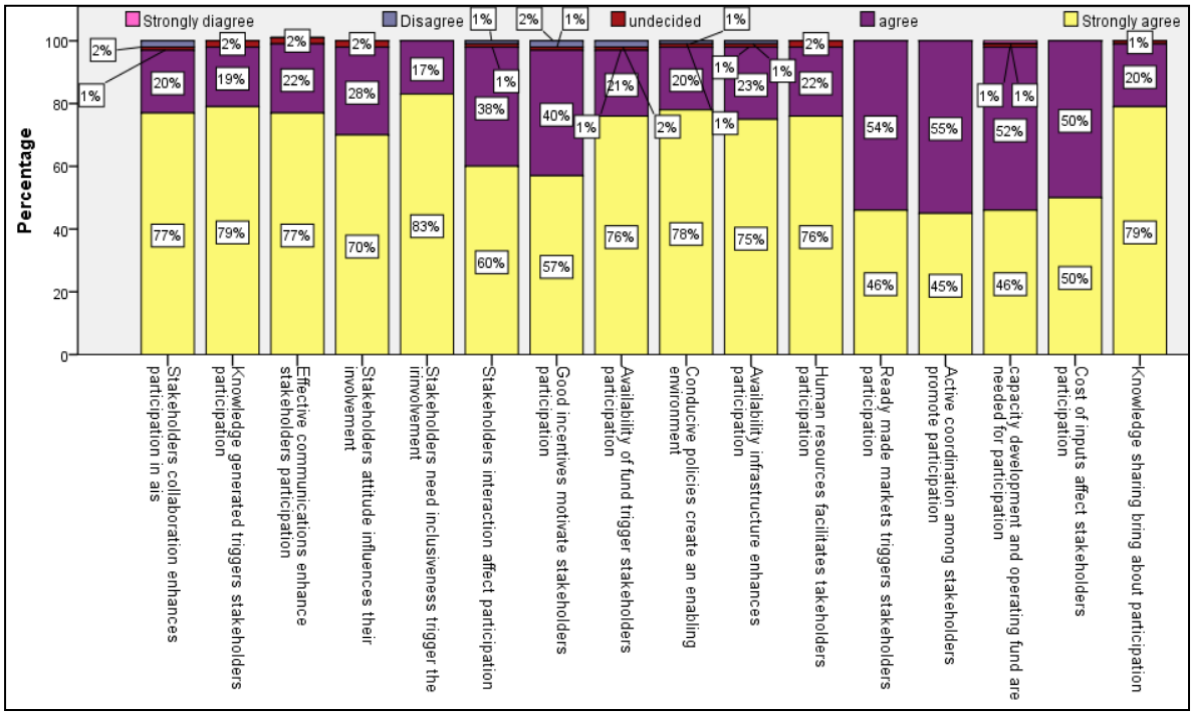
According to Hoffecker (2021), the operationalization and improvement of development in agriculture depend increasingly on the integration, interaction, and interplay of multi-stakeholder initiatives and interventions, organisations, and intuitions in AIS

.Thus achieving food sustainability requires close synergies, active partnership, and strong collaboration among diverse stakeholders.

4.5 Factors influencing the participation of stakeholders (farmers, extension agents, researchers, input dealers, and NGOs) in agricultural innovation system (AIS)

The cluster bar chart in Figure 4.12 presents the aggregate factors influencing stakeholders' participation (farmers, extension agents, researchers, input dealers, and NGOs) in the agricultural innovation system (AIS)

Figure 4.11: Factors influencing the participation of stakeholders in AIS (farmers, extension agents, researchers, input dealers, and NGOs) in agricultural innovation system (AIS)



Source: Data of respondents from field survey, 2021

The factors influencing the participation of stakeholders in AIS is presented figure 4.11. The stakeholders that strongly agreed include: stakeholders collaborative relationship enhances their participation by 77%, knowledge generation triggers stakeholders participation in AIS by 79%, and knowledge sharing bring about participation in AIS by 77%, effective communication strategy enhances stakeholders participation in AIS by 77%, stakeholders attitude towards AIS influence their involvement in the system by 70%, stakeholders interest and felt need inclusiveness in AIS implementation process trigger their involvement by 83%, stakeholders pattern of interaction in AIS affect their participation by 60%, good incentives motivate stakeholders participation by 57%, availability of funds trigger stakeholders' participation in AIS 76%, conductive for stakeholders create enabling environment for their participation by 78%, availability of infrastructure for stakeholders enhances their participation in AIS by 75%, human resources facilitate stakeholders participation in AIS by 76%,

knowledge sharing among stakeholders bring about their participation in AIS by 79%, while the stakeholders agreed that ready-made markets trigger stakeholders participation with 55%, active coordination among stakeholders in AIS promote their involvement by 55%, and investments in capacity development and operating funds are essential to harness the stakeholders participation in AIS by 52%, cost of inputs affect stakeholder participation by 50%.

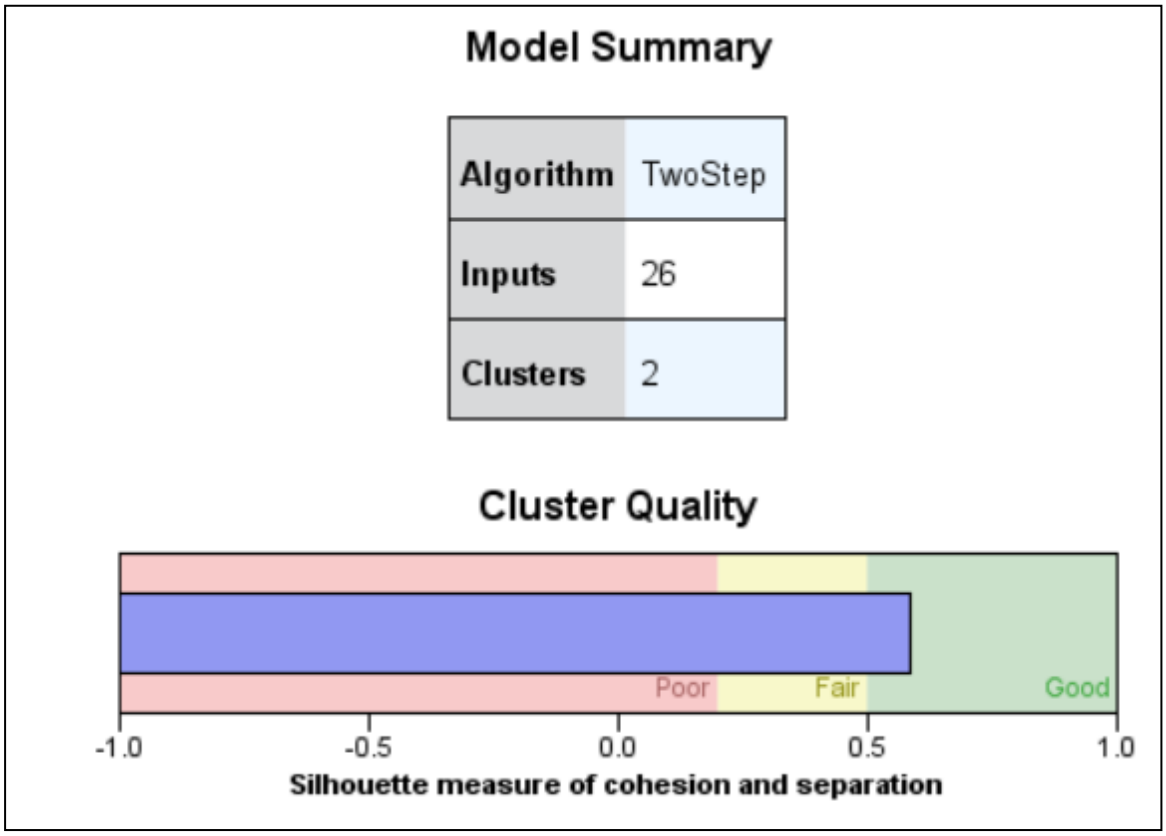
It shows that the vast majority of the collaborators firmly concurred that the aforementioned considerations affected their decision to participate in AIS. All of these elements were therefore crucial for increasing stakeholders' involvement in the study's AIS.

