

**Exploring the Dynamics of Innovation for Inclusive
Development Systems: A Study of the Nigerian Growth
Enhancement Support Scheme**

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DECLARATION

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ABSTRACT

Innovation remains central to industrial competitiveness and catching up and is crucial for providing targeted solutions to nagging development problems. This is because the innovation system (IS) framework, in principle, offers multiple learning pathways to issues of development and advocates context-specificity in the application. However, the problem with the framework is the limitation in accounting for the peculiarities of developing countries. Several authors have argued that there is a need to continuously modify the structural elements and processes to accommodate new sets of actors, institutions, and networks critical in the developing country context. This study contributes to the emerging literature on ISs and inclusive development by developing an analytical framework for assessing functional dynamics and performance. ISs performance is assessed by tracking how well the functions perform over time to determine policy interventions needed to strengthen the structural elements.

The goal of the study is two-fold, to 1) develop an analytical framework for expanding the ISs framework to inclusive development; and 2) to show the utility of the framework in the I4ID context by generating insights into the functional dynamics and performance of an IS.

The research design is the case study approach. It is operationalised using the Conceptual Framework Analysis (CFA) method developed by Jabareen (2009). This offers a qualitative procedure of theorisation for building and validating conceptual frameworks based on the Grounded Theory (GT) methodology. This study expands on previous works which adapt the systemic policy approach to assessing the performance of innovations in inclusive development (van der Hilst, 2012; Botha, 2017; van der Merwe, 2017). The systemic policy framework provides a guide for assessing innovation performance at a systemic level by combining the structural and functional approaches to identify systemic problems and proffer solutions (Wieczorek and Hekkert, 2012).

To explore and develop critical insights into the performance of I4ID systems, the developed framework was applied to the GES scheme in Nigeria's agricultural system through the event history analysis (EHA), qualitative analysis, and consultation of experts. Building on the work of Maarsingh *et al.* (2021), the study utilises the EHA to identify the functions and the relationship between them. It reveals the cumulative causation, motors of innovation, drivers and barriers to the evolution of the GES scheme. Key informant interviews and in-depth interviews were conducted with actors in the GES scheme to triangulate the findings of the

EHA and further provide evidence to identify systemic problems hindering the growth of the I4ID system and possible policies for solving them.

The study draws lessons from the Nigerian GES scheme to analyse the role of policy in the emergence of the I4ID system while also providing critical insights into the broader approach in the context of the I4ID system. While contributing to knowledge on the emerging field of the I4ID system, the study highlights some limitations in methodology and inclusivity. It suggests further areas of research, for instance, examining the broader policy structures, especially the political economy of the state and its influence on the performance of I4ID systems.

OPSOMMING

Innovasie bly sentraal tot industriële mededingendheid en opvang en is noodsaaklik vir die verskaffing van doelgerigte oplossings vir kwellende ontwikkelingsprobleme. Dit is omdat die innovasiesistiem (IS) raamwerk, in beginsel, verskeie leerpadte bied vir kwessies van ontwikkeling en voorstanders van konteksspesifisiteit in die toepassing. Die probleem met die raamwerk is egter die beperking in die rekeningkunde vir die eienskappe van ontwikkelende lande. Verskeie outeurs het beweer dat daar 'n behoefte is om die strukturele elemente en prosesse voortdurend aan te pas om nuwe groepe akteurs, instellings en netwerke krities in die ontwikkelende landkonteks op te neem. Hierdie studie lewer by tot die ontluikende letterkunde oor ISs en inklusiewe ontwikkeling deur 'n analitiese raamwerk te ontwikkel vir die evaluering van funksionele dinamika en prestasie. ISs prestasie word geëvalueer deur die spoor van hoe goed die funksies oor tyd presteer om beleidintervensies te bepaal wat nodig is om die strukturele elemente te versterk.

Die doel van die studie is tweeledig, om 1) 'n analitiese raamwerk te ontwikkel vir die uitbreiding van die IS se raamwerk na inklusiewe ontwikkeling; en 2) om die bruikbaarheid van die raamwerk in die I4ID-konteks aan te toon deur insigte in die funksionele dinamika en werkverrigting van 'n IS te genereer.

Die navorsingsontwerp is die gevallestudiebenadering. Dit word geoperasionaliseer deur gebruik te maak van die konseptuele raamwerkanalise (CFA) metode wat deur Jabareen (2009) ontwikkel is. Dit bied 'n kwalitatiewe prosedure van teoretisering vir die bou en validering van konseptuele raamwerke gebaseer op die "Grounded Theory" (GT) metodologie. Hierdie studie brei uit op vorige werke wat die sistemiese beleidsbenadering aanpas om die prestasie van innovasies in inklusiewe ontwikkeling te assesser (van der Hilst, 2012; Botha, 2017; van der Merwe, 2017). Die sistemiese beleidsraamwerk verskaf 'n gids vir die assessering van innovasieprestasie op 'n sistemiese vlak deur die strukturele en funksionele benaderings te kombineer om sistemiese probleme te identifiseer en oplossings te bied (Wieczorek en Hekkert, 2012).

Om kritiese insigte in die werkverrigting van I4ID-stelsels te verken en te ontwikkel, is die ontwikkelde raamwerk toegepas op die GES-skema in Nigerië se landboustelsel deur die gebeurtenisgeskiedenis-analise (EHA), kwalitatiewe analise en konsultasie van kundiges. Voortbouend op die werk van Maarsingh et al. (2021), gebruik die studie die EHA om die funksies en die verhouding tussen hulle te identifiseer. Dit onthul die kumulatiewe

oorsaaklikheid, motors van innovasie, drywers en hindernisse tot die evolusie van die GES-skema. Sleutel-informant-onderhoude en in-diepte onderhoude is gevoer met deelnemers in die GES-skema om die bevindinge van die EHA te trianguleer en verder bewyse te verskaf om sistemiese probleme te identifiseer wat die groei van die I4ID-stelsel belemmer en moontlike beleide om dit op te los.

Die studie trek lesse uit die Nigeriese GES-skema om die rol van beleid in die ontstaan van die I4ID-stelsel te ontleed, terwyl dit ook kritiese insigte verskaf in die breër benadering in die konteks van die I4ID-stelsel. Terwyl dit bydra tot kennis oor die opkomende veld van die I4ID-stelsel, beklemtoon die studie sommige beperkings in metodologie en inklusiwiteit. Dit stel verdere navorsingsgebiede voor, byvoorbeeld die ondersoek van die breër beleidstrukture, veral die politieke ekonomie van die staat en die invloed daarvan op die prestasie van I4ID-stelsels.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADP	Agricultural Development Programme
AFAN	All Farmers Association of Nigeria
AGRA	Alliance for a Green Revolution in Africa
AIMMS	Agricultural Inputs Mechanisation and Management Services
APP	Agricultural Promotion Policy
ATA	Agricultural Transformation Agenda
ATM	Automated Teller Machine
BoP	Base of the Pyramid
CA	Conservative Agriculture
CAC	Corporate Affairs Commission
CBN	Central Bank of Nigeria
CCFR	Certificate of Confirmation of Redemption
CFA	Conceptual Framework Analysis
CLD	Causal Loop Diagram
COBFAS	Centre for Community-Based Farming Scheme
DEA	Data Envelopment Analysis
DFID	Department for International Development
DUI	Doing User Interaction
EHA	Event History Analysis
E-wallet	Electronic Wallet
FCT	Federal Capital Territory
FEPAR	Federal Public Administration Reform Programme
FMARD	Federal Ministry of Agriculture and Rural Development
FVP	Fertilizer Voucher Programme
GDP	Gross Domestic Product

GES	Growth Enhancement Support
GESS	Growth Enhancement Support Scheme
GLOBELICS	Global Network for Economics of Learning, Innovation and Competence Building System
GT	Grounded Theory
GTM	Grounded Theory Methodology
I4ID	Innovation for Inclusive Development
IAR	Institute for Agricultural Research
ICT	Information Communication and Technology
ICT4D	Information Communication and Technology for Development
IDI	In-depth Interview
IFDC	International Fertilizer Development Centre
IFIAS	International Federation of Institutes for Advanced Study
IIS	Inclusive Innovation System
IITA	International Institute for Tropical Agriculture
IPR	Intellectual Property Right
IS	Innovation System
Kg/ha	Kilogram/hectare
KII	Key Informant Interview
MDA	Ministry Department Agency
MNC	Multi-National Corporation
MSME	Micro Small and Medium Enterprises
NACETEM	National Centre for Technology Management
NADS	National Agro-dealer Support
NAERLS	National Agricultural Extension and Research and Liaison Services
NAGESP	National Agricultural Growth Enhancement Support Programme

NAIDA	National Agro-input Dealers Association
NAISS	National Agricultural Input Support Scheme
NAPI	Nigeria Agricultural Payment Initiative
NASC	National Agricultural Seed Council
NBS	National Bureau of Statistics
NEC	National Economic Council
NESTA	National Endowment for Science Technology and the Arts
NFDB	National Farmers Database
NIC	National Insurance Commission
NIMC	National Identity Management Commission
NIRSAL	Nigerian Incentive-Based Risk Sharing System for Agricultural Lending
NIS	National Innovation System
NOCAIDA	North Central Agro Input Dealers Association
OECD	Organisation for Economic Co-operation and Development
OMR	Optical Mark Recognition
OSSADEP	Osun State Agricultural Development Programme
R&D	Research and Development
RC	Redemption Centre
SCM	Supply Chain Manager
SEEDAN	Seed Entrepreneurs Association of Nigeria
SIS	Sectoral Innovation System
SME	Small and Medium-size Enterprises
SMS	Short Messaging Service
STI	Science, Technology and Innovation
STP	Science Technology Push

SWOFON	Small-Scale Women Farmers Organisation in Nigeria
TAP	Token Administration Platform
TIS	Technological Innovation System
TL	Technological Learning
TPP	Technological Product and Process
UNCTAD	United Nations Conference on Trade and Development
UNU-INTECH	United Nations University – Institute of New Technologies
UNU-MERIT	United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology
UTIID	University-driven Technology-based Innovation for Inclusive Development
WACOT	West African Cotton Company Limited
WAIDA	West Agro-Input Dealers Association
WARDA	West African Rice Development Association
WCDEDAT	Western Cape Department of Economic Development and Tourism

CHAPTER ONE : INTRODUCTION

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
					Summary and conclusions		

1.1 BACKGROUND

The innovation system (IS) framework has been used widely to explain the global economic growth and transformation differences among countries (Freeman, 2002; Lundvall, 2007). The framework attributed the acceleration of industrialisation and economic development to competence building and interactive learning (Lundvall, 2011). This was used to explain the industrialisation of Britain and the United States and the success or otherwise of latecomer economies in Asia (Freeman, 2002). The framework focuses on knowledge accumulation through learning about new technologies and their application rather than the previously believed investments in physical tangibles. Recently, the framework has been extended to analyse and guide innovation policies in developing countries by seeking to accelerate the development of industrial sectors into broader global systems (Bell and Pavitt, 1993; Matthews and Cho, 2000).

There is, however, an ongoing debate on the appropriateness of the IS framework for developing countries. The debate centres on two broad areas: Can the IS framework explain and tackle the perennial challenges of poverty, inequality or unemployment in developing countries? Can it accommodate non-conventional actors, informal institutions and interactions that characterise developing countries? (Altenburg, 2009; Kraemer-Mbula and Wamae, 2010; Lizuka, 2013). The former aims to address the concept of innovation for inclusive development (I4ID) while the latter is, inclusive innovation system (IIS). In literature, the two concepts are used interchangeably by many authors. However, Chaminade, Lundvall and Haneef (2018) tries to differentiate between the two. IIS focusses on implementing innovations by adapting

the structures and functions to the peculiarities of developing countries while I4ID tries to reorientate the IS framework to tackle perennial challenges associated with developing countries. These include poverty, inequalities, unemployment, etc. The use of the two concepts interchangeably may be justified because adaptation of the actors, interactions and institutions as well as the activities that make up an IS is usually an important step in re-orientating IS framework for inclusive development. In this study, an attempt is made to develop a framework that aims at inclusive innovation as well as focusing on how the system can improve the livelihoods of the marginalised. Although, the term I4ID is used, the framework captures the essentials of both the IIS and I4ID.

A possible reason for the debate is that most of the early studies on ISs focussed on economic growth, measured in terms of the Gross Domestic Product (GDP) - production and consumption of goods and services – as a measure of performance. In contrast, development is broader, taking into cognisance improvement in people's living conditions and human welfare (Chaminade, Lundvall and Haneef, 2018). These studies were also carried out in developed economies in Asia (Japan) and the Nordic countries (Lundvall, 2011; Chaminade, Lundvall and Haneef, 2018), where the context and needs are different (Altenburg, 2009). In developing countries, the institutional frameworks are less formalised, rules are less enforceable, and the key agents, as well as the incentives that determine their behaviour, tend to be very distinct (Altenburg, 2009). This led to doubt in some quarters about the appropriateness and applicability of the IS concept in developing country context (Viotti, 2002).

While early empirical studies on IS framework might have utilised cases in the developed economies, the framework in concept and design, is also applicable to developing countries. This is because the framework offers multiple learning pathways to development issues, capturing the realities of both the developed and developing countries (Chaminade, Lundvall and Haneef, 2018). For instance, the framework advocates context-specificity in the application, accounting for variation in components of systems in and between countries and regions. This makes innovation and learning central to industrial competitiveness and catching up crucial for providing targeted solutions to nagging development problems (Chaminade *et al.*, 2009). While this may explain the relevance of the IS conceptually to developing countries, many authors however agree that there is a need to undertake further studies to adapt the IS framework to developing country context.

Altenburg (2009, p. 33) captures this succinctly:

... despite the fact that context-specificity is recognised in principle, a considerable part of this (innovation systems) literature fails to appreciate the important peculiarities of developing countries. In particular, it does not systematically address the specific needs for poverty-reducing and socially inclusive types of innovation.

It is on this premise that this study aims to contribute to the emerging literature on IS by developing an analytical framework that can be used to assess the functional dynamics and performance of ISs aimed at inclusiveness and development.

A central challenge to assessing the performance of the I4ID system is how to adapt the IS framework as an analytical tool in a developing country context. This is because existing IS analytical tools lack adequate methods to analyse and evaluate I4ID performance. Performance in this study implies how well or optimal the internal processes, regarded as system functions that make up the development and growth of a particular IS, are functioning (Wieczorek and Hekkert, 2012; Botha, Grobbelaar and Bam, 2019; Maarsingh *et al.*, 2021). Thus, IS performance can be analysed by tracking how well the functions perform to determine appropriate policy interventions needed to strengthen missing or weak parts that may undermine the performance of the IS as a whole (Bergek *et al.*, 2008; Wieczorek and Hekkert, 2012). To explore and develop insights into the functional dynamics of the I4ID system, this study adapts the systemic policy framework proposed by Wieczorek and Hekkert (2012) and builds on studies such as Van der Hilst (2012), Van Der Merwe (2017), Botha (2017), Maarsingh *et al.* (2021) and McClelland *et al.* (2022) that utilised the approach in the development context. The framework is a set of diagnostic tools that aims to evaluate an IS's systemic performance by assessing its functions and structural elements. It also identifies the systemic problems and suggests interventions to strengthen the IS. In this study, the framework is applied to an essential programme in Nigeria's agricultural sector, the Growth Enhancement Support (GES) Scheme, a programme aimed at creating new opportunities, reducing poverty and enhancing the livelihoods of the disenfranchised.

Specific indicative questions guide the process (Mackintosh, Chataway and Wuyts, 2007; Cozzens and Sutz, 2012; van der Merwe and Grobbelaar, 2016): What are the I4ID goals? Which marginalised or excluded group is to be the focus of I4ID? What are the indicators of assessing performance? How can we develop an IS to achieve I4ID goals? These questions form the core of this study as it seeks to guide it.

1.2 ICTS AND INCLUSIVE DEVELOPMENT

Central to the I4ID system is the role of information and communication technologies (ICTs). In many countries, ICTs have become a tool for expanding new opportunities and business services driven by booming mobile, wireless, and internet industries (Raja *et al.*, 2013). These have supported and spurred the development of new service delivery approaches and value chain finance in particular, therefore, performing an increasing aggregator role in establishing links between otherwise disconnected actors (Greijn *et al.*, 2013). There is therefore a rapid growth in literature on programmes that utilise ICTs in driving pro-poor growth and inclusiveness in many developing countries (IDRC, 2011; Cozzens and Sutz, 2012; George, McGahan and Prabhu, 2012; Foster, 2013; Heeks *et al.*, 2013). Examples include M-PESA and M-Shwari in Kenya, Agrinet Uganda and m-Kisan in India.

Therefore, ICTs offers incredible potential to address the challenges of unemployment, poverty, and food insecurity in developing countries. Thapa (2013) noted that the diffusion of ICT-enabled innovations represents the single most significant technological change within low-income communities in recent years and may remain so in the future. Various ICT-based applications developed in support of agriculture, health, education, and mobile banking have successfully improved the conditions for the lower-income groups (Paunov, 2013). For instance, ICT-enabled solutions in agriculture can facilitate access to local and regional markets, connecting suppliers, buyers, and end-consumers. They can provide vital information to increase market efficiency (Valverde, 2020). An important ICT is the mobile phone. This has been widely and rapidly diffused in developing countries. Several studies have examined the impact of mobile phone adoption on development and have found a positive correlation with poverty reduction (Beuermann, McKelvey and Vakis, 2012; Suri and Jack, 2016); financial inclusion (Abor, Amidu and Haruna, 2018) and good governance (Asongu *et al.*, 2018). These thus provide opportunities to improve the efficiency of production systems, thereby making the sector more attractive for investment and accessible for marginalised groups such as women and youths or the base of the pyramid (BoP). Despite this, it is important to exercise caution in adopting ICTs to drive inclusive development. This is because of the failure of these technologies in achieving intended goals in some instances. This is attributed to failure to integrate human capacity issues (Marais, 2011); contextualisation of user needs (Diniz, Bailey and Sholler, 2014), and wrong conceptualisation of development (Chipidza and Leidner, 2019) in their design and implementation. Hence, there is the need for ICT for development (ICT4D) interventions to shift focus from technology to human aspects,

emphasising an increase in power parity between the dominant stakeholders and intended beneficiaries. Therefore, developing a framework for evaluating the performance of ICT-enabled innovations to expand new opportunities and enhance development outcomes in developing countries is an area of interest for policy.

1.3 STATEMENT OF THE PROBLEM

The concept of IS has been widely adopted as a policy and analytical framework for assessing economic growth and development. Although the framework offers context-specificity and multiple pathways to learning and development, there is the need to modify the framework to accommodate new sets of actors, institutions, and networks critical in the developing country context (Altenburg, 2009; Kraemer-Mbula and Wamae, 2010; Foster and Heeks, 2013b). This is because the structural elements that define activities in developing contexts are often neglected in conventional ISs. In addition, experiential learning drives the relationships between actors, informal institutions, and informal networks. Non-integration of these in traditional ISs has often neglected many of the populace, mostly BoP, in the process and benefits of innovations.

Second, evaluation of the performance of ISs has been mainly undertaken using the structural analysis method. This has been complemented with the functional analysis where the activities that go on in an IS are evaluated. Studies have found that performance evaluation of ISs using either a structural or functional analysis is insufficient (van der Hilst, 2012; Botha, 2017; van der Merwe, 2017). This has led to the development of the component-function approach which aims to couple the structural and the functional approaches into a single approach to evaluate ISs. A typical example of this is the systemic policy approach which is used to evaluate the performance of Technology Innovation Systems (TISs) (Wieczorek and Hekkert, 2012). The main challenge with the systemic policy approach is that it fails to accommodate the peculiarities in developing country contexts, with few studies, mainly in the South African context, utilising the adapted framework as an evaluation tool in the context of I4ID (van der Hilst, 2012; Botha, 2017; van der Merwe, 2017; Maarsingh *et al.*, 2021). Since literature has shown that frameworks for evaluating I4IDs can be derived from existing traditional ISs frameworks if they can be adapted to accommodate certain underplayed concepts important in the development context (Foster and Heeks, 2013c), it is therefore essential to expand the systemic policy approach to assess the performance of ISs in development contexts in other countries.

Third, while several studies have used the ISs framework in the agricultural sector, limited studies have utilised the component-function approach to explore IS's performance in the context of inclusive development (van der Hilst, 2012). Many of the studies in the sector assessed the structural elements, processes or structures supporting the diffusion of innovation in I4ID settings (Swaans et al., 2014; Adejuwon, 2016; Nhantumbo et al., 2016; Malley et al., 2017; Odame et al., 2020; Horton et al., 2022). There is a need to expand research on I4ID systems in the agricultural sector to assess the performance from a systemic perspective. The use of the component-function approach offers a unique opportunity to achieve this. An example is a study undertaken by Van der Hilst (2012) to develop a similar framework using the component-function approach. It however narrows on the role of intermediaries in facilitating inclusive innovation. A more holistic approach will expand the component-function analysis to include systemic problems and instruments for resolving these. This study will therefore complement growing literature in a different sector on the use of the component-function approach to explore the I4ID system performance (Botha, 2017; van der Merwe, 2017; Maarsingh *et al.*, 2021), thereby providing a broader understanding of the performance of ISs in developing country context.

The focus on the agricultural sector is because of its importance to the economy of developing countries, especially sub-Saharan Africa. In Nigeria, it accounted for about 45% of labour in 2014 (Ajakaiye *et al.*, 2015) and contributed about 26.2% to GDP in 2020 (National Bureau of Statistics, 2021). The economy of Nigeria is highly informal, with 95% of activities in the agricultural sector contributed by the informal sector. Despite these, the country faces challenges of high food insecurity with high food import bills. In addition, unemployment remains high, especially among the youth with about 35% in Q2 2020 (National Bureau of Statistics, 2020). Also, 133 million people, about 63% of the populace, are multidimensionally poor – a term used to measure poverty as deprivations in four areas: sanitation, healthcare, food insecurity and housing (National Bureau of Statistics, 2022).

1.4 RESEARCH OBJECTIVE

The broad objective of the study is two-fold, to 1) develop an analytical framework for expanding the IS framework to inclusive development; and 2) show the utility of the framework by applying it to generate insights into the functional dynamics and performance of an IS in an inclusive development context.

Specifically, the study will:

1. Provide a comprehensive overview of Nigeria's agricultural IS;
2. Undertake a comprehensive review of existing literature on ISs; I4ID; and the evaluation of ISs;
3. Derive an analytical framework to develop insights into the performance of the I4ID system;
4. Explore and generate insights into the performance of ISs by applying the framework to a case in the Nigerian agricultural sector;
5. Examine the factors shaping and influencing the I4ID system; and
6. Analyse the role of policy in influencing the development and evolution of the I4ID system in Nigeria's agricultural sector and suggest policy responses to strengthen the I4ID system's performance.

1.5 ETHICAL CONSIDERATION

In undertaking the study, the candidate got the approval of the Stellenbosch University Research and Ethics Committee (CREST-2020-15381). The study adhered to standard ethical guidelines and protocols, which include ensuring that interviewees participate based on informed consent and complete anonymity of respondents (*see Appendix D for a copy of the ethical clearance*).

1.6 STUDY OUTLINE

The outline of the study is presented in Table 1-1. This shows the logical flow of the study from introduction to conclusion. The research design of the study is the case study approach and is expressed using the conceptual framework analysis (outlined in detail in Chapter Two). This is undertaken in four phases: problem analysis and research design, literature review, framework development and application.

Table 1-1: Outline of the study

Phase One: Problem Analysis and Research Design
Chapter One: Introduction
This chapter presents the background and identifies the research problem. The research objectives and questions that the study aims to answer are also highlighted. Similarly, the limitations of the study are also discussed.
Chapter Two: Research Design and Methodology

The research design and methodology for the study are discussed in detail in this chapter. The chapter also presents the framework development process, data analysis and framework application for the study.

Phase Two: Literature Review

Chapter Three: Innovation and Innovation for Inclusive Development Systems

Detailed analysis of existing literature on ISs and I4ID system fields is undertaken. The different frameworks and theories guiding the evolution of innovation and I4ID systems are also analysed.

Chapter Four: A Systematic Review of Literature on Innovation for Inclusive Development Systems

The primary aim of this chapter is to review the different approaches used in evaluating I4ID system performance and identify the appropriate method. This is undertaken using 60 studies in a systematic literature review.

Phase Three: Framework Development Process

Chapter Five: Development of the Analytical Framework

The chapter derives the analytical framework used to assess the performance of the I4ID system using the systemic policy approach. The approach combines the component, function, systemic failure and instrument's methods into a holistic framework used in developing the analytical framework.

Phase Four: Framework Application Process

Chapter Six: The GES Scheme, Boundary Definition and Identification of Structural Elements

This Chapter starts with the detailed description of the GES scheme. It is followed by the commencement of the process of exploring the performance of the I4ID system with the application of the analytical framework to the GES Scheme. The first two phases of the framework - the boundary definition and identification of structural elements – are undertaken. Themes and excerpts from the qualitative analysis are used to triangulate findings from the literature analysis.

Chapter Seven: Event History Analysis of the GES Scheme

In this Chapter, the third and fourth stages of the framework application process is undertaken. This utilises the event history analysis as a tool for undertaking the component-function analysis of the growth and evolution of the GES in Nigeria's agricultural system. This leads to identifying functions, the combination, and the systemic problems hindering the system's performance.

Chapter Eight: Identification of Systemic Goals and Instrument for I4ID System

This chapter presents the final stages of the process of exploring the performance of the I4ID system – the identification of systemic goals and instruments for improving the performance of the I4ID system. In undertaking these, the chapter expands on the problems identified by the EHA and identifies the interventions needed to enhance the performance of the I4ID system. This focuses on the adjustment of the four structural elements leading to the identification of systemic goals and interventions (instruments) for strengthening the performance of the I4ID system. Throughout the process, excerpts and quotations from qualitative analysis of interviewees of critical actors in the GES Scheme are used to triangulate the different steps of the process.

Chapter Nine: Innovation for Inclusive Development System and the Role of Policy

Analysis of ISs reveals the central role of policy. In this chapter, the role of policy in the I4ID system is examined using the lessons from the GES Scheme. This reveals the government policies driving or inhibiting the growth of the I4ID system. This provides evidence of how interventions around ISs can drive inclusive development in the policy space. The chapter ends with implications for policies aimed at enhancing I4ID system performance.

Chapter Ten: Summary and Conclusions

This is the final chapter of the dissertation. It summarises the study's significant findings and the contribution to knowledge in the evolving field of I4ID systems. It also highlights the limitations of the study and areas for future research.

1.7 CHAPTER SUMMARY

In summary, Chapter One provides the background of the dissertation. It indicates the context of the study and the problems to be addressed regarding exploring the dynamic performance of ISs from an inclusive development perspective. This is followed by the objectives and the general outline of the dissertation. The next chapter describes the research design and methodology used in the study.

CHAPTER TWO : RESEARCH DESIGN AND METHODOLOGY

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
		Summary and conclusions					

2.1 INTRODUCTION

Chapter Two describes the overarching research design and methodology of the study. This provides an overview of the framework and processes that guide the goal of exploring the dynamics of I4ID from an IS perspective, thereby driving the identification of interventions toward more inclusive systems. The research design is a case study design. The choice of this is predicated on the need to undertake an indepth and contextual study about a programme. The case study is analysed through the Conceptual Framework Analysis (CFA) approach developed by Jabareen (2009). This offers a qualitative procedure of theorisation for building and validating conceptual frameworks learning from the Grounded Theory (GT) methodology. This is appropriate for this study, which seeks to develop an I4ID system framework and explore its utility to generate more insights within the I4ID space. The development of the analytical framework is guided by a 6-stage process based on a systemic policy approach (van der Hilst, 2012; Wieczorek and Hekkert, 2012; Botha, 2017; van der Merwe, 2017). Similarly, the study assesses the performance of the I4ID system by applying the analytical framework to the case of the GES Scheme in Nigeria's agricultural system through qualitative analysis, event history analysis, and expert consultations. Due to the different methods used at different stages of the study, some elements of the methodology are further described in some Chapters in the dissertation. Specifically, in Section 4.2, the methodology for the systematic is described while in Sections 5.2.4 further details on the use of the EHA are provided.

2.2 RESEARCH DESIGN

In seeking to generate insights into the performance of the I4ID system, the study uses the case study, the exploratory case study approach as the research design. The approach is used because

it provides an understanding of the functional dynamics of a social phenomenon that requires an extensive and in-depth study of an emerging field of I4ID. It is designed as a single case study of the GES scheme in Nigeria's agricultural system.

2.2.1. The Case Study Approach

The case study research approach has wide application and can be used in different contexts. It can be used to explain, describe or explore events or phenomena in the everyday contexts in which they occur (Yin, 2009). However, it finds unique application in contexts where there is the need to obtain an in-depth appreciation of an issue, event, or phenomenon of interest, in its natural real-life context (Crowe *et al.*, 2011). According to Yin (2009), the case study approach is used when a study aims to answer the "how" or the "why" question. The approach is best suited to studying contemporary events, when the relevant behaviour cannot be manipulated. The uniqueness stems from the intensive analysis and description of a unit or system (Hancock, Algozzine and Lim, 2021). The approach holds an advantage over other research methods because it uses a variety of information sources such as interviews, documents, and observations. However, defining the case (unit of analysis or object of the study) and bounding the case can be difficult as many points of interest and variables intersect and overlap in case study research (Harrison *et al.*, 2017).

According to Creswell *et al* (2007), case studies can be categorised either by the size of the case or the intent of the case analysis. The first implies that case study research can focus on whether the case is one individual, several individuals, a group, an entire program, or an activity; however, when classified by intent, it implies the single instrumental case study, the collective or multiple-case study, and the intrinsic case study. In the single instrumental case study, the researcher uses a single case to analyse an issue of concern, while in the multiple case study, several cases are used. On the other hand, intrinsic case study is used in unique cases; hence, the case study is the object of analysis. One characteristic of case studies is that it cannot be used for generalisation. Even in multiple case-study, the objective is to be able to account for contextual differences and account for different perspectives to an issue of concern. This is because it is assumed that contexts differ, it will therefore be insensitive to contextualise differences if the focus is to generalise.

According to Yin (2009), case studies can be descriptive, explanatory, or exploratory. Explanatory when seeking to answer causal links in situations beyond surveys or experimental development. Exploratory cases are suited for exploring situations and processes, especially where the interventions have no clear, single set of outcomes. The descriptive case study

describes an intervention and the context where it occurs. According to Bennett (2004), case study methods have comparative advantages over other research approaches. These include the ability to achieve a high level of construct validity, the ability to generate new theories, make inferences regarding causal mechanisms, provide historical explanations of cases, and address complex causal relations like equifinality and path dependency.

Despite these, the case study research approach has some limitations. One major limitation is the lack of representativeness resulting in the inability to provide generalisation over a population (Creswell *et al.*, 2007). Others include case-selection and confirmation biases, potential indeterminacy and potential lack of independence of cases (Bennett, 2004). Despite these, Yin (2009) argues that the limitations do not limit the ability of the approach to influence policy and future research.

2.2.2. The Conceptual Framework Analysis

The case study research design is analysed through the Conceptual Framework Analysis (CFA) approach developed by Jabareen (2009) as an overarching methodology. The CFA utilises the qualitative approach to framework development and evaluation. The qualitative approach is based primarily on constructivist pre-determined perspectives that depend on interaction with individuals (Creswell, 2014). It seeks to understand individuals' historical and cultural settings by using the specific contexts in which people live and work, thereby providing a depth of insight into research problems. It also uses inquiry strategies such as narratives, phenomenology, ethnography, and grounded theory.

The CFA is a qualitative method for building conceptual frameworks for phenomena linked to multidisciplinary knowledge bodies. The framework is used to operationalise the GT methodology by generating, identifying, and tracing a phenomenon's central concepts, which constitute its theoretical framework. Since the study utilises the qualitative approach, data collection and analysis will be undertaken simultaneously through an iterative process.

In the context of sustainable development, Jabareen (2009) utilised the CFA to trace the major concepts, which together build the theoretical framework of sustainable development. The CFA has been used by similar studies which aimed at framework-building (van der Merwe and Grobbelaar, 2016; Botha, 2017). Jabareen (2009) identified eight stages of the CFA process. These are:

2.2.2.1. Phase 1: Mapping the Selected Data Sources

This is the first stage and involves an extensive review of multidisciplinary literature to identify text types and other sources of data, such as existing empirical data and practices relevant to the I4ID system. Identifying the sources follows an iterative process to select literature directly relevant to the I4ID context. The method also includes the initial consultation of experts and practitioners in the field of ISs, inclusive development, and related concepts.

2.2.2.2. Phase 2: Extensive Reading and Categorising of the Selected Data

This phase aims to read the selected data and categorise it by field and by a scale of importance and representative power within each field. This is expressed in Chapter Three and Chapter Four of the dissertation.

2.2.2.3. Phase 3: Identifying and Naming Concepts

This phase aims to read and reread the selected data and “discover” concepts. These involve moving from just describing what is happening in the data to explaining the relationship between and across incidents (Loonam, 2014) through a process regarded as coding. The outcome reveals numerous competing and contradictory themes, meanings, and concepts.

2.2.2.4. Phase 4: Deconstructing and Categorising the Concepts

This involves deconstructing each concept; identifying its primary attributes, characteristics, assumptions, and role; and subsequently organising and categorising the concepts according to their features and ontological, epistemological, and methodological functions (Jabareen, 2009). The stage also involves coding the assignment of themes and concepts to a selected unit, such as sentences taken from an interview transcript (Lawrence and Tar, 2013). Ontological assumptions relate to knowledge of the “way things are,” epistemological assumptions relate to “how things really work”, while the methodological role informs us about what the framework can tell about the natural world (Jabareen, 2009).

2.2.2.5. Phase 5: Integrating Concepts

At this stage, concepts with similar attributes are grouped into one new concept where each concept has distinctive meanings and represents close ideas (Jabareen, 2009). This phase drastically reduces the number of concepts and allows the researcher to manipulate a reasonable number of concepts.

2.2.2.6. Phase 6: Synthesis, Resynthesis, and Making it all Make Sense

This process is iterative and includes repetitive synthesis and resynthesis until the researcher recognises a general theoretical framework that makes sense (Jabareen, 2009). This is similar

to the concept of mutual interaction between data collection and comparison in grounded theory, where the theory begins to emerge from the process of mutual interaction between data collection, coding, and analysis in an iterative process. This continues till the emergence of a theory when the researcher reaches theoretical saturation, i.e. no new data are emerging from data collection (Loonam, 2014). Saturation in research implies getting to the point where collecting additional data does not add value in terms of new insight (Strauss and Corbin, 1994)

2.2.2.7. Phase 7: Evaluating the Conceptual Framework

The objective of this phase is to assess whether the developed framework and its concepts make sense not only to the researcher but also to other scholars and practitioners.

2.2.2.8. Phase 8: Rethinking the Conceptual Framework

Since the field of the I4ID system is multidisciplinary, there is a need to adjust the theory as new insights emerge continuously. Opinions will be sought through expert views.

In this study, Phase 7 of the CFA is modified using the framework to provide critical insights into an IS's functional dynamics and performance. This is done by applying the developed framework to a case in the Nigerian agricultural system.

2.3 GROUNDED THEORY METHODOLOGY IN QUALITATIVE RESEARCH

Grounded theory is used as a methodology for developing a theory that is grounded in data and is systematically gathered and analysed (Loonam, 2014). The theory evolves during the research process and is a product of continuous interplay between data collection and analysis (Strauss and Corbin, 1990). The objective of using the qualitative method is to provide a depth of insight into the research problem that quantitative methodology cannot do. Data are collected and analysed to develop themes from the data through inquiry strategies.

GT methodology originated from the work of two sociologists – Barney Glaser and Anselm Strauss – and was first published in 1967 in a landmark book, “The Discovery of Grounded Theory” (Glaser and Strauss, 1967). It is a method that has been used extensively across a variety of social science disciplines (Lawrence and Tar, 2013). The methodology attempts to derive a general, abstract theory of a process, action, or interaction grounded in the participants' views in a study through an inductive approach. This is undertaken through a continuous process of data collection, followed by analysis and memo writing, leading to questions that lead to more data collection, and so on (Corbin and Strauss, 2014). This implies a continuous interplay between data collection and analysis (Urquhart, Lehmann, and Myers, 2010). The theory is said to be ‘grounded’ when it emerges from data and generates explanations of

relationships and events that reflect the life experiences of those people and processes under consideration (Lawrence and Tar, 2013). The methodology of GT is iterative, requiring a steady movement between concept and data and a constant comparison across types of evidence to control the conceptual level and scope of the emerging theory (Orlikowski, 1993).

According to Urquhart, Lehmann, and Myers (2009), four distinctive features characterise GT methodology. These are:

1. Theory building;
2. No pre-formulated hypothesis;
3. Joint data collection and constant comparison; and
4. Theoretical sampling.

The goal of GT is to develop a theory intimately tied to the evidence so that the resultant theory is likely to be consistent with the data (Orlikowski, 1993). Hence, data collection, coding, integration of categories, abstracting from the data, and construction of theory are thus guided by the theory as it emerges (Lawrence and Tar, 2013). In the iterative process of theory building, each concept earns its way into the theory by repeatedly being present in interviews, documents, and observations in one form or another---or by being significantly absent (Strauss and Corbin, 1990). Hence, concepts rather than data are the basic unit of analysis. Concepts that pertain to the same phenomenon are grouped to form categories. These are higher in level and more abstract than the concepts they represent, forming the bedrock of which theories are developed.

The GT methodology involves coding the assignment of themes and concepts to a selected unit, such as sentences taken from an interview transcript (Lawrence and Tar, 2013). Coding is deciphering or interpreting data, including naming concepts and explaining and discussing them in detail. The concepts are combined into related categories; links between categories are identified and verified against the data; and selective coding attempts to integrate the categories into a theory in the study context (Lawrence and Tar, 2013).

Central to the GT methodology are two activities: constant comparison (Bohm, 2004) and theoretical sampling (Lawrence and Tar, 2013). The constant comparison focuses on searching for similarities and differences with new data to tease out emerging categories contextualising concepts within their fit categories. On the other hand, theoretical sampling involves searching the transcripts for emerging categories that characterise the narrative and seem significant (Draucker *et al.*, 2007). The more systematic and widespread the theoretical sampling, the more

completely the conditions and variations will be discovered that will enhance the precision and predictive capacity of the theory (Corbin and Strauss, 2012). Theoretical sampling and constant comparison reflect cyclical processes, which are fluid and flexible. Still, at the same time, they ensure that the analysis is planned and well-grounded in the data. They help to keep the iterative process of data collection and analysis within the focus of the study (Conlon *et al.*, 2020).

2.3.1. Interpretations of Grounded Theory Methodology

Literature has revealed two approaches to GT methodology emerging from the interpretations of the founders of the methodology – Glaser and Strauss. This section highlights the differences between the Classic and Straussian models of GT. It is, however, essential to note that other types of variants have emerged in literature, such as the constructivist, postmodernism GT, and multi GT (Charmaz, 1996; Rupsiene and Pranskuniene, 2010). The underlying philosophy behind GT methodology by the founders (Glaser and Strauss) is to create opportunities for researchers to undertake research activities based on inductive rather than positivist inquiry. This was made clear in the first publication, “The Discovery of Grounded Theory”, published in 1967 (Glaser and Strauss, 1967). However, as time passed, changes began to emerge in the co-founders’ understanding and interpretation of the methodology (Rieger, 2018). These led to different schools of thought on GT methodology in literature, that is, Classic or Glaser GT as well as the Interpretive or Straussian GT.

2.3.1.1. *Classic or Glaserian Grounded Theory*

In classic GT, a theory emerges from the data being analysed. Glaser discourages extensive a priori knowledge of the subject matter. Extensive pre-reading of literature violates the foundational premise of classic GT by forcing the emerging theory to fit into extant theory rather than emerging from data (Glaser and Holton, 2004). This can becloud the judgment of the researcher, thereby preventing theoretical sensitivity. In classic GT, literature is another data source to be integrated into the constant comparative analysis process. A researcher can conceptualise a theory as it evolves from the data under study. This is found on two premises: the researcher has theoretical insight in his area of research, combined with an ability to make something of his senses, and his personal and temperamental bent (Glaser and Strauss, 1967). Hence, in gaining theoretical sensitivity, it is essential to minimise predetermined ideas, especially logically deduced, prior hypotheses (Glaser and Holton, 2004). It, therefore, forecloses pre-conceived hypothesis formulation. In addition, Glaser views GT as a conceptual theory-generating methodology that can use any data. Despite qualitative data from interviews being the favourite, Glaser popularised the underlying data philosophy behind GT, “all is data”.

This implies that GT can work with any combination of data, irrespective of the type (Glaser and Holton, 2004). Therefore, GT, according to Glaser's school of thought, should not be confused with qualitative data technique.

2.3.1.2. *Interpretive or Straussian Grounded Theory*

The approach by Strauss differs from the Classical approach on the overarching philosophy of the GT as well as issues bordering on the emergence of theory from data. These differences manifest in critical concepts of GT such as theoretical sampling, memoing, theoretical sensitivity, and coding. In the emergence of the theory, the researcher's experience is vital in guiding the process. Also, Strauss categorises coding into three: open, selective, and axial, as against two by Glaser – theoretical and substantive coding (Fourie, 2015). In open coding, the data are read and categorised into concepts suggested by the evidence rather than imposed from outside (Orlikowski, 1993). Axial coding, on the other hand, involves re-building the data (fractured through open coding) by establishing relationships between categories and their subcategories. It is termed 'axial' because coding occurs around the axis of a category, linking categories at the level of properties and dimensions (Strauss and Corbin, 1998). Selective coding is the final integration of codes and categories into a coherent theory that counts for the investigated phenomenon (Darke *et al.*, 1998; Priest, Roberts, and Woods, 2002). This stage involves identifying one or two core categories to which all other sub-categories relate and building a conceptual framework from which to develop a 'grounded' theory (Priest, Roberts, and Woods, 2002). In addition, contrary to Glaserian GT, the Straussian school of thought views GT as a qualitative research method that uses a systematic set of procedures to develop a theory about a phenomenon (Rupsiene and Pranskuniene, 2010). Therefore, Strauss understands GT as the strategy of qualitative research based on the systematic 'emergence' of theory from the received qualitative data. Hence, the significant difference between grounded theory and other qualitative research methods is its specific approach to theory development. The main differences between the Glaser and Strauss GT models are highlighted in Table 2-1 (Glaser and Strauss, 1967; Strauss and Corbin, 1990; Glaser and Holton, 2004; Rupsiene and Pranskuniene, 2010; Chen, Yin and Mei, 2018; Rieger, 2018).

It is essential to state that this study is situated within the Straussian interpretation of GT, which acknowledges the researcher's influence in guiding the emergence of theory from data.

Table 2-1: Differences in grounded theory approaches by Glaser and Strauss

	Glaser Classical Approach	Strauss Interpretive Approach
Theoretical underpinnings	Inductive	Deductive
Use of literature	Existing literature can becloud the judgment of the researcher with no pre-existing hypothesis. Literature is used when the emerging theory is nearly completed as a data source for constant comparison.	Technical literature can be used at the initial stages to formulate questions that can guide the process of theory emergence. It encouraged the appropriate use of literature at every study step, discerning the difference between an empty head and an open mind.
Role of researcher	The researcher is blank and objective without any premeditation. The experience is restrictive to emerging theory.	The researcher's experience is helpful and helps generate hypotheses and create a base for making comparisons.
Research method	All data. Not limited to any	Qualitative data
Theoretical sensitivity	The ability to recognise and extract elements relevant to the emerging theory from the data. The researcher is expected to be immersed in the data, open, maintain analytical distance and yet have insight into the area of research to guide the emerging theory.	While the theory is expected to emerge from data, theoretical sensitivity is enhanced with analytic tools such as the flip-flop technique and waving the red flag. In contrast to Classical GT, research questions from existing literature should be stated before the research begins, which could inform the process.
Research applications	Objects to the use of computer applications for qualitative data on the pretext that it limits creativity	Recommends the use of qualitative data applications such as Atlas
Coding and analysis	Two types: open, theoretical, and substantive coding. Flexible theoretical codes guide the analysis after identifying a core category.	Open, axial, and selective. The analysis is guided by axial coding using a preconceived coding paradigm before the developing category.

The research design is carried out in four phases: problem identification, literature review, framework development, and application. These are described below:

2.4 RESEARCH PHASES

2.4.1. Phase One: Problem Identification and Design

The problem identification phase is described in Chapter One of this study. The main aim of the chapter is to correctly identify the problems, articulate the research objectives and develop the research design and methodology for the study (Figure 2-1).

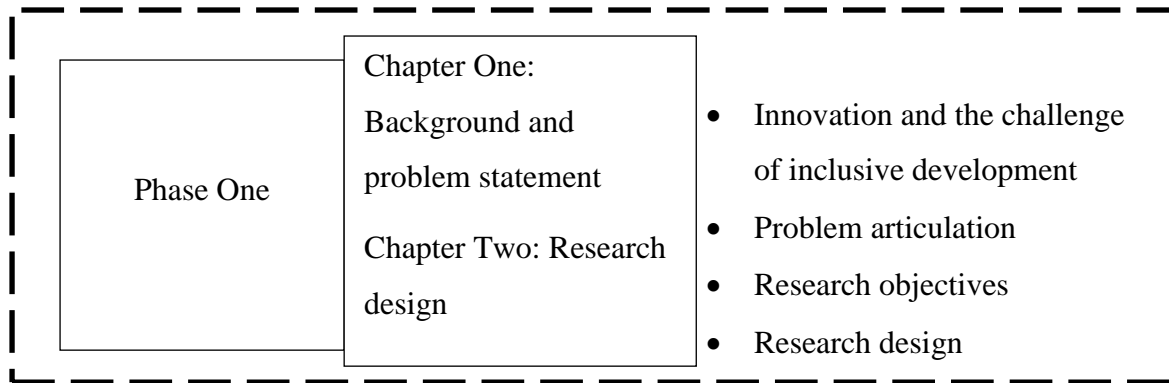


Figure 2-1: Definition of problem and background to the study

2.4.2. Phase Two: Literature Review

This section aims to give a broader narrative about the development and findings relating to the assessment of the performance of the I4ID system (Figure 2-2). The section consists of two types of reviews: traditional and systematic. The conventional literature review focuses on two areas: IS and I4ID systems. The systematic literature review is used to assess different frameworks used in evaluating ISs to determine the adequacy or effectiveness in tackling the challenges of inclusiveness and development and to indicate the appropriate methodology for exploring the performance of the I4ID system. These are expanded in Chapters 3 and 4 of the literature sections of the dissertation. The reviews reveal the actors, processes, and factors important for I4ID, and these are used to define the essential variables that are important to developing the framework (Chapter Five). The systematic review identifies the component-function approach as the most probable method for assessing the performance of the I4ID system. This leads to adapting the systemic policy approach developed by Wieczorek and Hekkert (2012) and utilised in other contexts for this study.