This study is in agreement with Klerkx and Begemann (2020) which affirms that funds availability, enabling environment, good incentives and capacity development are essential for facilitating stakeholders' involvement in AIS.

Additionally, in line with the findings of this study, Aerni et al. (2015) assert that for AIS to succeed, significant investments must be made in building capacity, which entails educating and training a variety of heterogeneous actors to advance knowledge and create human resources in the agricultural sector.

4.6 The constraints facing stakeholders in their participation in the agricultural innovation system

Figure 4.12: The segmentation table



Source: Data of respondents from field survey, 2021

The segmentation table of the participants under their perception of the constraints facing them in the agricultural innovation systems is presented in figure 4.12. The cluster analysis is used to group the respondents according to their perception of the constraints they faced in their participation in AIS. The cluster analysis was used because variables could not be computed with the means to form an aggregate response variable.

4.6.1 Cluster 1 (outputs of the respondents who answered “yes” to all the questions on the constraints facing stakeholders’ in their participation in AIS)

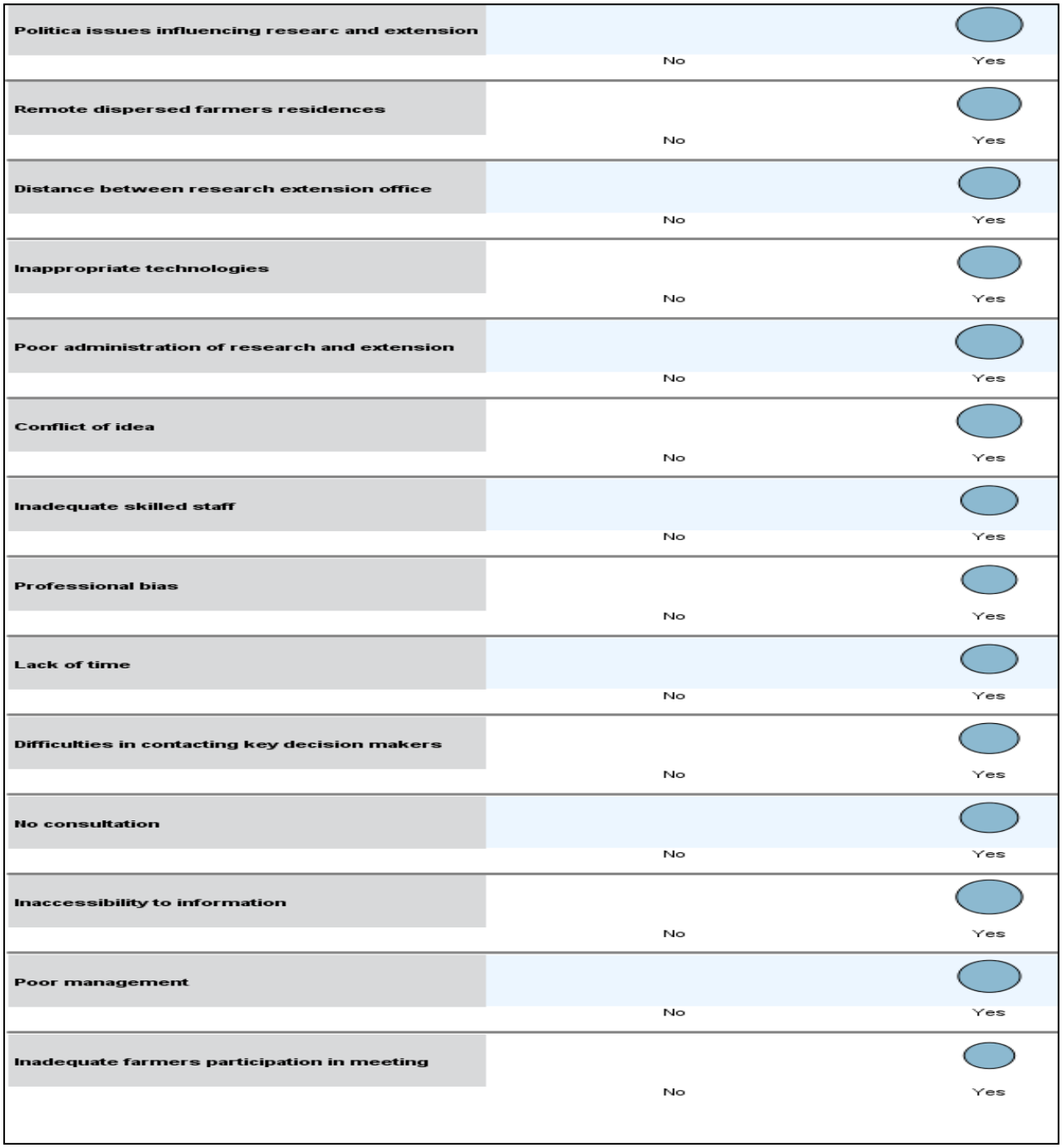
Figure 4.13a and Figure 4.13b present Cluster 1 which contains the outputs of the respondents who answered “yes” to all the questions on the constraints facing stakeholders’ in their participation in agricultural innovation systems.

The majority of the study participants faced a lot of constraints in their participation in AIS. The respondents claim that their agricultural productivity are on small-scale production because of the limited resources, poor communication among stakeholders, inaccessibility to information , insufficient funding, and inadequate technology among other factors.

To mitigate the hurdles, the study suggests that the participants should engage in interactive stakeholder participatory approach where they can be able to collaborate, communicate and shared share resources and shared information among themselves in the value chain. Therefore, engaging the stakeholders' participatory approaches is essential to promoting agricultural innovation systems which is also crucial for pooling together of their limited resources to scale up their production.