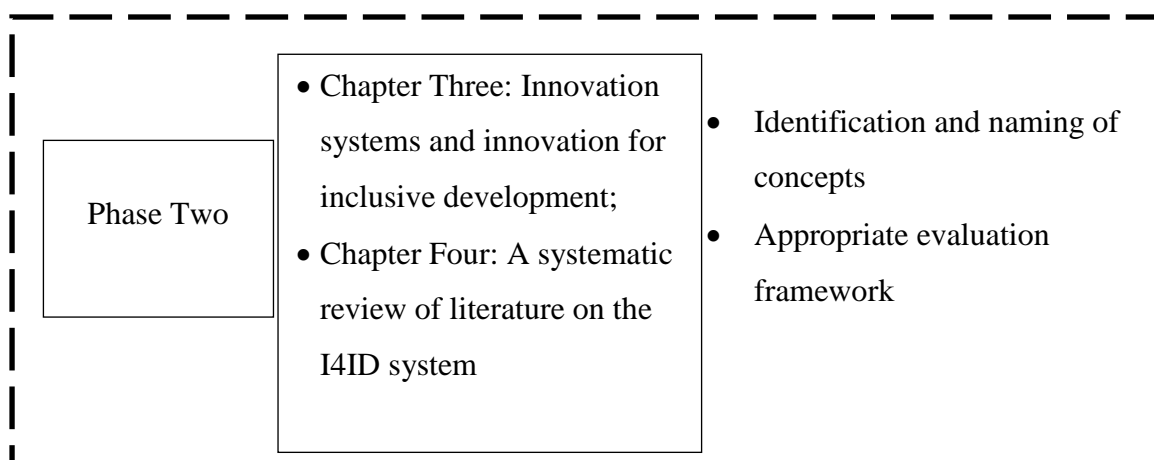


Figure 2-2: A literature review to identify relevant concepts for the study

2.4.3. Phase Three: Framework Development Process

The third phase of the dissertation is framework development (Figure 2-3). This is undertaken through extensive document analysis of identifying, naming, deconstructing, categorising, and integrating concepts related to the I4ID system until it is synthesised into a conceptual framework (Jabareen, 2009). The systemic policy approach guides the process. The approach is a 6-stage process of developing and evaluating an IS by combining the structural and functional analyses to identify systemic problems and suggest systemic instruments to address the issues (Wieczorek and Hekkert, 2012). The first two stages involve identifying and integrating the IS's structural elements and functions. The structural elements include actors, interaction and network, institutions, and infrastructure. At the same time, the functions comprise entrepreneurial activities, knowledge development, knowledge diffusion, influence on the direction of search, resource mobilisation, market formation, legitimacy, and positive externalities. The peculiarity of the I4ID system requires an examination of components that are demand-driven, inclusive of smaller actors and intermediary organisations (Foster, 2013; Van der Hilst, 2012). Also important are informal institutions, informal interactions, and social capital. These are prevalent in sub-Saharan Africa due to weak and inefficient formal institutions and networks characterising their ISs (Utz and Dahlman, 2007; Adelowo, Olaopa and Akinwale, 2016). The process is defined in Chapter Five of the dissertation.

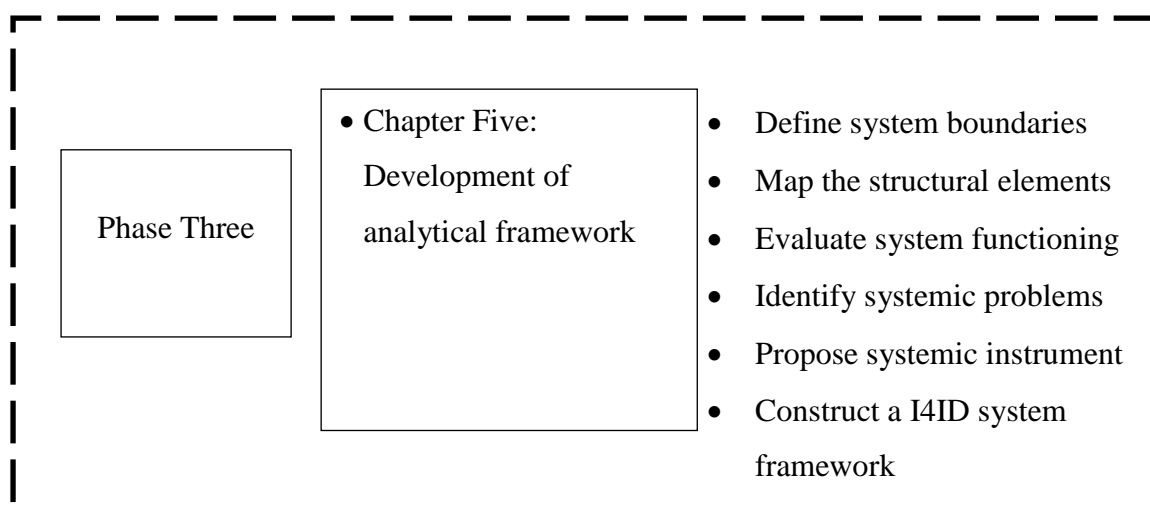


Figure 2-3: Framework development using the systemic policy approach

2.4.4. Phase Four: Framework Application

The final phase of the research design is to explore the performance of the I4ID system, as explained in Chapters 6 to 9 (Figure 2-4). This will be undertaken using three main methods: the EHA (Section 2.5), primary data collection (Section 2.6), and consultation of experts. This

approach is appropriate because it is exploratory and contributes to an in-depth understanding of a context, thereby satisfying the requirements of framework evaluation (van der Merwe, 2017). The EHA is a process of systematic identification and collection of events of a technology, programme or system from a wide range of sources. In this study, the EHA is applied to the GES Scheme in Nigeria's agricultural system. The sources include newspapers, government reports, journals, conference papers, etc. These are categorised into episodes, a block of events within a specific period. At the end of the analysis, a narrative is expected to emerge depicting the historical account of the functions that are important to the development of the GES scheme, the interaction between the functions, and the inducement and blocking mechanisms within and outside the system. The cumulative causation for each episode and the motors of the I4ID system are identified and illustrated using Causal Loop Diagrams (CLDs). Furthermore, the qualitative techniques are used to collect data from actors in the GES scheme to further develop insights into the dynamics of the I4ID system; thereby triangulating the outcomes of the EHA (The process of application of the framework to explore the performance of I4ID is illustrated in Figure 2-5).

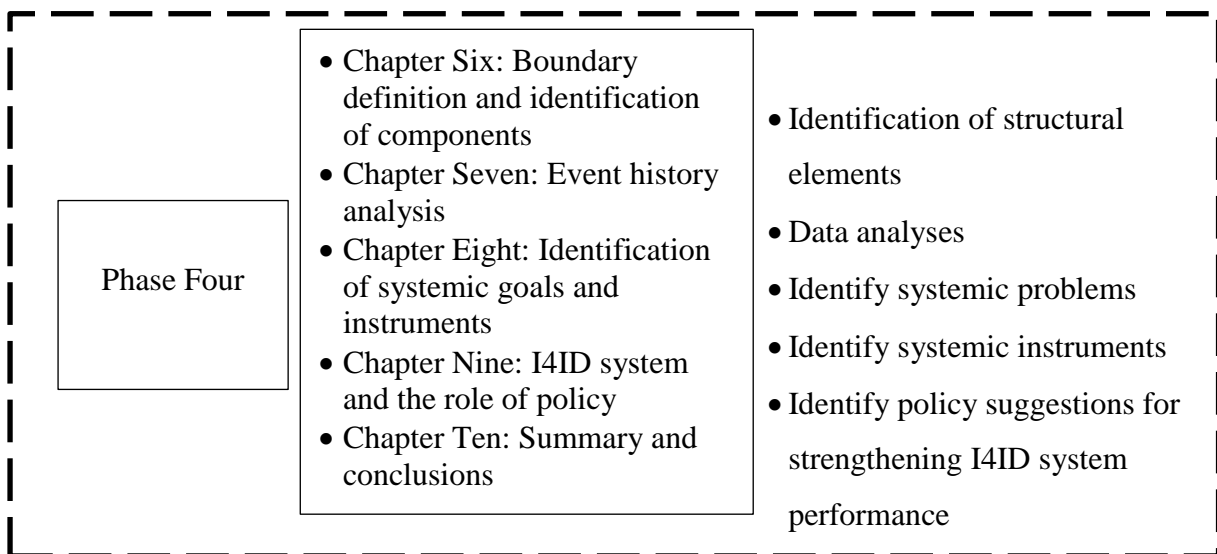


Figure 2-4: Framework application activities in the study

This phase ends with policy recommendations in the form of system interventions needed to enhance the system to address the BoP's needs (Chapter Eight and Section 9.3).

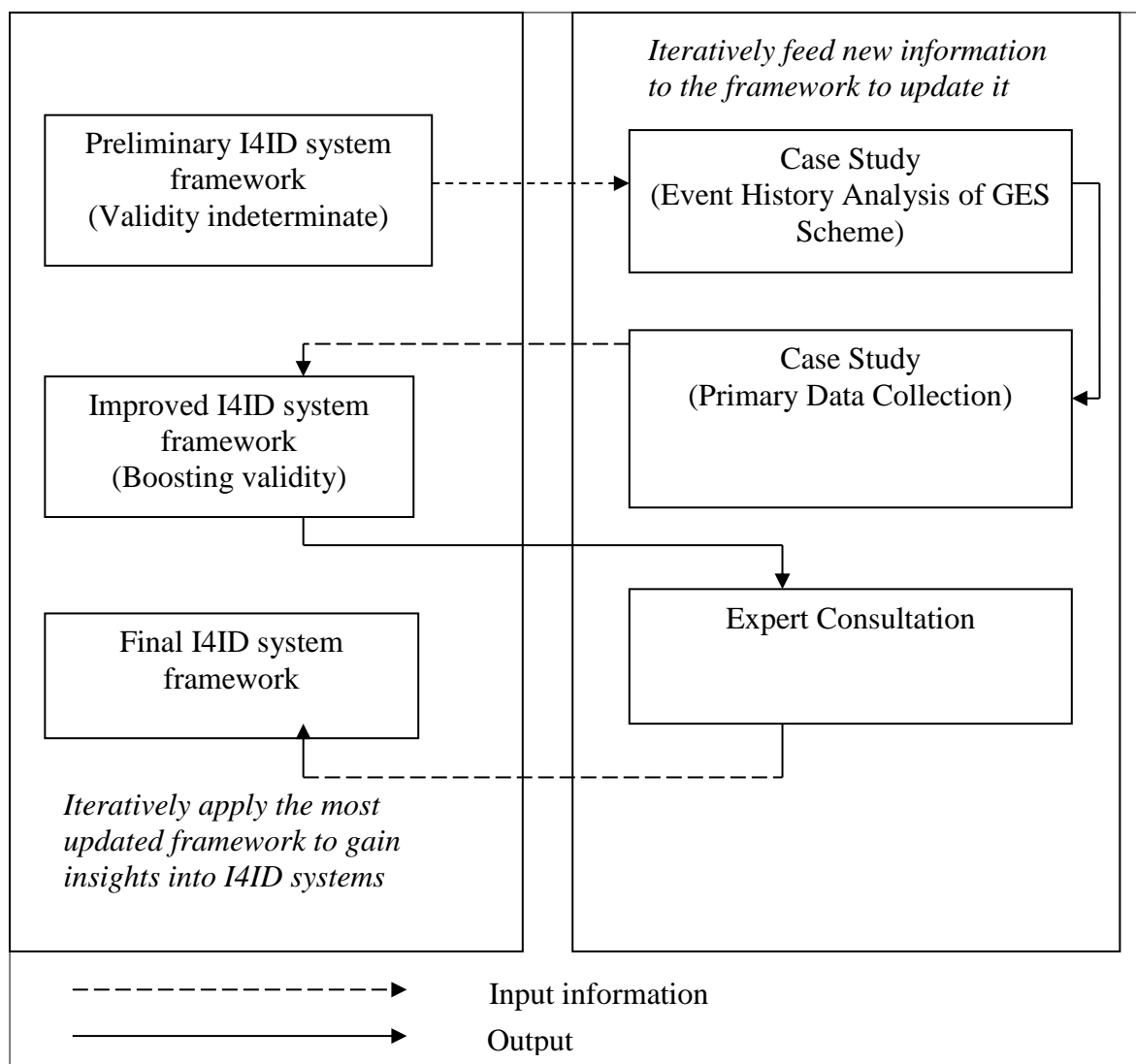


Figure 2-5: Evaluation process of the I4ID system framework
Source: Adapted from Mouton (2011) and Van Der Merwe (2017)

2.5 THE EVENT HISTORY ANALYSIS PROCESS

The EHA, also known as historical event analysis, adopts a process methodology to analyse research questions on how change unfolds in organisational entities (van de Ven and Poole, 1995). Change in this context is seen as a succession of events, stages, cycles, or states in the development or growth of an organisation, programme or project. That is why the EHA is referred to as a process approach, a method used to map the critical activities in a social system and their interactions with the system's growth. This takes a historical perspective and focuses on the sequences of incidents, activities, and stages that unfold throughout a central subject's existence (van de Ven, 1992). The main objective is to undertake a real-time collection of events of a social system as they unfold to understand the factors driving the system. van de

Ven (1992) argues that to reduce the likelihood of bias, it is better to undertake a historical study before the outcomes of a strategic change process are known or launch a real-time study of the process as change occurs. However, Suurs (2009) makes a case for the EHA to be used as an ex-post method when assessing the change process in a TIS. This is because of the size and heterogeneity of activities in a TIS and the fact that change processes in a TIS typically take time.

One way of effectively evaluating TISs is to focus on system functions. This provides a framework for undertaking a critical assessment of processes that contribute to the build-up and growth of the system. The development of a TIS is influenced by the contribution of the different structural elements, that is, actors, institutions, interaction, and infrastructure, to the activities that make up the system. Therefore, system functions make suitable intermediate performance criteria. Performance may be assessed in terms of the “functionality” of a particular IS, that is, how well the functions are fulfilled within the system (Bergek *et al.*, 2007).

Within the EHA method, events constitute the primary analytical unit. These can be interpreted in two ways: concrete facts, capturing what is happening within the level of structural factors, and concepts explaining the performance of a system as a whole (Suurs, 2009). Tracking events and constructing a narrative around the evolution of events in a TIS enable a researcher to determine the system’s growth, the drivers and barriers, and the impact. This establishes the capacity of the EHA as a performance evaluation tool for ISs.

The stages of an EHA are listed below (Negro, 2007; Suurs, 2009):

1. Literature search and data collation on GES Scheme in journals, conference proceedings, newspapers, periodicals, reports and websites;
2. Database categorisation;
3. Allocation of events to functions;
4. Summary data and graphical representation;
5. Historical timeline;
6. Identification of patterns, virtuous, and vicious cycles;
7. Triangulation of results; and
8. Comparison of case studies.

The final phase, comparing case studies, is irrelevant to this study since the study focuses on only one case, the GES Scheme. The stages are described below:

2.5.1. Literature Search and Data Collation

The first stage of the analysis involves searching an online database to retrieve a broad collection of documents on information about the activities (events) of the GES. The literature search was undertaken using the Google search engine (News) to explore a broad collection of documents. This includes newspapers, policy documents, and technical reports, among others. The selection was based on the criterion that the texts cover topics related to GES in Nigeria's agricultural system.

2.5.2. Database Categorisation

In this phase, the data collected is collated and sorted chronologically: event, reference, event description, and event category. This is done by reading through the literature and identifying and collating events relevant to the functions. During the process, the conceptual framework of system functions was used as a heuristic (Suurs, 2009). This enables the researcher to link the events to each function and subsequently construct a timeline of the events of the GES as it evolves.

2.5.3. Allocation of Events to Functions

The events are further grouped and classified along the system functions (Table 7-3). The process is undertaken inductively and iteratively through which the events are continuously reviewed. The events can however have a positive or negative effect on the functions. Attraction of funds by the Scheme leads to a positive effect on resource mobilisation; however, a negative effect on the function is witnessed, if the funding is denied, inadequate or withheld. In allocating events to functions, it is essential to note that the process was guided and not forced. Hence, in instances where specific events contribute to multiple functions, these are separated and allocated to the different functions. Also, in cases where several sources report similar events in the same period, the allocation to functions is reported once. Similarly, where events are repetitive activities across several years, they are only written in the first appearance and not allocated to any system function subsequently.

2.5.4. Summary Data and Graphical Representation

In order to provide an understanding of the activities that contribute to the evolution of the I4ID system, the events contributing to specific functions are tracked over time and presented in graphs. The graphical representation shows an insight into the development of the functions and changes that these developments produce within the IS over time. The activity can either contribute positively to the evolution and growth of the function, or it can hinder the development of a specific function. At the commencement of the process, all events are

assigned the value zero. This changes to +1 whenever the event has a positive effect on the function, adding 1 to the total value of the function. On the other hand, the value -1 is assigned to the event whenever there is a negative influence, leading to a deduction of 1 from the total value of the function (See sample classification in Table 2-2). The graph for each function is then plotted, indicating the progress of the function in the IS. This is combined into a single map showing a comprehensive view of the growth of functions of an IS.

Table 2-2: A classification scheme for measuring System Functions

Functions	Event categories	Sign
Entrepreneurial Activity	GES Scheme started	+1
	GES Scheme suspended or stopped	-1
	Entry of firms	+1
Knowledge Development	Research studies	+1
	Learning from the experience of actors	+1
Knowledge Diffusion	Training of key stakeholders	+1
	Meetings	+1
	Monitoring and evaluation	+1
Guidance of Search	Policy design	+1
	Target setting	+1
	Lack of trust at inception	-1
Market Formation	Subsidy on inputs	+1
	Obligatory use	+1
	Setting incentives	+1
	Reduction of subsidy	-1
Resource Mobilisation	Loan	+1
	Supply of technology infrastructure	+1
Creation of Legitimacy	Farmers organise in groups, lobbying	+1
Development of positive externalities	Creation of spillover companies	+1

2.5.5. Historical Timeline

The historical timeline explains the changes in the dynamics of the functions. This differentiates it from the graphs, representing events influencing a specific function over time. This, in addition to the graphical representation, provides a complete picture of the evolution of the I4ID system (Negro, Hekkert and Smits, 2007). The outcome of the process analysis is

a storyline of how the development of the I4ID system has changed over time and the role of the different functions in this evolution (Hekkert *et al.*, 2007).

2.5.6. Identification of Patterns

By interpreting events as indicators of system functions, it becomes possible to identify the particular sequence through which specific functions occur. These are referred to as patterns. Patterns can occur in two ways: trend or interaction patterns (Suurs, 2009). Trend patterns indicate the fulfilment of individual system functions over time. The best way to analyse trend patterns is by plotting the aggregated number of events for each year per system function with the slope of the graph indicating an increase or decrease in the number of events per system function. Positive and negative events can be plotted separately. While the trend patterns may not reveal the underlying factors influencing the dynamics of processes of ISs, they can be a valuable tool to show the issues that need to be addressed in specific components of ISs, such as the actors or networks. This way, it becomes possible to indicate whether system functions interact with each other. Interaction patterns can be developed by showing the causal chains of events based on the sequence in which they occur. The interaction pattern, however, explains the causal factors driving the functions and how the functions complement one another, leading to a build-up or breakdown of the I4ID system. Suurs (2009) refers to the cyclic relationship as the motor of innovation if particular system functions reoccur in an ordered sequence manner. The complementarity could be positive or negative. When positive, the event sequence forms a repetitive loop of system functions reinforcing each other towards the build-up of the I4ID system. This is usually referred to as a virtuous cycle. However, when the event sequence results in conflict, complete standstill or breakdown of the I4ID system, a vicious cycle is said to have occurred (Suurs, 2009). These reinforcements of interaction among functions are referred to as cumulative causation, and the dominant form of interaction is called the motors of innovation (see 5.2.4 for details on the motors of innovation).

As trend patterns and interaction patterns emerge, it is essential to identify and group significant trends in the lifecycle of an I4ID system. These are referred to as episodes (Suurs, 2009). Episodes help classify essential milestones in the lifecycle of an I4ID system using the occurrence of particular motors of innovation. It can also be used to examine the inducing or blocking factors involved in the I4ID system dynamics and evolution in a specific period. In this study, the cumulative causation and motors are identified in each episode of the development of the I4ID system.

2.5.7. Triangulation of Results

Triangulation of the results helps to evaluate the narrative to ensure that the story presented by the researchers is unbiased and represents an accurate picture of the IS. In the process of analysing the EHA, triangulation serves two purposes. One is to develop a narrative that captures the reality of the events of the I4ID system from the perspective of the actors that participate in it and to create a normative stance towards this development (Suurs, 2009). To undertake this, in the case of the GES Scheme, interviews are conducted with the stakeholders in the system. This enables the researcher to reconstruct, when necessary, the narrative with insights from the interviews.

2.6 QUALITATIVE DATA ANALYSIS PROCESS

To generate profound insights into the performance of the I4ID system, the developed analytical framework is applied to the GES scheme. The research is designed as an exploratory study using the qualitative method. Qualitative techniques are more effective in providing insights into underlying structures and mechanisms influencing social systems (Foster, 2013). They have been proven successful in studies requiring an in-depth examination to develop a more meaningful understanding. The case study approach is beneficial when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest in its natural, real-life context (Crowe *et al.*, 2011). It is a research approach used to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context (Yin, 1999; Crowe *et al.*, 2011). The choice of the agricultural sector is because it satisfies the conditions of significance, typicality and intensity, which are crucial to the I4ID system (Foster, 2013). The first is the intensity, which is based on a high volume of activity in the sector, especially the active participation of BoP. Second is the sector's significance to the economy, and lastly, it provides a view of core issues relating to BoP actors within an IS. Nigeria's agricultural sector significantly impacts the BoP by providing employment opportunities and supporting the livelihoods of millions of Nigerians.

2.6.1. Unit of Analysis

The unit of analysis for this study is primarily business enterprises involved in the development and diffusion of the GES Scheme in Nigeria's agricultural sector. These include agro-dealers, input suppliers, financial service providers, supply chain managers and the technology provider. Others are smallholder farmers, policymakers from the State and Federal Ministries of Agriculture, industry associations, and regulatory agencies. The interview focused on questions about business description and activities, firm characteristics and history. Other

questions include the nature of relations and market engagement of firms with other actors and the impact on their practices. Furthermore, the effect of institutional and regulatory issues on firms' activities and their relations, as well as challenges facing them in their activities, practices and relations, were analysed.

2.6.2. Data Collection

The study uses two qualitative techniques - documentary analysis and interviews - to collect data. These are described as follows:

2.6.2.1. *Documentary analysis*

This refers to sourcing information from secondary sources. This is particularly important in the study's first phase of developing the I4ID system framework. Secondary sources provide an overall background of this study's case and information for undertaking the literature reviews and the EHA. They are sourced from different sources, including bulletins, farmers' association documents, and published and unpublished articles. In addition, they provide a source of methodological triangulation of data collected from the interviews, thereby providing support for the evidence obtained (Foster, 2013)

2.6.2.2. *Interviews*

In seeking to explore the utility of the I4ID framework in development context, performance, primary data were collected through interviews of the actors in the GES scheme (*see Appendix C for sample interview guide*). These provide the opportunity to understand the role of actors, the systemic processes and their attributes. It also identified the systemic problems to define systemic interventions that can be used to enhance its performance. The interviews were also used to triangulate findings from the EHA.

Since the study is exploratory, the actors are categorised into two. Thus, two types of interviews were conducted with them – In-depth interviews (IDIs) and Key informant interviews (KIIs) (Table 2-3). IDIs were conducted with smallholder farmers, managers or owners of agro-dealers, and input suppliers. These were contacted through officials of the State Agricultural Development Programmes and Federal Ministries of Agriculture and Rural Development. However, the number of actors interviewed depended on theoretical saturation – where the conduct of new interviews was contingent on new knowledge from additional respondents (Mack *et al.*, 2005). KIIs were conducted with representatives of the remaining actors who were selected purposively. These included policymakers at the State and Federal Ministries of Agriculture and Rural Development, the Technology Developer, Supply Chain Managers,

intermediary associations (e. g. industry and farmers' associations), and financial institutions. As gatekeepers of knowledge, they provided in-depth information about their business operations and other variables of interest to the study. These organisations play specialised roles in Nigeria's agricultural system and are established to facilitate and support the diffusion of the GES scheme. Respondents from these actors comprised top-level officials and leaders of organisations directly responsible for the activities of the GES Scheme. In total, 53 interviews were undertaken for the actors in the GES Scheme.

Table 2-3: Selection of critical actors interviewed under the GES Scheme

Group name	Method	Number of interviews	Nature of information gathered	Respondents
Agro-dealers	IDI	8	Business and firm characteristics, relations and market engagement with other actors, challenges, and benefits	Owners or managers
Input suppliers	IDI	3	Business and firm characteristics, role and responsibilities, relations and market engagement with other actors, challenges, and benefits	Managers
Government Ministries & policymakers	KII	9	Development of the system; role and responsibilities, policy interventions; relations with critical actors, institutional frameworks, and challenges to the I4ID system.	Policymakers at the directorate level
Technology provider	KII	1	Business and firm characteristics; innovations introduced; development and management of the system; relations with other actors; challenges.	Managers
Supply Chain Managers	KII	3	Management of the value chain; monitoring and evaluation; relations with other actors; challenges and benefits	Managers
Finance Institutions	KII	2	Funding interventions; role and responsibilities; relations with other actors; challenges	Managers
Intermediary organisations	KII	4	Role and responsibilities under the GES; relations with other actors; challenges	Leaders of associations

Smallholder farmers	IDI	23	Roles and responsibilities; Impact of innovations on their productivity; relations with other actors; challenges and benefits	Smallholder farmers
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2.7 SYNTHESIZING THE FRAMEWORK DEVELOPMENT AND EVALUATION PROCESS

As noted above, the study's framework development and application processes follow the CFA, which gives practical application to the GT methodology. Consequently, the research design for the study is illustrated in Table 2-4.

Table 2-4: The overall design of the study

Project Phases	CFA Phases	Dissertation Chapters	Research Objectives	Outcome
Phase One (Problem identification)	<ul style="list-style-type: none"> • Mapping of selected data sources 	Introduction and Background Chapter One Research design and methodology Chapter Two		Problem Identification Research Objectives The Layout of the research process
Phase Two (Literature analysis)	<ul style="list-style-type: none"> • Mapping of selected data sources • Extensive reading and categorising of the selected data • Identifying and naming concepts 	Literature Review Innovation Systems and Innovation for Inclusive Development Chapter Three A Systematic Review of I4ID literature Chapter Four	Objectives One and Two Objective Two	Concepts to develop the I4ID framework Component-function approach
Phase Three (Framework development)	<ul style="list-style-type: none"> • Deconstructing and categorising concepts • Integrating concepts • Synthesis, resynthesis, and making it all make sense 	Analytical framework development Chapter Five	Objective Three	I4ID Analytical Framework
Phase Four (Framework application)	<ul style="list-style-type: none"> • Application of the conceptual framework • Rethinking the conceptual framework • Application of the conceptual framework • Rethinking the conceptual framework 	Boundary definition and identification of components Chapter Six The Event History Analysis of the GES Chapter Seven Identification of systemic goals and instruments Chapter Eight I4ID system and the role of policy Chapter Nine Summary and conclusions Chapter Ten	Objective Four Objectives Four and Five Objectives Four, Five and Six Objective Six	Components of I4ID Historical narrative, Motors of I4ID Performance analysis of I4ID system Policy recommendations Limitations, contributions to knowledge, and conclusions

2.8 CHAPTER SUMMARY

This chapter describes the research design and methodology used to achieve the study's objectives. The research design is the case study design which is analysed in this study using the CFA approach by Jabareen (2009). The CFA is used to operationalise the development of conceptual frameworks through grounded theory methodology. This process is carried out in four phases: problem identification, literature review, framework development, and application. The first phase identifies the problem, while the second phase is undertaken through both the traditional and systematic literature reviews to determine the concepts and the most promising approach to developing and exploring insights into the performance of the I4ID system. The third phase focuses on the development of the framework through the systemic policy approach – a 6-stage process of evaluating an IS by combining the structural and functional analyses to identify systemic problems and suggest systemic instruments to address the problems (Wieczorek and Hekkert, 2012). Finally, the framework application process is defined. In this phase, the framework is applied to a case of the GES Scheme in Nigeria's agricultural system. The chapter highlights the qualitative research technique, including the data collection methods.

The next chapter describes the first chapter of the literature review section. This focuses on a detailed analysis of existing literature in the ISs and I4ID system fields.

CHAPTER THREE : LITERATURE REVIEW ON INNOVATION AND INNOVATION FOR INCLUSIVE DEVELOPMENT SYSTEMS

Phase I	Phase II		Phase III	Phase IV			
Problem analysis: CFA Stage 1	Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8			
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
		Identification of system structures			Identification of systemic problems	The suggestion of systemic instruments	
		Summary and conclusions					

3.1 INTRODUCTION

This chapter aims to review the literature on IS framework and inclusive development. This focuses on the history, definitions of key concepts and the theoretical foundations of the framework. It also explains the concept of I4ID and other concepts around innovation systems in developing country contexts. This section also reviews the concept of the marginalised, explaining that the concept of inclusivity should be broad and context-specific factors other than income. This helps to situate the study within the confines of the I4ID system.

3.2 CONCEPT OF INNOVATION AND INNOVATION SYSTEMS

The field of innovation draws inspiration from the work of Schumpeter. He defined innovation through the concept of ‘new combinations’ from five perspectives. These are i) introduction of a new product or a new quality of a product; ii) introduction of a new method of production; iii) opening a new market; iv) a new source of supply of raw materials or half-manufactured goods; and v) implementing the new organisation of any industry (Hagedoorn, 1996). This considers innovation in terms of products and processes but also non-technological aspects such as marketing and organisational changes.

The broad definition of innovation has been reflected in the literature on innovation measurement. The OECD, for instance, defines innovation in the 3rd edition of the Oslo Manual as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD and Eurostat, 2005). In the latest edition of the

manual, business functions measuring marketing and organisational changes are included under ‘business process innovation’ – a generic name capturing process, marketing and organisational changes in firms (OECD and Eurostat, 2018). These definitions evolved from previous understanding, which limits innovation to technological product and process (TPP), focusing on firms’ technological development of new products and new production techniques and their diffusion to other firms. From this definition, innovation comprises new organisational or marketing methods and the introduction of new products and processes. The former includes introducing new management or marketing techniques, adopting new supply or logistic arrangements, and improving approaches to internal and external communications and positioning (Aubert, 2005). This is important in developing countries where non-technological innovations are more prevalent. Mytelka (2000) tries to capture this by defining innovation as the process by which firms master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their customers or the world. This definition is broadened to include a process that involves the application of new knowledge and skills, rather than easily identifiable once-and-for-all events (Hobday, 2007).

For innovation to occur in business, two conditions must be satisfied: novelty and diffusion (von Hippel, 1976; OECD and Eurostat, 2005). Novelty is at three levels: firm, market and world. For a firm to be innovative, the minimum requirement for change in a firm’s products or functions is at the firm level. Innovations are new to the market when the firm is the first to introduce the innovation to its market. Firms’ markets can be categorised along the line of the type of product (single or multiple) or geographic restriction (local, regional, national or international) (OECD and Eurostat, 2018). Innovation is new to the world when the firm is the first to introduce it in all markets and industries, domestic and international (OECD and Eurostat, 2005). Diffusion is how innovations spread, through the market or non-market channels, from their very first implementation to different consumers, countries, regions, sectors, markets and firms. Without diffusion, the impact of innovation is minimal (Kumar, 2015).

Conceptualising innovation towards economic realities is biased towards businesses while neglecting a broad range of activities that generate societal innovations. Hence, a new definition was coined, which is more generic and puts less emphasis on the market rather, than utilisation (OECD and Eurostat, 2018). This then makes innovation to be applied to cases of

individuals and households, government institutions and not-for-profit organisations. Innovation, therefore, is defined as “a new or improved product or process (or a combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)” (OECD and Eurostat, 2018).

This definition emphasises three issues:

1. Focus on utilisation rather than commercialisation;
2. Applicability to a wide range of actors rather than the business sector; and
3. Utilisation is based on the implementing unit.

It is also important to differentiate between innovation and invention. While innovation is the process of generating and diffusing new knowledge, the invention does not focus on diffusion, only on novelty. Innovation is thus the first commercialisation of an idea while the invention is the first occurrence. Hence, innovation in the business sense is a broader concept that is preceded by invention and ends with commercialisation. Not all innovation starts with invention but is a complex interactive process that involves different activities (Fagerberg, 2009). During the innovation process, firms undertake several activities. These are called innovation activities. They include all scientific, technological, organisational, financial and commercial steps which led, or are intended to lead, to the implementation of innovations. While some of these activities may be innovative, others are not but are necessary for the implementation of innovation (OECD and Eurostat, 2005). Examples of innovation activities are capital purchases, R&D, engineering and design, employee training, and other current expenditures related to innovations, which can be characterised as investments that may yield future returns. Such returns often go beyond the specific innovation the activity is directed towards. For example, R&D and training investments are often open-ended, allowing their application to other tasks (OECD and Eurostat, 2005). In the innovation process, firms interact with several actors, and these linkages are fundamental to the process (Gault, 2008). Linkages in the innovation process are of three types: open information source, acquisition of technology and knowledge and innovation cooperation (OECD and Eurostat, 2005).

The nature and level of innovation are firm- and industry-specific and can be influenced by economy-wide factors, stimulating and limiting the process (Silva *et al.*, 2011). Traditionally, firms leverage their internal capabilities in the process of innovation. These are driven by age,

investments in innovation activities, and R&D intensity. Due to the limitation of internal sources of knowledge, firms also exploit external sources and cooperate with other actors for innovation (Romijn and Albaladejo, 2002; Freel, 2003). External sources of information, especially market sources and industry associations (Oyelaran-Oyeyinka and Sampath, 2007; Egbetokun *et al.*, 2009; Egbetokun, Adeniyi and Siyanbola, 2012; Abdu and Jibir, 2018), become useful sources of knowledge for innovation to overcome the limitations of weak internal R&D capabilities and weak linkage with knowledge institutions. These ultimately define their innovation objectives, strategies and potential for success (Oluwatope *et al.*, 2016).

3.3 CHARACTERISING INNOVATION SYSTEMS

For firms to be innovative, they have to operate in a system of interaction among several actors in an innovation system (Edquist, 1997). The concept offers a suitable framework for conveying the notion of parts, interaction, evolution over time, and the emergence of novel structures (Juma, 2015). The IS framework embraces the science suppliers and the totality and interaction of actors involved in the innovation process. It extends beyond knowledge creation to encompass the factors affecting the demand for and use of knowledge in novel and useful ways (Juma, 2011). There are different definitions of the concept in literature. Within the boundary of a nation-state, it is defined as the “elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation-state” (B.-A. Lundvall, 2016), or as “all important economic, social, political, organisational, and other factors that influence the development, diffusion, and use of innovations” (Edquist, 1997). According to Cooke, Uranga and Etxebarria (1998), it is “the network of public and private organisations and institutions in a sovereign state whose activities and interactions initiate, import, modify, and diffuse new technologies and organisational models”.

Systems of innovation directions emerged in the ‘90s as a multidisciplinary field of study (Soete, Verspagen and Weel, 2010). Three authors: Christopher Freeman, Richard Nelson, and Bengt-Ake Lundvall, pioneered the framework through their collaboration in the International Federation of Institutes for Advanced Study (IFIAS) project (Edquist, 2001; Foster, 2013; Vertova, 2014). Although the IS approach was credited to the three authors, much inspiration was drawn from the works of Friedrich List’s concept of the “The National System of Political Economy”, published in 1841 (Freeman, 1995). Central to IS is the role of the linkages and interactive learning between the critical actors, including education and learning, production processes, research, and government. Also important is the part of firms’ learning trajectory in

developing incremental innovations through assimilating, imitating and reverse engineering imported technologies. This is contrary to the linear model of innovation, which suggests a clear separation between innovation, production, and diffusion processes. This has long been debunked as bearing little relation to the realities of innovation (Fleck, 1993). Processes of production, distribution and implementation are not separable, and they all involve continuous, iterative processes and feedback (Foster and Heeks, 2013b). Putting succinctly, Mytelka and Farinelli (2000, p. 7) posits that the IS framework “lays emphasis on the interactive process in which enterprises in interaction with each other and supported by institutions and organisations – such as industry associations, R&D, innovation and productivity centers, standard setting bodies, university and vocational training centres, information gathering and analysis services and banking and other financing mechanisms - play a key role in bringing new products, new processes and new forms of organisation into economic use”. To recognise the ubiquitous characteristics of innovations, there is the need to focus on their slow, gradual and cumulative aspects (B.-A. Lundvall, 2016).

The primary variant of the IS approach is the ‘national system of innovation’ or ‘national innovation system’ popularised by Bengt-Ake Lundvall in the edited book, “National Innovation Systems: Towards a Theory of Innovation and Interactive Learning” (B.-A. Lundvall, 2016). This is because the system perspective is primarily concerned with the flow of knowledge and its impact on economic growth; it makes sense, therefore, to concentrate on the level that seems most centrally implicated in governing these flows – national (Feinson, 2003). This makes sense in the context of national boundaries because a country’s innovative performance depends on the relationship between the different actors making up the system in their goal of knowledge creation and diffusion. Since then, other variants such as technological, sectoral, local, regional and supranational ISs have emerged (Gault, 2010). The sectoral system of innovation and production is defined as a set of new and established products for specific uses and the group of agents carrying out interactions to create, produce, and sell those products (Malerba, 2002). This focuses on various technology fields or product areas (Edquist, 2001). When the system is mapped around a group of actors interacting to implement a particular technology, it is called Technology Innovation System (TIS). Therefore, TIS can also be defined as sectoral since it is defined along a specific technology domain (Edquist, 1997). IS within national boundaries or parts of different countries are termed regional innovation systems (Cooke, Uranga and Etxebarria, 1998). Supranational concept of innovation system views the system from a multi-country, global level such as the European Union. Edquist

(1997) argues that the different types of ISs are complementary. While other elements interact in the system, there seems to be a consensus that critical elements of any IS are the following: innovative firms; public and private institutions conducting and supporting research and promoting the diffusion of knowledge and innovation; the systems of education and training of the personnel; and financial systems (Vertova, 2014).

At the heart of it is the process of learning (Edquist, 2001). Learning is the essential process in a knowledge economy, while knowledge is the most critical resource (B.-Å. Lundvall, 2016). While the capability to innovate depends on science and R&D activities, experience from day-to-day routine activities in production, distribution, and consumption is fast becoming a central theme of learning processes and, consequently, innovation processes (B.-Å. Lundvall, 2016). Central to innovation is the process and nature of learning. Carayannis and Alexander (2002) defined technological learning (TL) as the process by which a technology-driven firm creates, renews, and upgrades its latent and enacted capabilities based on its stock of explicit and tacit resources. In other words, learning is the absorption of existing techniques, i.e., innovations produced elsewhere, and the generation of improvements in the vicinity of acquired techniques (Viotti, 2015). There is a need to understand how learning takes place at three analytical levels: 1) the primary functions of the system; 2) the broad strategies that can be employed to create and manage those functions effectively; and 3) the actors, institutions and linkages within the system that collectively implement that strategy (Feinson, 2003). The importance of learning and the modes of learning are essential in ISs. There are two types: the Doing-Using-Interacting (DUI) mode and the STI mode. The latter is a narrow form of learning, where firms innovate by undertaking R&D (Jensen *et al.*, 2016). On the other hand, the DUI mode describes the activities of firms that innovate without doing R&D (Gault, 2010). It is a broader form of learning built on relationships and interactive learning typical of firms in developing countries where the capacity and capability for R&D are lacking (Lundvall, Vang and Chaminade, 2009). These firms innovate through technology adoption, minor modifications or incremental changes to products or processes, imitation, including reverse engineering and combining existing knowledge in a new way (Arundel, Bordoy and Kanerva, 2008). This is because how a firm responds to stimuli depends upon the habits and practices developed over time. These become important elements in shaping their policies, dynamics and policy outcomes. Hence, innovation policies in developing countries should focus on a continuous process of learning and unlearning past habits and practices at the firm and government levels (Mytelka, 2005). While this is true for developing countries, this does not entirely negate the relevance of the

STI mode of learning. Parrilli and Alcalde Heras (2016) argue that while the DUI mode of learning finds more relevance among businesses, the STI mode generates more impact in technological and radical innovations. In addition, Adeyeye *et al.* (2016) found that R&D investments influence the introduction of all types of innovation. Hence, the broader definition of innovation, which focuses on learning and SMEs in traditional industries, should be promoted while developing competencies for generating new knowledge through R&D and absorptive capacity within firms (UNU-INTECH, 2004).

3.4 OVERVIEW OF THEORETICAL FOUNDATIONS OF INNOVATION SYSTEMS

Bergek *et al.* (2008) argue that the IS framework is primarily an analytical construct – a tool used to illustrate and understand system dynamics and performance. Hence, several authors have argued that the framework of ISs provides the foundation for understanding the performance of the I4ID system. This can therefore benefit from the understanding of the systems concept.

Carlsson *et al.* (2002) identified three methodological issues associated with systemic evaluation. These are the analysis level, boundaries definition, and performance measurement. The authors identified three levels of analysis: technology in the sense of a knowledge field, product or artefact; or competence bloc (a set of related products and artefacts aimed at satisfying a particular function, such as health care or transport). The level of analysis selected will influence the delineation of the system boundaries, the actors involved, the networks and institutions. By delineating the level of analysis in the technology field, the study will focus on analysing the relation between technologies and the diffusion of technologies into different applications. The actors included will be those for whom the technology is essential. The analysis identifies the actors within a given industry. Research at the competence bloc level implies studying a specific market and the system of actors and institutions supplying products to the market.

Setting the boundaries of a system is undertaken along the level of analysis adopted for the study. For a technology system, a good understanding of the boundaries of the knowledge field is needed; hence, familiarity with the technology domain and interaction with experts in the field helps to set the boundaries adequately. In determining the performance of the innovation system, the actors are evaluated not individually but on how they contribute to the system as a whole. However, the level of analysis and the system's maturity influences this.

In exploring the performance of innovation systems, the role of each element is undertaken by assessing the functionality of the functions. This gives a systemic perspective to evaluating ISs (Wieczorek and Hekkert, 2012). This study will adapt and expand the systemic policy framework to cover issues related to the marginalised and the BoP.

3.4.1. Structural Elements of Innovation Systems

Regarding the links between innovation and development, I4ID models need to consider a more comprehensive set of development outcomes, not solely related to economic growth (Foster, 2013). An IS comprises elements that make up the system. These are categorised into three: operating parts, also referred to as components, relationships between the components and attributes of the components (Carlsson *et al.*, 2002). The components of ISs are actors, institutions and infrastructure, while the relationships are usually referred to as interactions or networks (Carlsson and Stankiewicz, 1991; Foster, 2013; Johansson and Johnson, 2001; van der Hilst, 2012; van der Merwe, 2017; Wieczorek and Hekkert, 2012). To address the peculiarities of I4ID, the elements need to be adapted. These are discussed below:

3.4.1.1 Actors

Actors are regarded as organisations in an IS that, through choices and actions, generate, diffuse and utilise technologies (Suurs, 2009). These include civil society, government, non-governmental organisations (NGOs), enterprises (micro, small, medium, large, multinationals), knowledge institutes (universities, technology institutes, research centres), and others (legal organisations, financial organisations/banks, intermediaries, knowledge brokers, consultants) (Wieczorek and Hekkert, 2012). In assessing the performance of I4ID systems, focus in developing countries requires examining components, emergent, demand-led and inclusive of smaller actors (Foster, 2013). These often operate in the informal sector and are central to serving the BoP markets (van der Hilst, 2012). Examples include micro, small and medium enterprises and intermediary organisations. On the contrary, multinational companies (MNCs) can play a role in driving inclusive development by tapping into the untapped potential of the vast, low-class market of the BoP. They can achieve this by leveraging their economies of scale and efficient supply chains to offer quality products at lower prices while maintaining attractive margins (Prahalad and Hammond, 2002).

3.4.1.2 Institutions

These encompass a set of everyday habits, routines and shared concepts used by humans (weak institutions) organised by rules, norms and strategies (hard institutions) (Crawford and Ostrom, 1995). Institutions can be formal or informal. Formal institutions are the rules that are codified

and enforced by some authority. According to Foster (2013), formal institutions include public policy, viewed as not only laws and legislative rules but also more comprehensive courses of action, including activities of state-sanctioned bodies. These include regulations, supply-side policy, demand-side policy and firms' innovation-driven policy. Informal institutions are practices and norms that organically evolve through the interaction of actors (Jacobsson and Lauber, 2006). Informal institutions are more prevalent in the I4ID context, especially in sub-Saharan Africa, where innovation systems are characterised by weak and inefficient formal institutions (Utz and Dahlman, 2007). Weaknesses of the legal and regulatory framework (Lawrence and Tar, 2010) make contract enforcement difficult and increase transaction costs.

3.4.1.3 Interaction and Networks

Since firms operate within a system, they often interact with different actors within the system. Sometimes this interaction occurs within networks, and when the system is in its early stages of formation, they occur primarily as bilateral relationships between actors (Wieczorek and Hekkert, 2012). Within a developing country context, formal interactions between the different components of the ISs are often weak (Adelowo, Olaopa and Akinwale, 2016); hence, interactions are often informal and based on social relationships. This is important for I4ID as most of these firms depend more on trusted relationships in horizontal networks and other informal relations such as industry associations for information that help them to introduce and diffuse innovations (Goedhuys, Janz and Mohnen, 2006; Egbetokun, Adeniyi and Siyanbola, 2012).