Figure 4.13a: Cluster 1

Figure 4.13b: Cluster1(Continued)



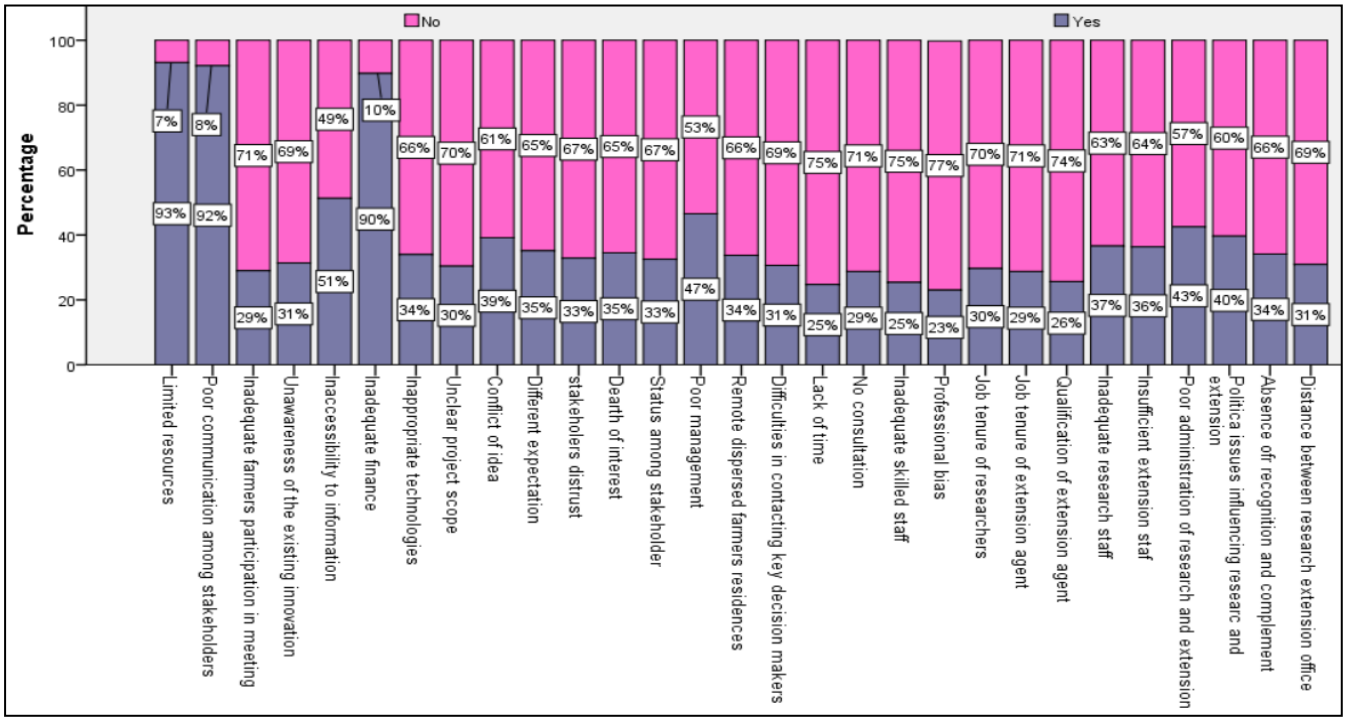
4.6.2 Cluster 2 (the outputs of the respondents who answered "no" to all the questions on the constraints facing stakeholders' in their participation in AIS)

Figure 4.14a and Figure 4.14b depict Cluster 2 which contains the outputs of the respondents who answered "no" to all the questions on the constraints facing stakeholders' in their participation in agricultural innovation systems. The respondents claim that they are not limited by the following limitations, extension staff , unclear project scope , differenrt expectations, job tenure of researchers.

Figure 4.14a: Cluster 2

Figure 4.14b: Cluster 2

Figure 4.15: The constraints facing stakeholders on their participation in the agricultural innovation system



Source: Data of respondents from field survey, 2021

The cluster bar chart in Figure 4.15 presents the constraints facing stakeholders on their willingness to participate in the agricultural innovation system. The following are the constraints indicated as yes by the collaborators (farmers, extension agents, researchers, input dealers and NGOs) in percentages they are: limited resources at 93%, poor communication among stakeholders 92%, inadequate farmers participation in the meeting with 29%, unawareness of the existing innovations 31%, inaccessibility to information 51%, inadequate finance 90%, inappropriate technology 34%, unclear project scope 30%, conflict of idea 39%, different expectation 35%, stakeholders distrust 33%, death of interest 35%, status among stakeholders 33%, poor management 47%, remotely dispersed farmers residents 34%, difficulties in contacting key decision makers 31%, lack of time 25%, no consultation 29%, inadequately skilled staff 25%, professional biasness 23%, job tenure of researchers 30%, qualification of extension agent 26%, inadequate research staff, insufficient extension staff 36%, poor administration of research and extension, political issues influencing research and

extension 40%, absence of recognition and complement 34%, and distance between research and extension office 31% .

Stakeholders in the research region had to deal with a lack of human, financial, and technological resources as well as poor communication. Their capacity to work together and generate high levels of production has been limited. To remedy the problem, however, a budget must be made aside for the training of key participants in agricultural innovation systems to support capacity building and knowledge dissemination for sustainable agricultural growth in Nigeria's Oyo State. Enabling environments should be established in order to facilitate good policies for stakeholder participatory techniques.

4.7 Chi-square analysis of the association between demographic characteristics of stakeholders and their participation in the linkage activities in AIS

Table 4.3: Chi-square analysis of the association between demographic characteristics of Farmers with other stakeholders and participation in the linkage activities in AIS

Variable	X^2 Values	DF	Asymp. Sig	Decision
Are you currently studying for a higher degree & participating in AIS (farmers with the researcher)	11.341	1	0.001	Significant
Age & participation in AIS (farmers and researchers)	0.290	3	0.962	Not Significant
Age & participation in AIS (farmers and NGO)	0.782	3	0.859	Not Significant
Age & participation in AIS (farmers and extension agents)	0.447	3	0.930	Not Significant
Working experience & participation in AIS (farmers and researchers)	0.463	2	0.793	Not significant
Working experience & participation in AIS (farmers and NGOs)	0.206	2	0.902	Not Significant
Working Experience & participation in AIS (Farmers and Extension agents)	0.119	2	0.942	Not significant
Gender& participation in AIS(Farmers and Researchers)	1.000	1	0.317	Not significant

Gender & participation in AIS (Farmers and NGOs)	1.197	1	0.274	Not significant
Gender & participation in AIS Farmers and Extension agents)	1.351	1	0.245	Not significant
Marital Status & participation in AIS (Farmers and Researchers)	6.914	3	0.075	Not significant
Marital Status& participation in AIS(Farmers and NGOs	1.078	3	0.782	Not significant
Marital Status& participation in AIS(Farmers and Extension agents)	0.976	3	0.807	Not significant
Religion & participation in AIS(Farmers and Researchers)	0.954	2	0.621	Not significant
Religion& participation in AIS (Farmers and NGOs)	0.985	2	0.611	Not significant
Religion & participation in AIS (Farmers and Extension agents)	0.694	2	0.707	Not significant
Highest Educational Qualification & participation in AIS(Farmers and Researchers)	1.887	3	0.596	Not significant
Highest Educational Qualification& participation in AIS(Farmers and NGOs)	5.605	3	0.132	Not significant
Highest Educational Qualification& participation in AIS (Farmers and Extension agents)	6.640	3	0.084	Not significant
Are you currently studying for a higher degree & participation in AIS (Farmers and NGOs)	2.530	1	0.112	Not significant
Are you currently studying for a higher degree & participation in AIS (Farmers and Extension agents)	2.825	1	0.093	Not significant
What is your source of information& participation in AIS (Farmers and Researchers)	4.198	7	0.757	Not significant
What is your source of information & participation in AIS (Farmers and NGOs)	13.572	7	0.059	Not significant

What is your source of information & participation in AIS(Farmers and Extension agents)	13.918	7	0.053	Not significant

Significant at $p < 0.05$; not significant at $p > 0.05$

Source: Data of respondents from field survey, 2021

Table 4.3 presents the Chi-square analysis of the association between demographic characteristics of farmers with other stakeholders and their participation in the linkage activities in agricultural innovation systems (AIS).

The Chi-square analysis, the variable "Are you currently studying for a higher degree" at (p = 0.001) had dependency (at 5% level) on the participation in the linkage activities of AIS between farmers with the researcher.

This variable impacts the extent of their exposure to learning new skills and knowledge, which could be explained by the fact that farmers grow more skilled at their jobs as they gain more knowledge by pursuing higher education.

However, other variables which include gender, marital status, working experience, religion, highest educational qualification and what is your source of information did not have dependency on participation in the linkage activities in AIS betwee farmers with other actors (at 5% level).

4.8 Chi-square analysis of the association between demographic characteristics of extension agents with other stakeholders and participation in the linkage activities in AIS

Table 4.4: Chi-square analysis of the association between demographic characteristics of extension agents with other stakeholders and participation in the linkage activities in AIS

Variable	X^2 Values	DF	Asymp. Sig	Decision
Age and participation in AIS (extension agents and researchers)	None	None	None	None

Age and participation in AIS (extension agents and NGOs)	36.034	2	0.00	Significant
Age and participation in AIS (extensions agents and input leaders)	21.214	2	0.000	Significant
Age and participation in AIS (extension agents and farmers)	16.808	2	0.000	Significant
Religion and participation in AIS (extension agents and farmers)	5.387	1	0.220	Not significant
Are you currently studying for a higher degree and participating in AIS (extension agents and farmers)	4.267	1	0.0392	Not significant
Work experience and participation in AIS (extension agents and Researchers)	None	None	none	None
Work experience and participation in AIS (extension agents and NGO)	4.938	3	0.176	Not significant
Work experience and participation in AIS (extension and input leaders)	1.580	3	0.664	Not significant
Work experience and participation in AIS (extension agents & farmers)	3.136	3	0.371	Not significant
Gender and participation in AIS (extension agents and researchers)	none	none	none	None

Gender and participation in AIS (extension agents and NGO)	1.391	1	0.238	Not significant
Gender and participation in AIS (extension input leaders)	0.116	1	0.734	Not significant
Marital Status and participation in AIS (extension agents and NGO)	1.020	1	0.313	Not significant
Marital Status and participation in AIS (extension and input leaders)	1.437	1	0.231	Not significant
Marital Status and participation in AIS (extension agents and farmers)	1.743	1	0.187	Not significant
Religion and participation (extension agents and researchers)	none	none	none	None
Religion and participation in AIS (extension agents and NGO)	0.574	1	0.449	Not significant
Religion and participation in AIS (extension Input leaders)	2.867	1	0.090	Not significant
Highest Educational & participation in AIS Qualification (Extension Agents and Researchers)	none	none	none	none
Highest Educational Qualification & participation in AIS (Extension Agents and NGOs)	1.822	3	0.610	Not significant
Highest Educational Qualification & participation in AIS (Extension Input Leaders	1.443	3	0.696	Not significant

Highest Educational Qualification & participation in AIS (Extension Agents and Farmers)	2.816	3	0.421	Not significant
Are you currently studying for a higher degree & participation in AIS (Extension Agents and Researchers)	none	none	none	none
Are you currently studying for a higher degree and participation in AIS (Extension Agents and NGOs)	0.069	1	0.793	Not significant

Significant at $p < 0.05$; not significant at $p > 0.05$

Source: Data of respondents from field survey, 2021

Table 4.4 shows the Chi-square analysis of the association between demographic characteristics of extension agents with other stakeholders and their participation in the linkage activities in AIS. The Chi-square analysis, the variable "Age" at ($p = 0.000$) had dependency (at 5% level) on the participation in the linkage activities of AIS between extension agents with other stakeholders.

Thus, it implies that the variable ''age'' had dependency on the participation in the linkage activities in AIS between extension agents with NGOs, extension agents with input dealers, and extension agents with farmers.

There Chi-square analysis was not done for the relationship between the demographic characteristics of extension agents with researchers and their participation in the linkage activities in agricultural innovation systems (AIS) since there was very minute variation in the variables in the cluster bar chart measuring their participation in the linkage activities of AIS between them.

4.9 Regression (Relationship between demographic variables & participation in the linkage activities in AIS between farmers and researchers)

Table 4.5: Relationship between demographic variables & participation in linkage activities in AIS between farmers and researchers

Omnibus Tests of Model Coefficients								
	Chi-square			**Df**			**p-value**	
Model	11.322			1			0.001	
Variables in the Equation	B	S.E.	Wald	Df	p-value	Exp()	95% C.I.for EXP(B)	
							Lower	Upper
Currently Studying	1.326	.384	11.922	1	0.001	3.766	1.774	7.995
Constant	-1.812	0.216	70.521	1	0.000	0.163		

Significant at $p < 0.05$; not significant at $p > 0.05$

Source: Data of respondents from field survey, 2021

Table 4.5 presents the Stepwise binary logistic regression analysis of the relationship between demographic variables and participation in the linkage activities of AIS between the farmers and researchers. From the analysis, the only variable that affects the dependent variable (participation in AIS) that was retained in the model was "Are you currently studying for a higher degree".

The logistic regression shows that the variable ''Are you currently studying for a higher degree'' (with $p = 0.001$) had a significant effect (at 5% level) on the participation in the linkage activities of AIS between farmers and researchers. The variable 'Are you currently studying for a higher degree' had a limiting effect on farmers participation with the researchers in AIS.

The odds ratio (Exp (B)) is greater than 1 implying that the farmers who are currently studying are (3.766-1) = 2.766 times more likely to collaborate with researchers in the linkage activities of AIS.

It connotes that this variable 'Are you currently studying for a higher degree' will contribute substantially to farmer participation with the researcher in the linkage activities of AIS. This variable determines the extent of their exposure to acquiring skills and knowledge.This could be explained that the more the farmers acquire knowledge through studying for a higher degree, the better they become proficient in their work.

Thus, the null hypothesis which stated that there is no significant relationship between stakeholders' socio-demographic characteristics and their participation in the agricultural innovation system is hereby rejected .