3.4.1.4 Infrastructure

Wieczorek and Hekkert (2012) classified infrastructure into physical, financial and knowledge. Physical infrastructure encompasses artefacts, instruments, machines, roads, buildings, telecom networks, bridges and harbours, while knowledge infrastructure includes knowledge, expertise, know-how and strategic information. Financial infrastructure includes subsidies, financial programs, grants, etc. Evidence in literature points to the fact that the absence of or inadequate infrastructure can negatively affect the functioning of ISs (Adeyeye *et al.*, 2018) and thus may constitute a systemic problem (Woolthuis, Lankhuizen and Gilsing, 2005). This is particularly important to I4ID systems in developing countries where challenges of inadequate physical, technological and policy infrastructure are prevalent (Hadjimanolis, 1999).

3.4.2. Functions of Innovation System

According to Wieczorek and Hekkert (2012), system functions are more evaluative than system components. This is because it focuses on the dynamics of what is achieved rather than on the dynamics in terms of structural elements only (Bergek *et al.*, 2008). IS's functions contribute to the system's overall goal of developing, applying and diffusing new technological knowledge (Hekkert *et al.*, 2007). An IS, therefore, can be assessed by its functional pattern, which is determined by the dynamics of each function and the interactions between the functions (Hekkert and Negro, 2009).

In addressing the challenges of ISs, eight functions have been identified as relevant to assess performance (Wieczorek and Hekkert 2012; Bergek *et al.*, 2008; Hekkert *et al.*, 2007). These are as follows:

1. Entrepreneurial activities;
2. Knowledge development;
3. Knowledge diffusion;
4. Guidance of search;
5. Resource mobilisation;
6. Market formation;
7. Creation of legitimacy; and
8. Development of positive externalities

3.4.2.1 *Entrepreneurial activities*

The entrepreneur is the vital link who turns potential into action. Entrepreneurship is the first indication of system functioning, and its prosperity is a critical determinant of the success of any IS (Hekkert *et al.*, 2007). In assessing I4ID systems, it is essential to investigate factors that marginalise certain groups from entrepreneurial activities. The most significant potential for improving people's livelihoods at the BoP comes from growth-oriented, innovation-generating entrepreneurial activities (Linna Sonne, 2010). For example, integrating the concerns of women entrepreneurs in agriculture is crucial in I4ID because innovation policies and strategies are found to be naturally biased towards the male gender (Lina Sonne, 2010). In addition, most firms serving the BoP markets are small and operate in the informal sector. They are established out of necessity rather than an opportunity (van der Hilst, 2012). Therefore, issues such as entry and exit barriers and the micro-enterprises' capacity to scale up their businesses are important considerations for firms serving the BoP markets (Foster, 2013; Sonne, 2011).

3.4.2.2 Knowledge Development

Knowledge development is at the heart of ISs, driven by the process of learning (Lundvall and Johnson, 1994; Bergek *et al.*, 2008). The kind, breadth or diversity of knowledge a firm is exposed to will determine the likelihood of success of its innovation efforts (Mol and Birkinshaw, 2009). Typically, traditional indicators such as R&D investment and patents are considered performance indicators for assessing knowledge development; however, since most firms in developing countries generate new knowledge through DUI learning mode, there is the need to develop new indicators that suit the peculiarities of knowledge generation within the I4ID system. In addition, knowledge generation depends upon the quality of absorptive capacity within the firms. Assessment of the nature of linkages used by different actors in accessing knowledge for innovation is important for I4ID (Ukpabio, Adeyeye and Oluwatope, 2016) as well as firms' capacity to undertake open innovation.

3.4.2.3 Knowledge Diffusion

Diffusion of knowledge within an IS occurs through interaction among various actors (Suurs, 2009). Low skills and educational qualifications hinder innovation diffusion in developing countries. In addition, inappropriate diffusion mechanisms and channels, as well as the nature of innovation, are critical factors that determine the rate and level of knowledge diffusion in the BoP market (Utz and Dahlman, 2007). Factors such as social capital within BoP communities are essential factors in driving knowledge diffusion among BoP communities, and such should be an important index for evaluating I4ID performance (van der Hilst, 2012).

3.4.2.4 Guidance of Search

This refers to the activities within the IS that can positively affect the visibility and clarity of specific wants among technology users (Hekkert *et al.*, 2007). It helps to set priorities and direct investments towards achieving the goals of the IS. While R&D investments are used to measure the attainment of goals, policies aimed at I4ID systems should seek to strengthen development outcomes such as poverty reduction, and employment generation, among others (van der Merwe, 2017). Furthermore, institutional arrangements and incentives to support emerging innovations, new actors, and knowledge diffusion mechanisms to support the needs of the marginalised should be considered (van der Hilst, 2012).

3.4.2.5 Resource Mobilisation

Resources are important factors in developing and introducing new technologies. These include financial and physical resources (van der Merwe, 2017). Small firms, which are prevalent in the BoP market, face barriers associated with access to credit, technology, equipment, and

skilled staff, making it difficult to mobilise resources to support the introduction of innovations. Exploring the resources and policy instruments facilitating access to productive resources is essential for I4ID systems.

3.4.2.6 Market Formation

The market formation process is important for a new or transforming technology in ISs. Market formation is often characterised by an immature market, unarticulated demand by potential customers, and uncertainties in many dimensions (Bergek *et al.*, 2008). When added to the competition with established technologies in the market, it is imperative to create market space for new technologies (Hekkert *et al.*, 2007). This is even more important within the context of I4ID; hence, appropriate policy measures and strategies to understand market formation's process and drivers must be investigated. The government should implement policies protecting new technologies and innovations from competing with matured technologies and established firms (van der Hilst, 2012). Since most firms operating in the BoP markets are small and resource constrained, they cannot introduce innovations that can compete with large or multinational firms with the advantage of scale and higher efficiency. Hence, fiscal and monetary instruments to aid the diffusion of technologies within I4ID systems, such as subsidies, tax exemptions, and favourable tax regimes, among others, should be examined.

3.4.2.7 Creation of Legitimacy

Competing groups usually resist new technologies (van der Hilst, 2012). Legitimacy concerns the social acceptance of new technologies and compliance with relevant institutions (Bergek *et al.*, 2008). This is important to generate demand and mobilise the needed resources to drive innovation. It is attained through advocacy, lobbying and civil society groups. In addition, innovation's 'liability of newness' often negatively affects the legitimisation process, thereby slowing the diffusion rate (Bergek *et al.*, 2008). Previous experience with new technologies among the BoP may result in a lack of trust, affecting acceptance (van der Hilst, 2012). The role of interest groups and intermediaries such as industrial and trade associations to legitimise innovations relevant to the BoP market are important considerations.

3.4.2.8 Development of Positive Externalities

This function is usually left out of literature by many authors. According to Bergek, Jacobsson and Sandén (2008), it is an indicator of the overall performance of an innovation system since externalities magnify the strength of the other functions. It is, therefore, a measure of the power of the collective dimension of the innovation and diffusion processes. Positive externalities are referred to as beneficial spillover to a third party or parties because of the implementation of

an innovation. One indicator of new technology's positive externalities is the emergence of new entrants (Bergek *et al.*, 2008). This is because new entrants, by extension, the function, work by strengthening the other functions. This is done by enhancing the power of advocacy (legitimacy) and helping to overcome the initial resistance to new technology and market (guidance of search and market formation). In addition, a rise in the breadth of new entrants in an IS increases the likelihood of new combinations and experimentation with the system, thereby contributing to knowledge development, diffusion and entrepreneurial activities.

3.5 UNDERSTANDING INNOVATION FOR INCLUSIVE DEVELOPMENT

As noted earlier, there is a rising interest in the concept of the I4ID system due to the need to expand the conventional IS framework to accommodate the development peculiarities of the marginalised (Heeks *et al.*, 2013). The interest and the purpose of the I4ID system, therefore, is not just to promote growth but to cater for the lower income groups, the poorer segment of society, as well as the marginalised by innovating in such a way that their welfare is enhanced (Cozzens and Sutz, 2012; Paunov, 2013). This section, therefore, focuses on defining, characterising and analysing the different frameworks for assessing I4ID system performance.

Questions have been raised on how relevant is the IS approach to inclusive development. Does it need to be modified? And, if so, how? (Mackintosh, Chataway and Wuyts, 2007; Cozzens and Sutz, 2012). In refining the IS framework, many scholars have developed new concepts to tackle the perennial developmental challenges of inequality, poverty and unemployment in developing countries. These include user, social, open, frugal, inclusive innovation and I4ID (Gault, 2010; Kraemer-Mbula and Watu, 2010; Lizuka, 2013; OECD, 2015). It is essential to note that in literature, I4ID and inclusive innovation are used interchangeably. Since this study focuses on expanding opportunities by and for the poor through an IS approach, literature that refers to either, irrespective of the coinage, will be used as I4ID. This refers to innovations that can propel the type of development that marginalised groups participate in and benefit from regardless of gender, ethnicity, age, disability or poverty (Cozzens and Sutz, 2012). This is because the process and benefits of development have eluded different categories of people in developing countries either by social status, class, or region (Chaminade, Lundvall and Haneef, 2018). According to Cozzens and Kaplinsky (2009), the process of technological change has implications for poverty and inequality. With inequality, there is a bimodal causal relationship. Innovation can reinforce or undercut inequalities, while inequalities can influence the innovation trajectory. I4ID models, therefore, need to consider a more comprehensive set of development outcomes, not solely related to economic growth (Foster, 2013) but the living

conditions and employment opportunities for the marginalised through the introduction of new products, processes, services or business models (Cozzens and Sutz, 2012; Paunov, 2013). Several authors have given varying definitions to the concept of I4ID (Utz and Dahlman, 2007; Altenburg, 2009; Cozzens and Kaplinsky, 2009; Cozzens and Sutz, 2012; George, Mcgahan and Prabhu, 2012; Daniels, Ustyuzhantseva and Yao, 2017; Grobbelaar, Tijssen and Dijksterhuis, 2017). These are illustrated in Table 3-1.

Table 3-1: Definitions of I4ID

Literature on I4ID	Definition of I4ID
Daniels, Ustyuzhantseva and Yao (2017)	Innovation that facilitates the participation of the broadest possible spectrum of the society in socio-economic development activities
Grobbelaar, Tijssen and Dijksterhuis (2017)	Improvement of living conditions and creation of employment opportunities for the poor through the development of new products, services, processes and business models aimed at resource-poor communities
Cozzens and Sutz (2012)	Innovations that can propel the type of development that marginalised groups take part in and benefit from regardless of gender, ethnicity, age, disability or poverty
Ng <i>et al.</i> , (2015)	A continuous effort in translating the outputs from innovation-related activities to all levels of communities, especially the vulnerable groups or individuals that catalyses good progress in both the physical and social well-being of development
IDRC (2011)	Innovation was perceived as a means for attaining development trajectories where all groups of people can contribute to creating opportunities, sharing the benefits and participating in decision-making about development strategies and outcomes.
Tan and Gangopadhyay (2020)	It is described as the infusion of external inputs through human participation, even direct intervention, so that the innovation's outcomes benefit the segment of society, who, when left to their own devices, are excluded from the benefits that are enabled by scientific and technological progress.
George et al. (2012)	The development and implementation of new ideas which aspire to create opportunities that enhance social and economic wellbeing for disenfranchised members of society

Mashelkar (2012)	Any innovation that leads to affordable access to quality goods and services creates livelihood opportunities for the excluded population, primarily at the base of the pyramid and on a long-term sustainable basis with a significant outreach.
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Differing in its foundational view of development, I4ID refers to the inclusion within some aspect of innovation of groups currently marginalised or excluded from the mainstream of development (Foster, 2013). I4ID is conceived as the development, diffusion and outreach of innovations that improve the conditions of less-advantaged groups other than the poor (Foster and Heeks 2013). Therefore, this study focuses on implementing innovations in a way that expands opportunities for the marginalised. Conceptualising I4ID in this way triggers three key issues:

- i. Which marginalised or excluded group is the focus of inclusive innovation?
- ii. Which aspects of innovation must the excluded group be included?
- iii. Who from the excluded group is to be included in innovation? (Heeks, et. al., 2013).

The marginalised group varies. These may include women, youth, the disabled and ethnic minorities (Codagnone and De Luca, 2009; Kingiri, 2013). For instance, UNCTAD (2012) identified the specific disadvantaged group as women and argued for inclusiveness in gender, making a case for policies to facilitate women's access to technologies that can improve their livelihood and opportunities. The general underlying principle is that a group of people excluded from innovations will now be included. The excluded group is referred to in the literature as 'below the radar', 'bottom-of-the-pyramid' or 'base-of-the-pyramid' (Prahalad and Hart, 2002; Foster and Heeks, 2013b, 2014; Pansera and Owen, 2018). However, dominant attention has been on "the poor", those with the lowest incomes, which may typically be between US\$1 and US\$1.25 – per day (Heeks *et al.*, 2013). I4ID conceives development as actively including those excluded from the mainstream of development (Foster, 2013). The issue of the aspect of inclusivity also varies. According to Cozzens and Sutz (2012), the I4ID system should focus on two factors: inclusivity of process (e.g. the involvement of the base of the pyramid (BoP) in design and development) and inclusivity of output (delivery of goods and services that meets the needs of the BoP). Similarly, Heeks, *et. al.* (2013) identifies six aspects of inclusivity. These are intention, consumption, impact, process, structure and post-structure. Other areas are highlighted as follows: inclusivity of innovation precursors and inclusivity of

innovation adoption (Utz and Dahlman, 2007; Altenburg, 2009). I4ID system would require one or more of these criteria to be met, so they subject innovation to critical scrutiny that is absent in conventional understandings (Foster and Heeks, 2013). According to Mohnen and Stare (2013), the inclusive innovation (I4ID) system integrates a more equitable distribution within the innovation process by furthering equality in access. In contrast, the conventional approach to innovation addresses the issue of equality only ex-post, by redistribution of gains.

In literature, similar concepts to I4ID have emerged, such as ‘pro-poor innovation’, ‘frugal innovation’, or grassroots innovation. These concepts are difficult to disentangle from I4ID because they assess IS’s from the development perspective. Pro-poor innovation is an innovation that is aimed at the poor. Generally, one considers producing affordable goods corresponding to their needs (Mohnen and Stare, 2013). This is suited to the consideration of IS approach in which communities, local entrepreneurs and development stakeholders engage in network relationships without a robust hierarchical process or order (UNCTAD, 2012). Berdegúe (2005) claims that a pro-poor innovation system is a multi-stakeholder social learning process that generates and uses new knowledge that expands the capabilities of the poor. This definition places greater emphasis on the process rather than the product (knowledge) while at the same time highlighting the social process of learning, discovery and utilisation that is mainly responsible for the effective and sustainable expansion of opportunities to the poor.

Frugal innovation focuses on producing goods and services in an affordable way (Pisoni, Michellini and Martignoni, 2018). It can be classified into three: frugal mindset, frugal process and frugal outcome (Soni and Krishnan, 2014). The priority of frugal innovation is to deliver goods to low-income countries by removing non-essential or luxury features from products. For instance, certain luxury features, such as various functionalities in a smartphone, are sacrificed to produce a phone that allows just to call but is affordable to the poorest in society (Winkler *et al.*, 2020). Based on this school of thought, the underlying principles behind frugal innovation are summarised as substantial cost reduction, concentration on core functionalities, and optimised performance level (Weyrauch and Herstatt, 2016). However, NESTA’s report (2012) pointed out that frugal innovation could not be reduced to low-cost solutions and could be of great interest to developed economies. This is because frugal innovation responds to limitations in resources (sustainability), whether financial, material or institutional, and through a range of methods, turns these constraints into advantages (Bound and Thornton,

2013). Successful frugal innovations are low-cost, outperform the alternative and can be made available on a large scale (Mohnen and Stare, 2013).

When innovations are produced by members of the same group that the IS system is supposed to cater for, one speaks of grassroots innovation. These are introduced mainly at the local level and often by the users, who know their specific needs more than outside suppliers (von Hippel, 1976). This type of innovation has the characteristics of user innovations. Grassroots innovations may not have a high potential value outside the low-income community. Still, they improve the welfare of the low-income group and sometimes represent large markets.

3.5.1. Characteristics of Innovation for Inclusive Development

Even though the field of the I4ID system is still in the infancy stage, some authors have provided some guidelines and frameworks that could be useful for this study (this is summarised in Table 3-2):

- i. UNCTAD identifies three factors that may influence the potential effectiveness of I4ID policies. These are the characteristics of low-income markets, instrument design and the importance of inter-organisational collaboration (UNCTAD, 2014);
- ii. The World Bank also identifies five features characterising I4ID: affordable access, sustainable production, goods and services that help create livelihood opportunities, orientation towards excluded populations, primarily those at the base of the pyramid and significant outreach (World Bank, 2013);
- iii. Mashelkar (2012) identifies five characteristics of I4ID. These are affordable access, financial sustainability, high-quality goods and services, empowerment of the excluded population and massive outreach;
- iv. According to Prahalad, I4ID involves building the capacity of low-income groups to increase their income to afford to consume more. This is built on four principles: awareness, affordability, access and availability (Prahalad, 2011);
- v. Anderson and Billou Four As of inclusive innovation. The authors identified four important factors for an I4ID to succeed in emerging markets. These are affordability, availability or accessibility, acceptability and awareness (Anderson and Billou, 2007);
- vi. E.F. Schumacher first introduced the theory of appropriate technology in his book 'Small is Beautiful.' The concept of appropriate technology stresses that innovation for developing countries needs to be different (Pattnaik and Dhal, 2015). The theory recommends that innovations for developing countries should be more labour intensive, require fewer

resources, and use low-cost or readily available materials wherever possible. Special attention must be paid to the social, cultural, and ethical aspects of the communities for which the technology is intended; and

- vii. Learning from the principles of appropriate technology, Thapa (2013) identifies specific criteria that new technologies need to meet before being considered inclusive. These criteria include technical feasibility, social acceptability, resource availability, economic affordability, favourable institutions, and environmental sustainability.

Table 3-2: Characteristics of I4ID

	World Bank (2013)	Mashelkar (2012)	Prahalad (2011)	Anderson & Markides (2007)	Thapa (2013)
Affordability	√	√	√	√	√
Accessibility	√	√	√	√	
Sustainable production	√				√
Livelihood opportunities	√				
Empowerment of BoP	√	√			
Significant outreach	√	√			
Financial sustainability		√			
High quality		√			
Acceptability				√	√
Awareness				√	
Social acceptability					√
Favourable institutions					√
Environmental sustainability					√

In implementing policies for I4ID, certain factors have been identified as constraints to implementing the I4ID system in developing countries. Heeks, *et. al.* (2013) identifies the absence of policy support, lack of collaborative structures and organisations, lack of skills and knowledge necessary for inclusive innovation, poor access to capital, poor ICT connectivity and bandwidth and failure to address the need of the excluded groups and lack of information about the demand for innovations among these groups. Other constraints include the challenge of innovation trajectories, scale, policy objectives and the trade-off between price and quality (Mohnen and Stare, 2013; Chataway, Hanlin and Kaplinsky, 2014). In implementing national innovation policies in inclusive innovation UNCTAD (2014) raised some questions that may facilitate the dialogue. These include:

- a. What specific pro-poor innovation policies have been successfully implemented, and what lessons can be drawn from the experiences that can be replicated in other developing countries?
- b. What are the main governance challenges faced by innovation systems in designing and implementing inclusive innovation policies?
- c. How could these innovations be implemented in small economies with high poverty rates but low aggregated demand?
- d. What types of incentives would have to be created to ensure the engagement of private sector players in inclusive innovation initiatives in these countries?

This is because the I4ID system has primarily evolved in contexts with large low-income populations because of the aggregated purchasing power of the poor in these countries, among other reasons.

3.5.2. Innovation, Bottom of the Pyramid and the Challenge of Inclusive Development

One of the challenges of developing innovations for the BoP is the belief that the market is unviable, unprofitable and characterised by an unsustainable business model, despite the fact that the BoP is estimated to be about two-thirds of the world's population (Prahalad and Hammond, 2002). In the widely read paper, *The Fortune at the Bottom of the Pyramid*, Prahalad & Hart (2002) argue precisely the opposite. They regarded the BoP market as untapped with 'invincible opportunity.' MNCs can enhance their profitability if they view their business and globalisation strategies through a new lens of inclusive capitalism. To understand the vast potential of the BoP market, the authors considered the world as a pyramid with three classifications segmented according to income status (Figure 3-1). At the top of the pyramid

(Tier 1) is about 75 to 100 million people - a group comprising middle- and upper-income people in developed countries and wealth elites from the developed world. The second category (Tiers 2 and 3) comprises poor customers in developed nations and the rising middle classes in developing countries. These are estimated to be between 1.5 to 1.75 billion people occupying the middle of the pyramid. The two categories (Tiers 1 – 3) constitute the target market for MNCs, thereby neglecting the people at the base of the pyramid, which comprises the largest single block of people, estimated at 4 billion with per capita income below \$2 per day at PPP rates (Prahalad, 2011).

Annual per Capita Income	Tiers	Population in millions
More than \$20,000	1	75 – 100
\$1,500 - \$20,000	2 & 3	1,500 – 1,750
Less than \$1,500	4	4,000

Figure 3-1: World economic pyramid
Source: Prahalad and Hart (2002)

Prahalad and Hart (2002) identified six assumptions that underline the neglect of the BoP market by MNCs:

- Assumption 1: The poor are not our target consumers because, with our current cost structures, we cannot profitably compete in that market;
- Assumption 2: The poor cannot afford and have no use for the products and services sold in developed markets;
- Assumption 3: Only developed markets appreciate and will pay for new technology. The poor can use the previous generation of technology;
- Assumption 4: The bottom of the pyramid is not important to the long-term viability of our business. We can leave Tier 4 to governments and nonprofits;
- Assumption 5: Managers are not excited by business challenges that have a humanitarian dimension; and

- Assumption 6: Intellectual excitement is in developed markets. It is hard to find talented managers who want to work at the bottom of the pyramid.

In overcoming these assumptions, Anderson and Billou (2007) and Prahalad and Hart (2002) highlighted examples of MNCs and strategies used in successfully implementing innovations in BoP markets profitably. This is done by developing business strategies that focus on what they termed 4As: availability, affordability, acceptability and awareness (Anderson and Billou, 2007) or a business model that combines low cost, good quality, sustainability, and profitability (Prahalad and Hart, 2002). Since MNC's production system is characterised by efficiency and economy of scale, introducing products in BoP markets can become profitable if MNCs implement innovations, business models and management processes driven by creating buying power, shaping aspirations, improving access, and tailoring local solutions.

Prahalad and Hart (2002) argue that the successful implementation of new products in the BoP market will:

1. Enhance the profitability of MNCs significantly;
2. Lead to inclusive development by reducing poverty; and
3. Assist in developing environmentally sustainable technologies and products for the entire world by using developing countries as a testing ground.

However, another school of thought contradicts this philosophy. In the paper, "Fortune of the Pyramid: The Mirage. How the private sector can help alleviate poverty", Karnani (2006) argued that unless the people at the BoP are made producers rather than consumers of technology, alleviating poverty and inclusive development will remain a mirage. The argument is based on weak infrastructure and high costs of serving the BoP market, which ultimately nullifies the economies of scale. Other factors are poor purchasing power and lack of disposable income. To make BoP producers, Karnani (2006) posit that markets have to be more efficient by removing rents associated with middlemen such that the value of the outputs from the poor can reflect their value. Inclusive development can only be possible when MNCs invest in upgrading the skills and productivity of the poor. This can open up high quality and decent employment opportunities for them. Karnani (2006, p. 30) further argued that "to solve the problem of poverty, we need to go beyond increasing the income of the poor; we need to improve their capabilities and freedoms along social, cultural, and political dimensions as well. The role of the government is critical in some of these dimensions. By emphatically focusing

on the private sector, the BoP proposition detracts from the imperative to correct the failure of government to fulfil its traditional and accepted functions such as public safety, basic education, public health, and infrastructure, all of which increase the productivity and employability of the poor, and thus their income and well-being.”

3.6 CHAPTER SUMMARY

In this chapter, literature is reviewed to determine the status of literature on innovation systems and the I4ID systems. The chapter also examines the structural and functional dynamics of the framework. This provides an understanding of the ISs framework as an analytical construct for understanding system dynamics and performance. These are examined from the perspective of inclusive development.

The characteristics of the BoP and the BoP market are also examined to determine the appropriateness and profitability of private sector investments in the market. Two schools of thought were studied: one argues that the market is profitable due to the advantage of scale that the BoP offers. The counterargument is that any benefit provided by the economy of scale is nullified by weak infrastructure in developing countries and poor purchasing power among the BoP; therefore, it argues that unless the people at the BoP are made producers, through building of capabilities rather than consumers of technology, alleviating poverty and inclusive development will remain a mirage.

This Chapter leads to a systematic review of literature, which aims to assess the different frameworks to assess the performance of ISs to determine the most promising in the I4ID context.

CHAPTER FOUR : A SYSTEMATIC LITERATURE REVIEW OF LITERATURE ON INNOVATION FOR INCLUSIVE DEVELOPMENT SYSTEM

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
					Summary and conclusions		

4.1 INTRODUCTION

In light of the literature in Chapter Three, evaluation of the ISs framework in the context of inclusive development will provide a platform for applying the framework to the I4ID context. This is because the literature on ISs has grown substantially in the last two to three decades and has been widely diffused in global policy circles irrespective of the divide: small or large; developing or developed; North or South (Lundvall, 2007). In addition, the performance of ISs varies depending on the disparities in capabilities among countries.

Several studies have been undertaken to develop frameworks/methods for evaluating ISs performance. It is, therefore, essential to review these to determine their adequacy or effectiveness in tackling the challenges of inclusiveness and development. To undertake this, it is imperative to undertake a systematic review. This holds the advantage over traditional literature review because it is reliable, replicable and unbiased (Reinhardt, Gurtner and Griffin, 2018). Learning from (Kitchenham and Ebse, 2007), a systematic review of literature will therefore allow researchers to critically review existing literature on ISs, inclusive innovation and performance, identify gaps and develop a framework for assessing I4ID performance. The rise in literature and interest in I4ID and related concepts (Cozzens and Sutz, 2012; Foster and Heeks, 2013b; Lizuka, 2013; Botha, 2017; Grobbelaar, Tijssen and Dijksterhuis, 2017) make systematic review the effective methodology for achieving this.

4.2 THE SYSTEMATIC REVIEW PROCESS

A systematic literature review aims to identify, critically evaluate, and integrate the findings of all relevant, high-quality individual studies addressing one or more research questions (Cook, Mulrow and Haynes, 1997). Also, Kitchenham and Ebse (2007) define it as a form of secondary study that uses a well-defined methodology to identify, analyse and interpret all available evidence related to specific research questions in a way that is unbiased and (to a degree) repeatable. Systematic reviews define research questions by collecting and summarising documented empirical evidence that fits pre-specified eligibility criteria (Bearman and Dawson, 2013). Due to its systematic process of identifying all possible literature on a subject matter, this review is transparent, objective and replicable (Tranfield, 2003).

The review presented in this article follows a three-stage procedure shown in **Error! Reference source not found**. This is an adaptation of a study undertaken by Botha, Grobbelaar and Bam (2016).



Figure 4-1: Systematic review process

4.2.1. Stage 1: Planning the Review

The planning review stage comprises three activities as follows:

1. Determining the objectives of the review;
2. Laying out a broad framework; and
3. Identifying the criteria for the selection of literature.

4.2.1.1. *Determining the objectives of the review*

The first activity of the planning process is to determine the review's objectives. This helps to set the boundaries for the activities in the study. In this review, the goals are as follows:

- Assess the pattern and trend in literature on I4ID systems;
- Identify possible methods and approaches for analysing and exploring the performance of I4ID systems; and
- Identify the most promising methodology for assessing the performance of I4ID systems.

4.2.1.2. Developing a broad framework

The second activity of the planning stage is to develop a broad framework for undertaking the systematic review, especially identifying the relevant ISs methodologies. The study by Botha, Grobbelaar and Bam (2016) adopted two comprehensive sets of criteria. The first assesses the conditions needed to determine the appropriateness of ISs approaches to serve as an evaluation methodology. At the same time, the second focuses on the adaptability of the framework to evaluate the performance of the I4ID system. In determining the appropriateness of ISs methodologies to serve as evaluation methodology (first criterion), the study relied on inputs from previous studies. The study by Schut et al. (2015) is important, which develops a diagnostic tool to guide the analysis of complex agricultural problems and the innovation capacity of the agricultural system embedding the problem. Research from the study provides a guide for determining the appropriateness of methodologies that can be used to assess the functioning of agricultural ISs. This has been used by a similar study that conducted a systematic review of literature in the I4ID context (Botha, Grobbelaar and Bam, 2016). Insights from these help to develop a broad set of criteria for determining the appropriateness of ISs approaches to serve as evaluation methodologies. The criteria include:

1. Utilisation of a mix-method approach to data collection rather than either qualitative or quantitative methods. Qualitative data provide an in-depth analysis of a specific case of an innovation system. In contrast, quantitative data analysis complements qualitative data by providing statistical data that allows it to be generalised over a population (Schut *et al.*, 2015)—utilising a mix of both harnesses each advantage to give a comprehensive assessment.
2. Focus on both internal and external analysis: External analysis is used to complement internal investigation because the former provides an independent assessment of the problem (van Mierlo and Arkesteijn, 2009);
3. Integration of a plethora of actors across different levels; One of the main attributes of ISs is the wide range of actors interacting to develop and diffuse innovations (Cozzens and Sutz, 2012). Including different actors, small or big, formal or informal, is essential for any methodologies that seek to evaluate ISs in the development context.
4. Focus on integrated analysis of complex problems and innovative capacity of the system in focus (Schut *et al.*, 2015);
5. Focus on systemic problems rather than problems associated with the functioning of an individual component (Borrás and Laatsit, 2019); and

6. Support policy intervention to address systemic problems (Wieczorek and Hekkert, 2012).

The second step is to derive the criteria guiding the framework's applicability to evaluate I4ID system performance. According to Foster and Heeks (2013c), frameworks for assessing inclusive innovation systems (IIS) (and I4IDs) can be derived from existing traditional ISs frameworks if they can be adapted to accommodate certain underplayed concepts. These include processes of technology diffusion, informal demand-side actors and intermediaries, and the role of localised and informal institutions (Altenburg, 2008; Kraemer-Mbula and Watu, 2010; Cozzens and Sutz, 2012; Castellacci, 2015; Saka-Helmhout, Chappin and Vermeulen, 2020). To develop a framework for evaluating the performance of I4ID systems, this study identifies the following issues:

1. Focus on a broad range of actors: According to Heeks *et al.*, (2013) and Foster and Heeks (2013b), I4ID system frameworks should encompass a wide range of actors, especially non-traditional, informal actors that are typically excluded from the traditional ISs. These include intermediaries, demand-side actors, and vertical and horizontal linkages, among others (Cozzens and Sutz, 2012);
2. Determination of inclusion/exclusion criteria: Central question in developing the I4ID framework is the criteria for inclusion. These have to be defined in the context of the specific I4ID system under study (Botha, Grobbelaar and Bam, 2016);
3. Complete analysis of processes: This indicates the activities that are important to the development and diffusion of innovations. Relevant activities driving the functioning of I4ID systems are to be included (van der Hilst, 2012; van der Merwe, Grobbelaar and Bam, 2020; Maarsingh *et al.*, 2021);
4. Learning and relations: The learning process is at the heart of ISs. I4ID systems should emphasise the DUI mode of learning, which is prevalent in production systems in most developing countries. In addition, the boundary of DUI mode should be expanded to include social processes that stimulate learning during the process of diffusion of innovations instead of limiting it to production systems (Foster and Heeks, 2013b);
5. Integrate formal and informal institutions: While traditional ISs emphasise the role of formal institutions, the framework for evaluating the performance of I4ID systems needs to be broadened to include informal institutions such as norms and practices. This should also include other non-market institutions embedded within local social relations that are endogenously enforced rather than exogenously imposed (Altenburg, 2008;

Castellacci, 2015; Saka-Helmhout, Chappin and Vermeulen, 2020). This is more important in developing countries where formal institutions are sometimes inexistent or weak (Castellacci, 2015);

6. Context-specificity: The evolution of studies in ISs underscores the importance of contexts (Chaminade, Lundvall and Haneef, 2018). Understanding this helps to shape the emerging field of I4ID systems and seek a broad understanding in different contexts. This provides an opportunity to build in-depth knowledge through specific cases, thereby providing feedback for theoretical underpinnings and conceptual models (Foster, 2013); and
7. Qualitative approach: This provides the most appropriate method for undertaking an exploratory study based on an iterative process; hence, it is better suited to the emerging field of knowledge, such as the I4ID system. This ensures that decision-making is grounded within empirical data, where subsequent stages of investigation are dependent on the emerging research. When necessary, this can be complemented with a quantitative method (Foster, 2013).

4.2.1.3. Determining the criteria for literature selection

The third part of the planning stage includes setting the parameters for selecting the literature used in the review. The main objective is to undertake a comprehensive study and map all possible literature sources on the chosen topic. The use of multiple databases ensures the removal of bias in the process. This starts with identifying and selecting relevant databases from which relevant literature is selected. The identified web-based databases for this study are Google Scholar and Scopus. Scopus represents the largest bibliographic database comprising over 25,000 scientific publications and peer-reviewed literature from more than 5000 publishers. This is complemented with Google Scholar to account for grey literature, especially thesis/dissertation, conference papers and working papers. In an emerging field such as the IIS/I4ID system, grey literature represents an essential source of information, thereby broadening the literature sources and removing the likelihood of bias (Mahood, Van Eerd and Irvin, 2013). In addition, relevant keywords and all possible combinations were identified, starting from the traditional ISs literature to the narrow IIS or I4ID systems. This is because I4ID system literature is still in its infancy; hence, there is the need to cast a wide net to undertake a comprehensive literature search. The literature was restricted to journal articles, briefs, working papers, theses, reports and conference papers. This follows similar studies on the evaluation of ISs (Botha, Grobbelaar and Bam, 2016).

Due to knowledge of literature, a list of search terms was developed. The search focused on the title, abstract and keywords of each publication for Scopus, while Google Scholar focused only on the title. In developing the search terms, a broad strategy that situates within the concept of ISs and three general classifications of concepts relevant to the aim of the study was developed. These categories are approaches/methods, innovation systems and objectives (Table 4-1). The terms within each category were joined using the Boolean operator “OR”, after which the operator “AND” was used to join the three categories. This ensures that each search result contains at least one term from each category.

Table 4-1: Search strategy used in developing the search terms

Group	Terms			Position	
Approach(es) /Method(s)	Evaluat*	Analy*	Framework	Title	
Innovation system / System of Innovation	Innovation System	System of Innovation		Title, Abstract, Keywords	
Objective	Development	Inclusive innovation	Frugal innovation	Grassroot innovation	Title, Abstract, Keywords

4.2.2. Stage 2: Data Selection

The data selection phase was undertaken to prune down the literature further using specific inclusion criteria (Table 4-2). The need to reduce the number of literature is due to the time devoted to undertaking a systematic review. At the end of the data collection, some 428 literature were identified from the two databases: Scopus (391) and Google Scholar (37). To further reduce the number of literature, specific exclusion criteria were imposed. These include language, publication type, duplication, methodology, relevance, and access to the full paper. For example, a publication is included only if it is written in English, focuses on the evaluation of ISs and has an objective of either development or inclusiveness. The data selection process is illustrated in Figure 4-2. At the end of the process, 62 publications were selected. These were further reduced to 60 because of the non-availability of full texts of two publications. Hence, 60 publications are used in the systematic review for this study (see Appendix A for the list of publications).

Table 4-2: Inclusion or exclusion criteria

Criteria	Description
Type of paper	Lecture notes, panel discussions, and conference reviews were excluded.
Empirical relevance	Basic methodology and evaluation of research
Language	Literature in the English language only.
Approaches	System level that focuses on the evaluation of innovation systems
Relevance to project scope	Innovation systems papers that focus on development, inclusion, and frugal or grassroots innovations only were included.

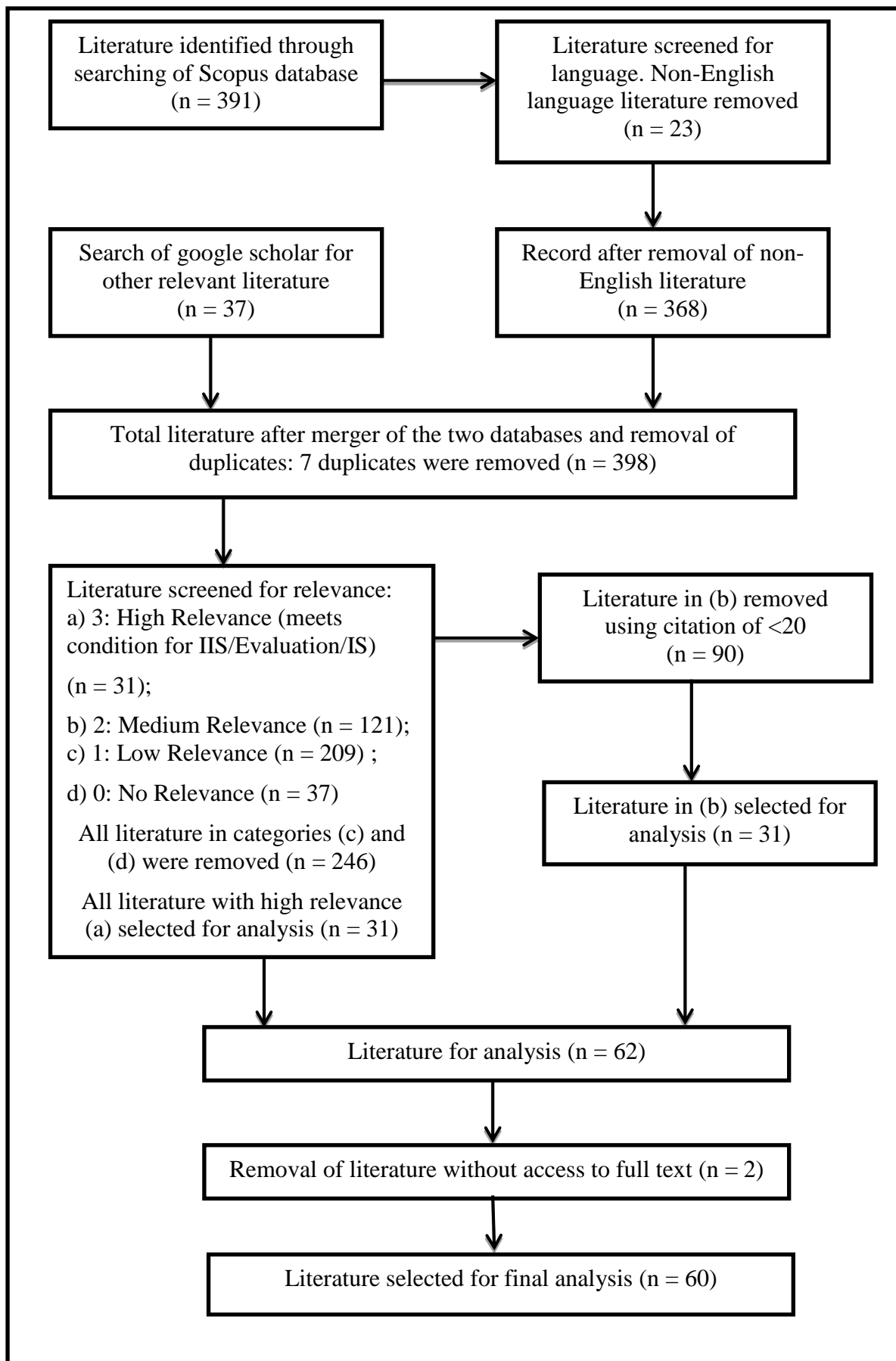


Figure 4-2: Data selection process for the systematic review

4.2.3. Stage 3: Data Analysis

To investigate the objectives of this study, the 60 literature included in the review were analysed and coded. This was done through an iterative process aimed at standardising the information in the studies and assisting in identifying emerging trends in the literature. The main aspects of the articles relevant to the objective of this study are:

1. Affiliation of researchers and country/region of study: This provides information on the institutions of researchers responsible for undertaking ISs studies that focus on development issues. In addition, it allows us to understand the countries where these studies are being undertaken;
2. The year, subject area of paper as well as the publication type: This is extracted to understand the chronology of the publications, the pattern of growth, and the target audience of the study in focus;
3. Type of paper: This gives a broad understanding of the dimensions of the studies. It provides an insight into the developments in the field of knowledge of ISs with a development focus;
4. Data collection technique: This explains the data collection method in each literature. This shows the objective of each literature and goes further to establish the level of development of knowledge in studies focussing on ISs with emphasis on growth;
5. The type of IS analysed/evaluated and its context/discipline. This is extracted to connect the method/approach to the type of IS applied to identify patterns.
6. The method/approach used in the article: This is the core of this study. It highlights the main objective, which is to review and recommend the most appropriate framework for evaluating the performance of the I4ID system; and
7. The goal of the evaluation. This again serves to provide insights into the objectives of the evaluation approaches. The study relies on the purpose of the evaluation framework (Chen, 1994; Patton, 2008). The framework classifies evaluation approaches into three: summative (to provide judgement), formative (to improve programmes' processes) and inform policy or build new theories (to generate new knowledge).

The data analysis discussion is undertaken in two broad categories: i) descriptive statistics and ii) methodological foundations. These are presented in the sections below.

4.3 RESULTS AND DISCUSSION

4.3.1 Descriptive Analysis

The descriptive statistics reveal the profile of the 60 publications analysed in this review. This includes the chronology of publications, type of publications, region of focus, authors' affiliation, the sector of focus and the methods used. The objective is to build a narrative on the characteristics and methodologies in the studies that focus on evaluating ISs from the perspective of development or inclusiveness.

The publications used in this study cover 23 years, from 1999 to 2021. These are classified into five groups of five-year periods. The last group (2019 – 2021) covered three years because of the limited time. The findings indicate a gradual rise in publications (Figure 4-3). This reveals a growing interest in studies that seek to evaluate the performance of ISs from an inclusive development perspective. The drop in the last period (2019 – 2021) is due to the period covering three years instead of five.

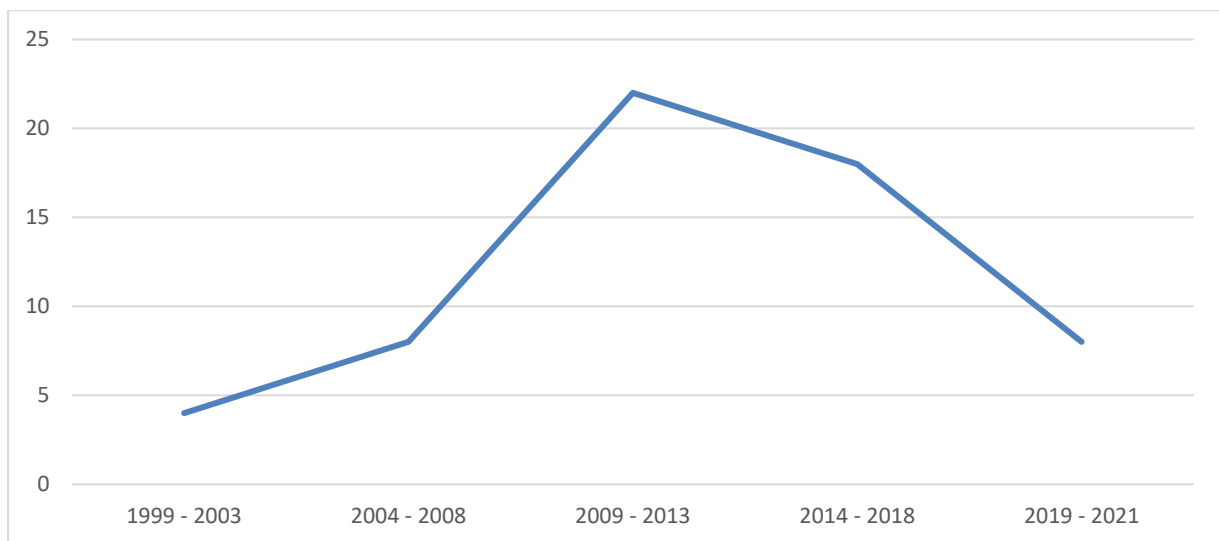


Figure 4-3: Literature by the chronology of publication

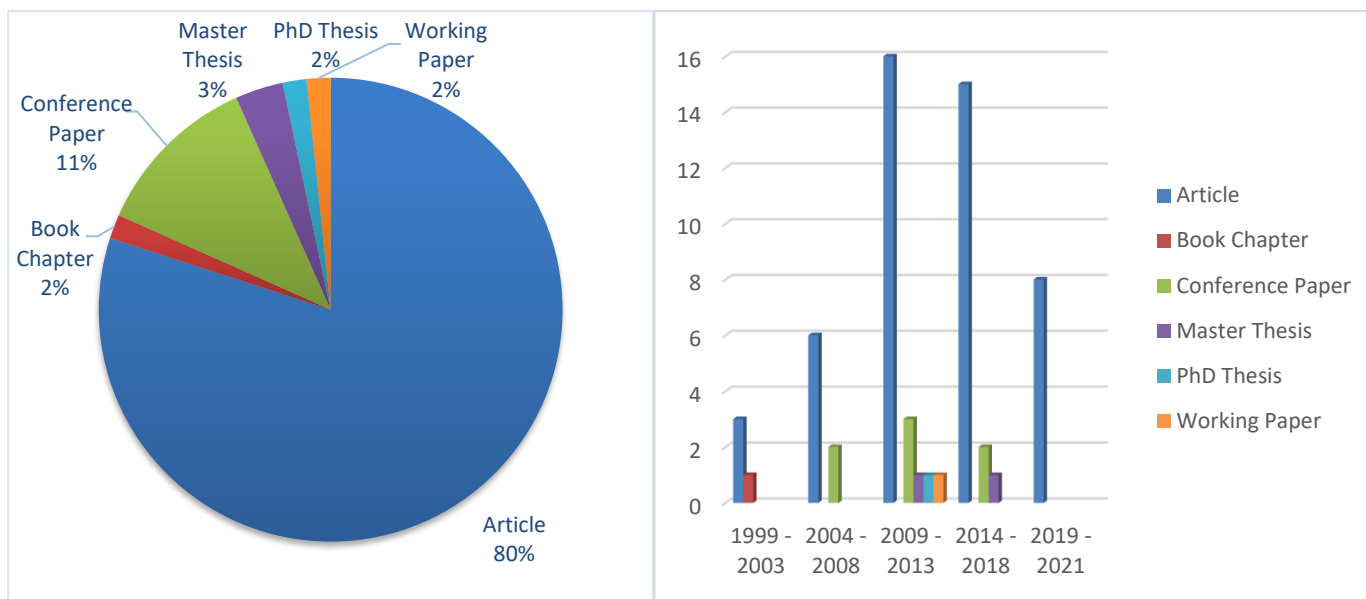


Figure 4-4: Publications by type and phase

In Figure 4-4, the distribution of the analysis by publication type and chronology is presented. The result indicates that about four-fifths of the publications are journal articles. This reveals that publications that seek to evaluate ISs from an IIS or I4ID system perspective are predominantly published in journals. Presentations at conferences follow this. What is also important to note is that publications in journals and conferences are not only high in number but also growing over time. In addition, most journals are traditional, established outlets focusing on different industrial sectors. Among the journals, however, the African Journal of Science, Technology and Innovation for Development featured the highest number of publications, closely followed by the Journal of Technological Forecasting and Social Change, Innovation and Development and Research Policy (Table 4-3). The four journals focus on issues of R&D and STI from different angles. The rising importance of the African Journal of Science, Technology and Innovation for Development is worth mentioning. It is a relatively new journal established in 2007 to give voice to STI and Africa's development issues. The relatively high patronage of the journal indicates acceptability and a gap that is being filled on issues of STI management in Africa. The Journal of Technological Forecasting and Social Change focuses on the theory and practice of future trajectories and assessing technologies and their impact on social issues. In contrast, Research Policy focuses on multidisciplinary studies on policy problems posed by research and development activities. Another important finding is that almost all the studies in this review are presented at GLOBELICS Conferences.

Table 4-3: Publication type by source

Article	48
African Journal of Science, Technology and Innovation for Development	6
Technological Forecasting and Social Change	5
Innovation and Development	4
Research Policy	4
Agricultural Systems	3
Energy Policy	2
Industrial and Corporate Change	2
Journal of Cleaner Production	2
Regional Studies	2
Science and Public Policy	2
Technovation	2
Agriculture and Human Values	1
Environmental Innovation and Societal Transitions	1
European Journal of Development Research	1
European Journal of Operational Research	1
Industry and Innovation	1
Innovation: Management, Policy and Practice	1
International Journal of Agricultural Sustainability	1
Journal of Indian Business Research	1
Local Economy	1
Research Evaluation	1
Scientometrics	1
South African Journal of Industrial Engineering	1
Sustainability	1
Telecommunications Policy	1
Book Chapter	1
Sectoral Systems of Innovation: Concepts, Issues and Analyses of Six Major Sectors in Europe	1
Conference Paper	7
GLOBELICS Conference	6
PICMET 2016 – Portland International Conference on Management of Engineering and Technology: Technology Management For Social Innovation, Proceedings	1
Master Thesis	2
Stellenbosch University	1
Utrecht University	1
PhD Dissertation	1
Maastricht University	1
Working Paper	1
UNU-MERIT Working Paper Series	1
Grand Total	60

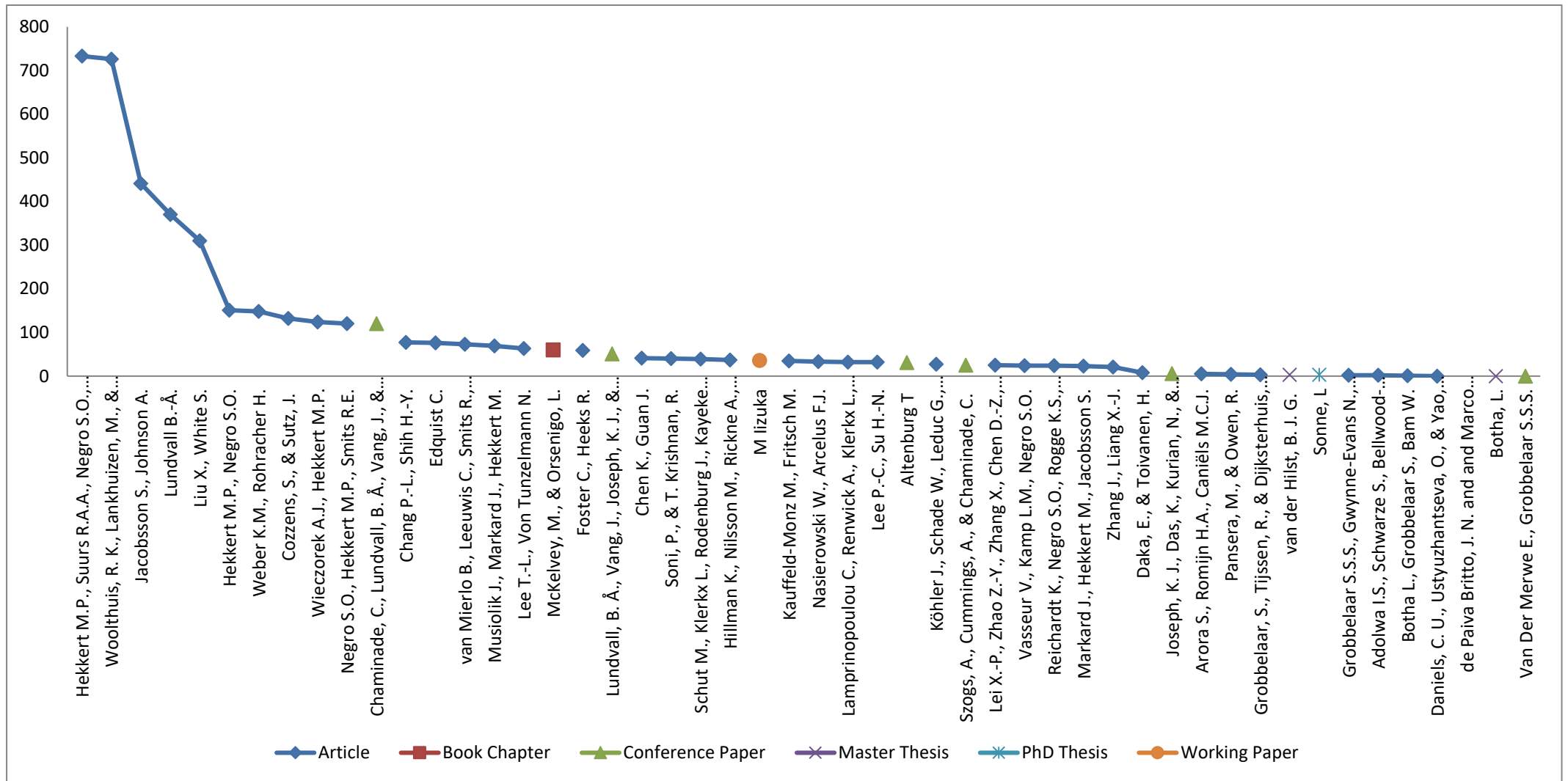


Figure 4-5: Publication type by number of citation

When disaggregated by the number of citations, the study shows that the highly cited publications are journal articles (Figure 4-5). The top ten highly cited publications are journal articles. This represents about 73% of the total citations. Similarly, among the top 20, 17 are journal articles, 2 are conference publications, and the last is a book chapter.

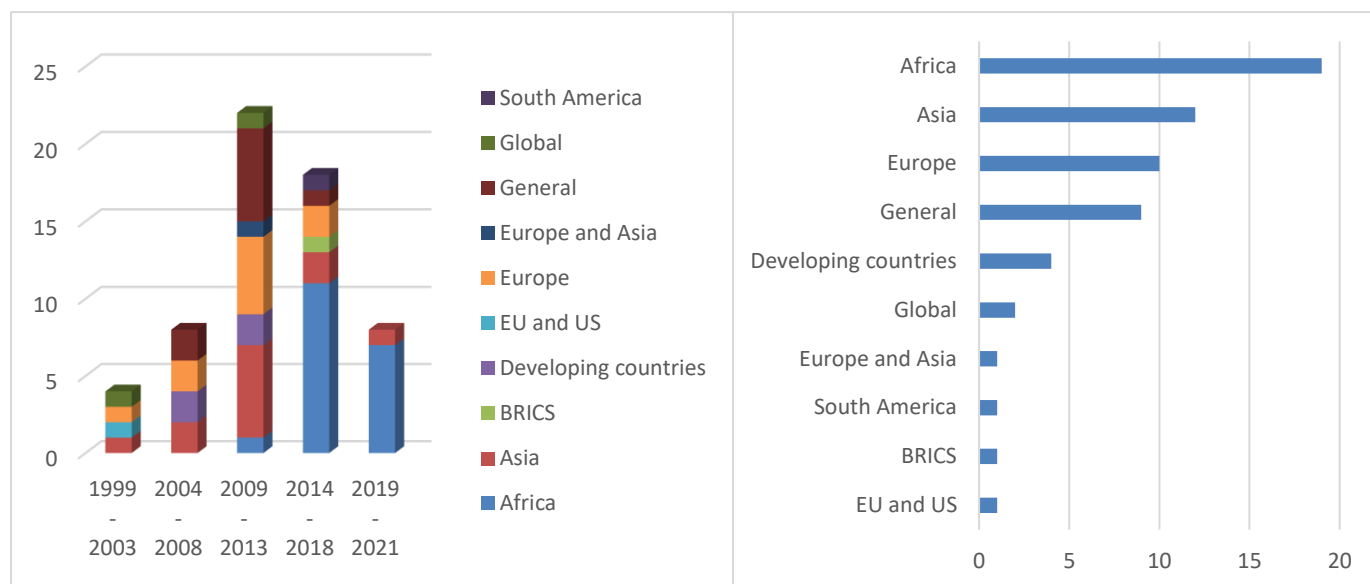


Figure 4-6: Publications by region of study focus

In Figure 4-6, the region of focus of the publications and the trend is depicted. This reveals that most publications focus on developing countries in Africa, followed by Asia. An important finding is that with time, more focus seems to be on Africa, as more than half of the publications in 2014 – 2018 focused on the region compared to zero in 1999 – 2003. This may explain that issues of development challenges are more prominent on the African continent than any other. While authors affiliated with South African institutions have the highest number of publications in this category, most studies were undertaken in countries outside the African continent. Most of these institutions are in Europe, especially the Netherlands, Germany, UK, Denmark and Sweden (Figure 4-7). Institutions in these European countries represent about 44% of the total institutions where the authors in this review are affiliated. Only three countries in Asia (China, Taiwan and India) have authors affiliated with institutions in the top ten countries. This is revealed by the country of affiliation of the researchers who undertook the study (Figure 4-7). In South Africa, however, most studies emanate from Stellenbosch University, and the analysis reveals a gradual rise from three in 2016 to ten in 2021. Aside from South Africa, it is worth noting from this review that institutions training young researchers in this field of study are based in the Netherlands. This is reflected by the fact that the only PhD

dissertation and one of the two Master's theses reviewed in this study are affiliated with Maastricht and Utrecht Universities, both in the Netherlands (Table 4-3). This reveals that while issues bordering on the innovation systems from the lens of inclusive innovation or development are more critical in developing countries, especially in Africa, research capacity measured in terms of peer-reviewed research outputs to undertake such work may be lacking on the continent.

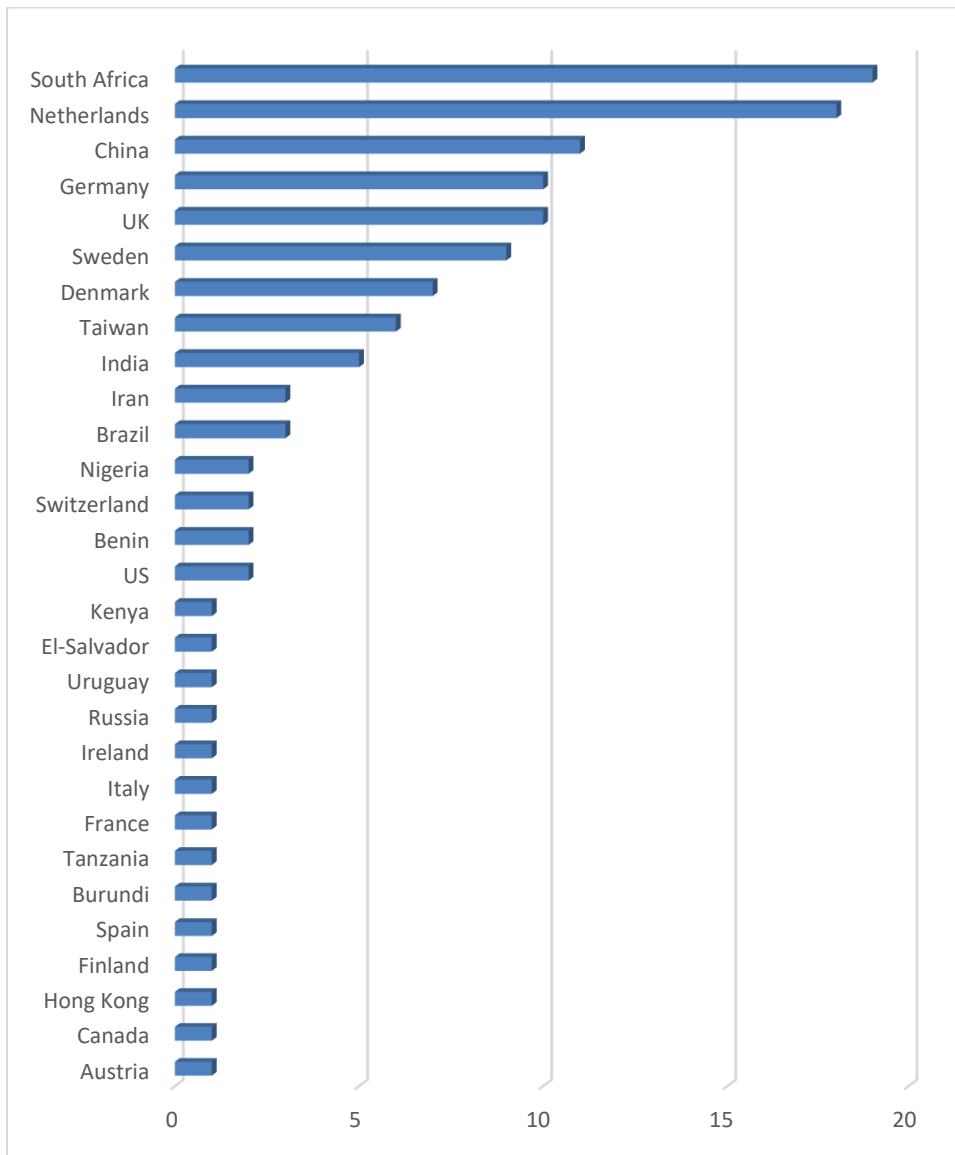


Figure 4-7: Publications by authors' country of affiliation

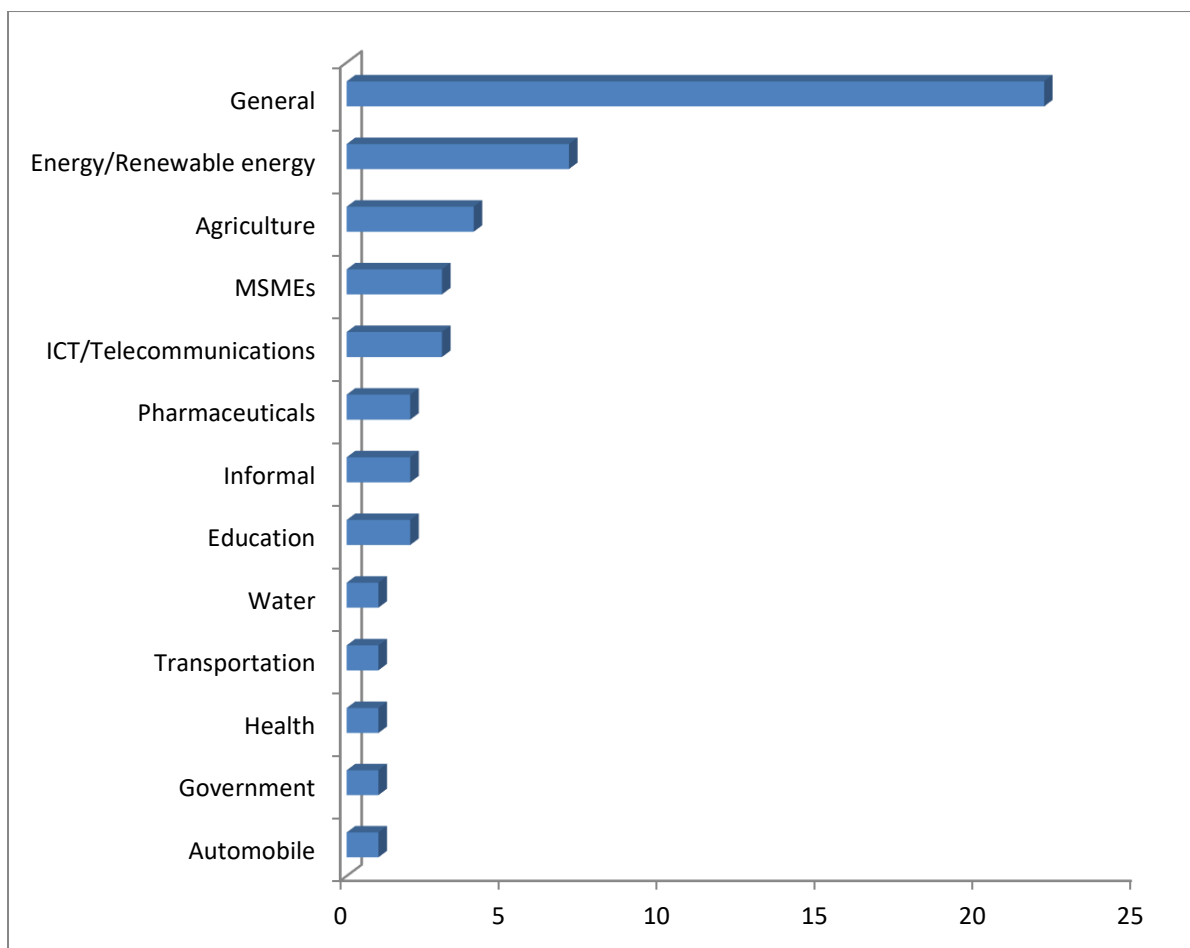


Figure 4-8: Publications by sector of focus

The sectoral focus of the publications is shown in Figure 4-8. The result shows that the majority, close to half, of the studies, focus on general issues of ISs rather than specific sectors. However, energy and agricultural areas are also important subjects of study. This can be explained by the fact that only about 24% of the publications are empirical. The majority are either theoretical or conceptual.

4.3.2 Methodological Foundations: The Evaluation Framework for I4ID System Performance

4.3.2.1 Goals of Evaluation

The goals of the papers under review can be summarised broadly as utilising the framework of innovation systems to evaluate policies, projects and programmes in different contexts. The purpose of evaluation can be classified into three: make judgements about a programme (summative), and improve its effectiveness (formative), or inform programming or policy decisions.

Using this framework, the study found that most of the literature analysed was aimed at summative evaluation, which usually dominates evaluation literature. This seems to support the emerging nature of the assessment of ISs, focusing on evaluating performance and development issues. As stated earlier, most early studies are conceptual, with the primary objective of developing new theories and models of inclusive innovations or informing policy. Only one literature source in this study (Schut *et al.*, 2015) utilised the formative approach to evaluating IS's performance. Undertaken through a participatory approach, the aim is to analyse constraints and opportunities for innovation to effectively address parasitic weeds in rain-fed rice production systems in Tanzania and Benin. This was undertaken through a series of multi-stakeholder workshops that identified, categorised and analysed constraints for innovation in the agricultural system.

Similarly, the papers provide a broader understanding of the framework in development contexts. While the purpose of the studies is largely summative or geared towards informing programming or policy decisions, they do this through different approaches. These are classified broadly into four:

1. Adapting the innovation systems to development contexts by modifying the elements and functions (Zhang and Liang, 2012; van der Merwe and Grobbelaar, 2016; Botha, 2017; Pansera and Owen, 2018; Botha, Grobbelaar and Bam, 2019; Maarsingh *et al.*, 2021);
2. Providing a theoretical foundation of issues in the innovations systems approach to development (Woolthuis, Lankhuizen and Gilsing, 2005; Lundvall, 2007; Altenburg, 2008; Markard and Truffer, 2008; Lizuka, 2013);
3. Expanding the framework by including new concepts that can broaden its applicability (Hekkert *et al.*, 2007; Cozzens and Sutz, 2012; Wieczorek and Hekkert, 2012; Schut *et al.*, 2015; Weber and Truffer, 2017; Reinhardt, Gurtner and Griffin, 2018); and
4. Conducting empirical studies to evaluate different projects, policies and programmes in different contexts (Szogs, Cummings and Chaminade, no date; Chen and Guan, 2012).

While the primary goal of the papers is to evaluate IS's performance, the method it uses varies. Irrespective of the differences, the underlying philosophy is that through the elements (actors, institutions, networks, infrastructure) and functions, the evaluation of ISs could be undertaken. For empirical studies, the problems associated with the system usually reveal the weakness or

absence of a particular actor, institution, network or process within the system. It could also be problems related to the attributes of any elements or functions.

4.3.2.2 Categories of Evaluation Methods

The 60 selected papers were analysed through an iterative process to identify the evaluation frameworks used in each literature. Of these, 59 utilised a specific evaluation method either implicitly or explicitly. It is only in Markard and Truffer (2008) that a particular form of evaluation could not be identified based on the classification used in this study. After a thorough exercise, ten approaches were identified (Table 4-4) and are described below:

1. Components of innovation system: This approach identifies the various structural elements of ISs. According to Lundvall (1992), this comprises all the parts and aspects of an economic structure and the institutional set-up affecting learning, searching, and exploring; the production, marketing and finance system. While different authors identify different elements, actors, institutions, and interactions are universally acceptable. The analysis reveals that 17 literature utilised either explicitly stated or inferred this framework. Literature that used this approach constitutes the highest proportion of selected literature in this study;
2. Functions of innovation system: Rather than the structural elements that make up an IS, this approach focuses on the activities taking place in ISs that lead to technological change. This framework assesses the performance of different activities in the IS as well as the weaknesses and strengths. In all, 14 kinds of literature either recommended this framework as a tool for conceptual mapping of ISs or utilised it in empirical studies where the performance of ISs was assessed;
3. Component-function approach: This approach builds on previous innovation frameworks - component and functional analyses - and integrates them to provide analytical building blocks of a systemic policy framework. In all, 13 literature utilised this approach in different variants, with each differing structurally, functionally or the way they are integrated. It provided a more holistic evaluation rather than using components or functions individually;
4. System failure framework: This framework discusses an alternative view of analysing ISs by identifying the different kinds of failures associated with the elements of ISs. The aim is to be able to analyse systemic performance and design innovation policies to address the imperfections;

5. Triple-helix model: This model highlights the relationship between the three main actors in the IS - academia, industry and government. The framework assesses the performance of ISs through the quality of interaction between the actors;
6. Systems dynamics approach: System dynamics involves the construction of causal loop diagrams that describe causal assumptions of a specific system and often include quantitative modelling through stock and flow diagrams. The dynamic systems approach is suitable for complex, non-linear behaviours in ISs. Hence, it helps to provide feedback and causal analysis that can provide understanding and explanations of these behaviours;
7. Network analysis: This is a qualitative method of analysing the kind of opportunities and benefits accruing from actors in relationships in a network. The nature and strength of the network will go a long way in determining the type of opportunities that exist as well as the benefits that can be appropriated. Using this approach, Adolwa *et al.* (2017) assessed the adoption of new agricultural technology among smallholder farmers in Kenya and Ghana;
8. Data envelopment analysis (DEA): The DEA is an efficiency evaluation method which uses mathematical techniques that can use various variables and constraints to evaluate the relative efficiency of Decision-Making Units (DMUs). In this study, the technique was employed to assess the efficiency of Chinese RIS.
9. Bibliometric analysis: Bibliometric analysis is defined as a statistical evaluation of published scientific articles, books, or the chapters of a book, and it is an effectual way to measure the influence of publication in the scientific community (Iftikhar *et al.*, 2019). In this study, the only journal article using this method undertook a network-based author keyword analysis by integrating social network analysis and bibliometric analysis on the development of RIS research using data obtained from Web of Science databases (Lee and Su, 2010); and
10. Systematic review: This seeks to review the literature on specific studies through a rigorous and documented methodology in the search strategy and the selection of studies. The only study that utilised the methodology was undertaken to develop a conceptual framework for evaluating IISs (Botha, Grobbelaar and Bam, 2016).

The analysis reveals that most studies employed the component-based approach to analysing ISs (Table 4-4). This is explained by the fact that the theoretical foundation of the ISs framework was built on the component approach necessitating its adoption by a majority of

early studies. For instance, in the publication by Christopher Freeman, titled the 'National System of Innovation a historical perspective', Freeman highlighted the historical differences in development trajectories of Western countries by analysing the actors, key institutions and network of relationships responsible for the development and diffusion of new technologies. Other prominent frameworks adopted by the literature assessed in this study are the component-function approach, the functions of IS approach and the systems failure approach (Table 4-4).

Table 4-4: Studies that applied each of the ten evaluation approaches

Method/ Approach	*Studies	Total No
Component of IS	3, 4, 8, 17, 18, 19, 21, 24, 26, 29, 32, 37, 38, 39, 41, 51, 55	17
Functions of IS	1, 5, 6, 11, 12, 15, 22, 30, 42, 52, 53, 54, 57, 58	14
Component-function	9, 23, 27, 33, 34, 43, 45, 47, 49, 50, 56, 59, 60	13
System failure	2, 7, 10, 13, 14, 36	6
Network analysis	25, 44	2
Triple helix	31,48	2
Bibliometric analysis	28	1
Network Data Envelopment Analysis (DEA)	20	1
System dynamics	16	1
Systematic review	46	1

**See the complete list of literature in Appendix A*

The analysis shows a gradual change in methodological approach over time. While the field is still evolving, there seem to be gradual changes in methodological approach from theoretical/conceptual to empirical (Figure 4-9). A possible explanation for this is due to the emerging nature of the field. Most early studies to evaluate ISs from a development perspective tried to develop new concepts from existing theories or frameworks. As shown in this study, many of these rely on theories such as resource-based view, capability approach and social learning to develop new concepts or new lines of thought on which future studies on ISs will be built. However, with a deeper understanding, more empirical studies are now conducted to assess the performance of innovations leading to inclusive development.

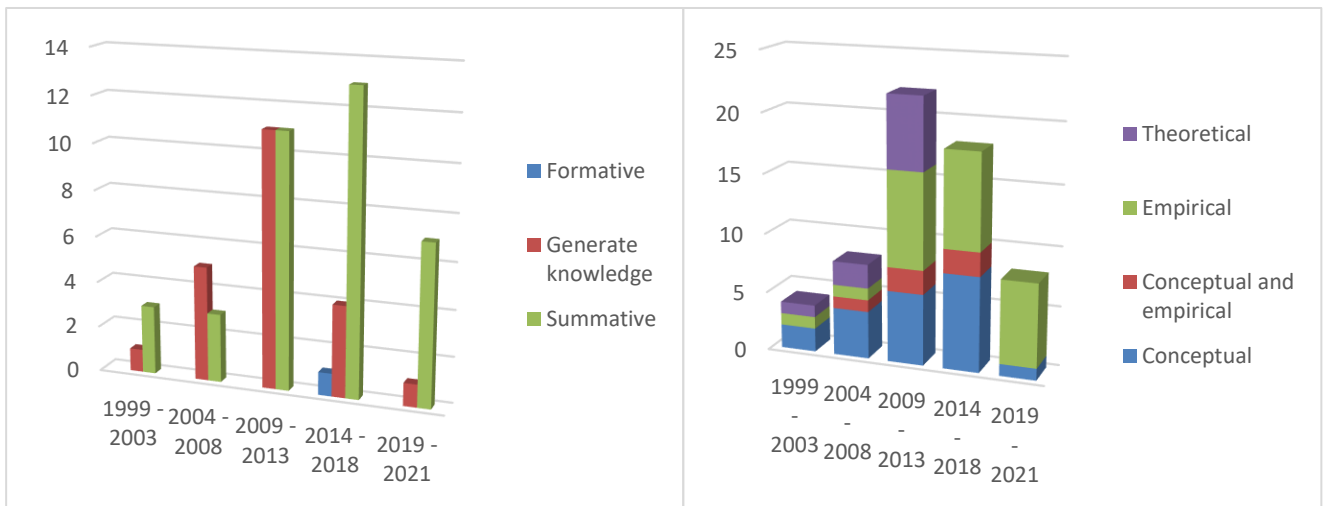


Figure 4-9: Publications by the methodology of the study

Similarly, studies focusing on sectoral innovation systems seem to be attractive options for authors evaluating the performance of ISs (Figure 4-10).

This is because most of the studies were conducted in sectors that offer opportunities for scaling up development or overcoming the emerging challenges or weaknesses associated with ISs. These seek to broaden the understanding of ISs by expanding the sectoral innovation system to include new concepts in different contexts. These include organisational models and institutional arrangements (Arora, Romijn and Caniels, 2014), social inclusive perspective (Scherer *et al.*, 2015), social learning perspective (van Mierlo and Arkesteijn, 2009) or green ICT innovation (Zhang and Liang, 2012). Other studies seek to adapt the traditional ISs framework to inclusive development (Foster and Heeks, 2013b; Botha, 2017; Grobbelaar, Tijssen and Dijksterhuis, 2017).

Top among the sectors are energy, agriculture, MSMEs and ICTs. Agriculture and MSMEs dominate the economic landscape of many developing countries, with many of these countries facing challenges in the energy sector. Following this are studies which do not focus on specific innovation systems; instead, they offer a blueprint for new concepts that can be used to address the weakness associated with implementing ISs approach in developing countries. This explains the nature of the conceptual studies and a few theoretical ones. In addition, empirical studies utilised case studies and qualitative methods to evaluate IS performance of ISs. These allow the studies to undertake exploratory and in-depth analyses of the cases.

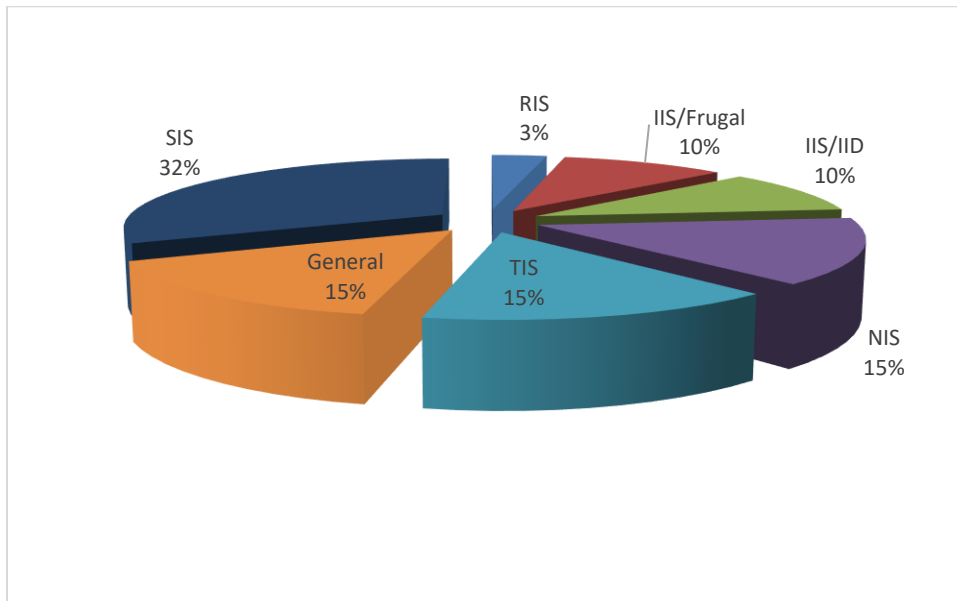


Figure 4-10: Publications by type of innovation system

Table 4-5: Studies that applied each of the ten evaluation approaches

	Assessment of IS methods and approaches						Applicability to the I4ID System framework						
	Mix-method approach	Internal and external analysis	Plethora of actors	Integrated analysis of complex problems	Systemic problems	Policy intervention	A broad range of actors	Inclusion / exclusion criteria	Complete analysis of processes	Learning and relations	Formal and informal institutions	Context-specific	Qual. approach
Components			√			√	√			√	√	√	
Functions	√				√	√			√	√		√	√
Component-function	√		√	√	√	√	√	√	√	√	√	√	√
System failure	√		√	√	√	√	√		√			√	√
Triple helix													
Systems dynamics	√		√				√						√
Network analysis			√				√						√
Data Environ. Analysis			√				√						
Bibliometric analysis			√			√	√						
Systematic review								√				√	√

4.3.2.3 Selection of the Component-Function-Based approach as the promising framework

As noted earlier, an analysis of the 60 literature under review shows that ten different evaluation frameworks were utilised by literature in the study. After a thorough analysis of each evaluation framework, three methodologies: function of ISs, system failure, and component-function frameworks, satisfy most of the criteria needed to evaluate the performance of I4ID systems (Table 4-5).

The analysis reveals that many studies evaluating innovation performance from a development perspective utilised the component framework. However, it is essential to note that many of these studies are theoretical or conceptual reviews. They elucidate how the ISs framework can be made to be more applicable to developing countries (Lundvall, 2007; Lundvall, Vang and Chaminade, 2009); raise conceptual issues that are germane to inclusive development such as governance and socio-technical transitions (Hillman *et al.*, 2011), and organisational models and institutional arrangements to sectoral innovation systems of jatropha (Arora, Romijn and Caniels, 2014). In addition, Foster and Heeks (2013) attempted to modify the existing ISs framework to suit the peculiarities of I4ID by using case studies from Kenya's ICT sector. Only a few empirical studies utilised the component approach in evaluating ISs from a development perspective (Nasierowski and Arcelus, 1999; Szogs, Cummings and Chaminade, 2011; Daka and Toivanen, 2014; Aluko and Okuwa, 2019; Chinseu, Dougill and Stringer, 2021). Chinseu, Dougill and Stringer (2021) utilised KIIs and document analysis to comprehensively analyse stakeholders across conservative agriculture (CA) in Malawi's agricultural innovation system. The study found limited collaboration among stakeholders of Malawi's CA platforms at the grassroots level. Smallholder farmers are not adequately involved in the R&D processes despite being the ultimate beneficiary of CA. This arises from the mismatch between the expectations and priorities of the international donors and local actors, especially the government and the smallholders. On the other hand, Aluko and Okuwa (2019), using the case of the community-based farming scheme in the Federal University of Agriculture, Abeokuta, found out that the livelihoods of the marginalised communities have been enhanced with the introduction of the initiative. Despite this, the threat of marginalisation, driven by inadequate funding of the Scheme and lack of rural infrastructure, remains substantially unchanged.

Another widely used evaluation framework is the functions of the innovation system approach. The approach assesses IS functioning by evaluating the processes within the system. Analysis reveals that the majority of the studies employed empirical techniques. While early studies that

utilised this approach were conceptual, recent studies have shifted to empirical methodologies using qualitative methods to evaluate the functioning of ISs.

Despite the component approach's wide acceptability, the component-function method's use to evaluate the performance of I4ID systems is recommended. The integration of the component and functions approaches offers a holistic and comprehensive view of the evaluation of ISs (Wieckzorek and Hekkert, 2012). It is essential to note other authors' different variations of the component-function approach. For instance, Lamprinopoulou *et al.* (2014), in the comparative evaluation of Dutch and Scottish agrifood sectors, utilised the component-function approach with market, structural and transformational failures, while van der Hilst (2012) used the component-function method by identifying the key elements and processes and the problems hindering the performance of intermediaries in the Vietnamese agri-processing industry. On the other hand, (Maarsingh *et al.*, 2021) used the event history analysis as a tool to undertake the component-function analysis of Information and Communication Technologies for Development (ICT4D) projects. The projects aim to improve the living conditions of elderly rural women in Mafarafara in Limpopo, South Africa. Most of the thirteen studies utilising the component-function approach are either conceptual or theoretical. Like the functional approach, recent studies have also shifted towards empirical analyses (van der Merwe and Grobbelaar, 2016, 2018; Botha, 2017; van der Merwe, Grobbelaar and Bam, 2020; Maarsingh *et al.*, 2021). In the case of the University-driven Technology-based Innovation for Inclusive Development (UTIID) projects in the Western Cape region of South Africa, (Botha, 2017) utilised the component-function approach to develop a framework that identifies system weaknesses within UTIID projects and propose tools to address the systemic weaknesses. Van der Hilst (2012) successfully developed an analytical tool based on the component-function approach to assessing the performance of innovation intermediaries within the agricultural IIS of Vietnam. Both Grobbelaar *et al.* (2016) and Van der Merwe and Grobbelaar (2018) developed frameworks conceptual frameworks for evaluating I4ID system performance using the case of the Department of Economic Development and Tourism (WCDEDAT) and eHealth innovation system, both in the Western Cape region of South Africa respectively.

The analysis presented in this study reveals that the component-function approach satisfies all the requirements for evaluating the performance of the I4ID system. It accommodates a plethora of formal and informal actors and seeks to identify complex relations between actors. The approach also makes a case for context-sensitive studies requiring experimental techniques to evaluate IS's performance. It is therefore concluded that the component-function evaluation

framework offers the most promising pathway for evaluating ISs from a development perspective (Table 4-5). The systemic policy framework developed by Wieczorek and Hekkert (2012) is recommended in this study as a variant of the component-function approach to evaluate the performance of I4ID systems. The framework goes beyond the traditional component-function analysis by integrating two additional frameworks - systemic problems and systemic instruments – to develop a framework for evaluating the performance of ISs. This not only examines the functionality of the IS but also identifies the systemic problems that hinder the system's performance and suggests possible systemic interventions that can strengthen its performance (Wieczorek and Hekkert, 2012). To align with traditional ISs literature, this study still refers to the systemic policy framework proposed by Wieczorek and Hekkert (2012) as a component-function framework.

4.4 CHAPTER SUMMARY

The paper seeks to contribute to the rising literature on I4ID systems by recommending an appropriate methodology for evaluating their performance. Using the systematic review of 60 literatures from Scopus and Google Scholar, the study concluded that the component-function approach offers the most promising methodology for assessing functional dynamics and the performance of I4ID systems. This is because the method satisfies the criteria highlighted in the study necessary for the I4ID context. These include the accommodation of a plethora of actors and complex relations between actors. The approach also makes a case for context-sensitive studies requiring exploratory techniques, which collect qualitative data to assess the functioning of ISs. This is important because studies in this field are still in the infancy stage; hence, the focus should be on exploratory studies using case study approaches in different contexts. This probably explains why early studies in the field are conceptual, using the sectoral innovation system approach. However, trends in recent years have shown a clearer understanding of the subject matter; hence, a gradual move toward empirical studies using qualitative techniques.

After this, the next chapter describes developing the analytical framework for assessing the functional dynamics and performance of the I4ID system.

CHAPTER FIVE : DEVELOPMENT OF ANALYTICAL FRAMEWORK

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
					Summary and conclusions		

5.1 INTRODUCTION

This chapter presents the analytical framework for the study. This follows Chapter Four, the systematic review which recommends the component-function approach as a promising framework to assess the core dynamics of I4ID systems. The framework development was undertaken through a six-stage process adapted from the systemic policy approach of Wieczorek and Hekkert (2012). The approach provides a guide for assessing innovation performance at a systemic level by combining the structural and functional approaches. In doing this, the systemic problems were identified and the solutions proffered. The systemic policy approach is used to develop the analytical framework by adapting each stage to the marginalised's peculiarities. The chapter concludes by proposing a set of instruments to address the systemic problems and attain I4ID systems.

5.2 SYSTEM DESCRIPTION

The systemic policy analysis framework is implemented in five stages. Learning from a similar adaptation of the framework by Van der Hilst (2012) and Van Der Merwe (2017), the framework is modified to a six-stage process as follows:

1. Defining the system boundary;
2. Identifying the structural elements of an innovation system and their capabilities;
3. Undertaking the component-function analysis;
4. Identifying the systemic problems;
5. Identifying the systemic instrument goals; and
6. Designing the systemic instruments aimed at addressing the problems.

5.2.1 Phase One: Definition of the Boundary

A system can be defined around a spatial or geographic space (national, region, sub-region), technology, sector, or activities within the system (Carlsson *et al.*, 2002; Malerba, 2002; Suurs, 2009). This allows a study to define the key elements and the activities that constitute the system and the study. Setting the boundaries of a system aligns with the level of analysis adopted for the study. This could be technology, product or competence bloc (Carlsson *et al.*, 2002). In reality, delineating a system boundary for a specific technology or programme remains difficult. This is because different activities and processes of technologies or knowledge fields are intertwined in a technology continuum. This difficulty leads to the suggestion of a circular approach to boundary definition (Suurs, 2009). Following this approach implies 1. Defining the purpose of the system; 2. Mapping the core structural elements of the system along its purpose; and 3. Constantly modifying the boundaries to include other structural elements as the understanding of the system increases. Defining the system boundary in this way helps to account for context-specificity in the IS framework and also captures the dynamics of the system's activities as it evolves (Suurs, 2009). Hence, in the beginning, the actors, institutions, interactions and infrastructure that make up the I4ID system are identified and modified with new structural elements as the study progresses.

Delineating the boundary of an IS in this way is essential for I4ID. This is because of the heterogeneity and diversity of the structural elements. Relationships are more informal and changeable; actors are diverse – some are large, whilst others are small and informal – and the dominant role of informal institutions exists either to complement or substitute formal institutions (Foster, 2013). In addition, to understand the evolution of I4ID systems, studies must be contextualised along different sectors critical to the BoP market. This is because analysing I4ID around technological or national ISs may be too broad to derive policy solutions that can drive inclusive development (Foster, 2013). The study of a sectoral innovation system within the national borders is desirable because innovation policies and strategies are being developed primarily on the national level, even though they may be influenced by factors external to the boundaries of a nation (Suurs, 2009). Assessing I4ID systems in this way helps to understand the dynamics of activities within the system. Hence, the focus of consideration of the I4ID system is the sector.

5.2.2 Phase Two: Identification of the Structural Elements of the I4ID System

Central to ISs are the structural elements whose activities contribute to the functioning of ISs. Structural elements represent the static aspect of an IS, meaning that they remain relatively

stable over time (Suurs, 2009). The presence or absence and their capacities are critical to the functioning of ISs (van der Hilst, 2012). The elements of an IS are the components (actors, institution and infrastructure) and the interactions between them. Hence, this study identifies four structural elements: actors, interactions, institutions, and infrastructure. These are described below:

5.2.2.1 Actors

Actors are the drivers of ISs through their actions or behaviour. They include any individuals or organisations contributing (with their knowledge and competencies) to the emerging technology or programme in focus, either directly as a developer or adopter of technology or indirectly as a regulator, financier, etc. (Suurs, 2009). Traditionally, they include firms operating in the whole value chain of ISs, knowledge institutions such as universities and research institutions, public bodies and influential interest organisations such as industry associations (Bergek *et al.*, 2008). In seeking to develop a framework for assessing the performance of the I4ID system, the study will identify and examine the critical role played by key actors in the BoP market. The actors comprise a mix of small and large firms, smallholder farmers, and public organisations. Some of these actors are usually marginalised in traditional ISs.

Van der Merwe (2017) identified five categories of actors in the I4ID context as follows:

- Government
- Formal actors
- Intermediaries
- Embedded intermediaries
- Informal consumer/user

In the context of this study, they are broadly classified into four groups: government, formal actors, intermediaries and informal users

a) Government

The position of government as an actor in an IS is well established. What is debatable is the level and the type of public interventions needed in ISs (McCormick and Oyelaran-Oyeyinka, 2007). Government plays an active role in the coordination and setting of the direction of growth of the IS through policy instruments and economic incentives, among others. This is because government policies are crucial in orienting the speed and direction of technological changes (Freeman and Perez, 1988). In the I4ID system, the role of government is more

prominent than in traditional ISs. This is because the BoP market is unattractive to formal, private sector players; hence, governments provide economic incentives, including subsidies and financing schemes to support and steer moves toward new technology adoption. Because government operates at different levels and is represented by different organisations, the I4ID system needs to examine the government's roles to provide a holistic assessment.

b) Intermediaries

Intermediaries strengthen the interaction between actors in the IS by serving as bridging institutions. In the innovation management literature, they are referred to as innovation intermediaries, knowledge brokers, innovation brokers, or knowledge intermediaries. Innovation intermediaries are defined by Dalziel (2010) as “organisations or groups within organisations that work to enable innovation, either directly by enabling the innovativeness of one or more firms, or indirectly by enhancing the innovative capacity of regions, nations, or sectors.” They perform inter-organisational network activities, promotion and lobbying activities, technology development and related activities, leadership roles, and community and consensus-building activities to create collective benefits (Dalziel, 2010). In the agricultural innovation system, the role of innovation intermediaries is classified under three broad headings: demand articulation, network brokerage and innovation process management (Klerkx and Gildemacher, 2012). They, among other things, enhance communication between the actors involved, bridging the cultural and cognitive differences between different knowledge domains. In the context of the I4ID system, intermediaries comprise industry associations, both formal and informal, which play important roles in achieving the objectives of the I4ID system. They are expected to strengthen the IS to facilitate inclusive development, thereby positively influencing the BoP by creating income sources and extending product and service offerings to BoP consumers (van der Hilst, 2012). Within this study, innovation intermediaries are essentially umbrella associations of the different actors informal users (smallholder farmers), SMEs and producer groups serving the BoP market. The insight will be drawn from their functions, roles and contributions to achieving the objectives of the I4ID system.

c) Informal users

The traditional IS is characterised by large, formal, supply-side actors interacting to introduce innovations. However, the I4ID system focuses on small, demand-driven actors (Foster and Heeks, 2013). In agriculture, they are usually smallholder farmers and small businesses that operate mainly in the informal sector. The smallholder farmers are characterised by small

landholdings, labour-intensive technologies, and sub-optimal productivity, which limits their bargaining power (van der Hilst, 2013). Many are uneducated in English and live in rural areas where access to infrastructure is lacking or inadequate. When they live in urban areas, they are usually marginalised in access to productive resources. Therefore, the need to identify the right platform and method to transfer knowledge to them. In many instances, they are neglected in the processes of developing innovation. Instead, they are treated as mere consumers of innovation outcomes. However, Heeks *et al* (2013) argue that the extent to which the marginalised are involved in the innovation processes determines the level of inclusivity of the I4ID system.