4.9.1 Relationship between demographic variables & participation in the linkage activities of AIS between farmers and NGOs

Table 4.6: Relationship between demographic variables & participation in the linkage activities AIS between farmers and NGOs.

Variables in the Equation	B	S.E.	Wald	Df	p-value	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper

Currently Studying(1)	-1.180	.630	3.510	1	0.061	0.307	0.089	1.056
Constant	-0.693	1.225	0.320	1	0.571	0.500		

Omnibus Tests of Model Coefficients		
Chi-square	Df	p-value
6.007	2	0.049

Significant at $p < 0.05$; not significant at $p > 0.05$. **Source**: Data of respondents from field survey, 2021

Table 4.6 shows the stepwise binary logistic regression relationship between demographic variables and participation in AIS between farmers and NGOs.The stepwise binary logistic regression revealed that, at the 5% level, the variable "currently studying for a higher degree" (with $p = 0.049$) had a significant impact on the participation in AIS's linking activities between farmers and NGOs.

The variable ‘‘Are you currently studying for a higher degree’’ poses a limiting factor on farmers’ participation with NGOs in the linkage activities of AIS. Therefore, building comprehensive educational systems and training supports innovations and boosts output in AIS.

Thus, the null hypothesis, which claimed that there is no relationship between stakeholders' sociodemographic traits and their involvement in the agricultural innovation system, is hereby rejected.

4.9.2 Relationship between demographic variables & participation in the linkage activities AIS between farmer and extension agent

Table 4.7: Relationship between demographic variables and participation in the linkage activities AIS between farmers and extension agents

Omnibus Tests of Model Coefficients								
Chi-square				Df			p-value	
10.271				4			0.036	
Variables in the Equation	B	S.E.	Wald	Df	p-value	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Certificate	0.768	0.471	2.656	1	0.103	2.156	0.856	5.428
Degree	0.933	0.510	3.350	1	0.067	2.542	0.936	6.902
Master	2.737	1.293	4.484	1	0.034	15.442	1.226	194.513
Source of information	-1.232	0.643	3.673	1	0.055	0.292	0.083	1.028
Constant	-2.394	1.521	2.476	1	0.116	0.091		

Significant at $p < 0.05$; not significant at $p > 0.05$

Source: Data of respondents from field survey, 2021

Table 4.7 presents the stepwise binary logistic regression relationship between demographic variables and participation in the linkage activities of AIS between farmers and extension agents. The logistic regression showed that only farmers that posses a master's degree from the variable “highest educational qualification” had a significant effect (at 5% level) on the participation in the linkage activities of AIS between them and extension agents.

The likelihood that farmers with master's degrees will frequently engage in linking activities with extension agents is (15.442 - 1) = 14.442 times higher.

It suggests that the farmers' propensity to participate in AIS linkage activities will rise if they are willing to make significant educational investments. They will become more productive as a result.

There is no inferential statistics done for the relationship between demographic variables and in the linkage activities of AIS between extension agents with researchers, since the aggregate score for this section is ‘often’ and other categories are not showing since they are very minute (the only variable that shows variation is the ‘attendance of seminars and workshops’).

No inferential statistics was done between the demographic variables and the participation in the linkage activities of AIS between researchers and farmers since the variable is constant.

4.10 Regression of the relationship between demographic variables and factors influencing stakeholders’ participation in the agricultural innovation system (AIS)

Table 4.8: Relationship between demographic variables and factors influencing participation in the agricultural innovation system (AIS)

Omnibus Tests of Model Coefficients						
Chi-square		Df			p-value	
18.843		2			0.000	
Variables in the Equation	B	S.E.	Wald	Df	p-value	Expo(B)
Highest Educational Qualification (Degree, Masters or PhD)	-0.729	0.247	8.693	1	0.003	0.482
Source of information (Family, Friend, Bulletin, magazines and newspapers, Radio, TV)	2.231	0.713	9.791	1	0.002	9.310
Constant	-0.582	0.703	0.685	1	0.408	0.559

Significant at $p < 0.05$; not significant at $p > 0.05$.

Source: Data of respondents from field survey, 2021

Table 4.8 shows the Stepwise logistic regression model of the relationship between demographic variables and factors influencing participation in agricultural innovation. The highest level of education (Master's or PhD), and the participants' sources of information (family, friends, bulletin, magazines, newspapers, radio, and TV), had a significant impact on the participants' perceptions of the factors that influence stakeholders' participation at the 5% significance level.

However, the odds ratios (Exp(B)) show that the odds of respondents whose highest level of education is either a Degree, Master's or PhD 'strongly agree' with the suggested factors that are perceived to influence their participation in AIS are (1 - 0.482) = 0.518 less than that of those with a Certificate or Diploma.

Also, the odds ratios (Exp (B)) show that the odds of respondents whose source of information is Family, Friends, Bulletin, magazines and newspapers, Radio, or TV 'strongly agreeing' with the suggested factors that are perceived to influence their participation in AIS are (9.310 - 1) = 8.310 more than those whose source of information is either Workshop/seminar and Personal experience, Internet or Traditional Ruler and Community Leaders

The relevance of agricultural education and training in reducing poverty among rural populations worldwide is highlighted by Freer (2015) and the World Bank (2012). The variables "currently pursuing a higher degree," "and source of information," and "highest educational qualification" influence the stakeholders' engagement in the linkages activities of AIS, as can be observed in the regression analysis. This could be explained that if the training and education gap are bridged, they will increase stakeholders' performance, productivity and economic growth.

The factor "Source of income" has an impact on stakeholders involvement in AIS's linkages operations. It does imply that for the agricultural innovation system to be sustainable, a budget must be set up for investments in boosting building integrative education, trainning and knowledge dissemination.

Therefore, the null hypothesis which state there is no significant relationship between demographic variables and factors influencing participation in the agricultural innovation system (AIS) is rejected

4.11 Regression of the relationship between demographic variables (type of stakeholders) and constraints facing them in their participation in agricultural innovation system

Table 4.9: Regression of the relationship between stakeholders demographic variables (type of stakeholders) and constraints facing them in their participation in agricultural innovation system

Omnibus Tests of Model Coefficients			
	Chi-square	Df	p-value

Model	341.284		3		0.000
Variables in the Equation	B	S.E.	Wald	Df	p-value	Exp(B)
Extension Agent	5.791	0.555	108.798	1	0.000	327.491
Input Leader	6.161	0.786	61.439	1	0.000	474.000
NGO	2.520	0.448	31.714	1	0.000	12.430
Constant	-3.070	0.308	99.086	1	0.000	0.046

Significant at $p < 0.05$; not significant at $p > 0.05$.

Source: Data of respondents from field survey, 2021

Table 4.9 presents the Stepwise regression analysis of the relationship between demographic (type of stakeholders) variables and constraints facing them in their participation in agricultural innovation system.