5.2.2.2 *Interaction*

Interaction within an IS occurs at different levels and is multi-dimensional. They involve relations between actors, relations between institutions, and between actors and institutions. These are multifaceted (Markard and Truffer, 2008). Lundvall and Johnson (1994) identified four types of knowledge that serve as sources of learning between different actors in an IS:

1. know-why;
2. know-what;
3. know-who; and
4. know-how.

The categorisation refers to the possibility of carrying through transactions with economically relevant knowledge and combining pieces of knowledge in new ways (Lundvall and Johnson, 1994). These are described as follows. Know- what refers to knowledge about 'facts'. Know-why refers to scientific knowledge of principles and laws of motion in nature, the human mind, and society. Know- who refers to specific and selective social relations and networks that can enhance learning. It also involves the social ability to cooperate and communicate with different people and experts. Relational learning may contribute to common codes of information and social bonds of friendship (Lundvall and Johnson, 1994). Closely associated with know-who is know-how which refers to skills and capability to do different kinds of things. Aside from the four broad classifications, Lundvall and Johnson (1994) classified another two, know-where and know-when, as a form of know-how. They refer to knowledge about time and space - the concrete and economically useful knowledge about markets.

The difference between these types of knowledge is that the first two (know-what and know-why) can be coded and reproduced under certain conditions. Knowledge can therefore be reduced to commodities with attendant challenges of transactional costs. However, know-who

and know-how are difficult to turn into codes and, therefore, cannot be treated as commodities in the usual manner. The important consideration about innovation and learning is that all the different categories of knowledge can be combined in the innovation process.

Although knowledge may be found to be abundant, the ability to use it is scarce. Knowledge utilisation depends on the capacity to identify new knowledge, draw from it, and combine it. These have transactional costs and therefore determine the direction and strength of interaction between actors in ISs. The more technically or scientifically advanced the knowledge, the more complicated the communication processes they usually require (Lundvall and Johnson, 1994).

Jensen *et al.* (2016) linked the two modes of learning (STI and DUI) with the knowledge typology. While STI- mode prioritises the production of ‘know- why’, ‘know-who’ and ‘know-how’ find much relevance in the DUI- mode. A form of know-how is the apprenticeship relations prevalent in the informal sector, where the apprentice learns from the master through observation, training and direct instruction. Know-how is what characterises a skilled worker and an artisan, but it is also something that distinguishes the first-rate from the average manager and scientist. Know- who is learnt in social practice, and some of it is understood in specialised education environments; hence, important in groups and social networks (Jensen *et al* 2016). Therefore, in the I4ID system, know-who becomes an important form source of learning where membership in associations is an important network for building social capital and facilitating access to resources. Know-how also develops through day-to-day dealings with customers, suppliers and other actors in the innovation system. Therefore, the DUI mode of learning refers to know-how and know-who, which is tacit and often highly localised. The DUI mode can be intentionally fostered by building structures and relationships, which enhance and utilise learning by doing, using and interacting.

Almost all learning is interactive, and the types of learning depend on the nature of the interaction. Learning arises from different forms – rote learning, systematic and organised searching for new knowledge, learning driven by feedback, as well as those gained from economic activities, which are not explicitly or primarily aimed at its generation, but rather a by-product of activities organised with other aims in mind (Lundvall and Johnson, 1994). The first (organised and systematic searching for new knowledge) is further classified as ‘learning by searching’ while the latter (experiential learning) is referred to as “learning by producing”. These are, however, not mutually exclusive activities. They are interdependent, and many mixed forms exist (Lundvall and Johnson, 1994).

Interactions can be strong, weak or absent (van der Hilst, 2012). Within the agricultural innovation system, the process of innovation, its diffusion and its outcome crucially depend on the extent of interactive learning within the given institutional context and the co-evolution of the system in response to changes within and outside the system (Joseph, Thapa and Wicken, 2018). Within the context of this study, factors that influence the interaction between the different actors will be examined. Particular attention will be paid to both drivers of formal and informal interactions. Informality, because interaction among BoP is primarily driven by informal intermediary organisations and actors facilitating learning and knowledge diffusion in informal settings. This makes social capital, manifesting in the form of trust, shared values, community learning, knowledge generation and sharing, important factors driving learning and interaction within the I4ID system (Joseph, 2014). While the DUI mode of learning is often important and emphasised in the I4ID context, Foster (2013) argues that this is insufficient to explain learning in low-income markets. Learning within this context goes beyond systemic interaction but focuses on contexts of local demand or related to securing or improving livelihoods. Hence, the focus of I4ID systems should emphasise re-ordering relationships and interactions between stakeholders.

Consequently, how is innovation limited or expanded in these relationships? To complicate this perspective, there is also a dynamic consideration. Given that IS framework is often constantly evolving, one also needs to consider the evolving nature of these systems to analyse their relations as systems develop or decline.

5.2.2.3 Institution

Institutions are regarded as the rule of the game, which can be formal (laws, regulations and policies) or informal (norms, practices and beliefs) guiding the activities going on within an IS. Formal institutions are rules codified and enforced by some authority, while informal institutions are tacit and organically shaped by the collective interaction of actors (Suurs, 2009). Institutions are important in determining innovation processes' speed, magnitude, and quality (Berdegué, 2005). Formal and informal policies and institutions shape how actors jointly learn, interact, generate, share, and use knowledge. In the context of I4ID systems, institutions determine the extent to which the marginalised will be able to participate in the process of innovation and share in the potential benefits. The distributional effects of innovation processes are mediated by institutions such as those related to social class, gender, age, ethnicity, or political power (Berdegué, 2005). For ISs to take care of the interests of the BoP, institutions should be modified to address the needs of the marginalised, such as the women, smallholders,

and the poor. Hence, a focus on aspects of the implementation of policy and the role of less formal institutions is essential to fully understand how institutions impact the BoP (Foster, 2013). This is important for I4ID because while government policies and laws are meant to guide the activities of the critical actors in the system, informal institutions play a vital role in the daily activities of the small actors. More so, formal institutions are either lacking or weak, and the role and nature of informal institutions have become more prominent (Utz and Dahlman, 2007). The I4ID system governance structure are examined to determine its inclusiveness regarding the needs and concerns of the marginalised. Another critical factor is the relationship between formal and informal institutions, and how this influences the development and diffusion of I4ID system. The role of policy in shaping institutions and the behaviour of I4ID systems is also examined. This provides insight into appropriate policy approaches that can enhance the performance of I4ID systems. Actors' response to the duality of institutions within the I4ID system will determine how they can benefit from it.

5.2.2.4 Infrastructure

In addition, the study assesses the adequacy of infrastructure to support activities aimed at BoP markets. The place of infrastructure as a structural element of IS is debatable. In some instances, it is subsumed under institutions, while in others, it is identified as a unique structural element as either financial (O'Sullivan, 2005), technological (Link and Metcalfe, 2008), or tangible physical infrastructure (Smith, 1997). Wieczorek and Hekkert (2012) categorise infrastructure into physical, knowledge and financial. Physical infrastructure includes tangible assets such as artefacts, instruments, machines, roads, buildings, telecom networks, bridges and harbours. Knowledge infrastructure comprises knowledge, expertise, know-how and strategic information, while financial infrastructure includes subsidies, financial programs, grants etc. Regardless of the classification, the importance of infrastructure as an enabler of ISs is more pronounced in I4ID systems. This is because of their absence or inadequacy in developing countries, especially in informal settings.

Poor physical infrastructure, especially electricity, has been regarded as one of Nigeria's most significant obstacles to innovation (Radwan and Pellegrini, 2010). A study by Adenikinju (2003) reveals that Nigerian firms spend up to 40% of their overhead on the alternative power source. Availability of electricity has a catalytic effect on farmer incomes and productivity and can be transformational for rural economies (Agrilinks, 2020). Lack of electricity prevents farmers from processing produce and optimising value-addition benefits under favourable market conditions. Because of this, many farmers are forced to sell their crops before they

perish, which also does not encourage farmers to take measures to increase farm yields. Poor roads negatively affect market access and, ultimately, farmers' livelihoods. This is worse in rural areas where smallholder farmers live predominantly. This negatively affects agricultural productivity in rural areas. There is prevailing evidence that public investments in infrastructure- specifically, in the rehabilitation of rural roads, improve the local community and market development (Adepoju and Salman, 2013; Adefalu *et al.*, 2016). Aside from poor rural roads, there is weak telephone connectivity and inadequate electricity supply. Financial support in terms of access to capital, subsidies, and fiscal incentives to support the implementation of I4ID are examined. The study also investigates the factors that enhance capacity building for I4ID systems and the institutional architecture that facilitate competence-building of actors. These cover capacity development at the individual, organisational, and enabling environment levels. This is because the impact of poor infrastructural support on innovation has been found to have a disproportionate effect on the marginalised, bearing most of the brunt (Berdegué, 2005).

Based on the discussion in Section 5.2.2, the structural elements of ISs and the peculiarities of I4ID are summarised in Table 5-1 (von Hippel, 1976; Linna Sonne, 2010; Foster and Heeks, 2013b; Thapa, 2013; van der Merwe, 2017).

Table 5-1: Adaptation of the structure of innovation systems to I4ID peculiarities

Structural elements	Conventional ISs	Adaptation to the I4ID system
Actors	High-income supply side actors R&D institutions	<ul style="list-style-type: none"> • Non- traditional demand-side actors; from intermediaries, suppliers, sellers and lead users who might not generally be defined as innovators • Disenfranchised and marginalised groups • Visibility of micro-enterprises and informal actors. • Demand side innovators • Non-R&D actors; technology developers, and technology providers
Interaction	Formal orientation Focus more on the STI mode of learning Contractual relationships Formal linkages	<ul style="list-style-type: none"> • Informal socialised relations with deep-rooted partnerships with unconventional actors; • Learning centred around the contexts of local demand or related to securing or improving livelihoods • Use of social capital: interaction based on trust, reciprocity, etc. • Emphasis on DUI mode of learning
Institutions	Formal static institutions Government policy, laws, and regulations	<ul style="list-style-type: none"> • Less formal institutions • Strong rules by intermediary associations • Norms and practices
Infrastructure	Physical infrastructure and soft infrastructure from knowledge institutions	<ul style="list-style-type: none"> • Weak or inadequate infrastructure supporting I4ID systems; remote location of some actors further aggravates access to infrastructure • Lack of capabilities by the BoP

5.2.3 Phase Three: Perform Component-Function Analysis of the System

The performance of ISs is analysed through a coupled functional and structural assessment, as functions can only be improved by altering one or several of the structural elements (Hekkert *et al.*, 2007; Bergek *et al.*, 2008; Wieczorek and Hekkert, 2012; van der Merwe, 2017). For policy or diagnostic analysis, each function is assessed from the perspective of the structural elements, i.e. actors, institutions, interactions and infrastructure. This implies that an alteration of the structural elements can either create or remove a new function or strengthen an existing one. The coupled functional–structural analysis, therefore, provides an insight into the happening and diagnosis of ISs (Wieczorek and Hekkert, 2012).

Functions are regarded by Johnson (2001) as the contribution of the components to the ISs goal – development, diffusion and utilisation of innovations. Hence, functions are all the activities within an IS that contribute to the development and diffusion of innovations (Jacobsson and Bergek, 2006a). Since innovation has been defined as a process of technological change, all activities in an IS that contribute to this have to be clearly and systematically identified and mapped (Hekkert *et al.*, 2007). Literature on the function of innovation systems is primarily implemented in cases of disruptive technologies in developed economies, with few implemented in developing country-context (Jacobsson and Bergek, 2006a; Van Alphen, Hekkert and Van Sark, 2008; van der Hilst, 2012; Tigabu, Berkhout and van Beukering, 2015; Botha, 2017; Lizuka and Gebreeyesus, 2017; van der Merwe, 2017). These either focus on the diffusion of renewable energy technologies to developing countries (Van Alphen, Hekkert and Van Sark, 2008; Tigabu, Berkhout and van Beukering, 2015) or export of non-traditional agricultural products in Ethiopia and Chile (Lizuka and Gebreeyesus, 2017) or explain the catch-up and capability building processes in developing countries – Brazil, Korea and Chile (Jacobsson and Bergek, 2006a). Few studies adapted the function of innovation systems approach to I4ID in different sectors: agriculture in Vietnam (van der Hilst, 2012); University-driven Technology-based Innovation in South Africa (Botha, 2017); and health in South Africa (van der Merwe, 2017).

In implementing this study, a new function, the development of positive externalities, is added to the list proposed by Hekkert *et al.* (2007), following Bergek *et al.* (2008a) and Lizuka and Gebreeyesus (2017). This is because the adoption and diffusion of innovations within I4ID systems have the potential for positive externalities and spillover effects to other actors in the system. This is important within the I4ID context as the benefit from exploiting the opportunities offered by innovations influences agricultural and firm productivity and impacts the main actors' livelihoods.

Hence, the following functions are used to develop the analytical framework for assessing the performance of the I4ID system:

- Entrepreneurial activities;
- Knowledge development;
- Knowledge diffusion;
- Guidance of search;
- Resource mobilisation;

- Market formation;
- Creation of legitimacy; and
- Development of positive externalities

The functions are adapted to the I4ID context in this phase by systematically mapping the activities. Thapa (2013) classified the functions as either market or infrastructure functions. Infrastructure functions are the enabling functions that help create the value of the innovation, while market functions focus on implementing the innovation in the market. While the first six functions depict specific activities of the IS, the creation of legitimacy and the development of positive externalities are used to measure the overall performance of the IS (Jacobsson and Bergek, 2006a). These are illustrated schematically in Table 5-2.

Table 5-2: Classifications of functions (Jacobsson and Bergek, 2006a; Thapa, 2013)

Classification 1	Classification 2
Market functions	General function
Market formation	Market formation
Guidance of search	Guidance of search
	Entrepreneurial activities
	Knowledge development
	Knowledge and diffusion
	Resource mobilisation
Infrastructure functions	Performance functions
Entrepreneurial activities	Creation of legitimacy/Counteract
Knowledge development	resistance to change
Knowledge and diffusion	Development of positive externalities
Resource mobilisation	
Creation of legitimacy/Counteract	
resistance to change	
Development of positive externalities	

The functions adapted for this study are described below:

5.2.3.1 Entrepreneurial Activities

The entrepreneur is at the heart of every IS. Their role is to turn the potential of new knowledge, networks, and markets into concrete actions and take advantage of new business opportunities (Hekkert *et al.*, 2007) or identify and select the commercially viable innovations to be commercialised (Johnson, 2001). Therefore, the presence and activity of entrepreneurs is a pointer to the functioning of an IS. This is because the effectiveness of other functions provides a conducive environment for the entrepreneur to blossom (Botha, 2017). Hence, the ability of firms to participate effectively and efficiently in an IS will depend primarily on how the system is developed in terms of its functions (Hekkert *et al.*, 2007). The entrepreneurial function is

measured by mapping the number of new entrants, the diversification activities of incumbent actors, the ease of entry and exit, and the number of experiments with the new technology (Hekkert *et al.*, 2007; Botha, 2017).

Some indicative questions that guide the assessment of entrepreneurial activities are identified as follows (Hekkert *et al.*, 2007; van der Hilst, 2012; Wieczorek and Hekkert, 2012; Thapa, 2013; van der Merwe, 2017):

- How can the business environment be characterised?
- What extent and level of involvement of the marginalised in the IS?
- To what extent are the needs of the marginalised incorporated in the IS?
- How easy is it for entrepreneurs to enter or leave the system? and
- What IP protection/contracts are directed at the disenfranchised to assure fair treatment and involvement?

5.2.3.2 Knowledge Development

The function captures the breadth and depth of the IS knowledge base (Jacobsson and Bergek, 2006a). Central to the process of knowledge development is learning. While the traditional IS views learning from the narrow perspective of STI mode, the learning process in the I4ID system emphasises a broader perspective of DUI mode. The STI mode emphasises formal R&D as the source of knowledge development, whereas the DUI mode covers other aspects of learning, especially tacit and localised knowledge. In the I4ID setting, knowledge development takes place through training, apprenticeship, and partnerships between different actors. Therefore, the traditional indicators, R&D investments, and patents used to measure knowledge development in conventional ISs are irrelevant.

To assess the knowledge development function in the I4ID context, the following indicative questions guide the process (van der Hilst, 2012; Thapa, 2013; Botha, 2017; van der Merwe, 2017):

- What is the adequacy of the research capacity to support I4ID?
- What is the level of involvement of the marginalised in knowledge development?
- How does learning take place?
- What and who are involved in the process of knowledge development?
- Is there collaboration between different producers of knowledge, between producers and users?
- Is the knowledge that is created of sufficient quantity and quality?

5.2.3.3 *Knowledge Diffusion*

The diffusion of technology or knowledge represents the flow of knowledge between several innovation system stakeholders. It is centred on the process of learning. This occurs during interactions between network actors involved in the system, from knowledge producers to users. Within the context of I4ID systems, knowledge diffusion is centred on the know-how of using the IS and the benefits appropriated by the key actors. Hence, the knowledge's type and method of dissemination are important in the I4ID system context. The nature and level of interactions between the key actors are assessed. Also, the kind of learning and the factors that enhance learning relevant to the I4ID systems are evaluated. This includes the role of social capital in the diffusion of new technologies to the BoP. Other factors are investigated, such as the availability and accessibility of resources and skills needed to effectively utilise and diffuse the innovation.

The indicative questions that guide the knowledge diffusion function include (van der Hilst, 2012; Thapa, 2013; van der Merwe, 2017):

- What kind of knowledge is being diffused?
- To what extent is knowledge disseminated?
- What are the platforms or methods used in knowledge sharing and diffusion? Are these appropriate and adequate?
- What is the role of actors, especially the marginalised, in knowledge diffusion?

5.2.3.4 *Guidance of the Search*

This is also referred to as demand articulation or influence on the direction of search (Bergek *et al.*, 2007). The function refers to those activities by users and suppliers of technology within the IS that can positively affect the visibility and clarity of specific wants among technology users (Hekkert *et al.*, 2007). It refers to the choices of individual actors to support emerging innovation (van der Merwe, 2017). The function, therefore, assesses the willingness of intended targets to adopt or reject the technology. There is the need to adopt different policy mixes to incentivise, induce or pressure the actors through regulations to adopt the technology to achieve the objective of the function (Bergek *et al.*, 2008). This function is important for emerging innovations, especially in the I4ID context. This is because significant investments are required for the development and diffusion of innovations within the BoP market. Many investors shy away due to low potential for profit maximisation, lack of trust, or poor awareness. Hence, appropriate policies and incentives are needed to guide the process of determining potential new actors entering the system (Suurs, 2009). The role of policy and incentives to stimulate

demand among the actors responsible for the diffusion of I4ID, the adequacy of the incentives, as well as the factors influencing these are examined. In addition, the role of intermediaries in influencing the demand and diffusion of the I4ID are also analysed.

Consequently, the following questions guide the evaluation of the guidance of the search function:

- What targets are being set? Are these realistic?
- Do the targets sufficiently address the expectations of the marginalised?
- What were the views and expectations of actors of the emerging I4ID?
- What institutional support exists for the emerging innovations for inclusive development?
- What were the tangible manifestation of I4ID in terms of the promises and expectations (targets and constraints) – the belief that exists for the future growth and influence on disenfranchised, not only disenfranchised but also for investors?

5.2.3.5 Market Formation

Most studies focus on the market formation function of creating a new market or strengthening the capacity of the existing market to absorb new technologies, products or services. The aim, therefore, is to build a successful market structure around the I4ID system to support the technology to achieve its intended benefits and ensure the buy-in of critical stakeholders for its successful diffusion (van der Merwe, 2017). Issues bordering on incentives and policy environment that can accelerate the diffusion of innovations aimed at the BoP market are important to market formation.

In assessing the market formation function in I4ID systems, the following questions serve as a guide:

- What are the characteristics of the market?
- What kinds of incentives or policies are offered to stimulate market formation? Are these sufficient?
- Can the potential consumers buy the end product at its regular price, or do they need support?
- Must a new market be created or open up an existing one?
- What are the incentives for scaling up? Are these adequate?

5.2.3.6 Resource Mobilisation

For every IS, a range of resources, human, managerial, technological, financial and other complementary assets, have to be mobilised. The extent to which these resources are mobilised will determine the success or otherwise of the system (Jacobsson and Bergek, 2006a; Bergek *et al.*, 2008). Within the context of the I4ID system, financial and physical (roads, buildings, technological) resources are often limiting factors for innovation (van der Merwe, 2017). This is worse in developing countries, which suffer from a dearth of expertise, finance, physical infrastructure, and complementary services that aid the diffusion of innovations to BoP. Therefore, policies and programmes to implement innovations for the BoP market should examine strategies to mobilise resources. The challenges of formal finance mechanisms in supporting SMEs and informal actors have been documented (Kauffmann, 2005; Oyefuga *et al.*, 2008). This is because of recent positive changes in commercial banks through modifying their operational activities to suit the informal sector (Harriss-White, 2017). Hence, the study examines the role of commercial banks and other formal institutions in financing the I4ID system. In addition, alternative financing sources that will guarantee value and sustainability are examined. This is because of the dwindling government revenue and competition for scarce public resources. Alternative institutional sources include private-public partnerships, financing from multilateral and development partners, etc., but the question remains their applicability in the I4ID context. It is also important to assess the informal financing mechanism used by actors supporting the BoP market. This is because effective strategies for mobilising resources provide access to the needed resources and offer legitimacy to ISs (Lizuka and Gebreeyesus, 2017).

The following questions guide the assessment of the resource mobilisation function in the I4ID context:

- What are the size and type of investments?
- What kind of human resources are needed? Are these sufficient to drive the programme?
- Do the marginalised have access to financial resources? What are the terms for accessing financial credits?
- What kind of technological capabilities is needed to be implemented in disenfranchised space?
- What are the infrastructural barriers to resource mobilisation in BoP markets?

5.2.3.7 *Creation of Legitimacy*

Legitimacy concerns the social acceptance of new technologies and the activities that support this (Botha, 2017). The desirability of the technology by relevant actors will enhance the successful mobilisation of resources and demand articulation by actors in the new technology (Bergek, Jacobsson and Sandén, 2008). Legitimacy is crucial to the success of diffusion and demand articulation functions. There is the usual resistance to change about new technologies, especially when farmers are used to a particular type of technology (Ntshangase, Muroyiwa and Sibanda, 2018). Hence, there is the need for concerted efforts to enlist the buy-in of critical actors to enhance the rapid diffusion of innovations meant for the BoP market, thereby creating legitimacy for the technology. This can be done through partnerships between different actors especially the marginalised and intermediary associations. The role of interest groups and intermediaries such as industry associations in legitimising innovations relevant to the BoP market are important considerations. In addition, incentivising the process through subsidies helps to counteract the resistance to change and creates legitimacy.

The following questions guide the assessment of the creation of legitimacy function;

- What is the experience of actors with previous programmes/projects in the agricultural sector?
- Is there a coalition forming?
- Does the private sector show commitment to the advancement of the sector?
- Is there resistance to change? Where is the resistance coming from? How does this resistance manifest itself?
- What is the lobbying power of the actors in the system?
- Is investment in the technology seen as a legitimate decision?

5.2.3.8 *Development of Positive Externalities*

The systemic nature of the innovation and diffusion process strongly suggests that the generation of positive external economies is crucial in the formation and growth of a TIS (Bergek, Jacobsson and Sandén, 2008). Externalities in the context of ISs generally refer to benefits accruable to one part or component of the system because of activities in the other parts or components. They are beneficial spillovers to parties within the IS as an outcome of the development and diffusion of innovations. These are sometimes referred to as external economies or free utilities and may be either material or otherwise. The function works through strengthening the other seven functions and may therefore be a good indicator of the system's overall performance (Bergek *et al.*, 2008). A driver of externalities is the entrance of new firms

into the IS. This helps to resolve initial scepticism and uncertainties, strengthen the political power of advocacy coalitions and improvement on the system through further experimentation. These contribute to the IS's guidance of search, legitimacy and entrepreneurial functions. The positive externalities development's function indicates the system's dynamics since externalities magnify the strength of the other functions (Bergek *et al.*, 2008). To summarise, the strength of the positive externalities function can be analysed by searching for external economies in the form of resolution of uncertainties and scepticism, political power, legitimacy, combinatorial opportunities, pooled labour markets, specialised intermediates, as well as information and knowledge flows. These, in turn, lead to the emergence of other functions such as market formation, knowledge diffusion and resource mobilisation. For instance, positive externalities may improve legitimacy, which in turn, may positively influence changes in 'resource mobilisation', 'influence on the direction of search', 'market formation' and 'entrepreneurial activities'(Lizuka and Gebreyesus, 2017).

The following indicative questions are used to evaluate the positive externalities function.

- Is there an emergence of pooled labour markets?
- Are there the emergence of specialised intermediate goods and service providers?
- Is there an emergence of new actors and industries?
- Do information flows and knowledge spill-overs evolve?
- How were the initial uncertainties and scepticism overcome?
- Are there combinatorial opportunities with the innovation?
- What is the strength of the political power of advocacy coalitions?

The summary of the application of the function of the innovation system approach to the I4ID context is presented in Table 5-3 (Van der Hilst, 2012; Van Der Merwe, 2017; De Fuentes, Figueiredo and Peerally, 2018).

Table 5-3: Application of functions of innovation system to I4ID context

Functions of IS	Issues about the I4ID system
Entrepreneurial activities	The inclusion of unconventional actors, usually small enterprises and smallholders, as knowledge enablers and diffusers and inclusion in the entire process of innovation development and diffusion. Entrepreneurs are out of necessity rather than out of opportunity. Factors that enable low entry and exit and capacity to scale up the technology should be factored in.
Knowledge development	Driven by non-R&D modes, the DUI mode facilitates learning. Market pull strategies take the requirements of the marginalised into account. Considerations of literacy, capabilities and capacity of marginalised groups in the design and development of innovations. Using marginalised actors as knowledge providers. Forms of training and development provided to marginalised groups
Knowledge diffusion	Diffusion is based on strong, informal social ties and networks. Informal intermediaries play an essential role in diffusion.
Guidance of search	Government is at the heart of designing policies and setting targets and promises; experience from previous programmes influences trust. Need for clear plans, structured targets, incentives, and governmental policies toward inclusive development.
Resource mobilisation	Mobilising and developing infrastructure, funds, technologies and innovations focusing on the peculiarities and requirements of the disenfranchised. Alignment of resources to the needs of the system. Incentives for successful scaling programmes or innovations encourage local entrepreneurs to participate actively.
Market formation	Special governmental efforts to develop an environment that support I4ID and to prepare the market for successful uptake of innovation.
Legitimacy	It is essential to form legitimacy around a market and, more importantly, around the impact of interventions in disenfranchised markets, especially legitimacy from

	disenfranchised actors. Intermediary associations play a significant role in advocacy. The role of government in driving legitimacy.
Positive externalities	Unintended benefits of the implementation of a technology or programme. The impact on the livelihoods, recognition and goodwill. Spillover effects help to enhance the sustainability and legitimacy of I4ID programmes.

5.2.4 Performing the Component-Function Analysis

The component-function analysis is undertaken in two stages. First, the weaknesses within functions of a specific IS are identified. Second, the weaknesses are analysed from a structural perspective to determine their relatedness to particular structures. This allows a researcher to explore the functionality of an IS from a systemic perspective. A critical assessment of processes that contribute to the build-up or breakdown of the I4ID system is then assessed through the contribution of the different structural elements to the activities that make up the system.

5.2.4.1. *The EHA as a component-function analysis tool*

The EHA methodology is utilised to undertake the component-function analysis. The EHA therefore provides the evaluative tool to exploring the functional dynamics of the I4ID system. Within the EHA, events constitute the primary analytical unit. These can be interpreted in two ways: concrete facts, capturing what is happening within the TIS on the level of structural factors and concepts explaining a system's performance as a whole (Suurs, 2009).

Following the identification of the structural elements of an I4ID system, as they contribute to its performance, the evaluation will emerge as a socially constructed judgement that arises from within the system. This enables the researchers to build a historical narrative of the evolution by collecting the events that map the activities. The researcher, therefore, determines the performance of the I4ID system by relating the successes and failures of the activities to system functions through the events. This makes system functions a suitable framework for exploring the performance of an I4ID system in terms of activities that contribute to its build-up or breakdown. When build-up occurs, it is referred to as a virtuous cycle, otherwise, a vicious cycle. The consequent reaction of the structural elements to a virtuous or vicious cycle is called cumulative causation. Consequently, through the EHA, an analysis of structures that relate to these functions, either as underlying causes of change (drivers and barriers) or as targets of

change (impact), can be undertaken. In addition, the interaction between the different functions and the dominating functions that accelerate the growth of the I4ID system is examined. These are referred to as motors of innovation (Suurs, 2009) and are described below.

5.2.4.2. *Motors of Innovation*

Suurs (2009) classified motors of innovation into four: science and technology push motor, entrepreneurial motor, market motor and system-building motor. Each of the motors is characterised in terms of dominant system functions and interactions between the system functions. Two new motors – demand-pull and interaction are added to cater for some peculiarities in the I4ID system. Consequently, the motors of innovation are explained briefly as follows:

a) Science and Technology Push Motor

The Science and Technology Push (STP) motor refers to a pattern in ISs dominated and driven by knowledge development and diffusion, especially R&D activities (Walrave and Raven, 2016). The motor is knowledge-intensive, implying that positive expectations lead to research activities whose outcome will define the direction of the innovation system. A favourable outcome galvanises advocacy coalition, resource mobilisation, the guidance of search, and knowledge diffusion (Suurs, 2009). The STP motor is dominated by knowledge development, knowledge diffusion, the guidance of the search, and resource mobilisation. In this motor, entrepreneurial activities are absent or, at most, weak, while the creation of legitimacy plays a minimal role. Within the context of I4ID, knowledge development and diffusion are characterised by non-R&D activities driven by experiential learning. This leads to the development of a new motor – interaction motor.

b) Entrepreneurial Motor

The motor presents a pattern where entrepreneurial activities of firms drive an innovation system by leveraging potential technology opportunities. The rise in entrepreneurial activities helps to give legitimacy to the technology, thereby attracting investments from government and private actors (Walrave and Raven, 2016). While activities such as knowledge development, knowledge diffusion, the guidance of the search and resource mobilisation continue to be relevant in this motor, entrepreneurial activities become dominant. This is what practically distinguishes the entrepreneurial motor from the STP motor.

c) Market Motor

This motor is catalysed by an institutional framework that guarantees a market for a new or emerging technology. This refers to a pattern in which the IS can nurture the technology to maturity from sufficient market demand needed to sustain its growth (Walrave and Raven, 2016). In this motor, the market is established, and all the functions are active in the realisation of the goal of the TIS. This helps to create expectations, mobilise resources, and increase entrepreneurial activities about the technology (Suurs, 2009). In this motor, it is expected that all functions take an active role except the creation of legitimacy since the need for an advocacy coalition is low in an already established market.

d) System-building Motor

The system-building motor is similar to the entrepreneurial motor but increases the intensity of the entrepreneurial activities. It indicates a pattern in an IS characterised by new institutions, enactment of structures and agencies, and institutional reconfigurations needed to create a conducive environment for attracting new actors or expanding the entrepreneurial activities of existing actors (Walrave and Raven, 2016). It is initiated by firms considering potential pre-commercial technology opportunities (Suurs, 2009). The only difference is the ability of the firms to work together with others, thereby developing a network which can pull resources, organise, form coalitions and seek support from the government to develop the technology to a market-ready state further. Hence, the system-building motor, while starting with entrepreneurial activities, ultimately captures all the other functions of the innovation system.

e) Motor of Decline

As noted earlier, the interaction between functions may reinforce either the build-up or breakdown of an IS. The motors above define the acceleration of functions, reinforcing one another towards the build-up of ISs. However, otherwise, it is referred to as a motor of decline. Factors responsible for this include overstretched expectations and a limited structural basis in terms of institutions, actors or networks, which makes it difficult to withstand shocks or distrust among actors based on disappointing outcomes (Suurs, 2009).

It is important to note that the classification of motors of innovation is within the context of the cases studied by Suurs (2009). Therefore, the type may be enlarged depending on the context being studied. Hence, introducing two new motors relevant to the context of I4ID – demand-pull and interaction motors.

f) **Demand-pull and Interaction Motors**

In the case of I4ID systems, formal R&D activities are weak or missing; hence, STP motor may be non-existent. Market formation may result from two factors: demand-pull and interaction effects. In demand-pull, investments in new markets are determined by opportunities created by changes in market conditions (Nemet, 2009). Regulatory demand-pull policies have become an effective catalyst in the formation and growth of new markets (Hannon, Foxon and Gale, 2015). These become more important in the context of I4ID, where regulatory policies are needed to stimulate private-sector participation in BoP markets which are usually considered unprofitable (Prahalad and Hammond, 2002). Another important motor important in the I4ID context is the interaction motor. Learning from the concept of positive interaction effects (Nemet, 2009), innovation occurs not only due to science-push and demand-pull activities but also due to their interaction. This is similar to the concept of user-producer interaction (Lundvall, Vang and Chaminade, 2009). The interface between actors enables the flow of knowledge upon which learning occurs. Hence, the interaction between a broad range of actors leads to the implementation of innovation (Godin, 2016).

Much more importantly is the fact that science is not a compulsory activity in the innovation process. Hence, the concept of positive interaction effects is important in the I4ID context. This is because the learning and knowledge development process is driven by actors' interaction and experimentation with new technologies within the I4ID system; hence, the prevalence of the DUI mode of learning. The DUI mode emphasises actors' experience and informal interactions between actors resulting in competence building, often with tacit elements (Jensen *et al.*, 2007). It is localised, tacit and contextualised. It focuses on diffusion, use, problem-solving and broader social processes (Foster and Heeks, 2013b). Therefore, it is assuring that the use of the DUI mode of learning to examine sectoral innovation in developing countries has taught the importance of interaction and learning between actors in I4ID settings (Foster and Heeks, 2014).

5.2.5 Phase Four: Identification of the Systemic Problems

Systemic problems hinder the development and diffusion of ISs. They are also called system failures, imperfections or weaknesses (Wieczorek and Hekkert, 2012). Failure is used loosely as problems affecting the functioning of ISs, not necessarily the perfection or optimality implied in traditional economics. This is because ISs are path-dependent, and there is no ideal or optimal system. Failure, as used in mainstream economics, becomes inapplicable in IS context (Chaminade and Edquist, 2010; Wieczorek and Hekkert, 2012). This is important in

developing countries where the ISs are typically fragmented or emerging. While the literature on systemic failures, like other concepts in ISs, take root in mature ISs in developed economies and have been developed in correcting failures in well-functioning ISs, policy needs to account for different kinds of failures associated with missing or weak component and with missing or weak links among the components prevalent in developing countries (Chaminade *et al.*, 2009). Learning from literature, Chaminade *et al.* (2009, p. 5) define a systemic problem broadly as “the inability of the system to support the creation, absorption, retention, use and dissemination of economically useful knowledge through interactive learning or in-house R&D investments.” Systemic problems occur if there is a problem with any of the components of the system, the relationship or attributes (Wieczorek and Hekkert, 2012).

Aside from performing component-function analysis, the EHA is also used to identify systemic problems. This is done by identifying the weak or missing functions in the system. The process begins by counting the occurrence of the event type over the lifecycle of the I4ID system and allocating them to a specific function. Whenever an event occurs, it is allocated a positive value of 1 (+1) and added to the total value for the particular function. On the contrary, when an event is absent or insufficient, it is allocated a negative 1 (-1). It is then subtracted from the function’s total value (A template for identifying the positive and negative events in the I4ID system is shown in Table 5-4). All indicators carry the same weights. The comparison between the result and the highest possible score for a specific function is used to identify the problem areas of the I4ID system and the potential areas for improvement.

Table 5-4: Allocation of events to functions of the I4ID system

Function	Functional indicators typical to the I4ID system framework	Value
Entrepreneurial Activities	Commencement of programme	+1
	Termination or suspension of the programme	-1
	Entry of firms or informal actors	+1
	The exit of firms or informal actors	-1
	Portfolio expansion	+1
	Portfolio contraction	-1
Knowledge Development	Commissioned research studies	+1
	No commissioned research studies	-1
	Different learning types – learning by doing, learning by searching, learning by using, learning by interacting	+1
	Poor learning types	-1
Knowledge Diffusion	Alliances between actors	+1
	Poor alliances between actors	-1
	Awareness campaigns	+1

	Poor and inadequate awareness campaigns	-1
	Stakeholders' engagement	+1
	Inadequate stakeholders' engagement	-1
	Training of key actors	+1
	Lack or insufficient training activities	-1
Guidance of Search	Communicate research outcomes to the public	+1
	Improper communication	-1
	Defining expectations	+1
	Undefined expectations	-1
	Designing favourable regulations and policies	+1
	Lack of or unfavourable regulations or policy	-1
	Setting policy targets, standards and research outcomes	+1
	Lack of target or unrealistic target	-1
Market Formation	Reforming regulations and program structure	+1
	Lack of or inadequate reforming regulations	-1
	Regulations supporting niche markets	+1
	Lack of or poor regulations supporting niche markets	-1
	Setting tax incentives, exemptions or other financial incentives	+1
	Lack of or inadequate incentives	-1
Resource Mobilisation	Infrastructure developments	-1
	Insufficient infrastructural development	+1
	Loans and credit	-1
	Insufficient access to loans and credit	+1
	Recruiting human resources (including consultants and technical staff)	-1
	Inadequate or exit of human resources	+1
Creation of Legitimacy	Advocacy coalitions	+1
	Poor advocacy coalitions	-1
	Lobbying activities	+1
	Lack of or ineffective lobbying activities	-1
Development of positive externalities	Spillover effect to actors within the I4ID	+1
	No spillover effects	-1
	Award and recognition	+1
	Criticism and lack of recognition	-1
	Creation of new industries	+1
	No new industries created	-1

Systemic problems occur when there is a malfunctioning or absence of the structural elements of the I4ID system, which hinders the process of learning and innovation, thereby slowing down the innovation system as a whole (Woolthuis, Lankhuizen and Gilsing, 2005). Therefore, they negatively influence the direction and speed of innovation processes and hinder the

development and functioning of ISs (Wieczorek and Hekkert, 2012). Woolthuis, Lankhuizen and Gilsing (2005) developed a framework for analysing systemic imperfections around each element of an IS. These are described as an actor, institutional, interaction or infrastructural failure. Learning from these, a typology which can be used to assess systemic failures is developed (Table 5-5). Within the context of the I4ID system, systemic problem analysis is aimed at identifying possible system processes that hinder the ability of the system to effectively meet the needs of the BoP and then identify the structural elements responsible for the malfunctioning.

The problems can therefore be summarised as follows:

- Presence or capabilities of actors;
- Presence or quality of institutions;
- Presence or quality of interactions; and
- Presence or quality of infrastructure.

In adapting this to the I4ID context, lessons are drawn from Van Der Merwe (2017). Issues critical to the marginalised are emphasised. These include lack of competence on the part of actors, entry barriers to micro-enterprises, the weak linkage between the enterprises and other actors such as government or financial institutions, access to market, weak capacity for absorption of innovation, inadequate infrastructure, and non-recognition of informal laws and regulations.

Table 5-5: Identification of systemic problems (Wieczorek and Hekkert, 2012)

Functions	Structural elements	Systemic problems	Type of systemic problems	Description
F1 ... F8	Actors	Actors' problems	Presence Capabilities	Identify missing actors <ul style="list-style-type: none"> • Weak absorptive capacity • Lack of competence on the part of actors • Transition problems among actors
	Interactions	Interaction problems	Presence	Weak/missing interactions resulting from: <ul style="list-style-type: none"> • Lack of trust, especially between government and other actors (social capital) • Cognitive distance between the actors • Non-clarity or opposing objectives

		Quality	<ul style="list-style-type: none"> • Conflicting objectives between actors • Weak linkage between key actors inhibiting learning and diffusion of innovation • Strong network problems • Myopia – arrangement is biased towards existing actors and relationships
Institutions	Institution problems	Presence	Missing institutions – laws, policies, etc. Neglect of informal institutions – norms, etc.
		Quality	Weak institutions
Infrastructure	Infrastructure problems	Presence	Missing infrastructure (physical, financial, technological, etc.)
		Quality	Poor or inadequate infrastructure

5.2.6 Phase Five: Identify the Systemic Instrument Goals

After identifying the systemic problems, the next step is to suggest the strategies and tools that would aim to solve the problems, thereby positively influencing the overall functioning of the I4ID system. These are systemic instruments (Smits and Kuhlmann, 2004). The goals of systemic instruments are prescriptive and meant to support policy design and the selection of tools that can address the identified problems holistically (Wieczorek and Hekkert, 2012). Building on the work of Smits and Kuhlmann (2004), Wieczorek and Hekkert (2012) identified eight goals of systemic instruments that can be used to address the challenges of systemic problems within an IS as follows:

1. Stimulate and organise participation of relevant actors;
2. Create space for actors' capability development;
3. Stimulate occurrence of interactions;
4. Prevent too strong and too weak ties;
5. Secure presence of hard and soft institutions;
6. Prevent too weak and too stringent institutions;
7. Stimulate physical, financial and knowledge infrastructure; and
8. Ensure adequate quality of infrastructure.

These goals assist in targeting specific elements of an IS to address the structural problems hindering the system's performance (Table 5-6). Therefore, systemic instruments aim to create

a conducive environment for the optimal performance of the IS (Wieczorek and Hekkert, 2012). The goals are adapted to the I4ID context in designing the systemic instruments to enhance its functioning.

Table 5-6: Identification of systemic instruments' goals

Functions	Systemic Problems	Type of systemic problems	Description	The goal of systemic instruments
F1 – F8	Actor problems	Presence	Missing actors	Stimulate and organise the participation of relevant actors
		Capabilities	Weak absorptive Capacity	Create spaces for actors' capabilities development
	Interaction problems	Presence	Missing interactions	Stimulate necessary interactions between diverse actors
		Quality	Strong or weak network problems	Block ties that are either too strong or too weak
	Institution problems	Presence	Missing institutions	Stimulate the presence of hard and soft institutions
		Quality	Stringent or weak institutions	Prevent too weak and too stringent institutions
	Infrastructure problems	Presence	Missing infrastructures	Stimulate the presence of different infrastructure
		Quality	Insufficient or poor Infrastructure	Ensure adequate quality of infrastructure

5.2.7 Phase Six: Design the Systemic Instruments Aimed at Addressing the Problems

A systemic policy approach aims to design policies and instruments to address systemic innovation problems that negatively influence the speed and direction of the innovation process (Table 5-7). These instruments are therefore geared towards achieving the systemic goals of a specific IS. Since this study is conceptualised within the context of I4ID, the instruments will consequently be designed to address the challenges associated with the effective functioning of the I4ID system and meet the needs and concerns of the marginalised. The systemic instruments identified by Wieczorek and Hekkert (2012) and used by van der Merwe and Grobbelaar (2018) are therefore adapted as policies and instruments that can strengthen the I4ID system performance.

Table 5-7: Identification of systemic instruments

Description of Systemic problems	Systemic goals	Systemic instruments
Missing actors	Stimulate and organise the participation of relevant and marginalised actors.	<ul style="list-style-type: none"> • New forms of Public-private Partnerships • Fiscal incentives such as tax holidays or rebates
Weak absorptive Capacity	Create spaces for actors' capabilities development	<ul style="list-style-type: none"> • Workshops • Training and education sessions • Formal engagements
Missing interactions	Stimulate necessary interactions between diverse actors	<ul style="list-style-type: none"> • Establishment of innovation platforms • Enabling social capital platforms, e. g. farmers' association
Strong or weak network problems	Block ties that are either too strong or too weak	<ul style="list-style-type: none"> • Incentivize interaction through strong IPR; • Tax incentives to stimulate the BoP market; • Review procurement laws
Missing institutions	Stimulate the presence of hard and soft institutions	<ul style="list-style-type: none"> • Enact new policies and laws • Incorporate informal norms and practices
Stringent or weak institutions	Prevent too weak and too stringent institutions	<ul style="list-style-type: none"> • Reform credit incentive provisions to favour the small actors; • Strengthen programme policy; • Participatory planning
Missing infrastructure	Stimulate the presence of relevant infrastructure	<ul style="list-style-type: none"> • Government investments in physical infrastructure • Fiscal and monetary interventions, e.g. subsidies, tax rebates/holidays, etc.
Insufficient or poor infrastructure	Ensure adequate quality of infrastructure	<ul style="list-style-type: none"> • New technologies/technology platforms suitable for rural areas • New technology platforms to overcome the challenges with infrastructure in the rural areas

5.3 ANALYTICAL FRAMEWORK FOR EVALUATING THE PERFORMANCE OF I4ID SYSTEM

Adapting the traditional IS approach to I4ID system indicates the need to remodel each element to address the marginalised's peculiarities. As noted earlier, the core components and focus of ISs are well suited to explaining the functional dynamics of the I4ID system. However, there is a need to tinker with the way the components and processes of conventional ISs are structured to accommodate the needs and concerns of the BoP. This is done by accommodating new actors, institutions, interactions and infrastructure important in the context of the I4ID system.

In addition, the processes of technology diffusion, informal demand side actors and intermediaries, and the role of localised and informal institutions are examined (Foster and Heeks, 2013b). In this study, the IS framework is developed by evaluating the structural elements and functions in light of the peculiarities and needs of the BoP. Therefore, the analytical framework hopes to broaden the research landscape and understanding of ISs in I4ID settings. Van Der Merwe (2017) summarised the issues to take note of in adapting the IS framework to I4ID as follows:

1. engage and support a new constellation of actors;
2. identify a range of new institutions and a “reinvention of the commons”;
3. real requirement for social innovation;
4. actors to engage in new ways; and
5. identify new capabilities which have implications for the type and form of learning that needs to take place.

Other issues of interest, according to Foster (2013), are:

1. Innovation needs to be conceptualised in minor processes, as well as the inclusion of broader intermediary actors and a more contextual examination of relations and institutions;
2. The role non-lead firm actors, particularly micro-enterprises, play in driving innovations towards low-income users;
3. How systems actors connect and learn from such activity through network relations; and
4. The relationships that engineer interactive learning and reverse learning flows between system actors and demand-side intermediaries.