At a 5% significance level, the independent variable ‘type of stakeholders’ which include Extension Agents, Input Leader and NGOs (with all having the p-value of 0.000) had a significant effect on the constraints facing them in their participation in AIS. Among other factors, stakeholder interests and perceived needs, knowledge sharing, human resources, funding, encouraging policies that created an enabling environment, effective communication, knowledge creation, and stakeholders' collaboration will increase stakeholders likelihood of success in AIS.

Therefore, the null hypothesis which states that there is no significant relationship between demographic variables and constraints facing stakeholders on their participation in the agricultural innovation systems is thereby rejected.

However, the null hypothesis which stated that "there is no significant difference in stakeholders’ perception of AIS and their participation in the agricultural innovation system" cannot be tested statically because there is not enough variation in the variable " perception of AIS" since almost all stakeholders answered "yes" to the questions on their knowledge test of AIS.

4.12: The chi-square analysis of the relationship of the factors influencing farmers to participate in AIS with other respondents

Table 4.10: The chi-square analysis of the relationship of the factors influencing farmers to participate in AIS with other respondents

Variable: Factors influencing farmers' willingness to participate in AIS	**X2**	**DF**	**Asymp. significance**	**Decision**
(Farmers and Researchers)	28.431	1	0.000	Significant
Farmers and NGOs Significant at $p < 0.05$; not significant at $p > 0.05$	91.755	1	0.000	Significant

Source: Data of respondents from field survey 2021

The table 4.10 shows the chi-square analysis of the relationship of the factors influencing farmers' participation in AIS with other respondents.

It is only the farmers who have variation for both participation in the linkage activities in AIS and the factors influencing participation in the chi-square analysis.

Both the factors driving farmers to participate with researchers in AIS ($p = 0.000$) and the factors motivating farmers to participate with NGOs in AIS ($p = 0.000$) had associations that were statistically significant at a level of 5% significance.

The analysis clearly shown that farmers and researchers as well as farmers and NGOs were dependened on the factors influencing their participation in AIS.

Therefore, if stakeholder collaboration in AIS is strengthened, among other things, knowledge will be generated significantly and information will be efficiently distributed.

4.13 Chapter Summary

This chapter presented the results from both descriptive and inferential analysis in different sections based on the objectives of the study. The socio-demographic (which were categorical variables) were shown on tables 4.1 and 4.2 using frequency and percentages. The descriptive statistics (mean) were used to present the age in years and the working experience in years since both were continuous variables.

Other variables were presented by cluster bar charts which include: The stakeholders' perception of knowledge of AIS, factors influencing the participation of stakeholders in AIS (farmers, extension agents, researchers, input dealers, and NGOs), the constraints facing stakeholders in their participation in AIS. The Chi-square and Stepwise regression analysis tables were presented.in analyzing the dependency and relationship between independent variables and dependent variables.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presented the summary and conclusion on the important facts and findings of this study "analysis of stakeholders' participation in agricultural innovation systems in Oyo State of Nigeria." The recommendations for this study were also included in this section.

5.2 Summary and Major Findings

This section focused on the summary of the analysis of this study while answering the research questions based on the specific objectives of the study.

5.2.1 Demographic Characteristics of Respondents

The majority of the stakeholders in this study were male which was in agreement with some pieces of literature Onemolease and Oriakhi (2011) and The World Bank, (2012) that men are the most dominant gender among stakeholders.

Also, the respondents were predominantly married which was in support of studies of Jibowo (1992) and Dire et al. (2016) that in any society, the majority were always married, people.

Furthermore, most of the stakeholders were Muslim and Christian while they all had some level of education with the researchers having the highest educational level at the Master's level and majorly studying for a higher degree.

The majority of the respondents got their information from workshops/seminars through stakeholders' collaboration and personal experience.

The study showed that middle-aged men were mostly involved in this study while the majority of the respondents had over 10 years of experience in their job designations.

Thus, the aforementioned provided the answer to thesis research question "What are the socio-demographic characteristics of the stakeholders (farmers, extension agents and researchers, input dealers and NGOs) in agricultural innovation systems".

5.2.2 The stakeholders' perception of knowledge of AIS

The majority of the stakeholders had perception of knowledge of the agricultural innovation system. The respondents (farmers, extension agents, researchers, input dealers and NGOs) predominantly responded that agricultural innovation systems contributed significantly to food production, food security and food sustainability thereby proffering an answer to thesis research question "What are the stakeholders' perceptions in agricultural innovation systems".

5.2.3 The Participation in the Linkage Activities of AIS among Stakeholders

It was revealed that the majority of the stakeholders often participate in the linkages activities in AIS which include the following: farmers and researchers, farmers and NGOs, farmers and

extension agents, researchers and farmers, researchers and extension agents, extension agents with researchers, extension agent with NGOs, and the NGOs with farmers, thereby signifying the relationship between these various collaborators were strong. While it was revealed that the researchers and NGOs along with researchers and input dealers rarely participate in the linkages activities in AIS. Thus, this provided the answer to thesis research question "what are the participation levels of stakeholders in the linkages activities in agricultural innovation systems"?

5.2.4 The Factors Influencing the Participation of Stakeholders (Farmers, Extension Agents, Researchers, Input Dealers and NGOs) in Agricultural Innovation Systems

The majority of the stakeholders strongly agreed that stakeholders' collaborative relationship enhances their participation, knowledge generation and sharing triggers stakeholders' participation in AIS, effective communication strategy enhances stakeholders' participation, stakeholders' attitude toward AIS influences their involvement in the system, stakeholders' interest and the need felt for inclusiveness in AIS implementation process trigger their involvement. The stakeholders' pattern of interaction in AIS affects their participation, good incentives motivate stakeholders' participation. The availability of financial resources triggers stakeholders' participation, this is conducive to stakeholders' creating enabling environment for their participation. The availability of infrastructure for stakeholders enhances their participation in AIS, human resources facilitate stakeholders' participation and knowledge sharing among stakeholders brings about their participation in AIS, while the other stakeholders agreed that ready-made markets trigger stakeholders' participation, active coordination among stakeholders in AIS promotes their involvement, investments in capacity development and operating funds are essential to harness the stakeholders' participation in AIS. The cost of input affects stakeholder participation.

Hence, answering the thesis research question "what are the factors influencing the participation of stakeholders (farmers, extension agents, researchers, input dealers and NGOs) in the agricultural innovation system (AIS)"?

5.2.5 The Constraints Facing Stakeholders on Their Participation in the Agricultural Innovation System

The majority of the respondents revealed that the constraints they encountered in their participation in the agricultural innovation systems were mostly limited resources, poor communication among stakeholders, and inadequate finance among other existing constraints.

This provides an answer to the thesis reseach question “What are the barriers to stakeholders' (collaborators') participation in the agricultural innovation system”?

5.2.6 Relationship Between Stakeholders’ Socio-demographic Factors and Their Participation in Agricultural Innovation Systems

The Chi-square analysis of the association between demographic characteristics of farmers with other stakeholders in participation in the linkage activities of AIS. It shows that the only variable which was statistically significantly associated with participation in the linkage activities in AIS was ‘Are you currently studying for higher degree’. It explains that acquisition of new skills and knowledge increases farmers participation with other stakeholders in the linkage activities of AIS, thereby increasing food production, their income and improve livelihood.

Also, from the Chi-square analysis of the association between demographic characteristics of extension agents with other stakeholders and participation in the linkage activities in AIS, only the variable “age” out of all other existing variables had an association with extension agents and NGOs, between extension agents and input dealers, between extension agents and farmers. This is an indication that the age of the extension agents posed a limitation on their participation with other stakeholders.

Furthermore, the Stepwise binary logistic regression analysis presented the relationship between demographic variables and participation in the linkage activities of AIS: the farmers and researchers. The variable ‘Currently Studying for a higher degree’ was statistically significantly associated with participation in the linkage activities in AIS.

Likewise, the stepwise binary logistic regression showed the relationship between demographic variables and participation in AIS between farmers and NGOs. The only variable "Currently Studying for higher degree" retained in the model was insignificant. It is an indication that none of the socio-demographic variables influenced the farmers' participation with NGOs in the linkage activities in AIS.

Correspondingly, the stepwise binary logistic regression relationship between demographic variables and participation in the linkage activities of AIS between farmer and extension agents showed that only farmers with Master's were statistically significantly associated in their participation in the linkage activities in AIS. Therefore, farmers who have a Master's degree are more likely to "frequently" engage in AIS linkage activities with extension workers.

5.2.7 Relationship between Demographic Variables and Factors Influencing Participation in the Agricultural Innovation Systems (AIS)

Similarly, the Stepwise logistic regression model presented the relationship between demographic variables and factors influencing participation in agricultural innovation. The independent dependent which includes the highest educational qualification (degree, Master's or PhD) and source of information transformed (Family, Friends, Bulletin, magazines and newspapers, radio, TV) had a significant impact on the participants' perceived factors that influence stakeholders' participation (the dependent variables). It was used in determining the extent to which each independent variable (demographic variables) explains the variance in the factors influencing participation in the agricultural innovation system (AIS).

More so, the Chi-square analysis presented the association of the factors influencing farmers' participation with other respondents in AIS. It was only the farmers that had a variation for both participation in the linkage activities in AIS and the factors influencing participation.

5.2.8 Relationship between Demographic Variables and Constraints facing stakeholders on their participation in agricultural innovation systems

The Stepwise regression analysis presented the relationship between demographic variables and constraints facing stakeholders on their participation in the agricultural innovation system.

The variables “type of stakeholders” (the dependent variable) which include extension agents, input leaders and NGOs had a significant effect on the constraints facing them in their participation in AIS.

5.2.9 Relationship between the Stakeholders’ Perception of Knowledge and Their Participation in Agricultural Innovation Systems

Due to insufficient variation in the knowledge test of AIS, the relationship between the stakeholders' perception of knowledge and their engagement in AIS could not be statistically investigated. Almost all stakeholders who took their AIS knowledge test gave "yes" answers to the questions.

The null hypothesis which stated that "the is no significant difference in stakeholders’perception of knowledge and their participation in the agricultural innovation system"could not be tested.

5. 3 Conclusion

This study analysed stakeholders' participation in agricultural innovation systems in the Nigerian state of Oyo. It emphasized the importance of stakeholder involvement in agricultural innovation systems to promote agricultural growth in the face of growing populations. Most stakeholders had positive opinions about the agricultural innovation system. Almost all stakeholders engage in the linkage activities of AIS. The dearth of human, financial, and technological resources and ineffective communication were challenges faced by stakeholders in the research region.

The study revealed that the variable "Are you currently studying for a higher degree?" "Highest level of education," "age," and "Source of information" (Family, Friends, Bulletin, Magazines and Newspapers, Radio, TV) influenced farmers' participation in linkage activities with other stakeholders in agricultural innovation systems.

In no doubt, agricultural innovation systems that emphasize and embrace the participation of a plurality of stakeholders play a dominant role in the generation of knowledge and the creation of value-added products (technologies) and processes, thereby ensuring food sustainability.

5.4 Recommendations

The engagement of Stakeholder participatory approaches should be recommended for long-term agricultural innovations and policy interventions in low-income countries. From the study conducted, it enables the greatest possible strategic development, large-scale manufacturing and high marketability.

For the planning, development, implementation, monitoring, and evaluation of agricultural innovations for sustainable development, the stakeholder participation approaches (SPA), stakeholder participation models (SPM), and elements for enhancing agricultural innovation systems (EEAIS) in agricultural innovation systems should be reinforced. It will strengthen robust linkage mechanisms for collaboration amongst the role players in the value chain.

An investment budget must be set aside for the training of role players. This will enhance the capacity building (both human and technical) and dissemination of information in agricultural innovation systems for sustainable agricultural development in Nigeria's Oyo State.

Enabling frameworks should be put in place to support appropriate policies for stakeholder participatory techniques in achieving novelty, co-evolution and intensification of production.

The study recommends comprehensive solutions based on the bottom-up participation model, collaborative stakeholder participation model, college stakeholder participation model, and interactive participation approach in AIS, where all value chain participants should be actively engaged to enable food production, enhance large-scale manufacturing, and promote high marketability.

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APPENDIX

QUESTIONNAIRE

Questionnaire for: analysis of stakeholders' participation in agricultural innovation systems (AIS) among stakeholders namely: farmers, researchers, extension agents, non-governmental organizations and input dealers in the Oyo State of Nigeria

Dear respondent,

This questionnaire is designed to collect from the Farmers, Extension agents, Researchers, Non- governmental organizations and input dealers their willingness to participate in the agricultural innovation system (AIS) in the Oyo State of Nigeria. The information provided will be highly appreciated and any answer provided will be confidentially treated. Please, kindly complete the questionnaire to the best of your ability and no names are required.

SECTION A: Demographic Characteristics

1. What is your gender?

Male

Female

2. What is your marital status?

Single

Married

Divorced

Widowed

3. Please specify your age in years ……

4. What is your highest educational qualification?

Certificate

Diploma

Degree

Masters

PhD

5. Are you currently studying for a higher degree?

No

Yes

6. Please indicate your working experience (in years)……..

7. Which type of stakeholders are you in agricultural innovation systems concepts?

Farmers

Extension agents

Researchers

Input dealers

Agro non-governmental organization

8. What is your source of information?

Family

Friends

Traditional Rulers/community leaders

Bulletin, magazines and newspaper

Radio Broadcast

TV Broadcast

Internet

Workshop/seminar through stakeholders' collaboration Personal experience

Section B: Please indicate your knowledge of agricultural innovation systems (AIS)

Statements on knowledge acquisition in AIS	True	False
AIS is a mainstream of orchestrating agricultural development.		
AIS stresses collective learning by synthesizing harmonious synergy among stakeholders		
AIS integrate education and training as parts of its components and brings about unlimited access to new knowledge		
Stakeholders' collaboration in AIS enhances the improvement of the livelihoods of the populace and the achievement of viable economic growth		
AIS is a tool for the generation, dissemination, adaptation of knowledge and adoption of a technological output or a new process		
AIS stresses on the application of knowledge and skills from different sources among stakeholders will strengthen the linkage system for the novelty in achieving large-scale production.		
AIS serves as a means of generating income, creating jobs and mitigating poverty		