Analytical frameworks developed through the adaptation of IS approach to the I4ID system would therefore need to build on this narrative to adequately capture the peculiarities of I4ID. Based on the discussion in this chapter, the analytical framework for analysing the performance of the I4ID system is presented in Figure 5-1

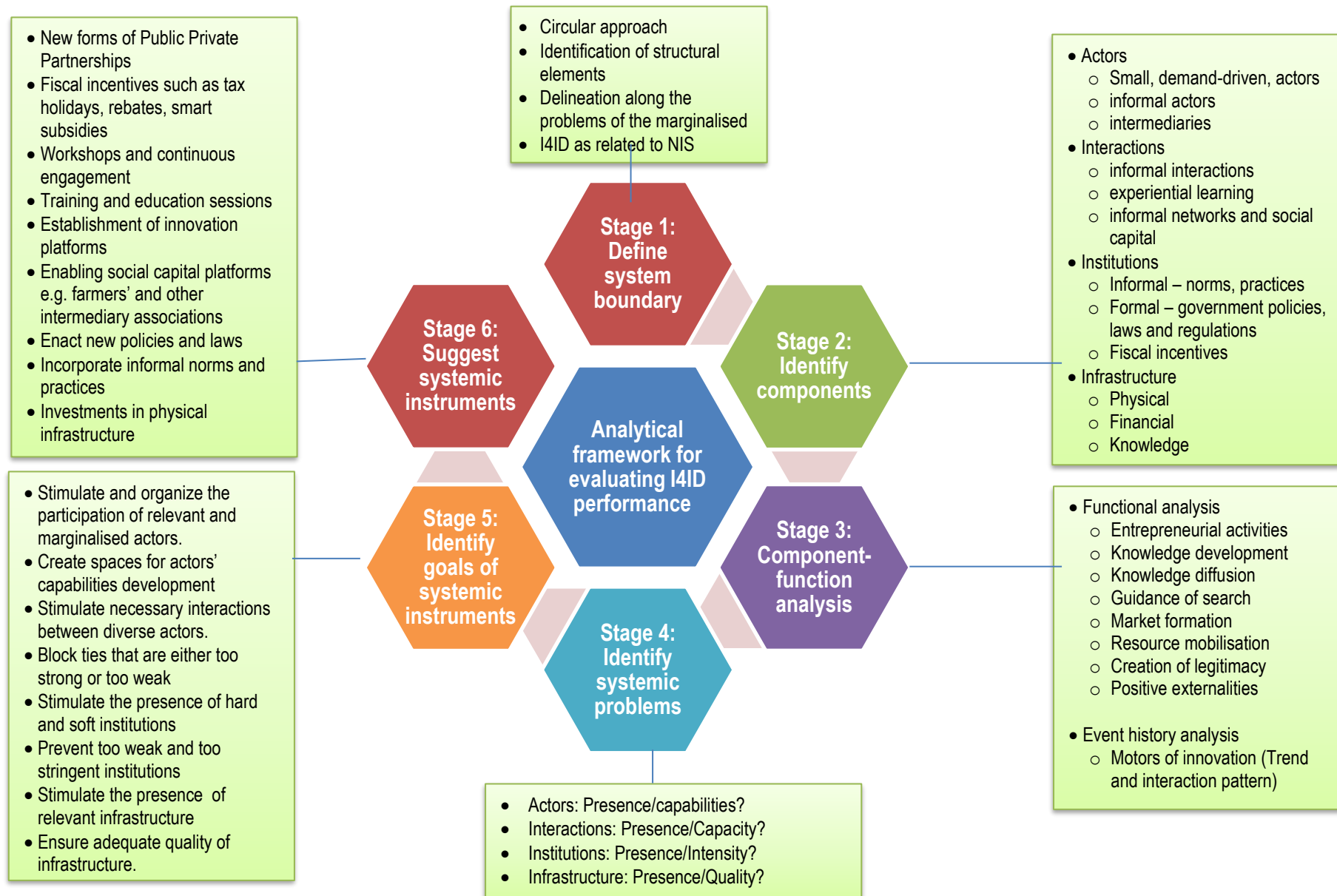


Figure 5-1: Analytical framework for the exploration of the dynamics of the I4ID system

5.4 CHAPTER SUMMARY

The analytical framework for this study is presented in this chapter. This is undertaken using the systemic policy approach developed by Wieczorek and Hekkert (2012). The primary aim of the approach is to develop a framework for performing a component-function analysis that first identifies the systemic problems and suggests the systemic instruments that would address them. The analytical framework is implemented through a six-stage process which includes: 1) Defining the system boundary; 2) Identifying the structural elements of an innovation system and their capabilities; 3) Undertaking the component-function analysis; 4) Identifying the systemic problems; 5) Identifying the systemic instrument goals; and 6) Designing the systemic instruments aimed at addressing the problems.

At every stage of the process, efforts are made to contextualise the activities to suit the peculiarities of I4ID (van der Hilst, 2012; Botha, 2017; van der Merwe, 2017). The boundary definition follows a circular approach where the identified core structural elements can be modified with a deeper understanding as the system evolves (Suurs, 2009). The structural elements are actors, institutions, interactions and infrastructure, while the functions were defined based on adaptation from studies such as Jacobsson and Bergek (2007); Lizuka and Gebreeyesus (2017) to the I4ID context. The focus of I4ID on inclusive development necessitates the inclusion of another function, the development of positive externalities, in the functional analysis. This is because the adoption and diffusion of innovations within I4ID systems have the potential for positive externalities to other actors within the system. Subsequently, the functions of ISs used in this study are: entrepreneurial activities, knowledge development, knowledge diffusion, the guidance of search, resource mobilisation, market formation, creation of legitimacy/counteract resistance to change, and development of positive externalities. Finally, the analytical framework identifies the systemic problems and the systemic instruments' goals and concludes by identifying the instruments aimed at achieving the goals.

The next chapter starts the process of the application of the framework to the I4ID system by describing the case of this study – the GES Scheme in Nigeria's agricultural system.

CHAPTER SIX : THE GES SCHEME, BOUNDARY DEFINITION AND IDENTIFICATION OF STRUCTURAL ELEMENTS

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
Summary and conclusions							

6.1 INTRODUCTION

This chapter gives a detailed background to the GES Scheme. This is to set the stage for the first stage of the framework application process, the boundary definition. The chapter also discusses the historical development, the components, innovations under the scheme as well as the challenges encountered during the implementation of the Scheme.

Furthermore, the chapter presents the first stage of the application of the framework to the I4ID system – the boundary definition and the identification of structural elements of the I4ID system, the GES scheme. As noted earlier, the boundary definition considered different approaches, such as the circular approach by Suurs (2009), the sector of innovation, the needs of the marginalised and the structural elements making up the system. Excerpts from the qualitative analysis are used to triangulate findings from the literature.

6.2 INTRODUCING THE GES SCHEME

The Nigerian government introduced the GES Scheme in 2011 to enhance the efficiency of the procurement and distribution of agro-inputs among Nigerian farmers. The initiative is one of the pillars of the Agricultural Transformation Agenda (ATA) launched by the then Minister of Agriculture and Rural Development, Akinwumi Adesina, upon assuming office in 2011. ATA provides a comprehensive framework for transforming agriculture in Nigeria by promoting agribusiness, attracting private sector investment in agriculture, reducing post-harvest losses,

adding value to local agricultural produce, developing rural infrastructure and enhancing access of farmers to financial services and markets (GrowAfrica, 2016). At the heart of the ATA is the GES Scheme.

The Scheme has the following specific objectives (Onyekwena *et al.*, 2018):

- Provide affordable agricultural inputs like fertilisers, hybrid seed and agrochemicals to farmers;
- Remove the usual complexities associated with fertiliser distribution;
- Encourage critical actors in the fertiliser value chain to work together to improve productivity;
- Enhance farmer's income and promote food security; and
- Shift provision of subsidised fertilisers away from the general subsidy and towards genuine smallholder farmers.

To achieve these, the Scheme was segmented into the following components (GrowAfrica, 2016):

- Development of a competitive agro-dealer network;
- Stimulating the banking sector to finance the agro-dealer network;
- Uptake by farmers by creating a national farmers' database; and
- Delivery of the e-wallet through an IT platform.

In implementing the GES Scheme, transparency and accountability were identified as the core values. The belief is to gain the confidence and trust of significant stakeholders who, because of previous disappointments with previous government programmes, were sceptical about new ones. The GES Scheme functioned through an interconnection of different actors in the inputs supply system such as agro-dealers, input suppliers and extension agents to effectively deliver agriculture inputs such as fertilisers, seedlings, chemicals and others to farmers through an electronic voucher (see Figure 6-1). Other prominent actors in the scheme are the helpline personnel, technology developer, finance institutions, State, and Federal Ministry of Agriculture officials. The voucher is referred to as an electronic wallet or simply an e-wallet. It also serves as an avenue to educate, inform and communicate with farmers in rural areas across the country on the latest and best agricultural practices and the current prices of commodities in the market (Adebo, 2014).

Before the introduction of GES, the government was the sole importer, producer, distributor, and regulator of the agricultural inputs system in Nigeria, the most important of which is fertiliser. As

with most subsidy regimes, the sector was grossly underdeveloped and characterised by fraud and inefficiencies manifesting in late delivery and the diversion of fertiliser from intended beneficiaries (Nagy and Edun, 2002). Leakages of the product into the open market were common, distorting the market price and providing arbitrage opportunities and a lengthy and cumbersome bureaucratic tendering process (Minot and Benson, 2009). Before the introduction of the GES Scheme, it was estimated that a maximum of 30% of farmers received subsidised inputs due to the corruption and inefficiency in the former system (GrowAfrica, 2016). Other problems with government-controlled fertiliser procurement and distribution system are low fertiliser application rates, low impact on agricultural productivity and national food output and poor increase in fertiliser consumption (Banful, Nkonya and Oboh, 2009). Fertiliser consumption in Nigeria was only 13.27 kg/ha of arable land in 2008 (World Bank, 2008) compared to over 100 kg/ha in India and Pakistan (Liverpool-tasie, 2012) and far below the 200 kg/ha recommended by the United Nations Food and Agriculture Organisation (World Bank, 2014).

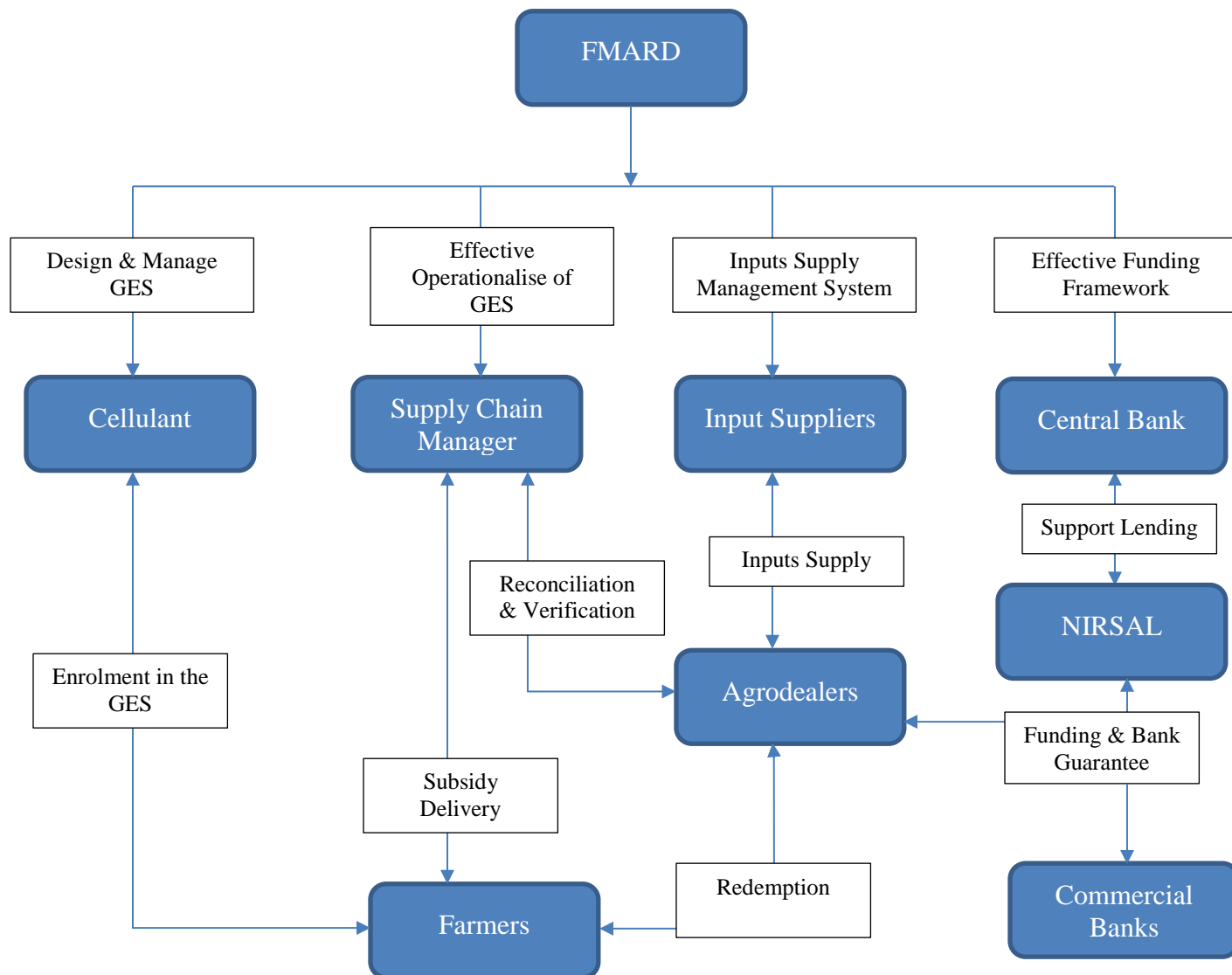


Figure 6-1: The GES operational architecture

Similarly, the government’s direct involvement in the procurement and distribution of fertilisers weakened the ability of private companies to participate in the sector and compete efficiently for market share. The inefficiencies experienced under the government-led inputs distribution programme are categorised as follows (Olomola, 2014):

- Non-targeted and poorly managed subsidies. This leads to a high level of corruption and failure to reach the intended audience of agricultural inputs;

- Overbearing role of government, which limits the participation of private-sector operatives in the system. This undermines the development of a vibrant input market in Nigeria; and
- Conflict of interest and government's poor performance as distributor and regulator of the system. This makes government lose focus of its functions as a regulator in maintaining quality in the supply of inputs, and enforcing standards, among others.

The challenges with the government-controlled agricultural input system can be summarised along the different activities of the value chain in Table 6-1 (IFDC, 2012).

Table 6-1: Challenges facing agro-input supply system in Nigeria

Value chain activities	Challenges
Importation	<ul style="list-style-type: none"> • Fragmented, inefficient importation • Poor port infrastructure • Limited importer competition • Unavailability on a timely basis
Processing	<ul style="list-style-type: none"> • Niche, over-engineered blends imported at higher costs
Distribution	<ul style="list-style-type: none"> • Poor inland transport infrastructure • Limited distributor competition • Limited and expensive credit • Warehouse shortages
Agro-dealership	<ul style="list-style-type: none"> • Limited dealer network and reach • Low retailer margins • Limited and expensive credit; high collateral requirements • Unavailability or insufficiency of fertilisers at the right time in the planting season
Farmer	<ul style="list-style-type: none"> • Limited credit for smallholder farmers • Inefficient and misuse of subsidies • Poor farmer awareness and know-how
Market	<ul style="list-style-type: none"> • Poor access to stable and competitive output markets

With the commencement of the GES, the government withdrew from direct fertiliser purchase and distribution and introduced an alternative system of distribution built on the voucher system. This is based on an earlier experiment developed by International Fertiliser Development Center (IFDC) and successfully implemented in four States (GrowAfrica, 2016).

One of the significant challenges with implementing the input supply system in Nigeria is the lack of reliable farmers' register. This led to the development of the National Farmers' Database (NFDB), where eligible farmers were pre-registered at the different wards at local government

levels across the country (*see Appendix B for a sample registration form*). The NFDB contains 47 data fields such as unique identity number, farmer's phone number (first four digits only. The farmer is expected to complete the remaining seven digits as part of the authentication process during redemption), names, location, state, local government, ward, sex, age, educational status, associations, crops and value chain cultivated, among others (Olomola, 2015a). Registration took place over a period of about two weeks in each location. There was no limit to the number of farmers who could register in each location, but farmers were requested to be physically present during registration. After registration, farmers were provided with a tear-off slip as proof of registration. In some instances, these were laminated to serve as identification cards through which farmers are expected to 'redeem' inputs. However, certain preconditions were considered in principle before a farmer was eligible to be registered. Since GES is a poverty-targeted subsidy programme, eligibility is based on being a full-time farmer with a landholding size of three hectares. It, however, is considered the practice of men and women in the same household having separate landholdings; hence, all adults in a household may register individually (GrowAfrica, 2016). Two main challenges came up with the registration procedure in the first year. It was difficult to ascertain the genuineness of the farmers, and providing accurate information on land size was challenging for genuine ones. This is because the land tenure system does not delineate land owned or used. Private sector players, agro-dealers and input suppliers already entrenched in the agricultural sector were selected after a competitive bidding process. This was after meeting specific criteria, including association membership, capacity, financial strength, and experience. The agro-dealers were expected to source their inputs from accredited suppliers.

The programme made significant strides within its short lifespan. For instance, about 14 million farmers were reached with inputs, while fertiliser and seed companies recorded sales worth about \$100 million and \$10 million, respectively. In addition, banks lent \$20 million to agro-dealers with a zero percent default repayment (Adesina, 2015).

6.3 IFDC INTERVENTIONS IN NIGERIA AGRICULTURAL SYSTEM

The implementation of the GES could be traced to two earlier initiatives by the International Fertiliser Development Company (IFDC) in Nigeria: The National Agro-dealer Support (NADS) Project and the Fertiliser Voucher Programme (FVP). The two programmes had a similar overarching goal – to deliver agricultural inputs to smallholder farmers efficiently and effectively.

The IFDC secured a grant from Alliance for a Green Revolution in Africa (AGRA) to implement the NADS over three years, 2008 – 2011. The programme aimed at boosting the agro-dealers capacity to provide quality inputs and services to farmers. Agro-dealers are typically SMEs that engage primarily in buying and selling agricultural inputs and ensuring the delivery of such inputs to farmers, even at the grassroots level (Olomola, 2014). They are the closest suppliers of farm inputs to farmers; hence, the efficiency in their business operations is important for the efficient delivery of inputs to farmers. Specifically, NADS focused on increasing the agricultural productivity and incomes of one million smallholder farmers by increasing the availability, accessibility, and affordability of quality seeds and other agricultural inputs in rural areas (Olomola, 2014). Specifically, NADS operated along four thematic areas (Olomola, 2014):

- Agro-dealer capacity building through training and technical assistance;
- Institutional strengthening of agro-dealers by incentivising their membership in trade associations;
- Technology transfer through the conduct of field demonstrations, soil testing and promotion of better agricultural practices; and
- Financial support by facilitating agro-dealers' access to credit for business development through risk-sharing arrangements.

Before the implementation of the NADS, the agro-dealers were unorganised, lacked access to financing, and were characterised with poor technical and business capacity. At the end of the programme, IFDC built the capacity of about 2300 agro-dealers and strengthened their technical and business knowledge (IFDC, 2012). While implementing the NADS, IFDC started another programme, the Fertiliser Voucher Program (FVP). The goal of the FVP was to enable farmers to obtain quality and subsidised agro-inputs in a timely fashion (using vouchers in lieu of cash) while also helping to build the businesses and enhance the professionalism of rural agro-dealers (IFDC, 2012). The experience of IFDC in implementing similar initiatives in other countries emboldened the organisation to commence the FVP in 2008 as a pilot in two states: Kano and Taraba. The pilot scheme was implemented among about 100,000 farmers with the active collaboration of the government (Federal and State), private-sector suppliers, and agro-dealers. Specifically, the FVP had three main objectives (Kiger and Adodo, 2010):

1. Ensure that the subsidies reach the targeted farmers;

2. Develop a distribution channel managed by the private sector that can function with or without subsidies while providing fertiliser to meet market demand; and
3. Improve the administration of subsidies by the federal and state governments.

The programme demonstrated the viability of using a voucher system powered by private enterprises to provide subsidised fertilisers to smallholder farmers. In implementing the FVP, extension officers gave each farmer a voucher. This contains identification information about each farmer, such as the farmer's name and photograph, a unique voucher serial number, indelible ink and a barcode. The voucher represents a 40% subsidy of the market price of fertiliser. At the point of redemption from certified agro-dealers, the smallholder farmer paid 60% of the cost of the product. Before releasing the products, the extension officer confirms the authenticity of the farmer's claim by checking the voucher against the information already documented about each farmer. Before the commencement of the FVP, critical actors, including farmers, agro-dealers and extension agents, were trained on the use of the voucher and monitoring team from State governments and extension services were deployed to monitor the programme. The staff of IFDC supervised these. Daily, reconciliation of the sales was done to record the total number of fertilisers sold and later determine the subsidy to be paid. At different intervals, the agro-dealers redeemed the vouchers from the suppliers, who subsequently were reimbursed the subsidy by the government after reconciliation.

By 2009, the success of the private-sector-driven pilot initiative led to the expansion of the initiative to cover about one-third of smallholder farmers in Kano (134,109) and Taraba (60,468) States (Kiger and Adodo, 2010). It was estimated at the end of the programme that fertiliser distribution reached more than the intended target against the maximum of 30% under the previous system, where the government was the sole distributor of fertiliser (Kiger and Adodo, 2010). With the pilot's success, the programme was extended to three states in 2010. These are Bauchi, Kaduna and Kwara states, with about 600,000 smallholder farmers in the five states as beneficiaries (IFDC, 2012). The success of the FVP sets the template for the introduction of the GES on a national scale.

6.4 COMPONENTS OF THE GES SCHEME

6.4.1. The Electronic Wallet System

A central driver of the GES Scheme is the deployment of technology innovation to enhance efficiency in the distribution of the inputs. Tagged the electronic wallet (e-wallet), the programme

targeted individual smallholder farmers through a smart subsidy using an electronic voucher system (GrowAfrica, 2016), thereby migrating smallholder farmers from subsistence commercialised agriculture between 4-10 years. It also targeted seeds and fertiliser to 20 million farmers within five years; 5 million farmers were targeted each year, with each group receiving support for four years.

The e-wallet includes specific modules in its package delivered to the target – smallholder farmers. These are farmer registration, transaction management, agro-dealer lending, and third-party auditing. The subsidised farm inputs were delivered directly to farmers through their mobile phones, allowing them to have the power to get information about their activities. Farmers then used the vouchers to buy inputs directly from the agro-dealers at a subsidised rate (Adebo, 2014; Signal Alliance, 2014). At the point of redemption, the farmer paid only 50% of the cost of fertilisers while seeds were given free. The Federal and State governments bore the balance of the cost of fertiliser equally, while the Federal government paid the subsidy on seed 100%.

6.4.2. Multi-actor Initiative Driven by the Private Sector

One of the major driving forces of the GES was the central role played by the private sector. This differs from previous interventions where the government directly procured and distributed agro-inputs. Under the GES, the government created a network of actors in the private sector, including the agro-dealers, input suppliers, commercial banks, supply chain managers and technology provider (Cellulant). The government's role changed from direct procurement to facilitation and providing the enabling environment for market development (See Table 6-3 for the summary of the roles of the main actors in the GES Scheme).

The actors in the GES and their roles are described as follows:

6.4.2.1. Agro-dealers

Agro-dealers are one of the most important stakeholders in the GES programme. They played different roles in their interaction with various actors in the Scheme. One of the key roles is that they served as the link between government, input suppliers and smallholder farmers. Further, agro-dealers were the link between the input suppliers and the farmers down the distribution chain. They received the value chain products from the input suppliers and made them available to the beneficiaries. In the first year of the implementation of the GES, about 1000 agro-dealers were selected to participate in the scheme, each allocated to a minimum of one redemption centre with

about 3000 smallholder farmers. The number of agro-dealers under the Scheme grew to about 2500 in the second year. The performance review of the agro-dealers at the end of the first year led to stricter conditions for participation in the second year. Agro-dealers were responsible for getting the stock of the necessary inputs from the input suppliers. They outsource the products from the suppliers and establish the needed infrastructure, such as a warehouse for storing products. This was an important criterion before they could be registered under the scheme. In addition, prospective agro-dealers were required to be situated in locations that are easily accessible to farmers.

Agro-dealers were also expected to:

1. Own a cell phone with a registered SIM card;
2. Understand the process of using an e-wallet, and attend training programmes designed for the project;
3. Conduct honest business and guide against fraud;
4. Choose and prepare a location for the business transaction;
5. Possess the capacity to source the necessary inputs; and
6. Provide storage facilities and be available at the appropriate time to meet farmers' needs.

6.4.2.2. *Input Suppliers*

Input suppliers are major stakeholders under the GES. They feature at two levels: multinational organisations that import fertilisers and agrochemicals or local suppliers who supply seed stocks or aquaculture juveniles. These were pre-registered to participate under the GES based on their capacity, experience and network. Under the Scheme, the choice of the suppliers to get stock from was left to the agro-dealers. Hence, when many could not get credit to fund their operations, they resorted to established relationships and networks with suppliers to facilitate the input supplies, usually on credit.

6.4.2.3. *Supply Chain Managers*

At the beginning of the GES, the government, through FMARD and Cellulant, managed the supply chain for the Scheme, but this was fraught with challenges. A review of the performance of the Scheme after the first year necessitated the need to put in place an improved system for the GES supply chain. Subsequently, FMARD engaged three private organisations as supply chain managers through a competitive bidding process. These are IFDC, Jetlink Nigeria Limited and

Elcapemos Technologies Limited (Olomola, 2014). They performed information management functions among the key actors in the GES, especially the suppliers, agro-dealers, Cellulant and smallholder farmers. The supply chain managers carried the responsibility of managing supplies at various locations. They managed the relationship between smallholder farmers, suppliers, agro-dealers, government and Cellulant to ensure smooth operations of their transactions. The companies were allocated states in all the geo-political zones to ensure national spread. The distribution is listed in Table 6-2.

Table 6-2: Distribution of states allocated to supply chain managers under the GES

Supply Chain Managers	States Covered
IFDC	Lagos, Oyo, Ondo, Delta, Edo, Anambra, Benue, Kwara, Niger, Bauchi, Taraba, Kano, Kaduna, Sokoto, FCT
Jetlink	Adamawa, Cross River, Ebonyi, Ekiti, Imo, Kebbi, Osun, Plateau, Rivers, Yobe, Zamfara
Elcapemos Technologies Limited	Abia, Bayelsa, Borno, Akwa Ibom, Enugu, Kogi, Gombe, Nassarawa, Jigawa, Katsina, Ogun

Source: Olomola (2014)

6.4.2.4. Financial Institutions

Typically, the banking sector frowns at lending to the agricultural sector. This is attributed to the perceived risk of lending to the sector. The default rate in loan repayment from previous programmes could be as high as 80%. Hence, lending to the sector was abysmally poor. Eluhaiwe (2010) put the lending to the agricultural sector at 1.4% of total lending despite the sector accounting for 42% of the country's GDP. Under the GES, banks were expected to extend loan facilities to the key players, especially the agro-dealers and input suppliers. However, it was found that since most of the agro-dealers are SMEs, they could not finance the expected stock of two fertiliser trucks, which cost about six million Naira (Olomola, 2015a). Because of banks' credit averseness to the agricultural sector, the government, through the NIRSAL, facilitated special credit facilities to agro-dealers and suppliers through commercial banks. This led to the extension of a concessional loan of 50 billion Naira to agro-dealers through NIRSAL. While the repayment was undertaken with zero default (GrowAfrica, 2016), it was found that only six commercial banks

participated in the scheme, with most of them having a preference for big companies or companies with established relationships (Olomola, 2015a).

6.4.2.5. Technology provider – Cellulant

FMARD contracted Cellulant in a competitive process to develop and manage the GES database management system. The system defines a standard operating procedure set, providing checks and balances and penalties for non-compliance. The system also played a crucial role in reconciliation and provided regular monitoring of the performance through weekly reports submitted to FMARD. This was generated and made available for stakeholders as when due. The organisation also managed the NFDB. Cellulant was also responsible for integrating all other stakeholders into the system.

The responsibilities of the key actors of the GES Scheme are highlighted in Table 6-3.

Table 6-3: Responsibilities of key actors under the GES Scheme

MAJOR ACTORS	RESPONSIBILITIES
FMARD	<ul style="list-style-type: none"> • Formulates national policy and monitors the implementation • Overall coordination of the Scheme • Select input suppliers and agro-dealers after the thorough selection process • Chairs the national GES Technical Working Group, which regularly reviews the implementation of the Scheme • Designs and regularly update the National Farmers Database • Commit on behalf of the Federal Government to the support of a 25% subsidy on fertiliser and 100% on seeds
STATE Government	<ul style="list-style-type: none"> • Support in the mobilisation of critical actors for the scheme • Support the registration of farmers at each local government • Commit on behalf of the State Government to subsidy support of 25% on fertiliser • Commit not to undertake any other input supply system • Commit to logistics support for the operational efficiency of the scheme
CELLULANT	<ul style="list-style-type: none"> • Design and manage the database for the management of the GES • Manage the National Farmers Database and make it available to all the critical stakeholders • Provide weekly updates of redemption activities nationwide to the National Technical Working Group. • Design and manage the e-wallet system

INPUT SUPPLIERS	<ul style="list-style-type: none"> • Ensure the timely supply of the required inputs to assigned agro-dealers at the approved redemption centres • Develop an effective supply system with agro-dealers
AGRO-DEALERS	<ul style="list-style-type: none"> • Provide a space to serve as a redemption centre where the inputs will be stocked • Ensure adequate stocking of redemption centres with the required inputs • Ensure the efficient operation of the scheme, especially during redemption
SUPPLY CHAIN MANAGERS	<ul style="list-style-type: none"> • Ensure the operational efficiency of the e-wallet during the redemption period • Recruit and train helpline staff at the redemption centre • Train other actors such as supervisors, farmers, agro-dealers etc. • Map agro-dealers to designated locations of redemption centres • Generate reports on the progress of redemption
FINANCIAL INSTITUTIONS	<ul style="list-style-type: none"> • Commercial banks to provide credit to agro-dealers at a discounted rate • NIRSAL to provide credit guarantee for loans obtained by agro-dealers
CENTRAL BANK	<ul style="list-style-type: none"> • Developed the input lending framework jointly with FMARD • Deducts the subsidy contribution of the States from the Escrow account with the bank • Established the NIRSAL to support lending to the sector
SMALLHOLDER FARMERS	<ul style="list-style-type: none"> • Redeem inputs at the assigned redemption centre by paying 50% on fertiliser and 10% on seeds

6.4.3. The Redemption Process

Before the farmers are given the inputs, the information received on the farmer's phone is reconciled with that obtained at the redemption centre.

The redemption process is initiated when a smallholder farmer approaches the redemption centre operated by a certified agro-dealer based on a message (voucher) received on the phone (e-wallet). Cellulant sent the e-wallet as an SMS to all registered farmers during the redemption period. Usually, this should be a set of four SMS; however, in many instances, the messages are incomplete (Olomola, 2015a). This, however, does not pose a problem to the ability of the farmers to redeem the inputs. Farmers then proceed to the assigned redemption centre in the local government, where they register. Upon arrival at the redemption centre, the farmer is expected to present the identification card and the voucher on the phone to the helpline officer. The identity of

the farmer is crosschecked against the register at the Centre. Each redemption centre has a designated helpline officer responsible for managing the flow of information and transactions through the portal provided by Cellulant to the database management system. The electronic voucher contains a 10-digit identification code which uniquely identifies a farmer, the location of the redemption centre, the type and size of inputs to be redeemed, and the amount to pay. As part of the verification process, only four digits of the farmer's mobile phone number are listed in the register; the helpline officer is expected to complete the rest after confirmation from the farmer.

The next step is the connection with Cellulant. The officer sends an SMS to Cellulant using a USSD code indicating the inputs the farmer expects to collect. Usually, the message is sent using the farmer's phone. For instance, for a farmer that is to collect two bags of fertiliser (1 each of Urea and NPK and maize or seeds), the code will look like this:

- GES2 UNR (U for Urea, N for NPK and R for rice seeds)
- GES2 UNM (U for Urea, N for NPK and M for maize seeds)

Ideally, the helpline officer is expected to wait for a confirmation message from Cellulant; however, because of poor network and sometimes challenges with the DBMS, the message is usually not delivered. Initially, farmers were asked to wait or return later before being given the inputs; however, the system was later modified to allow farmers to get the inputs while still awaiting the confirmation message. The name is cancelled on the register while the officer tries to resend the message at a later time, usually in the evening. In cases where the confirmation message is received, it usually comes with a reference number written against the farmer's name, signifying redemption. At the same time, duplicate messages are sent to the farmer and the agro-dealer.

Due to the problem associated with the poor network during redemption, the offline redemption system was introduced. This allows the farmer to redeem the inputs once the name is on the registered list and presents the registration ID. The helpline staff is then expected to send all the messages at a later time and make the necessary documentation. Upon completion of the authentication process, the farmer pays 50% of the fertiliser market price and is subsequently given the inputs. The 50% (subsidy) balance is shared equally between the state and federal governments. GES was implemented in two types: generic and special value chain. Under the generic GES, farmers were given either maize or rice seeds, while under the special GES, farmers were given free inputs on different value chains such as cassava, wheat, cotton, etc. The focus on rice or maize

is because the crops enjoy widespread cultivation across the country and are the most consumed staples in Nigeria. Just like generic GES, inputs given under the special GES were based on the farmers' needs assessment by analysing the data captured during registration. It is important to note that farmers can only get seeds if they buy fertiliser. In general, the type of seeds/seedlings received by farmers is guided by the following: 1. Every farmer receives either maize or rice seeds; 2. A farmer is restricted to receiving additional seed/seedling from one special value chain; 3. The choice of either the maize or rice seeds under the generic GES or the seeds/seedlings received under the special value chain GES depends on information supplied during registration.

The operational framework of the GES Scheme was built on good network coverage throughout the country and farmers' ownership of mobile phones. The deployment of the GES faced specific challenges at inception. These included lack of trust, poor access to telephone networks, and inadequate ownership of phones, especially in rural areas. Only 30% of rural farmers had access to a telephone against 50% estimated during the planning stage, while a meagre 25% had a valid telephone number registered in their names (GrowAfrica, 2016).

6.4.4. The Reconciliation Process and Payment of Subsidy

Reconciliation is carried out to verify subsidy claims and determine the actual subsidy to be paid. This was done in three stages: redemption, state and federal levels (Figure 6-2). First, at the end of daily activities, reconciliation was undertaken to determine the quantity and cost of inputs sold and the expected subsidy to be paid by the government. These were confirmed and endorsed daily by the agro-dealer, representative of the supply chain managers, and representatives of government (state and federal). Second, at the end of the redemption period, usually four to eight weeks, the total volume of sales is recorded, and the subsidy amount is determined. The SCM confirmed the stock volumes and periodically reported stock levels to lenders, the guarantor and Cellulant for inventory control, collateral management and cash flow reconciliation. The total book of redemption is checked against the remaining stock at the end of the redemption period.

The four representatives of the stakeholders operating at the redemption centres, that is, the State Ministry of Agriculture, FMARD (State Office), Supply Chain Manager and the agro-dealer, endorsed the relevant Redemption Centre (RC) templates (i. e. Forms RC & CH) after due reconciliation. This is followed by reconciliation at the State Level (SL) by the State Level Reconciliation Committee comprising representatives of the four (4) organisations listed above.

After due diligence, the records of all the redemption centres in the State are reviewed and endorsed. After signing of the State level redemption templates (Form SL), the Certificate(s) of Confirmation of Redemption (CCFR) is then endorsed by the State authorised signatures (i. e. Commissioner of Agriculture or the Permanent Secretary) before countersigned by the State Director, FMARD. The completed/signed documents (i. e. RC, CH, SL & CCFR) are then forwarded to FMARD with a covering letter requesting the release of a 50% subsidy. FMARD, after due verification in conjunction with Cellulant, will deliver the documents to the Federal Ministry of Finance for deduction of the corresponding 25% value from the respective State's statutory allocation.

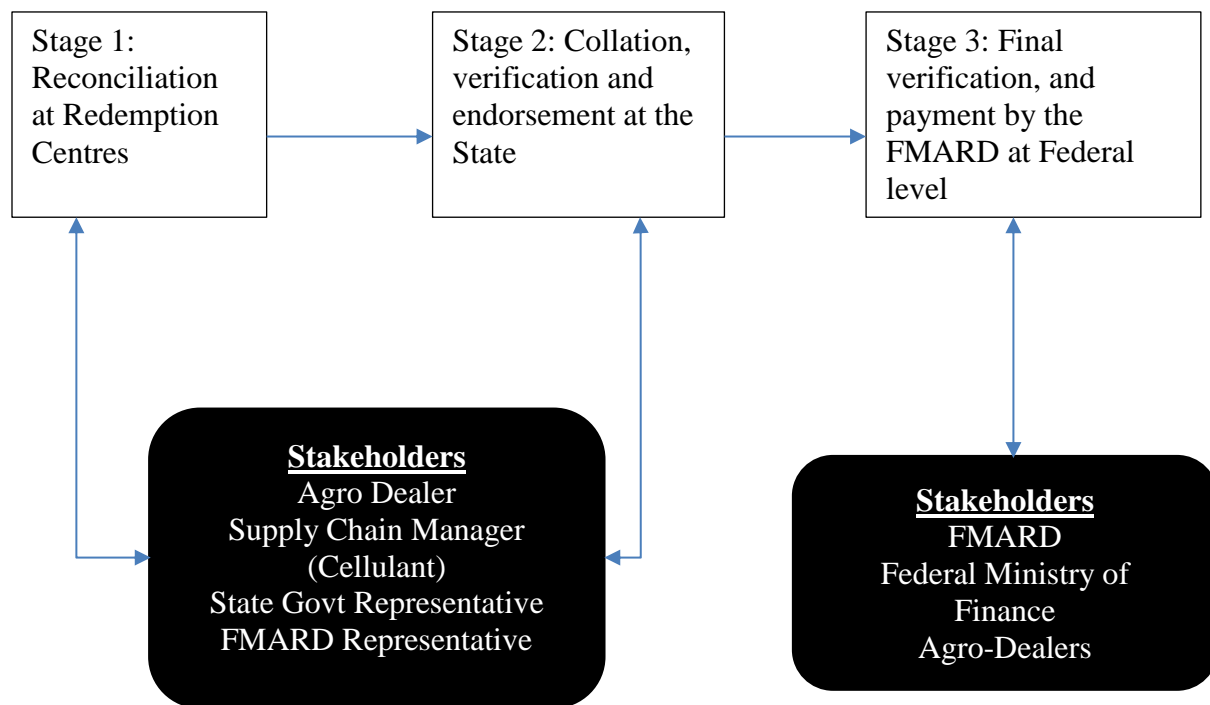


Figure 6-2: Schematic illustration of the input reconciliation and subsidy process under the GES Scheme

6.5 CHALLENGES TO THE IMPLEMENTATION OF THE GES SCHEME

Olomola (2015) summarised the challenges faced during the implementation of the GES under seven broad headings: administrative, technical, human resources, political, financial, operational and farmer-related constraints. These are reclassified into five and discussed as follows:

- Challenges in conceptualisation and design;
- Weak technological infrastructure;

- Sharp practices by farmers during registration;
- Financial challenges;
- Operational challenges; and
- Political challenges.

6.5.1. Challenges in conceptualisation and design

The Scheme faced several challenges, which could be attributed to the conceptualisation and design. For instance, most support and value chains were biased against the livestock sector, favouring the crop value chains (Onyekwena *et al.*, 2018). In addition, the design of the Scheme was based on the premise of mass ownership of mobile phones and network availability, but these were grossly inadequate and inaccurate (GrowAfrica, 2016). In addition, the number of redemption centres was restricted to a maximum of two per local government, irrespective of the size. Sometimes, this created a challenge of access for the farmers, who had to travel a long time before they could redeem their inputs. In addition, the limit of the number of fertilisers two for each farmer was deemed inadequate in some instances.

6.5.2. Weak technological infrastructure

A significant challenge with implementing the GES is poor telephone infrastructure, especially in rural areas where most smallholder farmers reside. This negatively impacted the redemption of inputs because the process depended on the availability of telephone services. The poor telephone infrastructure made it difficult to access the Cellulant platform to authenticate the genuineness of the farmers who presented themselves for input redemption. Without access to the mobile phone network, it was difficult to log in to the platform, make necessary queries and get the confirmation response from Cellulant. In addition, weak telephone services caused several challenges regarding non- or late delivery of SMSs to smallholder farmers. These challenges led to long queues towards the end of the redemption period and, in many instances, extended the period. It also contributed to the delayed submission of reconciliation documents and, consequently, delayed subsidy payment (GrowAfrica, 2016). In addition, many farmers lacked mobile phone access; hence, they did not get the SMS sent to redeem the inputs. The technological challenges led to several innovations (see Section 6.6), including manual registering and offline redemption. However, this fuelled corrupt practices such as round-tripping by farmers (Onyekwena *et al.*, 2018).

6.5.3. Financial challenges

At the commencement of the Scheme in 2012, the Nigerian economy, which is mainly dependent on the export of crude oil, was booming due to high prices in the international market. Oil prices fell from about 146 USD in the time of the boom to around 28 USD in January 2016 (Ogochukwu, 2016). Nigeria's economy was fatally hit because of its overreliance on crude oil for revenue and foreign exchange. Crude oil accounts for about 80% of government revenue and 95% of foreign exchange (Nwuke, 2021). This resulted in low government revenue and subsequent failure of the government to meet its obligations to subsidise the Scheme. When the Jonathan administration lost re-election in 2015, the new administration was handicapped by enormous economic challenges. The input-lending framework developed by the CBN and the credit guarantee scheme to support the GES favoured the big companies. In contrast, many small companies, especially agro-dealers, found it challenging to meet the requirements for accessing the funds (GrowAfrica, 2016).

6.5.4. Sharp practices by farmers during registration

At the commencement of the Scheme, there was no database of farmers. This made planning difficult. Developing a national farmers' database was fraught with challenges such as multiple registrations by farmers, and registration of non-farmers, among others. During redemption, some farmers employed different fraudulent methods to circumvent the checks. These include circulating the SMS to other farmers after redemption, trying to redeem multiple times, and selling the fertilisers at market price instead of using them on their farms. In some areas, farmers removed the passport photos on the ID card and replaced them with another person's image, re-laminating to cheat the system (Olomola, 2015). The use of OMR forms to capture farmers' information introduced to tackle the fraudulent challenges during registration had limited success because it did not integrate the use of biometrics for unique identification.

6.5.5. Operational challenges

Aside from technological challenges, the GES witnessed many challenges in the deployment of the Scheme. These include duplication of names in the register, long distance to redemption centres, poor mapping of farmers to redemption centres, wrong dissemination of vouchers, and shortage of seeds, among others. The register was initially not adequately cleaned. This led to duplication of names or misallocation to other wards or local governments and, in some instances, omission of names of registered farmers. Olomola (2015) reported that because redemption centres

did not compile the register, it was difficult for corrections to be made on time. There was also a problem with capacity building among helpline staff. In many instances, they were slow to catch up with new instructions from Cellulant on the running of the Scheme (Olomola, 2015). In addition, there was a shortage of seeds, especially maize and rice, leading to farmers' rationing and sharing seeds.

6.5.6. Political challenges

Most government intervention programmes in Nigeria are usually fraught with political interference. They are viewed as a form of political patronage. This is a major bane of previous intervention programmes in the sector. The design of the GES as private sector-driven was aimed at curbing this. Despite this, there were attempts to influence the agro-dealers selection, while some community leaders tried to influence farmers' registration and redemption process. In addition, the change of political leadership in 2015 also played a significant role in the suspension and consequent termination of the Scheme. The new administration, elected on the mantra of anti-corruption, perceived the high level of indebtedness arising from subsidy as fraud and therefore withheld subsidy payment until a review of the programme was undertaken. This led to long, delayed payment and apathy among other actors.

To overcome the challenges, several innovations were introduced as the programme evolved. These came from user feedback and continuous monitoring and learning activities instituted to enhance the operations of the Scheme.

6.6 INNOVATIONS INTRODUCED UNDER THE GES

6.6.1. Implementation of Manual Redemption System

During the process of implementation of the GES, specific innovations were introduced to enhance the operational efficiency of the Scheme and resolve specific challenges. These came mainly from feedback from the users. To reduce the challenge of the poor telephone network, manual redemption was introduced in 2013 (Olomola, 2015a). Through this method, farmers were allowed to redeem inputs once they presented the electronic voucher on their phone, completed the four missing digits of their phone number, identified themselves through the farmers' ID, and their names were confirmed on the manual register.

6.6.2. Introduction of ‘offline’ electronic redemption technology

Due to the challenges encountered, the use of manual registers or online platforms for the redemption of inputs was replaced with the Token Administration Platform (TAP) in 2014 (Olomola, 2015a). TAP was developed by Consult Hyperion, a UK company with experience in ICT-enabled in developing countries, and has participated in developing M-Pesa in Kenya. TAP allows for efficient redemption of inputs by providing a solution that can overcome the challenge of poor telephone service in rural areas. TAP was built on the near field communication system technology, which enables phones and tablets to be deployed as smart cards and function offline. This enables phones in close proximity to have radio communication, thereby allowing farmers to redeem inputs in areas where there are no telephone networks. The technology also will allow farmers’ biometrics to be captured. With the issuance of a TAP card with biometrics features, the efficiency of the redemption process is enhanced. This improved the significant challenges with the GES by tackling fraud and allowing offline redemption in places with no telephone network. In 2014, TAP was piloted in Sokoto state and the FCT to register 507,000 farmers, while about 256,286 farmers used the technology to redeem inputs (Olomola, 2015).

6.6.3. Establishment of NIRSAL

Another innovation introduced is the Nigerian Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL), a government institution established by the Central Bank of Nigeria to enhance credit access to the agricultural sector by de-risking the sector (Olomola, 2015b; GrowAfrica, 2016). While operating on five (5) strategic pillars: Risk Sharing; Insurance; Technical Assistance; Incentives, and Rating, NIRSAL focuses on using credit guarantees to address the risk of default and providing technical assistance to both financial institutions and borrowers to bridge the understanding and increase the capacity to payback. Under the GES, NIRSAL operates through two main instruments: Interest Drawback (IDB) and Credit Guarantee (CRG). The IDB allows the borrower to benefit from the incentive of a single-digit interest rate on loan only after the completion of the full payment. For the GES, the interest rate was capped at 9%. However, the borrower applies for the loan at an 18% interest rate but gets a refund of 9% after the completion of payment of the loan as scheduled. Under the CRG, NIRSAL helped to share the risk of loans with banks. This is done by using predetermined rates of the face value on loans in the different agricultural value chain areas: primary production and mechanisation - 75%; large scale & processing – 50%; and logistics - 20%.