AIS brings about a forum where researchers work closely with other stakeholders in knowledge generation		
AIS provides a platform where definitions of topics for learning are based on the felt needs and priorities		
AIS brings about the reformation of curricula which are necessary for achieving the desired changes		
Good teaching methods and tools enhance knowledge acquisition in AIS		
Capacity building may be initiated by researchers or other stakeholders in AIS		
Capacity building involves workshops, seminars, farm visitations and consultations in AIS		
Training evaluations and scoring exercises are required for monitoring the effect of knowledge in AIS		
Knowledge generation in AIS requires a significant investment of time and personal resources on the part of the stakeholders		
The provision of electronic learning facilitates AIS		

Section C: Please indicate if you do participate in the following linkage activities by specifying the frequency of your participation with the following; Often (O) (assign 3), Rarely (R) (assign 2) and Never (N) (assign 1)

For Farmers only

Function	Extension agents			Researcher			NGO			Input dealer		
	O	R	N	O	R	N	O	R	N	O	R	N
Joint problem identification												
Joint problem solving												
Joint learning												
Joint training.												
Joint survey												
Joint evaluation of trials												
Setting priorities												
Knowledge generation												
Contribution to the issue at stake												
Provision of advisory support												
Joint extension services												
Joint use of SMS for service providers												

Joint implementation

Joint feedback

Joint monitoring

Workshop & Demonstration and field visits

Joint research activities

Dissemination of knowledge and information

Financing of projects & Share use of resources

Attendance of seminar and workshop

Maintenance of project

Report publications

Reward system

Management capacity

Evaluation exercises

For Extension agents only

Function	Farmer			Researcher			NGO			Input dealer		
	O	R	N	O	R	N	O	R	N	O	R	N
Joint problem identification												
Joint problem solving												
Joint learning												
Joint training.												
Joint survey												
Joint evaluation of trials												
Setting priorities												
Knowledge generation												
Contribution to the issue at stake												
Provision of advisory support												
Joint extension services												

Joint use of SMS for service providers

Joint implementation

Joint feedback

Joint monitoring

Workshop & Demonstration and field visits

Joint research activities

Dissemination of knowledge and information

Financing of projects & Share use of resources

Attendance of seminar and workshop

Maintenance of project

Report publications

Reward system

Management capacity

Evaluation exercises

For Researchers only

Function	Farmer			Extension agent			NGO			Input dealer		
	O	R	N	O	R	N	O	R	N	O	R	N
Joint problem identification												
Joint problem solving												
Joint learning												
Joint training.												
Joint survey												
Joint evaluation of trials												
Setting priorities												
Knowledge generation												
Contribution to the issue at stake												
Provision of advisory support												

Joint extension services

Joint use of SMS for service providers

Joint implementation

Joint feedback

Joint monitoring

Workshop & Demonstration and field visits

Joint research activities

Dissemination of knowledge and information

Financing of projects & Share use of resources

Attendance of seminar and workshop

Maintenance of project

Report publications

Reward system

Management capacity

Evaluation exercises

For Non-governmental agents only

Function	Farmer			Extension agents			Researchers			Input dealer		
	O	R	N	O	R	N	O	R	N	O	R	N
Joint problem identification												
Joint problem solving												
Joint learning												
Joint training.												
Joint survey												
Joint evaluation of trials												
Setting priorities												
Knowledge generation												
Contribution to the issue at stake												
Provision of advisory support												
Joint extension services												

Joint use of SMS for service providers

Joint implementation

Joint feedback

Joint monitoring

Workshop & Demonstration and field visits

Joint research activities

Dissemination of knowledge and information

Financing of projects & Share use of resources

Attendance of seminar and workshop

Maintenance of project

Report publications

Reward system

Management capacity

Evaluation exercises

For Input dealers only

Function	Farmer			Extension agent			Researcher			NGO		
	O	R	N	O	R	N	O	R	N	O	R	N
Joint problem identification												
Joint problem solving												
Joint learning												
Joint training.												
Joint survey												
Joint evaluation of trials												
Setting priorities												
Knowledge generation												
Contribution to the issue at stake												
Provision of advisory support												
Joint extension services												
Joint use of SMS for service providers												

Joint implementation

Joint feedback

Joint monitoring

Workshop & Demonstration and field visits

Joint research activities

Dissemination of knowledge and information

Financing of projects & Share use of resources

Attendance of seminar and workshop

Maintenance of project

Report publications

Reward system

Management capacity

Evaluation exercises

Section D: Please indicate the factors that enhance stakeholders' involvement in the agricultural innovation system (AIS) where SA, A, U, D and SD mean strongly agree, agree, undecided, disgrace and strongly disagree respectively.

Statements on factors that enhance stakeholders' involvement in AIS	SA	A	U	D	SD
Stakeholders' collaborative relationship enhances their participation in AIS					
Knowledge generation and sharing trigger stakeholders' participation in AIS					
Effective communication strategy enhances stakeholders' participation in AIS					
Stakeholders' attitude toward AIS influences their involvement in the system					
Stakeholders' interest and the felt need for inclusiveness in the AIS implementation process trigger their involvement					
Stakeholders' pattern of interaction in AIS affects their participation					
The provision of good incentives for stakeholders motivates their participation in AIS					
Availability of financial resources triggers stakeholders' participation in AIS					

Conducive policies for stakeholders create an enabling environment for their participation.					
The availability of infrastructure for stakeholders enhances their participation in AIS					
Availability of human resources facilitates stakeholders' participation in AIS					
The availability of ready-made markets triggers stakeholders' participation					
Active coordination among stakeholders in AIS promotes their involvement					
Investments in capacity development and operating funds are essential to harness the stakeholders' participation in AIS.					
The cost of procuring technological inputs affects stakeholders' participation in AIS					
Knowledge sharing among stakeholders brings about their participation in AIS					

Section E: Please indicate the existing constraints to your participation in the agricultural innovation system

Constraints	**Yes**	**No**
Limited resources		
Weak or poor communication among stakeholders		

Inadequate farmer participation in innovation meeting		
Unawareness of the existing innovation		
Inaccessibility to information on new technologies		
Inadequate finance for technologies		
Inappropriate technologies		
Unclear project scope		
Conflict of ideas and roles among stakeholders		
Different expectations		
stakeholders distrust		
Dearth of interest		
Status among stakeholders		
Poor management		
Remote and dispersed farmers' residence		
Difficulties in contacting key decision makers when matters arise		
Lack of time		
No consultation		
Inadequately skilled staff		
Professional bias		
Job tenure of researchers		

Job tenure of extension agents		
Qualification of extension agents		
Inadequate research staff		
Insufficient extension staff		
Poor administration of research and extension institutions		
Political issues influencing research and extension		
Absence of recognition and complement from colleagues		
Distance between research centres and extension offices		