6.6.4. Establishment of NAPI

In 2013, the Nigeria Agricultural Payment Initiative (NAPI), a collaboration between the National Identity Management Commission (NIMC) and FMARD, was established as part of the strategic initiatives aimed at enhancing the efficiency of the Scheme. NIMC is the government agency responsible for issuing national identity cards with unique national identification numbers. NAPI rests on four pillars: identity; financial inclusion through wallet services; association of farmer with a location/group/cluster; and linkage to relevant services and markets and facilitates payments among stakeholders through the mobile wallet (Central Bank of Nigeria, 2015). NAPI aims to provide every farmer with a chip-based identity card with an e-wallet linked to a mobile phone. The card serves a multi-purpose function. Aside from providing a unique national identity, it also offers access to credit, insurance and other agricultural services, provided they are linked to an e-wallet account (Grossman and Tarazi, 2014).

6.6.5. Establishment of the Service Charter and Complaint Mechanism

Another innovation is the establishment of the Service Charter and Complaint Mechanism, a collaboration between the Federal Public Administration Reform Programme (FEPAR), FMARD, and the Department for International Development (DFID). The Charter demonstrates FMARD's commitment to rendering quality services based on set standards under the GES programme and expects similar commitments from other stakeholders participating in the programme. It also provides a structure for FMARD by creating the Complaint Desk to receive feedback from the public on services rendered. To enhance the sustainability of the GES, efforts were made to give it legal backing through appropriate legislation. The Federal Executive Council developed consequent to this, a bill for the establishment of the National Agricultural Growth Enhancement Support Programme and other related purposes (NAGESP) after approval in May 2015 at the last meeting of the President Jonathan Administration. The Federal Ministry of Justice forwarded the Bill to the eighth National Assembly for consideration and consequent enactment into law.

6.7 DEFINITION OF THE BOUNDARY

After detailed description of the case, this section starts the process of framework application – the boundary definition.

Defining the boundary of the I4ID system is essential in the process of framework application to the system. Generally, the boundary of the I4ID system for a study can be delineated by structural

elements, geography, sector, sub-sector or needs of the marginalised group. These were combined to guide the boundary definition in this study. The factors are described below:

6.7.1. Circular Approach to Boundary Delineation

The boundary of the I4ID system is defined around the concept of the circular approach utilised by Suurs (2009) in the case of evaluation of TIS. The guiding principle behind the circular approach is that the boundaries of innovation systems can be adjusted based on the changes occurring during the evolution of a particular I4ID system. Setting a system boundary in this way requires a methodology sensitive to the activities within the field under consideration (Suurs, 2009). In this study, the selection of actors and institutions, for instance, focuses on those responsible for the diffusion of the GES Scheme. These included smallholder farmers, agro-dealers, suppliers, government (state and federal), financial institutions, intermediaries, and the technology provider (Cellulant). However, as the study evolved, the I4ID system was expanded to accommodate new actors, technologies, policies and institutions such as NIRSAL, TAP technology and Input Lending Framework that were not hitherto identified or present at the beginning.

6.7.2. Identifying the Structural Elements

System boundaries are also defined in line with a particular IS's structural elements - actors, institutions, interactions and infrastructures –. In the case of the I4ID system, the main actors concerned with the development and diffusion of the system are included. In selecting the actors, van der Hilst (2012) argues that actors implementing innovations meant only for the marginalised should be selected. If this approach is followed, any firm that doesn't introduce a new product to satisfy the BoP market is left out. In this study, a slight modification was made to accommodate firms that did not specifically produce for the BoP market but were conditioned by policy or incentives to change their business models to support the evolution of the GES. For instance, a fertiliser company naturally produces for the agricultural market irrespective of the buyer's status; however, under the GES, they supported the BoP market by providing inputs on credit to agro-dealers. To take advantage of government policy, input suppliers supplied inputs to remote, rural areas. These markets are usually considered unprofitable but are dominated by many smallholder farmers. In addition, boundaries are determined by identifying interactions among a population of actors and institutions guiding these interactions.

6.7.3. Purpose of I4ID System

An essential guide to defining the boundary of the I4ID system is the unifying factor or needs of the particular marginalised group. The boundary in this study is defined along the actors supporting the supply of subsidised agro-inputs to the smallholder farmers. This is to tackle the age-long problem of inefficiency in the sector.

6.7.4. The I4ID System as Related to the SIS

Understanding the type of IS helps to set the boundary for the system (van der Hilst, 2012). This is because the type of actors, their interactions and the rules guiding these are defined within the confines of the IS context. In this study, the boundary is defined along the structural elements involved in the development and diffusion of the GES Scheme. The scheme focuses on government intervention in a specific sub-sector - the agro-input supply system within the Nigerian agricultural sector. More so, the focus of the intervention is the smallholder farmers, the marginalised group. Although they live and do businesses within the confines of the country, their activities are influenced by the actions, policies and activities of other actors operating inside or outside the country. It is thus argued that the most appropriate context will be to define the boundary within the context of the sectoral innovation system.

Based on the discussion above, the factors influencing the boundary delineation of the GES Scheme in Nigeria are shown in Table 6-4.

Table 6-4: Factors influencing the delineation of boundaries in the study

Boundary Definition	Application in the GES
Circular approach	<ul style="list-style-type: none"> • Identify the main structural elements. These include actors in government, the business sector, intermediary associations and informal actors. Also, formal and informal laws, regulations, norms and practices were identified as responsible for implementing GES. • Making modifications to these as the study evolves. For example, new components such as NIRSAL (actor), Input Lending Framework (institution) and TAP technology (infrastructure) were included as the study unfolds.

Identifying the structural elements	<ul style="list-style-type: none"> • All significant actors, their interactions, institutions guiding these, and the infrastructure support the GES scheme's evolution.
Clarifying the purpose of the I4ID system	<ul style="list-style-type: none"> • The GES aims to develop an innovative platform to deliver agricultural inputs to smallholder farmers efficiently and effectively. Hence, all the structural elements responsible for this are included.
The I4ID system as related to SIS	<ul style="list-style-type: none"> • Focus on agricultural sub-sector – input supply system. • All the structural elements involved in the development and diffusion of the GES Scheme.

6.8 IDENTIFICATION OF SYSTEM COMPONENTS

This is the second step in the 6-stage process of application of the analytical framework. In this stage, the roles and functions of the components of the GES Scheme are identified and described. These are the actors, interactions, institutions and infrastructure. The actors include government (state and federal), business sector players, agro-dealers, input suppliers, commercial banks, supply chain managers, intermediary organisations, and smallholder farmers. These and their roles are identified and described below.

6.8.1. Actors

The GES scheme comprises different actors working to deliver inputs to smallholder farmers at a subsidised rate. As shown in Chapter Five, these actors cut across different categories operating in both the private and public sectors. These are under four broad categories: government, business sector, formal and informal intermediaries, and informal sector actors.

6.8.1.1. Government

a) Federal and State Governments

Government plays a vital role in facilitating the innovation process. According to Carlsson and Stankiewicz (1991), the government's primary function is to establish and maintain institutional arrangements conducive enough for the dynamic efficiency of the system. On the demand side, this manifests in the form of legislation and rules regarding market and competition, as well as legal and institutional arrangements. These regulate the conditions of entry of firms into established industries and facilitate access to local and foreign markets. In the context of the GES

scheme, the government operated at two levels: Federal and State. These are represented by different organisations performing different functions to enable the I4ID process. The Federal government, through FMARD, was the overall coordinator and driver of the Scheme. It designed the policy that governed the GES. Referred to as the Agricultural Transformation Agenda (ATA), the policy spells out the role, responsibilities, and targets of each actor in the GES. At the State level, the State Ministries of Agriculture, through their ADPs, coordinated the programme's implementation on behalf of the Federal Government. Other government agencies that played an important role include the Central Bank of Nigeria (coordinated funding framework); National Agricultural Seed Council (advice and coordination on seed inputs); Nigerian Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) (financial incentives); National Identity Management Commission (NIMC); and public research institutes (development and supply of inputs). Worthy of mentioning is the role played by the Minister of Agriculture and Rural Development, Akinwumi Adesina, who brought to bear years of experience working on agricultural development programmes in international and multilateral institutions across Africa. These included the West African Rice Development Association (WARDA), Ivory Coast; Rockefeller Foundation; and Alliance for a Green Revolution in Africa (AGRA). In addition, the commitment of the National Economic Council (NEC), made up of State Governors, the Central Bank, the Federal Ministry of Finance and others who endorsed the programme and made financial commitments, helped to guarantee the programme's success. An ADP official encapsulated the role of the State governments as follows:

"[...] As a State Ministry of Agriculture and Agriculture Development Agency (ADP), we monitored the activities of the agro-dealers. The state extension services are in the ADP, they are the custodian of the farmers in the state, so they will want to ensure that the farmers benefit immensely from the programme. Not only that, but they also want to know that we are giving the right inputs to the farmers."

b) Central Bank of Nigeria

The Central Bank (CBN) played an essential role in the evolution of the GES. It developed the input lending framework, which provided the operational framework for credit provision to actors under the GES. In addition, in partnership with FMARD, the CBN established a new organisation, the Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL), in 2013. The central objective is to de-risk agricultural lending. Through the escrow account of State

governments with CBN, funds were directly withdrawn to agro-dealers and suppliers for subsidy payments. This ensures that payments are not delayed.

c) NIRSAL

Another body that played a significant role in the GES is NIRSAL. NIRSAL's primary function is to stimulate the flow of affordable finance and investments into the agricultural sector by de-risking the agriculture and agribusiness finance value chain and institutionalising incentives for agricultural lending. NIRSAL was a risk manager for loans taken during the Scheme. NIRSAL focuses on guarantees rather than direct funding, using a mix of incentives and penalties to shape financial system behaviour (GrowAfrica, 2016). For instance, NIRSAL guaranteed up to 75% of total loans during the GES Scheme. It also implemented the IDB incentive, which ensures that actors who got loans at 18% interest were given a 50% refund on the interest upon the payment of the loan. The objective is to provide confidence to lenders to support the sector and serve as a form of incentive for good loan management. This was recognised by one of the supply chain managers as follows:

"[...] for all I knew, and heard that they were doing, was, if you take a loan on the programme and repay on time, they still give you a kind of rebate, which is an encouragement that you have done well. When you take public fund next time, you will be able to pay back."

A policymaker at FMARD explained the strategy for this special funding vehicle as follows:

"[...] The agro-dealers do not collect cash, they collect products from the suppliers, and the banks give them an interest of 18%. Immediately after the agro-dealer repays the loan, NIRSAL will remit 9% to the bank, and the agro-dealer will now collect back part of the interest rate (9%). Invariably, you are collecting a loan at 9%. But if you did not complete loan repayment, you cannot benefit from that".

d) National Agriculture Seed Council

The National Agricultural Seed Council (NASC) played a prominent role under the GES based on their original, statutory mandate of quality assurance for seed production, processing and marketing. It also provided technical advice on seed varieties used in the project, helped in reconciliation and facilitated financial incentives for seed companies. Specifically, NASC

maintained a quality control function for seed production and distribution under the Scheme. A staff of NASC summarised the role of the Agency under the GES as follows:

“Under the GES, the Council (NASC) planned and coordinated breeder seed and foundation seed production for crops in the value chain. It was also the responsibility of the Council to ensure that the packaging was in line with the standard given under the GES, going by the seed requirement of each crop. Another role is the deployment of varieties of seeds to the agroecological zones by mapping the seed companies that produce the crop varieties to the locations. The role of the Council was to ensure that seeds get to the agro-dealers because as part of the effort then was to ensure that seeds get closer to farmers through the redemption centres.”

Another vital role of NASC under the GES was to bridge between seed companies and financial institutions. Because it was challenging for seed companies to access funds, NASC served as a guarantor and developed the framework for credit access in partnership with FMARD. This was highlighted by an NASC official as follows:

“The Council (NASC) also introduced the seed companies to access finance for seed buyback under the programme. This is because of the major problem of seed producers, which was their inability to buy back certified seeds from the farmers due to the challenge of finance.”

e) National Identity Management Commission (NIMC)

One of the significant challenges experienced during the implementation of GES is the development of a reliable, up-to-date register of farmers in Nigeria. Before the Scheme, there was none. That is why one of the first activities was farmers’ registration, through which a database was developed. The challenge of multiple entries led to the partnership between NIMC and FMARD in the later part of the Scheme to implement biometric data capturing for farmers. It helped to develop an efficient farmers’ database by removing duplicate entries. This helped to make the registration process reliable, faster and less error-prone. A policymaker at FMARD described the role of NIMC under the GES as follows:

“[...] the only way we could sieve genuine farmers is to take their biometrics. So we brought in the government institution responsible for creating and maintaining a database, the National Identity Management Commission (NIMC). The Ministry (FMARD)

empowered them (NIMC) to be able to work with us. So, we established a synergy with them. Through our platform, we filtered their data and clustered them to their chosen value chains. After which, the farmers were ready for biometrics capturing. So NIMC now has a database of all the farmers that have been validated and clustered, without any duplication.”

Introducing biometrics for data-capturing farmers opened up other opportunities for smallholder farmers. It enhances the opportunity for financial inclusion for smallholder farmers, many of whom are unbanked and excluded from the formal financial system. In addition, it improves operational efficiency in the reconciliation process, which constitutes a significant bane in paying subsidies to agro-dealers and suppliers. Two policymakers at FMARD explained the operation of the introduction of biometrics as follows:

“[...]The use of biometrics to capture farmers’ data was introduced later, around 2014, to tackle some of the problems associated with implementing the GES, especially during registration and redemption. The final data was handled by Cellulant[...].”

“[...] Once their biometrics and pictures have been taken, a national ID card will be issued to them. After obtaining the national ID card, they can now open an account. The aim of this arrangement is that in the future, as you are going to an agro-dealer shop to collect your inputs, immediately a farmer pays for the input at a subsidised rate, government’s matching funds will be paid directly so that the agro-dealer will no longer wait for payment of subsidies. Because under the current arrangement, he must wait until after reconciliation.”

f) Research Institutes

In traditional ISs, knowledge institutions play a significant role in the creation and diffusion of knowledge for implementing innovations. An essential part of these is the research institutions in Nigeria. Nigeria has about 20 agriculture-related research institutions and specialised agriculture universities. Each of the research institutions focused on different value chains. The research institutions provided knowledge support to the GES programme. A prominent role is the development of new varieties of breeder seeds that were developed further into foundation seeds before being commercialised.

6.8.1.2. Intermediaries (Formal and Informal)

The GES programme involved active multi-stakeholder participation, including intermediaries. These comprise umbrella associations of critical players in the formal and informal sectors. They include the National Agro-input Dealers Association (NAIDA) through its regional blocks, the West Agro-Input Dealers Association (WAIDA); North Central Agro Input Dealers Association (NOCAIDA); and North West Agro Input Dealers Association for agro-dealers. Others include the Seed Entrepreneurs Association of Nigeria (SEEDAN) for seed suppliers and the All Farmers Association of Nigeria (AFAN) for smallholder farmers. The agro-dealer associations, for instance, played critical roles in the GES, including coordination of activities of agro-dealers, ensuring the supply of the correct quantity and quality seeds, supporting access to finance, and lobbying the government on payment of subsidies as well as sensitisation and capacity building of their members. These are described below:

a) Quality Control

As one of the actors responsible for selecting the suppliers, agro-dealers and seed suppliers, the associations ensured the quality control process was enhanced by recommending and guaranteeing their members to FMARD for selection. This was highlighted by one of the leaders of WAIDA:

“Their (WAIDA) role is to ensure that all the agro-dealers involved do the right thing. They enhanced the image of the organisation by giving the right quantity and quality of inputs to farmers [...]”.

b) Mobilisation

At the commencement of the Scheme, the government relied on the associations to mobilise and authenticate the list of agro-dealers and suppliers before they were enlisted in the Scheme. This assisted in building trust among the stakeholders and engendering participation in the Scheme. These were highlighted by some of the agro-dealers as follows:

“WAIDA is an agro-input association; they coordinated the agro-dealers under the GES.”

“[...] they also played a regulatory role by nominating agro-dealers to government. WAIDA took note of the capacity, integrity, and location of agro-dealers, and you know all the three factors, if you put them in place, will go a long way in determining the success of the GES.”

c) Lobbying and Advocacy

The intermediaries played a prominent role in creating an advocacy coalition to support their members' interests. At the commencement of the scheme, when actors expressed reluctance, they lobbied their members and encouraged them to participate in the Scheme. Their lobbying and advocacy role became more prominent towards the end of the Scheme when the government started delaying on payment of subsidies. Officials of the agro-dealers association had several meetings with the Ministry of Finance, FMARD and the National Assembly to lobby for the release of funds. An agro-dealer recognised the role as follows:

"[...] they also used many efforts to assist. For example, when they did not pay some agro-dealers on time, WAIDA sent emissaries to Abuja and even to National Assembly to ensure they were paid. So, it was a very prominent role they played."

Aside from these associations are supply chain managers (SCMs). They performed information management functions among the critical actors in the GES, especially the suppliers, agro-dealers, Cellulant and smallholder farmers. The SCMs carried out the responsibility of managing supplies at various locations. They managed the relationship between suppliers and agro-dealers to ensure smooth transactional operations. One of the managers of the SCMs interviewed identified the role of the SCM as follows:

"Another thing the supply chain management did during that time which was very critical to the success of the programme was that they managed information flow ... they served as an intermediary between the beneficiaries, government and suppliers."

From time to time, different actors played the role of SCMs. Initially, Cellulant, in collaboration with government officials, played the role. This was later transferred to the private sector, with Jetlink Limited, IFDC, and Ecalpemos Technologies Limited contracted to perform the function. Towards the end of the programme, the role was reversed to the government through FMARD officials. This was to reduce the operational cost and maintain integrity in the Scheme. This was summarised by a Federal government policymaker as follows:

"When we discovered that the money we were spending and the type of people they recruited were private people who could easily compromise, we decided to engage our staff in the state offices. We trained them because they are civil servants governed by law."

They will stick to the rules and regulations. Initially, we had three supply chain managers, and IFDC was the lead. After two years of operation, we now replaced them with the Federal Ministry of Agriculture staff at the state level.”

6.8.1.3. Business Sector

The actors in the business sector under the GES comprise the agro-dealers, input suppliers, technology providers and commercial banks.

a) Agro-dealers

Agro-dealers are one of the most critical stakeholders in the GES programme. They played different roles in their interaction with various actors in the Scheme. One of these is to serve as the link between government, input suppliers and smallholder farmers. Agro-dealers are the last mile of the agro-input supply system. Through them, farmers procure inputs directly or access those inputs made available by the government. Further, down the distribution chain, agro-dealers were the link between the input suppliers and the farmers by receiving the value chain products from the input suppliers and making them available. In the first year of the implementation of the GES, about 1000 agro-dealers were selected to participate in the scheme, each allocated to a minimum of one redemption centre. The number of farmers allocated at each centre was an average of 3000. The number of agro-dealers under the Scheme grew to about 2500 in the second year. The performance review of the agro-dealers at the end of the first year led to stricter conditions for participation in the second year. Some of the agro-dealers described their role as follows:

“[...] Without input suppliers, there are no agro-dealers, and without agro-dealers, there are no farmers. So, we are the link between the input suppliers and the farmers[...].”

“[...] I am an agro dealer; we are like the middlemen between the government and farmers; we are the link between the government and farmers[...].”

In addition to sourcing inputs, under the GES, agro-dealers established the needed infrastructure, such as a warehouse for storing products. This is one of the criteria before they could be registered under the scheme. In addition, prospective agro-dealers were required to be situated in locations that are easily accessible to farmers. Some of the agro-dealers captured this as follows.

“Yes, the agro-dealers provided everything, including the warehouse and other logistics”.

“[...]What the Federal Government did was to look for agro-dealers who have the capacity, who are strategically located in a place that the farmers could easily access. [...]”

b) Input Suppliers

Input suppliers are another major stakeholder under the GES. They can be classified into two broad categories: multinational organisations that supply fertilisers and agrochemicals, as well as local suppliers that provide seed stocks, or aquaculture juveniles. These were pre-registered to participate under the GES based on their capacity, experience and network. Under the Scheme, the supplier and agro-dealer relationship was their choice. Hence, when many agro-dealers could not get credit to fund their operations, they relied on established informal relationships and networks with suppliers to facilitate the supply of inputs on credit. A supplier described their role as follows:

“[...] You know, under the system, we have the government side, the input suppliers, the agro-dealers and the farmers, and so many actors formed the GES. Our part is to be a supplier of fertiliser, so our responsibility is to distribute fertiliser. We supplied farm inputs, especially agrochemicals and tractor seedlings, where needed. Others may also have supplied fish and whatever, but our major supplies were fertiliser, herbicide, pesticide and insecticide.”

c) Commercial Banks

Typically, the banking sector in Nigeria frowns at lending to the agricultural sector. This is attributed to the perceived risk of lending to the sector. The default rate in loan repayment from previous programmes was as high as 80%. Hence, lending to the sector was abysmally poor. Eluhaiwe (2010) put the total lending to the agricultural sector at 1.4% of total banking lending despite the sector accounting for 42% of the country's GDP. Under the GES, banks were expected to extend loan facilities to the key players, especially the agro-dealers and input suppliers. However, it was found that since most of the agro-dealers are SMEs, they could not finance the expected stock of 2 trucks of fertiliser which cost about 6 million Naira (Olomola, 2015a). Because of the credit averseness of banks to the agricultural sector, the government, through NIRSAL, facilitated special credit facilities to agro-dealers and suppliers through commercial banks. This led to the extension of a concessional loan of about 50 billion Naira to agro-dealers. Despite this intervention, it was found that out of the 13 commercial banks that gave out about ₦19.6b loans

under the GES in 2013, a large proportion of this came from 6 commercial banks, the majority of them having a preference for big companies or companies with established relationship (Olomola, 2015a, 2015b).

d) Technology Provider – Cellulant

FMARD contracted Cellulant in a competitive process to develop and manage the GES database management system. The system defined a set of standard operating procedures and provided checks and balances and penalties for non-compliance. The system also played a crucial role in reconciliation and provided regular monitoring of the performance through weekly reports submitted to FMARD. The organisation also managed the National Farmers Database (NFDB). This was referenced by a policymaker at FMARD and a manager of one of the SCMs as follows respectively:

“FMARD and Cellulant coordinated the registration (of farmers) but with the support of ADP at the State level.”

“[...]they developed the network system[...] that’s a credit to them[...], it was Cellulant. The whole idea of the system, the whole idea of the way the system was set up, the whole idea of the way the system worked was from Cellulant,[...] in collaboration with the Federal Ministry of Agriculture[...].”

6.8.1.4. Informal Users

The informal users are the smallholder farmers, the programme’s primary beneficiaries. These are the marginalised group in agricultural production activities. This is despite the different intervention programmes in the agricultural sector. Smallholder farmers are characterised by small landholding, archaic tools, and lack of access to credit, among others. In this study, they constitute the BoP. GES aimed to deliver targeted solutions to individual smallholder farmers through a smart subsidy, using a technological delivery mechanism. In addition, the GES was expected to increase access to and use of improved seed and fertiliser by smallholder farmers. At the end of the Scheme, the intervention is expected to have helped transit their status and enhance their livelihoods. A policymaker at FMARD alluded to this:

“[...] Invariably what we wanted to achieve with this (GES) is to grow the smallholder farmers, after some period of years for them to move to medium scale farmer and then we move

the medium scale farmer to large scale farmers and commercial farmers. So, there is a growth system within the value chain.... That is why it is called the Growth Enhancement Support (GES) scheme [...]”.

From the preceding, the actors in the GES Scheme and their roles are summarised in Table 6-5.

Table 6-5: Roles of actors in the development and diffusion of the GES

Policy Direction	Programme Design	Implementation	Financing	Technology Development	Monitoring & Evaluation
Government (FMARD)	Consultants, FMARD	FMARD, State ADPs, Agro-dealers, Cellulant, Input Suppliers, NASC, AFAN, WAIDA, NIMC, CBN	NIRSAL, State Government, FMARD, Commercial Banks	Cellulant	Cellulant, SCMs, FMARD, State ADPs

6.8.2. Institutions

The main policy framework guiding the GES programme is the ATA. The policy was introduced by Akinwumi Adesina in 2011 upon resumption as Nigeria’s Agriculture and Rural Development minister as the overall blueprint for agricultural transformation in Nigeria. The vision of ATA is to achieve a hunger-free Nigeria through an agricultural sector that drives income growth, accelerates the achievement of food and nutritional security, generates employment and transforms Nigeria into a leading player in global food markets to grow wealth for millions of farmers. One of the ways to achieve this is through the GES Scheme, with investment targeted at 20 million farmers over four years. At the micro level, different rules and regulations were formed as criteria for stakeholders' participation, including the state government, agro-dealers, suppliers, banks, etc. There were policy instruments that aided the effectiveness of the different aspects of the Scheme. These included the Input Lending Framework developed jointly by FMARD and the CBN to enable sustainable funding and the Seed buyback policy to ensure the development of breeder and foundation seeds, among others. Towards the end of President Goodluck Jonathan’s administration, efforts were made to pass appropriate legislation to institutionalise the programme; however, this was unsuccessful. An official of the National Agricultural Seed Council described the impact of the Scheme on the sub-sector.

“This (seed buyback) policy helped the industry a lot because when we started in 2012, about 1.8 billion Naira was lent to the seed companies. This was increased to 6.0 billion Naira in 2014... We had never had it so good because, before that time, nobody was willing to lend to seed companies to buyback seed from the out-growers.”

Because of the large number of informal actors, especially the smallholder farmers in the GES system, the role of informal norms and institutions was prevalent. The supply of inputs between the suppliers and agro-dealers was guided by trust based on existing business relationships rather than a contractual agreement. In addition, the business associations of agro-dealers and smallholder farmers play an essential role in defining the rules of engagement on behalf of their members. The role of trust in facilitating credit was painted by a significant agro-dealer as follows:

“[...] along the line, banks were foot-dragging until it was getting almost inconvenient for agro-dealers. There is confidence in the major importers because of existing, built relationships. I think I can say authoritatively that in Oyo state if there is any agro-dealer that any bank supported, it must have been that they had a very robust relationship with the company.”

6.8.3. Interaction

The implementation of the GES was characterised by interactions between the key actors from the formal and informal sectors. The strength and quality of the interaction determined the success or otherwise of the Scheme. This manifested in stakeholder engagements, review meetings, and capacity-building activities. The platform created by Cellulant enabled regular monitoring of the activities on the system by the banks, FMARD and others. In addition, there were regular stakeholders’ meetings where the progress of the Scheme was reviewed and interventions made wherever necessary. These engagements were held weekly, monthly or annual, depending on the issues discussed. The experience from the actors also formed regular feedback into the operation of the Scheme. According to a Federal policymaker, the engagements allowed for continuous evaluation of the Scheme as follows:

“[...] Again, there is what we call every year, a review process. We called for review meetings at the end of the season. We discussed what has gone well, what did not go well

and what is the way forward to address the identified challenges collectively as stakeholders [...]”.

The different interfaces of the interaction between the other actors are highlighted in Table 6-6. The government interfaces with the different elements through policy instruments while institutional frameworks, policies, and organisations such as intermediary associations and brokerage organisations guide the relationships between other elements. Different kinds of interactions existed between different actors in the GES. Strong interaction was found between government and research institutions in seed development and production and between commercial banks and big suppliers and dealers; however, the relationships between small agro-dealers and commercial banks and between research institutes and the suppliers and agro-dealer were weak.

Table 6-6: Relations between the different actors of the innovation system of GES

SN	Interfaces	Policy Instruments/Brokerages	Activities
1.	Government – business sector	Input lending framework Policy instruments – Input subsidy Policy instruments – Liberalization of seed production Policy instruments – obligatory use	Production and supply of inputs
2.	Government – research	Policy instruments – Seed buyback (outgrower scheme) Policy instruments – Genetic Access and Transfer Scheme	The commercialisation of research outputs in new varieties of seeds and seedlings
3.	Business sector – research	Policy instruments – Seed buyback (outgrower scheme)	Financing commercialisation of research in new varieties of seed and seedlings
4.	Research – Banks	Policy instruments – Seed buyback (outgrower scheme)	Finance of commercialisation of research outcomes
5.	Banks – Business sector	Bank guarantee Brokerage – Farmers and agro-dealers association, e.g. AFAN, WAIDA, SEEDAN	Financing of supply of agro-inputs by big suppliers through lending from commercial banks
6.	Big suppliers – agro-dealers	Informal networks Trust Intermediaries – Farmers, agro-dealers, and suppliers’ associations, e.g. AFAN, WAIDA, SEEDAN	Financing of the supply of inputs by agro-dealers through an informal relationship between big suppliers and agro-dealers

The relationship between commercial banks and companies (agro-dealers and input suppliers) under the GES can be explained by the underlying philosophy guiding interactions in user–producer relationships. The relationship usually involves elements of power and hierarchy, and the direction of innovations will reflect the dominance of one of the parties (Lundvall and Johnson, 1994). Hence, commitment, loyalty, mutual respect and trust helped reduce transactional costs between the two parties in the relationship. In the context of the GES, this explained the strong interaction between commercial banks and large companies where credit facilities were only extended to big companies. At the same time, most small agro-dealers and suppliers could not access credit. The selective nature of the relationship only builds on existing relationships because it takes time to establish relationships of commitment, trust and common codes of conduct (Lundvall and Johnson, 1994). One of the agro-dealers summarised this as follows:

“At the beginning of the Scheme, the government met with the different banks and pledged to support the programme. However, many of them developed cold feet during the agreement’s implementation. They didn’t support most of the agro-dealers who registered under the initiative. They only supported those they have prior relationships with; in many of these instances, these are large agro-dealers and suppliers, not the small ones”.

While evidence shows a high increase in lending in absolute terms to the sectors, it was non-inclusive of small actors. Another factor is trust based on established relationships. While vertical and horizontal linkages exist in the GES Scheme, the critical factor determining benefit optimisation is trust based on existing relationships rather than potential benefits from promising new ones. Commercial banks’ lending preference was directed to big suppliers with the established relationship before implementing the GES. The picture was painted by a major agro-dealer as follows:

“[...] along the line, banks were foot-dragging until it was getting almost inconvenient for agro-dealers. There is confidence in the major importers because of existing, built relationships. I think I can say authoritatively that in Oyo state if there is any agro-dealer that any bank supported, it must have been that the company had a very robust relationship.”

The distrust for lending was not only from the commercial banks' end; it was mutual. Agro-dealers were also sceptical of accessing funds from banks. The scepticism was based on the failure of the government to fulfil its obligations and promises under previous intervention programmes, which may lead to accumulated interests. This was highlighted by two agro-dealers as follows:

"[...] they (the banks) came and approached me. The first time they came was in 2012. They came, and we discussed, they told me to come and take a loan, and I told them it is not easy to take a bank loan to work for the federal government, especially when a supplier can supply on credit."

"Agro dealers were sceptical, and our scepticism was finally confirmed because the payment was delayed for over six months by the time we participated in the 2014 GES. If it had been a bank that facilitated the deal, you know, it would have been a colossal loss to me as an agro-dealer. Still, using an organised major importer, the burden of bearing the interest has been shifted away from me. That is the challenge we had with banks in financing the project; we were sceptical about the timely payment of the outstanding 50%. For example, I have a 75million Naira outstanding against me, and the Federal government did not pay for six months, imagine the interest that would have accrued, which I have to bear if I have taken the credit from the banks."

6.8.4. Infrastructure

Infrastructure is classified into physical, knowledge and financial (Wieczorek and Hekkert, 2012). In Nigeria, there is inadequate and poor physical infrastructure, which negatively affects the implementation of the GES. These manifest in poor roads, weak telephone connectivity, poor access to credit and poor electricity services. These involved the redemption of inputs under the GES since the whole structure is built on the delivery of vouchers electronically. Bad roads delayed input supply, while poor electricity and telephone networks led to delays in the redemption of inputs. These resulted in long queues at redemption centres and ultimately led to extending the redemption period from 2 weeks to 8 weeks. An agro-dealer and a federal policymaker captured the effect of inadequate infrastructure on the performance of the GES Scheme as follows:

"No, it (the e-wallet) did not develop any technical problem during use. The only challenge was the lack of electricity. Without electricity, most time, the battery might have run down. Whenever there was a regular power supply, it worked perfectly."

“When we started, the network became an issue. We discovered that in most rural areas, there was no telephone network. This affected our operation because our programme was built on an electronic platform, the e-wallet. Our Minister (Agriculture) had to discuss the issue with the Minister of Communications at a meeting. We were prepared to support our farmers with inputs through the e-wallet, but we were incapacitated because there was no telephone network in many villages.”

The summary of the structural elements in the GES Scheme is presented in Figure 6-3.

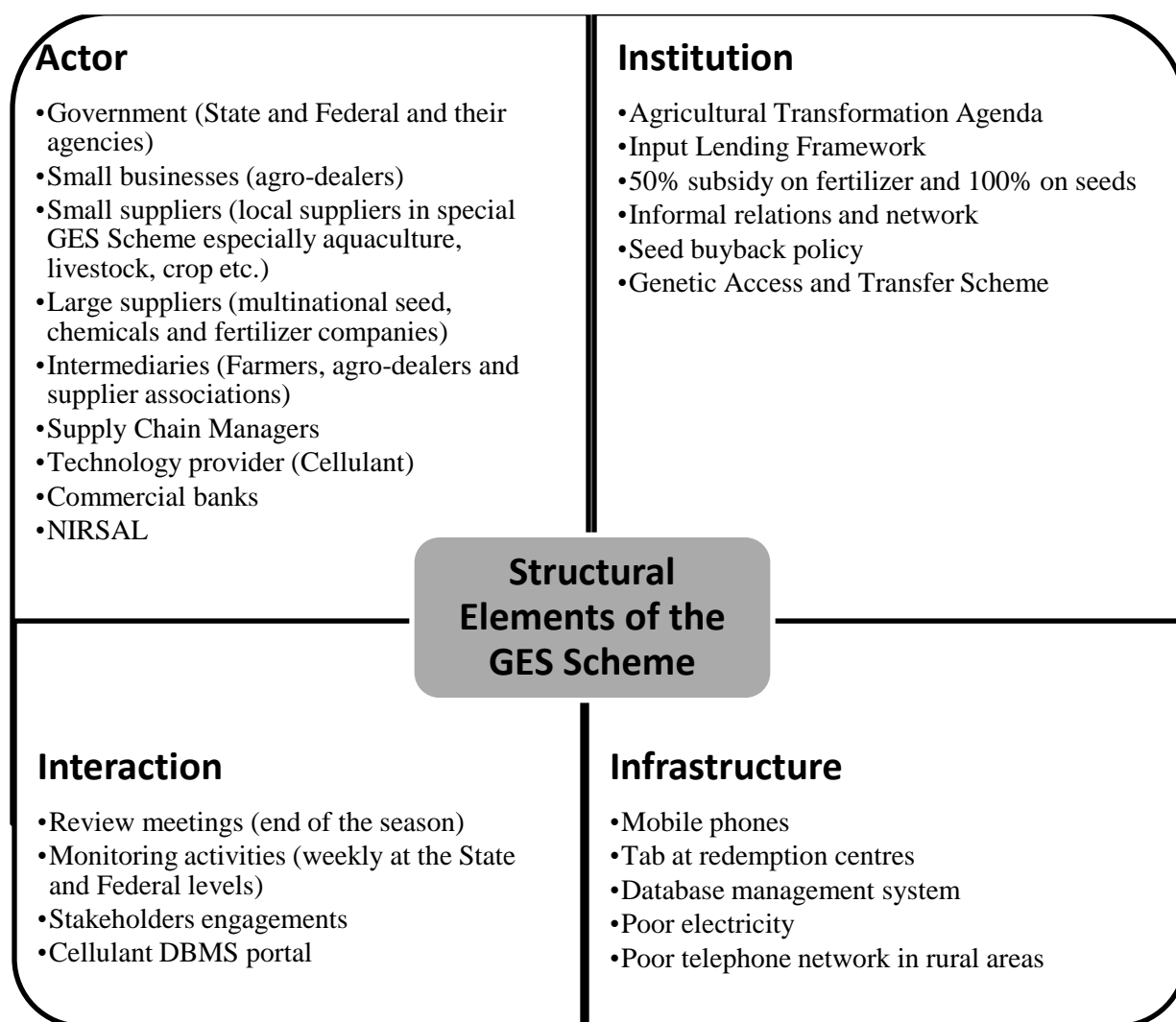


Figure 6-3: Structural elements identified in the GES scheme

6.9 CHAPTER SUMMARY

This Chapter presents the outcome of the first two stages of the application of the I4ID system – boundary definition and identification of system components. Before this, a detailed description of the case, the GES was undertaken depicting the historical development, components, challenges, and innovations that drove its implementation. The framework developed in Chapter Five was then applied to the case of the GES Scheme in Nigeria. The boundary of the I4ID system was delineated following the circular approach, which seeks to modify the structural elements as the understanding of the system deepens. In defining the boundary, the purpose of the I4ID system, the type of innovation system, and the structural elements were essential considerations. The identification of the structural elements was complemented with excerpts of the interviews with actors in the GES scheme.

CHAPTER SEVEN : EVENT HISTORY ANALYSIS OF THE GES SCHEME

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
					Summary and conclusions		

7.1 INTRODUCTION

This chapter is the third stage of the application of the framework, the component-function analysis. This is undertaken through the EHA. The EHA is used to identify the functions performed in specific periods of the evolution of the GES, their combinations, and the problems associated with the functions and elements of the system.

The process is guided by a 7-step procedure identified in Chapter Two. The EHA is analysed along the different stages of the growth of the GES, called episodes. These are identified, the historical narrative described, and the trend and pattern analyses examined. The trend analysis is undertaken using the assessment of the functions in each episode and presented using charts and graphs. These are complemented using the give-receive-participate framework, which elaborates on the actor's role in each event. Following the trend analysis, pattern analysis of events was undertaken to assess the functional fulfilment, the cumulative causation, as well as the roles of the actors in the development and diffusion of the I4ID system. These are carried out through the causal loop diagrams (CLDs).

Finally, the drivers, barriers and impacts of each motor on I4ID structures were identified.

7.2 EVENT HISTORY ANALYSIS AND EVALUATION OF THE I4ID SYSTEM

Traditionally, EHA is used to map firms' or firm networks' activities. However, the approach has been extended to understanding the activities in a system – such as a TIS. Examples include studies on IS for biomass digestion in the Netherlands (Negro, Hekkert and Smits, 2007); biomass digestion in Germany and biomass digestion in the Netherlands (Hekkert and Negro, 2009), as well as five cases of alternative energy development in Netherlands and Sweden (Suurs, 2009). The studies confirmed the validity of the use of IS functions in explaining the technological change process. They also found that interactions between system functions accelerate or slow innovation systems' emergence and growth. These go a long way to establish the validity of the EHA as a method of explaining the emergence of an IS. The EHA is undertaken by retrieving the historical events related to changes in a specific technological development over time from all possible sources of information, including professional journals, newspapers, and websites (Negro, Hekkert and Smits, 2007). Every event related to the technology was selected, stored and systematically allotted to specific system functions (Negro et al., 2007; Suurs, 2009). During the process, a functional pattern begins to evolve. These are then extracted from the database and described in narration to explain the development, inducements and blocking mechanisms experienced in the evolution of a particular technology.

While the EHA has been established as a method for exploring the TIS's functional dynamics and performance, its use in the I4ID system is limited. The only study found in the literature examined the case of ICT for a development project for elderly rural women in Mafarafara in Limpopo, South Africa (Maarsingh *et al.*, 2021). This study seeks to contribute to emerging literature by assessing the performance of the I4ID system in another sector vital to the BoP market (agriculture) in another developing country (Nigeria). The lesson from adapting the EHA to a TIS is that for an I4ID system to develop, there has to be cumulative causation – a build-up of different activities within the system that gathers speed at an accelerated rate. It is the build-up that accelerates toward the establishment of an I4ID system. In the process of build-up, a motor of innovation emerges. This captures the emerging pattern of interaction or dominance of specific functions that drive the evolution of the I4ID system in that stage.

The study follows the systematic identification and collection of events from newspapers, government reports, journals, conference papers etc., on the GES Scheme in Nigeria's agricultural

sector. The events are collated along the line of specific functions until a functional pattern emerges. At the end of the analysis, a narrative emerges depicting the historical account of the functions that are important to the development of the GES system, the interaction between the functions and the inducement and blocking mechanisms influencing the system. This enables the eventual exploration of the performance of the GES scheme as a case for assessing the performance of the I4ID system.

In this chapter, the EHA of the GES scheme is presented and seeks to answer the following questions:

- How suitable is the set of system functions to describe and analyse the dynamics of the I4ID system?
- What inducement and blocking mechanisms determine the evolution of the I4ID system?
- Which motors of innovation can be identified within the domain of the I4ID system?
- What are the impacts of the motors of innovation on I4ID structures?

7.3 DATA ANALYSIS OF THE EHA

The questions are addressed by studying and assessing the historical development of the GES System in Nigeria's agricultural system. The functions and motors essential for driving the evolution of the GES are identified, and the structures within the IS. Based on these, insights into the system's performance are discussed. Suurs (2009) argues that traditional evaluation methods of ISs such as bibliometrics or social network analysis are inadequate to capture the dynamics contributing to its evolution. Hence, the use of EHA is a method that is interpreted through two mutually reinforcing analyses: qualitative reconstruction of a historical narrative and quantitative identification of aggregate trends.

According to the literature, the EHA is undertaken in eight steps, as discussed in Chapter Two. Based on this, the steps identified in Table 7-1 will guide the analysis of the EHA in this study.

Table 7-1: Stages and tools of the EHA as used in this study

Stages of EHA	Steps and tools
Literature search and data collection	An online search on Google Scholar
Database construction	Identify events and arrange them chronologically. Events, ID, Year
Allocation of events to functions	Events, ID, Year, Activity, Function, Occurrence, Status

Construction of Narrative	Identify episodes; narrative Develop the narrative
Identification of patterns	
<ul style="list-style-type: none"> • Trend pattern <i>(It derives trends from aggregated data over a period).</i> • Interaction pattern <i>(track causal chains of events based on the sequence in which they occur)</i> 	Trend pattern <ul style="list-style-type: none"> • Charts and graphs • Give-receive-participate framework Interaction pattern <ul style="list-style-type: none"> • Causal Loop Diagrams
Triangulation of results	Qualitative data

The EHA process used in this study is described below:

7.3.1. Literature Search and Data Collection

As shown in Chapter Two, the process of EHA starts with event search, identification and collation in a database. The literature search was undertaken using the Google search engine (News) to explore a broad collection of documents. This was done without restricting the timeframe. The literature sources include newspapers, policy documents, technical reports, and journal articles. The selection was based on the criterion that the texts cover topics related to GES in Nigeria's agricultural system; hence, keywords such as "GES", "GESS", "Growth Enhancement Support", "Growth Enhancement Support Scheme", as well as "e-wallet" or "electronic wallet system" was used. In total, 168 events were retrieved. These form the basis of the analysis presented in this study.

7.3.2. Database Construction

The events were arranged chronologically, categorised and allocated to events (Table 7-2). Within the context of undertaking the EHA for the GES scheme, the 168 events were each assigned a unique identification number (ID). The events constitute the sequence of activities that contribute to the growth of the GES. These were mapped chronologically so that the development of the system was tracked over time.

Table 7-2: Sample event classification used in the EHA

Event ID	Event year	Event
18	2012	Registration and enumeration of farmers at the ward
26	2014	Selection and Registration of agro-dealers
138	2014	The NASC reported growth in Seed companies from 11 in 2011 to 134 in 2014

7.3.3. Allocation of Events to Functions

After identifying and mapping events, the next step is mapping each event to specific functions. The criteria for mapping functions depend on whether they lead to the fulfilment or otherwise of the particular activity. In cases where a single event contributes to more than one function, they were separated as unique events and allocated to different functions (see Section 2.5.3). During the process, three kinds of relationships are established. At the commencement of the process, all events were assigned the value zero. This changes to +1 whenever the event has a positive effect on the function, adding 1 to the total value of the function. On the other hand, the value -1 is assigned to the event whenever there is a negative influence, leading to a deduction of a value of 1 from the total value of the function (See the GES sample event database in Table 7-3). At the end of the allocation, the total value for each function is aggregated and used to plot the graphical illustration depicted by the trend pattern.

Table 7-3: Sample allocation scheme of events to function for the GES classification

ID	Year	Event	Occurrence	Recognisable activity	Applied function	Status	Episode	Value of functions		Total Values of functions	
								F1	.. F8	F1	.. F8
18	2012	Registration and enumeration of farmers	Single	Mapping of the marginalised groups within business models	F1	+ve	Pilot	1	0	1	0
26	2014	Selection and Registration of agro-dealers	Single	Entry of firms	F1	+ve	Scaling	1	0	2	0
138	2014	NASC reported growth in Seed companies from 11 in 2011 to 134 in 2014	Single	The emergence of new firms, actors or industries	F8	+ve	Scaling	0	1	2	1

The summary of the identified events and the allocation to functions is shown in Table 7-4

Table 7-4: Event categories and allocated function in the GES

Functions	Event categories	N	Sign
Entrepreneurial Activity	GES Scheme started	1	+1
	GES Scheme suspended or stopped	2	-1
	Entry of firms	2	+1
	Portfolio expansions	11	+1
	Seek or exploit business opportunities through knowledge generation, networks, markets, technologies or applications.	4	+1
	Monitoring and evaluation	10	+1
	Demonstrations	2	+1
Knowledge Development	Research studies	3	+1
	Learning by DUI	12	+1
Knowledge Diffusion	Training of key stakeholders	1	+1
	Meetings	3	+1
	Communication of program activities to stakeholders	1	+1
	Awareness campaigns	2	+1
Guidance of Search	Designing favourable regulations and policies	3	+1
	Designing unfavourable regulations and policies	1	-1
	Creating new working groups, institutions, organisations, instruments etc.	8	+1
	Setting policy targets, standards and research outcomes	9	+1
	Lack of policy targets, standards and research outcomes	1	-1
	Defining expectations	3	+1
	Trust	3	+1
	Lack of trust	1	-1
Market Formation	Obligatory use	2	+1
	Regulations supporting niche markets	5	+1
	Regulations limiting niche markets	2	-1

	Financial incentives such as bank guarantees, subsidies etc.	1	+1
	Financial disincentives such as bank guarantees, subsidies etc.	3	-1
	Reforming regulations and program structure	8	+1
Resource Mobilisation	Loans	4	+1
	Inability to access loan	1	-1
	Technology infrastructure	11	+1
	Inadequate or weak technology infrastructure	3	-1
	Subsidies	1	+1
	Stoppage or reduction of subsidies	2	-1
	Investments	3	+1
	Reduction in investments	1	-1
	Recruiting human resources	5	+1
	Inadequate or insufficient human resources	1	-1
	Physical infrastructural development	3	+1
Creation of Legitimacy	Advocacy coalition	9	+1
	Negative advocacy	2	-1
	Lobbying activities	7	+1
Development of positive externalities	Positive spillover effects	3	+1
	The emergence of new firms, actors or industries	3	+1
	Awards and recognition	5	+1
Total		168	

7.3.4. Construction of Narrative

The process of identification, categorisation, and construction of the event sequences, as well as describing the narrative, was done objectively as much as possible by the researcher using established procedures from similar studies on EHA (Negro, 2007; Suurs, 2009; Maarsingh *et al.*, 2021). To minimise bias, experts subjected the process to constant review and the feedback was used to review and sometimes reallocate the events or reconstruct the narrative. In constructing the narrative, the study utilises a naming system to identify each function as follows:

- Entrepreneurial activities ENT
- Knowledge Development KDV
- Knowledge Diffusion KDF
- Guidance of Search GOS
- Market Formation MKT
- Resource Mobilisation RES
- Creation of Legitimacy LEG
- Development of Positive Externalities EXT

The narrative provides a historical timeline of the changes in the dynamics of the functions. This differentiates it from the graphs, representing events influencing a specific function over time. The outcome is a storyline of how the development of the I4ID system has changed over time and the role of the different functions in this evolution (Hekkert *et al.*, 2007). The historical timeline is constructed according to the episodes identified in the narrative. When combined with the trend and interaction patterns, the historical timeline provides a holistic view of the evolution of the trajectory of the growth of the I4ID system.

7.3.5. Pattern Identification – Trend and Interaction Patterns

Trend patterns depict the fulfilment of the individual system functions and are used to identify significant developments of the functions in the narrative. During each phase, the events are used to provide further insights into how functions influence the development of each phase. These are illustrated using charts and graphs.

In addition, the give-receive-participate framework was used to further elaborate on the interaction between the actors concerning the performance of the functions. To ascertain the role of the actors in each event, a 3-category framework was developed: give-receive-participate (Figure 7-1). The actor initiating the event is classified as a ‘giver’ while the actor targeted by the giver as the direct recipient is classified as a ‘receiver’. The third category refers to actors that are present in or facilitate the fulfilment of the event but are neither the initiator nor the direct beneficiary of the event. These are referred to as ‘participants’. An example of an event is the redemption of inputs by farmers. While the government is the ‘giver’, the smallholder farmers are the ‘receiver’, and the agro-dealers and input suppliers are the ‘participants’. The data analysis was undertaken using

the database captured in the excel spreadsheet. For each event, the database captured the Recognised activity, assigned functions, and actors' roles of the actors.

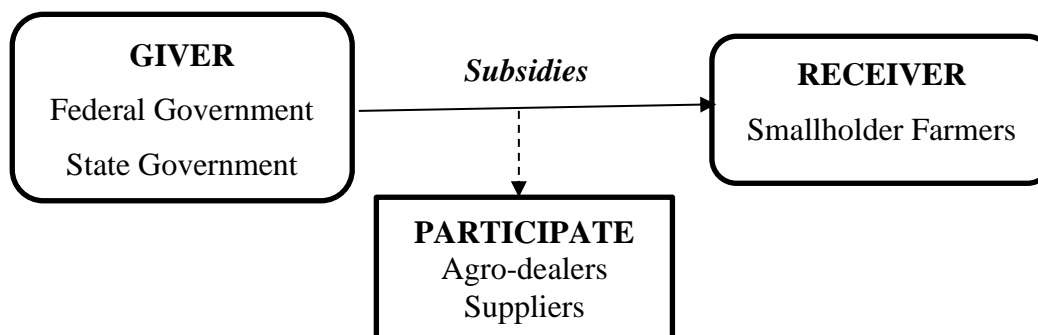


Figure 7-1: Schematic illustration of the give-receive-participate framework

However, different scenarios or possibilities can arise depending on the context of the activity captured in the event. Aside from the complete give-receive-participate in an event, there can be a give-receive in the case where there is no facilitator or observer. Other scenarios include cases where only one actor, in this case, is designated as a 'giver' or where more than one actor plays the giving role. An example is a subsidy paid to farmers but contributed by the state and federal governments. In this case, the farmers are the 'receiver' while two actors, the state and federal governments, are the 'giver'. The different scenarios of the give-receive-participate framework observed in the GES scheme are illustrated in Table 7-5. Defining the role of each actor in the fulfilment of events in EHA complements the traditional classification used in allocating events to functions established in the literature.

The interaction patterns of the functions and the resulting cumulative causation or motor are identified and illustrated using the CLDs. These are part of various systems thinking tools that aim to understand systemic relationships over time (Maarsingh *et al.*, 2021). CLDs summarised the cumulative causation in a phase or episode of the I4ID system. They provide visual linkages and interactions between system functions, thereby identifying circular causation leading to positive or reinforcing mechanisms (Uriona and Grobbelaar, 2018). By interpreting events as indicators of system functions, it becomes possible to identify the particular sequence through which specific functions occur. These can result in cumulative causation - either reinforcing one another towards the build-up (virtuous cycle), standstill or breakdown (vicious cycle) of the system (Chapter Two). For instance, a new government programme aimed at reducing poverty in a region of the country (F4/GOS) and building the capacity of many people in the BoP (F3/KDF), which further mobilises

funding from local and international partners (F6/RES) and in turn is diffused across the country (F3/KDF) may be referred to as a virtuous cycle. On the contrary, previous unfulfilled promises (F4/GOS) may lead to a lack of trust among the actors of a new programme (F4/GOS) which may have a negative effect on raising funds (F6/RES) and enlisting the buy-in of new actors (F1/ENT) thus may lead to the abandonment of the programme (F1/ENT). This may be referred to as a vicious cycle. Identifying the various forms of cumulative causation, or motors forms the core of our analysis. But, the specific motor of innovation driving the activities will be identified for each episode.

Table 7-5: Sample template of the give-receive-participate framework used in the GES Scheme

Actors performing roles				Specific roles of actors					
Event ID	Function	Farmer	Agro-dealers	Govt (Fed)	Govt (State)	Farmers	Agro-dealers	Govt (Federal)	Govt (State)
8	F2				1			G	
46	F1	1	1			R	G		
69	F6	1		1	1	R		G	P
162	F7			1				R	

7.3.6. Result Triangulation

As noted earlier (see Chapter Two), the triangulation of the EHA was done using knowledge from the interviews conducted with the GES actors.

7.4 HISTORICAL NARRATIVE OF THE EHA

The dynamic evolution of the GES is analysed in this section. The analysis reveals a detailed description of the development of system functions and the motors that occurred. The analysis is undertaken as a historical narrative of the evolution of the GES chronologically around the episodes. The contribution of events to the system functions forms the trend pattern, mapped out and assigned as [F1/ENT, F2/KDV ... F8/EXT]. The narrative section is followed by analyses of the trend and interaction patterns. In the development trajectory of the GES, the four episodes, description and the inducement or blocking factors are identified in Table 7-6. The episodes capture a specific trajectory of the events and the components that drive the activities from the formative, growth to the final stages of the GES.

Table 7-6: Episodes in the GES development and the inducement and blocking factors

Episode	GES Development	Inducing Mechanism	Blocking Mechanism
2011	Programme design and planning	High oil price, high food imports; market opportunities; new political leadership; stakeholder commitments and buy-in	Weak or lack of institutions; lack of trust among actors; poor sensitisation,
2012	Emergence and experimentation	The utilisation of the private sector in procurement and distribution of inputs; use of e-wallet technology for distribution of inputs	Scepticism; poor logistics
2013 – 2014	Scaling and acceleration	Increased trust among the marginalised smallholder farmers; strong MEL; introduction of technological and non-technological innovations	Poor lending to small actors especially agro-dealers who are mostly SMEs; Logistics issues – a slow rollout of TAP technology used to overcome network issues in rural areas; Weak intellectual property rights laws on breeder seeds
2015 - 2018	Uncertainty, suspension, and final termination	Strong advocacy and lobbying by intermediaries	Economic recession, low government revenue from oil crash, change in government, lack of legal backing

The first episode took place in 2011 at the commencement of the GES. It was driven primarily by a new vision for agricultural transformation developed and pursued by a new political leadership of the agricultural sector in Nigeria. The external driver was the rise in the price of crude oil, which is the mainstay of the Nigerian economy and the need to reduce dependence on food imports. The primary activities are policy formulation, operational framework, target setting, stakeholders' engagement and defining incentives through subsidies to farmers and market access to suppliers. This dramatically increases government revenue and provides incentives to drive the government's ambitious agenda for agricultural transformation.

The second episode captures the first year of the rollout of the Scheme implemented in 2012. This is more of an experimentation phase coming at the project's rollout for the first time. The high

price of crude oil continues to serve as an inducement factor. The huge market in Nigeria encouraged the participation of multinational fertiliser and other agro-input suppliers. The episode was, however, characterised by low redemption of inputs as a result of scepticism among actors due to previous negative experiences with government agricultural programmes, late start and poor sensitisation.

In the third episode, the efficiency of input delivery in the first year increased the enthusiasm and served as powerful motivation leading to its oversubscription in two years, 2013 and 2014. These led to the introduction of innovations to improve the efficiency of the Scheme as well as local and international recognition and support. The end of the period coincided with the decline in the price of crude oil, which reduced government revenue, thereby threatening the programme's implementation.

The fourth episode captures the activities between 2015 and 2018 when the programme was suspended, re-introduced and finally terminated. The primary factors were the economic recession arising from the crash in crude oil prices leading to a massive drop in government revenue. In addition, there was a change in the country's political leadership because of the national election. These factors led to the review of the programme and its subsequent suspension. Efforts to ensure the programme's sustainability and insulate it from political influence were unsuccessful, as the bill to give the programme legal backing failed at the National Assembly. Pressure from different stakeholders necessitated reviewing and reintroducing the system between 2016 and 2017. The review's outcome led to its scaling down and reduced subsidy. Despite these, many stakeholders withdrew from the Scheme, leaving only the federal government to bear the brunt. With the federal government unable to bear the burden alone, the Scheme was finally terminated in 2018 (*see Figure 7-2 for the schematic illustration of the different episodes of the GES*).

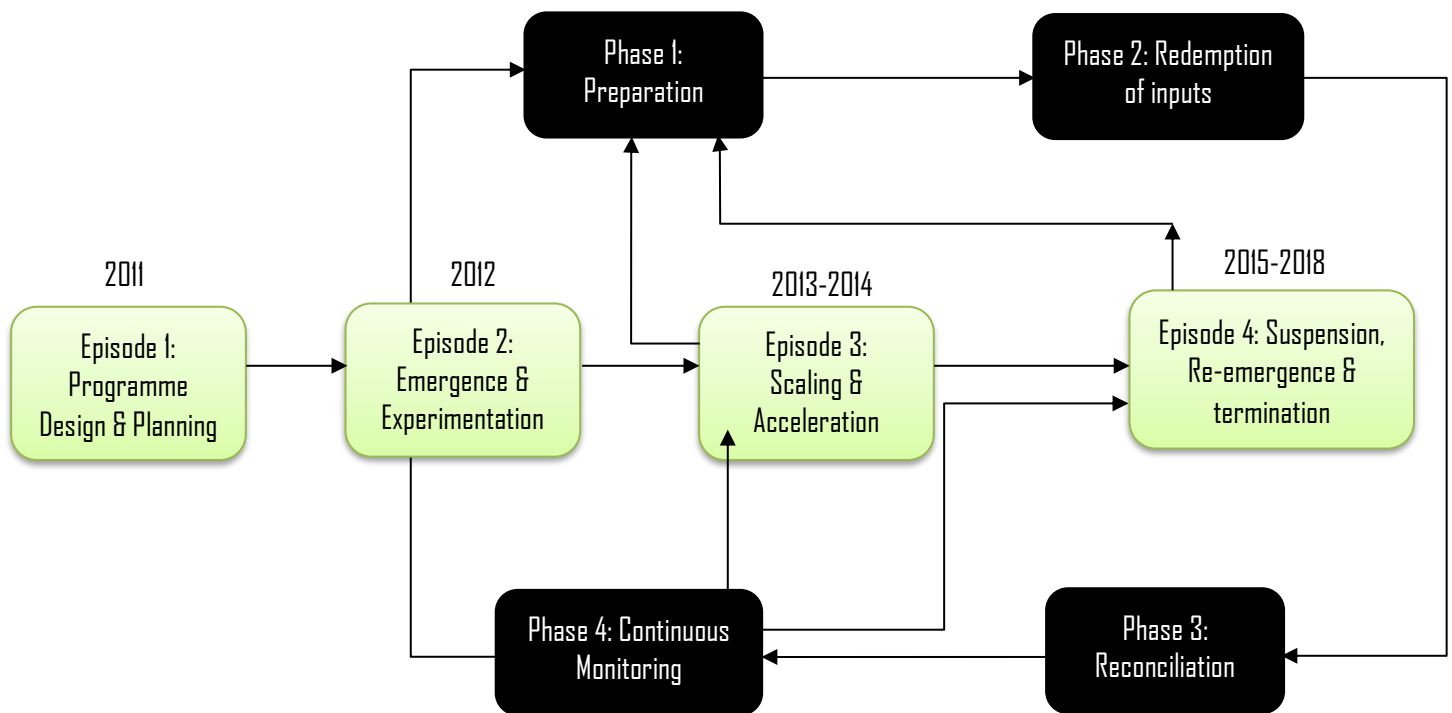


Figure 7-2: Schematic illustration of the iterative process of the episodes of the GES

7.4.1 Episode 1: Programme Design and Planning (2011)

The main focus of this episode is to build a coalition of actors and forge consensus and buy-in on how to successfully implement the GES (F4/GOS) and incentivise the agro-input supply system to enhance market formation (F5/MKT). The activities included identification of stakeholders, their roles and responsibilities; stakeholders' engagement and articulation of vision and goals; targets' definition (F4/GOS); definition of operational framework; and creation of awareness and sensitisation (F3/KDF). The guiding framework for GES was built on the Agricultural Transformation Agenda (ATA) – an overall policy framework for the agricultural sector - formulated by Akinwumi Adesina upon resumption of office as the Minister of Agriculture and Rural Development in August 2015. The scheme aims to move smallholder farmers from subsistence farming to commercialised systems over a 4-10 year period to facilitate trade and competitiveness (Federal Ministry of Agriculture and Rural Development, 2011) (F4/GOS). To actualise this, the GES changed agricultural inputs procurement and supply from the public to the private sector. Subsequently, a meeting of the National Economic Council (NEC) was held on 10th November 2011, where farmers in Nigeria (F4/GOS) endorsed the GES as a new policy framework

for providing access to agricultural inputs. The NEC, headed by Nigeria's Vice President, has a membership of all the 36 State Governors, the Central Bank Governor, the Minister of Finance and other Government officials. The NEC endorsed and directed that the GES Scheme be implemented across all the States and the Federal Capital Territory (FCT) (F5/MKT).

As part of the agreement, participating States committed not to undertake public sector procurement and distribution of farm inputs to ensure full market access for private sector participation and long-term sustainability (F5/MKT). The States and the FCT made a formal commitment through a written letter to partner with the Federal Government. Specific commitments made by the States and the FCT included:

- Participate in the GES, which will deliver inputs to farmers through the e-wallet system;
- Agree that the States will not run a parallel programme of government procurement and distribution of seeds and fertilisers, and other farm inputs to avoid undermining the GES scheme (F5/MKT);
- The State agreed that distribution of fertilisers and seeds, as well as other farm inputs, would be done by the private sector operators;
- Agree to provide 25% support from the State to complement the 25% to be provided by the Federal Government to bring the total support for the subsidised cost of fertilisers, seeds and other farm inputs to the smallholder farmers in the States and FCT to 50% (F5/MKT);
- Provide a list of smallholder farmers block by block or unit by unit in the Agricultural Development Project (ADP) system in the State for use in the verification of the farmers' database and effective targeting of farmers (F4/GOS); and
- Identify a list of warehouses available in the State that could be leased/rented to the agro-dealers to ensure that the agricultural inputs reach the farmers at doorsteps (i.e. at the village levels) (F6/RES).

A study was commissioned to determine the baseline of the agro-input supply system (F2/KDV). To enhance the efficiency and effectiveness of the programme, Cellulant, an indigenous technology company, was engaged through a competitive process to develop and manage the GES database management system for three years (January 2012 - December 2014) (F6/RES). The contract sum was 1.3 billion Naira (F6/RES). The database management information system defines a set of standard operating procedures that monitors all transactions, provides checks and

balances, and generates regular data for evaluating the performance of the GES on a day-to-day basis (F2/KDV). It also contains the names of all registered farmers, accredited (fertiliser companies, seed suppliers, other input suppliers), accredited agro-dealers, etc. In addition, a National GES Working Group was constituted (F4/GOS) to oversee the subsidy programme implementation (F7/LEG) and recommend adjustments and corrections when needed (F3/KDF). At the State level, a similar working group was constituted (F4/GOS) and was chaired by the State Director of FMARD (F7/LEG). To ensure an effective day-to-day running of the Scheme, a national GES Coordinator was appointed (F6/RES). The government set a target of reaching 20 million farmers with subsidised inputs in 4 years, an average of 5 million farmers per year (see Table 7-7) (F4/GOS). To provide access to funding for the actors who participated under the GES, the FMARD, the Federal Ministry of Finance, and the participating banks brokered an agreement that addressed the challenges of financing agricultural inputs (F5/MKT). High-interest rates were reduced through a back-end loan. Instead of collateral, the Federal Ministry of Finance provided a sovereign guarantee to cover 75% of a loan in the event of default (F5/MKT).

Table 7-7: Plan for farmers' enrolment and input redemption under the GES

Phase I	Period	Expected farmers	*Actual number of farmers reached with inputs
1	2012 - 2015	Group 1: 5 Million Farmers Target	1,608,148
2	2013 - 2016	Group 2: 5 Million Farmers Target	5,855,538
3	2014 - 2017	Group 3: 5 Million Farmers Target	6,853,133
4	2015 - 2018	Group 4: 5 Million Farmers Target	

**Group 4, which was to cover 2015 – 2018, was never implemented. None of the groups received the intervention (inputs) for the planned four years. Group 1, 2 and 3 received interventions for 3, 2 and 1 year(s), respectively. Group 4, which was to cover the years 2015 – 2018*

Source: Adapted from FMARD (2011) and NASC (2016)

7.4.2 Episode 2: Emergence and Experimentation (2012)

This episode marked the rollout of the programme on a national scale. After laying out the detailed action plan and securing key stakeholders' support, the GES Scheme entered the rollout stage. The programme commenced with a national launch in Ede, Osun State, in July 2012. The Minister of

Agriculture and Rural Development chaired the launch. The stage comprises sets of repetitive activities occurring annually until the end of the programme (see Figure 7-2). Three repetitive phases (Phases 1- 3) were executed each year as distinct activities. The phases are preparation, the redemption of inputs, and the payment of subsidies. Another repetitive training, monitoring and evaluation are implemented in episode 2 — a broad activity that permeates all the three phases. This implies that within each year of implementation, the programme was continuously evaluated, and innovations were introduced to improve its performance.

7.4.2.1 Phase 1: Preparation

The rollout of the Scheme commenced with a preparatory meeting (F3/KDF) initiated by the National Working Committee chaired by the Minister of Agriculture and Rural Development (F7/LEG). The meeting agreed on implementation modalities and a period for implementing various activities (F4/GOS). Key stakeholders such as farmers' unions, agro-dealers associations, suppliers, commercial banks, Central bank, Supply Chain Managers, the National Agricultural Seed Council and FMARD were represented at the meetings (F7/LEG). The structure was replicated in the 36 States and the Federal Capital Territory (K3/KDF), where the State Director of FMARD (F7/LEG) chairs the committee. To ensure the efficiency and integrity of the system, farmers were pre-registered using paper forms at the different wards at local government levels across the country (F1/ENT). After registration nationally, farmers' information was captured, analysed and developed into a database of smallholder farmers in Nigeria (F1/ENT), called the National Farmers Database (NFDB). Following a competitive bidding process, other participating actors, such as agro-dealers and input suppliers, were selected (F1/ENT). The agro-dealers were then mapped to redemption centres, which were expected to provide adequate inputs stocks in preparation for redemption (F1/ENT). Point of Sales devices and programmed tablets were deployed at each redemption centre to carry out the redemption process (F6/RES). As part of the preparation and due to poor ownership of phones among rural farmers, the FMARD planned a programme to facilitate the acquisition of phones where farmers were supposed to pay through the e-wallet at a subsidised rate (F2/KDV; F6/RES). However, the process was stopped due to a negative reaction from the public (-F6/RES) based on the misconception of corruption intent in the procurement process (-F7/LEG).

In addition, sensitisation and awareness were created in the mass media and other media platforms (F3/KDF). These include producing and airing documentaries of the GES programme on different

media houses by the FMARD, in collaboration with other stakeholders, such as the National Agricultural Extension and Research and Liaison Services (NAERLS) (F7/LEG).

7.4.2.2 Phase 2: Redemption of Inputs

After the development of the NFDB and the completion of preparation activities (meeting of stakeholders, selection and mapping of agro-dealers and suppliers and creation of awareness), the government selected and announced the date for the start of redemption (F4/GOS). The helpline officers were recruited, trained and deployed to the redemption centre by Cellulant in coordination with officials of the State ADPs (K3/KDF), after which the redemption process began. The process usually takes 4 to 6 weeks (F1/ENT). Challenges with the redemption process include erratic or absence of telephone networks in many rural areas (-K6/RES). These led to the introduction of scratch cards (F6/RES); however, this proved insufficient to solve the challenges (-F1/ENT), resulting in long delays in the collection of inputs (-F1/ENT).

To make the GES inclusive of the various crop value chains and cover all the agricultural activities, the programme was divided into two: generic and special GES (F5/MKT). The generic GES provides registered smallholder farmers access to two bags of 50kg fertiliser and one of 12.5kg of the seed of rice or 10kg of the seed maize (F1/ENT). At the commencement of the national rollout in 2012, farmers were given seed/seedlings free while they were expected to pay 50% of the cost of fertiliser (F5/MKT). This implies that farmers only paid for one of the two bags of fertilisers. Each farmer registered under the scheme is expected to have access to inputs under the generic GES (two fertilisers, seed (rice or maize)) in addition to the special value chain earlier captured during registration. In the first year, the Scheme was characterised by low patronage by farmers (-F1/ENT). Only 32% of the intended target, 1,608,148 farmers, was reached (-F4/GOS). This was attributed to low awareness (-F3/KDF), late rollout (-F1/ENT) and scepticism owing to negative experiences from previous governments' programmes (-F4/GOS). Despite these, a total of 26,325mt of certified seed of maize, rice, sorghum and cotton, amounting to about 6.13 billion Naira, were redeemed in 2012 (F1/ENT).

7.4.2.3 Phase 3: Reconciliation

To ensure efficient management of the Scheme, reconciliation was undertaken daily and at the end of the redemption season (F1/ENT). The outcome was uploaded into the GES database management system. A weekly report was submitted by Cellulant indicating sales volumes made at specific sites and the amount of subsidy (F1/ENT). Before the final subsidy was paid, the figures

were confirmed by representatives of key actors at the redemption centre, state, FMARD and Federal Ministry of Finance. The subsidy was then deducted from the State, and Federal Government accounts with the Central Bank of Nigeria (CBN) and paid directly to the input suppliers and agro-dealers (F5/MKT).

7.4.2.4 Phase 4: Continuous Monitoring

The implementation of the GES was characterised by continuous monitoring and evaluation, which permeates all the activities of the Scheme. As noted earlier, weekly reports were submitted by Cellulant to FMARD, which reflects performance indicators such as farmer participation, inputs redemption, and service delivery. The reports formed part of the inputs used by the GES Working Group during their weekly review meetings to evaluate programme progress, identify improvement areas, and implement them on behalf of FMARD (F1/ENT). At the State level, a monitoring team comprising officials of FMARD and the State Ministry of Agriculture was constituted (F4/GOS). The team conducted a physical inspection of the various redemption centres every week to monitor the implementation of the Scheme and resolve any challenges that may occur (F1/ENT). Banks also monitored the loans through an online portal to the database management system (F1/ENT). Based on the financing scheme by the FMARD and the Federal Ministry of Finance, some six banks loaned \$25 million in 2012, which was considerably lower than the target (F6/RES; -F4/GOS). To review the implementation of the rollout, the Fertiliser Suppliers Association of Nigeria (FEPSAN) undertook an independent study (F2/KDV) to assess success and constraints and make recommendations to improve the scheme in the coming cycles.

7.4.3 Episode 3: Scaling and Acceleration (2013 – 2014)

The year 2013 marked the second year of the rollout of inputs distribution under the GES and the third year of implementation of the Scheme. Central to the rollout in the second year was feedback from the continuous learning process from the activities in the first year (F2/KDV). This led to modifications and continuous improvement in the three phases of the rollout stage (F1/ENT). The rollout started with the year's preparatory process; operational modalities and action plans which were discussed and agreed (F3/KDF). Another key activity was the review of the NFDB (F1/ENT). This removed fake farmers and expanded the database to register new ones (F1/ENT). To avoid the need for manual input of high volumes of registration forms, the system was revised in 2013 (F2/KDV). Optical Mark Recognition (OMR) forms were introduced (F6/RES) and used for registration (F1/ENT). Enumerators marked the information on a pre-printed sheet, which was

later scanned and uploaded into the database. Farmers' information was captured if they visited the enumeration site in person. They were also provided with a tear-off slip as proof of registration. To reduce the challenges associated with poor telephone networks, an offline system with paper vouchers was adopted for redemption (F1/ENT; F2/KDV; F6/RES). From the farmers (F2/KDV), the special GES was subsequently expanded to include new value chains (F1/ENT). Also, the special GES was expanded to include new value chains (F1/ENT).

The increase in awareness about the programme (F3/KDF) and the acceptance among stakeholders (F4/GOS) led to the high turnout of farmers for registration in the second year of rollout (F1/ENT). At the end of 2013, 5,855,538 farmers at various redemption centres in 36 States and FCT redeemed a total of 63,629mt of rice, maize, sorghum, soybean, groundnut and cotton certified seeds valued at 14,673,920,000.00 Naira. The government paid 26 billion Naira as a subsidy to agro-dealers (F6/RES). A total of 45 seed companies also participated in the scheme (F1/ENT). To enhance the operational efficiency of the programme and based on experience from the first year of the rollout, due diligence and performance reviews of agro-dealers and input suppliers were undertaken at the commencement in 2013 (F2/KDV). The outcome led to the removal of non-performing agro-dealers and suppliers from the programme (F1/ENT) while others on the waiting list replaced them. To enhance operational efficiency (K2/KDV), FMARD engaged three private sector players (IFDC, Jetlink Limited, and Ecalpemos Technologies Limited) as SCMs (F6/RES). These managed the supply chain logistics and inventory for the GES Scheme.

Arising from feedback from actors on the funding performance (F2/KDV), a modification was made to the funding arrangement in 2013 with the establishment of NIRSAL (F4/GOS) by FMARD and the Banker's Committee of the Central Bank of Nigeria (F7/LEG). The new body replaced FMARD as a guarantor (F5/MKT). An Input Lending Framework (2013-2016) financing and guarantee agreement were set up, giving agro-dealers access to \$300 million through commercial banks (F6/RES). The experience from the first year of rollout (F2/KDV) led to the switching of the terms of financing to front-ending (F5/MKT), thereby placing the responsibility for repayment with the agro-dealers and reducing the discomfort of the banks. Loans were capped at an 18% interest rate, which includes NIRSAL's 1% administration fee. Upon the timely completion of loan repayment, agro-dealers then claim 50% of the interest. This implies that the actual interest was 9% since NIRSAL has provided an interest rate subsidy of 50% (F5/MKT).

The guarantee remained 75% of the loan's principal and interest accrued. NIRSAL set a 10-day window to attend to loan requests (F4/GOS). This enhanced the system's efficiency and further increased the trust in the Scheme among the stakeholders, especially the banks (F4/GOS). As a result, lending grew to \$125 million in 2013 through 113 loans dispersed by 13 commercial banks (F6/RES). In addition, the commercial banks requested an increase in the lending cap for agro-dealers from \$2 million to \$5 million and offered to double the loan period to 12 months (F5/MKT). As a result, loan projection for agriculture was expected to grow to \$250 million in 2014 (F4/GOS). Despite this, most agro-dealers, primarily SMEs, were unable to access funding from the banks (-F6/RES), attributed to stringent conditions for accessing loans such as a 10% equity requirement (-F5/MKT). Most agro-dealers utilised the informal contractual relationship between them and the input suppliers (F4/GOS) to source their inputs. While the input suppliers are usually big companies and some instances, multinationals, the agro-dealers are SMEs supplying inputs to smallholder farmers. To enhance the operations of the Scheme, the Federal government announced new initiatives. These are the allocation of funds to develop the capacity to regulate fertiliser quality through sampling and laboratory testing (F6/RES; F3/KDF)), the establishment of a new payment platform, the Nigeria Agriculture Payment Initiative (NAPI) (F4/GOS) and expansion of the GES scheme to help farmers access tractor hiring services (F4/GOS). Smart cards were issued to about 1 million farmers under NAPI to tackle the challenges of redemption in rural areas (F6/RES). The beneficiaries were, however, low compared to over 5 million registered farmers. The slow pace of rollout of NAPI cards made FMARD stick with the existing farmers' registration and inputs' redemption system (-F6/RES).

By 2014, the enthusiasm of key stakeholders in the Scheme had improved due to increased trust (F4/GOS), the success of rollout in previous years (F4/GOS) as well as a continuous learning process (F2/KDV). These led to the introduction of innovations to solve the challenges encountered in the first two years of rollout. As observed in the first two years of rollout, the challenges of low ownership of mobile phones among farmers and poor telephone networks in rural areas made it challenging to identify farmers uniquely, a central theme of the programme. Therefore, NAPI was piloted in Kogi and Zamfara States (F1/ENT). To successfully implement NAPI, the elaborate method of using OMR forms for registration adopted in 2013 was shelved to allow for the use of a simple enumeration form (R6/RES). This was based on feedback and a review of registration from the first two years of rollout (K2/KDV). This allowed NIMC to capture

the biometrics of farmers for unique identification (F1/ENT). NAPI was also aimed at enhancing financial inclusion among rural farmers who are largely unbanked (F8/EXT).

Further review of the programme was undertaken to enhance its efficiency (F2/KDV). The 100% subsidy on seeds was reduced to 90% (-F6/MKT). This is to ensure that farmers put a premium on the efforts of the government to subsidise seeds. To reduce operational costs, the role of SCM was reverted from the private sector to FMARD officials (-F2/KDV; -F4/GOS). The Scheme continued to witness improved performances. At the end of 2014, the number of redeemed certified seeds grew to 92,025mt, valued at 20,176,964,000.00 Naira. This was redeemed by 6,853,133 farmers in 36 States and the FCT. The number of seed companies participating under the scheme also grew from 45 in 2013 to 99 in 2014 (F1/ENT). Also, improved funding of the seed sector to support seed buyback under the GES increased to ₦6,035,255,000.00 in 2014, about a 70% increase from 2012 (F6/RES). In addition, global seed industry leaders such as Syngenta, Seed Company West Africa, Monsanto and DuPont-Pioneer commenced operations in or returned to Nigeria (F8/EXT). The credit to the seed sector also increased from ₦1.8b in 2012 to ₦4.2b in 2013 and ₦6.0b in 2014 (F6/RES). These represent an increase of 42.8% and 69.7% for 2013 and 2014, respectively. The high volume of feedback and requests led to the establishment of the GES Service Charter and Complaint Mechanism (F4/GOS). It handled complaints from various stakeholders involved in implementing the GES Scheme (F2/KDV). The Service Charter spelt out the roles, responsibilities, and expectations of stakeholders participating in the GES scheme (F4/GOS). To handle the complaints under the Service Charter, a Complaint Desk was set up (F4/GOS), with the average time to resolve complaints at seven days (F4/GOS). As a result, 576 complaints were received, out of which 390 were resolved (F1/ENT). To improve the integrity of the GES system, Consult Hyperion and the African Fertiliser and Agribusiness Partnership (AFAP) were commissioned by DFID to review the GES scheme (F2/KDV). The outcome led to the introduction of the Token Administration Platform (TAP) technology (F6/RES) which was piloted (F1/ENT) in partnership with the IFDC (F7/LEG) in Sokoto State and FCT between March and September 2014. The technology was used to register over 500,000 farmers and deploy 1.2 million e-wallets valued at over US\$19 million (F1/ENT). Despite these, signs began to emerge that the Scheme was running into troubled waters. This resulted from a sharp and steady decline in the price of crude oil in the international market, the mainstay of government revenue. This led to the

downward review of government budget projection for 2015, resulting in the reduction in the proposed appropriation for the GES by about 40 percent in nominal terms (-F6/RES).

7.4.4 Episode 4: Uncertainty Suspension and Final Termination (2015 – 2018)

The programme gained international recognition with many African countries, including Malawi, Tanzania, Kenya, and Uganda, sending representatives to understudy it (F8/EXT). The World Bank, early in 2015, approved the GES for all developing countries requiring its assistance to grow agriculture in their respective countries (F8/EXT). At home, there was a high clamour from all stakeholders, particularly the National Assembly and farmers, to institutionalise the GES Scheme (F2/KDV; F7/LEG). Arising from this, a draft bill for an Act to establish the GES Scheme was developed (F4/GOS). However, the National Assembly did not pass the proposed bill into law until the end of the administration (-F4/GOS). Consequently, the Scheme entered a period of uncertainty that threatened its continuation after years of consistent success. Two factors were responsible for this: a change of government and a decline in government revenue because of a crash in global crude oil prices. These led to the failure of the government to meet its obligation under the GES, with State governments reneging on the payment of their counterpart funding of 25% subsidy for fertiliser (-F5/MKT). This led to an accumulated backlog of unpaid debts to fertiliser and other input companies, running into billions of Naira (-F6/RES). Following this, several suppliers of inputs withdrew from the programme. According to the Federal Government, the outstanding subsidy payment owed by both the Federal and State Governments in 2015 on fertiliser alone was about 67bn Naira (-F5/MKT), resulting in the withdrawal of subsidy on fertiliser and subsequently suspension of the programme (-F5/MKT; -F1/ENT). The new Minister, Audu Ogbeh, summarised the situation in a published interview granted in the Daily Post newspaper in 2018 as follows:

“I found on arrival that I owed N67 billion on GES claims, and my budget was N33 billion. I said we couldn’t pay a debt of N67 billion, twice my ministry’s budget and continue with the programme. When we came in, some state governors said they had no money to pay their counterpart support of 25 percent for GES; some said they couldn’t continue because the economy had crashed.”

Consequently, the new Buhari administration suspended the Scheme and set up a committee to review it (F2/KDV). After the review, the Federal Government made a *volte-face* and reintroduced

the scheme (F1/ENT). The decision arose from the outcome of the review process (F2/KDV) and pressure from several groups, including farmers' and agro-dealer associations and other civil society groups (F7/LEG). The House of Representatives also called on Federal Government to implement the 2017/2018 dry season GES (F7/LEG). The pressure led to the renewal of the contract of the technology developer, Cellulant (F6/RES), for additional two years, January 2015 – December 2016 (F4/GOS). The Scheme was also modified to address the challenges that made it unsustainable (F4/GOS). Some modifications included adhering strictly to online verification of farmers before redemption, thereby eliminating the use of manual register (F1/ENT). This was done to stop some of the alleged cases of corruption associated with the scheme. In addition, subsidy on seeds was further reduced from 90% to 75%, with farmers paying 25% of the total cost of seeds (-F5/MKT). In addition, redemption centres were replaced with agricultural input centres to create a cluster of agro-dealers close to farmers (F4/GOS) and deploy the use of using Point of Sales (POS) devices (F6/RES). Despite these, the Scheme was never again implemented on a large, national scale. This is because of the overbearing subsidy payment on the Federal Government because of the withdrawal of the State governments from the programme. The Federal Government only reintroduced the GES for the 2016/2017 dry season farming in 30 states of the country (F1/ENT) instead of the wet season farming, which usually has higher participation of actors and is characterised by intense activities. The Minister of State for Agriculture, Senator Heineken Lokpobiri, undertook the flagging-off ceremony in Kano in February 2017 (F3/KDF). The inputs targeted 500,000 farmers but achieved a 92% success rate (F4/GOS). It successfully distributed inputs to 458,498 farmers across 30 states between December 2016 and February 2017 during the dry season farming (F1/ENT). The Federal government bore 50% subsidy on fertiliser and 75% on seeds. Stakeholders, including the National Coordinator, Zero Hunger Commodities Association (F7LEG), commended the programme's reintroduction. In addition, the programme continued to win accolades locally and globally (F8/EXT), leading to the engagement of Cellulant by the governments of Liberia and Afghanistan to develop a similar programme (F8/EXT).

Despite the government's promise to continue the programme, it was stopped with an announcement by the Minister in May 2018 (-F1/ENT). The government then announced a new programme, the Agricultural Inputs Mechanisation and Management Services (AIMMS), as a replacement. While the AIMMS was to distribute subsidised inputs to farmers, it was designed with government paying less subsidy. This implies that farmers will have to pay more for the

inputs. This indicates that the main reason the government scrapped the GES was the inability to pay the high subsidy cost on the inputs. Several stakeholders continued to call for the return of the GES Scheme, even after its formal scrapping. For instance, women farmers under the umbrella of the Small-Scale Women Farmers Organisation in Nigeria (SWOFON) called for the restoration of the Scheme (F7/LEG). At the same time, the President of the All Farmers' Association of Nigeria (AFAN), on a visit to the new Minister of Agriculture and Rural Development, Alhaji Muhammad Sabo Nanono, in March 2020, also appealed for the government to revisit and fine-tune the programme, which he believes would boost farmers production, create jobs and increase internally generated revenue (F7/LEG). Different stakeholders locally and internationally made several efforts to resuscitate the programme but all to no avail. The Ondo state government also plans to introduce a similar initiative in the state in 2020 (F1/ENT). The African Development Bank (ADB) also requested an Expression of Interest for a “consultant to support the implementation of a National Agricultural Input Support Scheme (NAISS) in Nigeria” (F6/RES).

7.5 ANALYSIS: IDENTIFICATION OF THE TREND AND INTERACTION PATTERNS

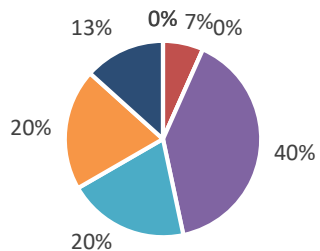
After the narration of the historical evolution of the GES, the next step is to undertake the pattern analyses – trend and interaction patterns.

The overall functional dynamics of the GES are shown in Figure 7-3. This reflects the contribution of different functions to the evolution of the GES over time. While the eight functions were present, the intensity varied over time. The pie charts indicate the functional fulfilment during each episode of the GES. By showing the presence of each function within each episode, the role of each function can be explained; hence, the overall performance of the Scheme can be evaluated.

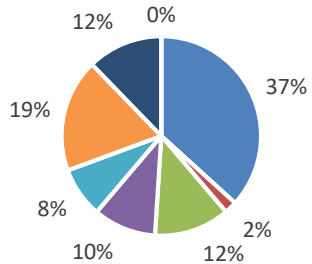
The analysis reveals that the dominant function in the design episode is the guidance of search (F4/GOS), while entrepreneurial and externalities functions were missing. The focus of this episode was policy formulation, target setting, the definition of roles and responsibilities and stakeholders' engagement. The aim is to develop an operational framework and strategies to overcome the initial distrust among actors and mobilise resources and policies needed to enhance smooth operation. This led to a high level of entrepreneurial activities (F1/ENT) in the second episode (emergence and experimentation), where key actors began experimenting with the GES. Prominent functions in the third episode (scaling) are resource mobilisation (F6/RES), the guidance of search (F4/GOS) and market formation (F5/MKT). The high level of entrepreneurial

activities has led to the introduction of innovations and regulations needed to expand the market among BoP. Hence, the need to mobilise adequate resources, develop a feedback mechanism to track progress and implement necessary changes to enhance performance. The I4ID system also witnessed positive spillover with the manifestation of positive externalities function (F8/EXT) for the first time. The final episode (uncertainty, suspension and termination) was dominated by resource mobilisation (F6/RES) and the creation of legitimacy (F7/LEG). The prevalence of the legitimacy function in the final episode indicates a high level of advocacy and lobbying to protect the actors' interests and resuscitate a dying programme. The resources deployed were aimed at optimising value and minimising operational costs. Despite the uncertainties, the episode witnessed increasing positive externalities in the form of high profit, awards and recognition, and the opening of new markets and industries.

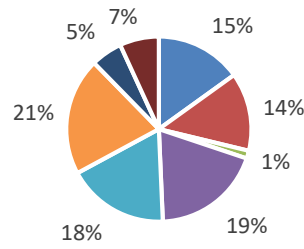
Programme design and planning



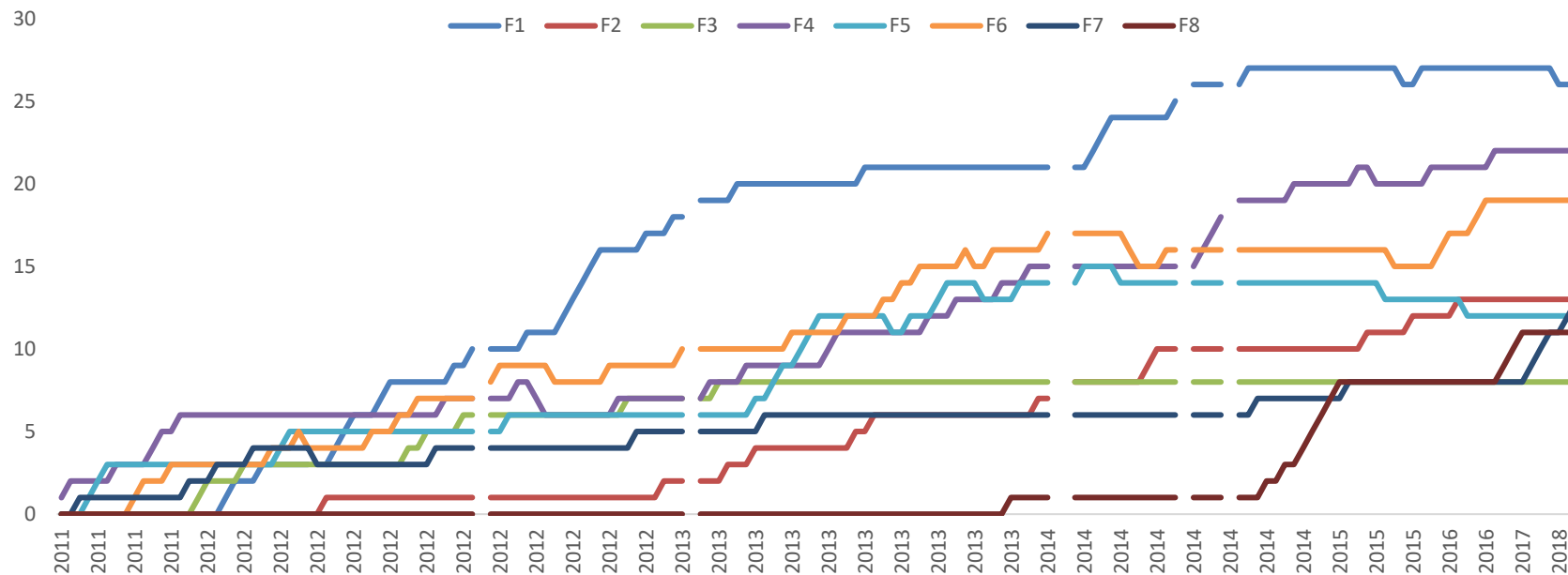
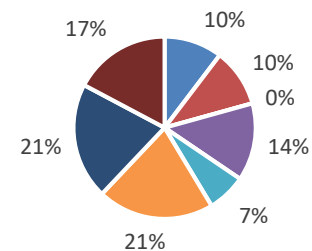
Emergence and experimentation



Scaling and acceleration



Uncertainty, Suspension and Final termination



7.5.1. Episode 1: Programme Design and Planning (2011)

As part of the analysis of the design episode of the EHA, the functional analysis was undertaken (Figure 7-4). The analysis reveals the guidance of search (F4/GOS) as the prominent function. This involves activities introduced during the formation years of the project aimed toward target-setting, definition of roles, expectations, responsibilities etc. These served to enlist the buy-in of stakeholders critical to the programme's success.

The trend pattern provides information on the functions that are important for driving the stage as well as the role of the actors. To visualise this, the give-receive-participate framework is used to illustrate the specific role of actors in different activities driving the functions (Figure 7-5). The analysis shows that functions (F4/GOS and F5/MKT) were the most 'given' function, while F4/GOS was the most 'received' by actors and most functions actors 'participate' in. There are some other functions involved in the relationship but in a minimal role. F6/RES was given while F5/MKT was received, and actors participated in the F7/LEG function.

Further analysis was carried out to investigate actors' role in fulfilling functions at the design stage using the give-receive-participate framework (Figure 7-6). The result shows that at the design stage, entrepreneurial activities (F1/ENT), knowledge diffusion (F3/KDF), and positive externalities (F8/EXT) were completely missing. The lack of F8/EXT at the commencement at the GES is not unusual. This is because positive spillovers to the other actors of the I4ID system usually occur at the later stages of the implementation of the system. The Federal Government's role as the enabler of the I4ID system at the design stage is also reflected. The Federal Government was the sole giver of direction (F4/GOS), providing resources (F6/RES) and enabling the coalition needed to kickstart the programme successfully (F7/LEG). The government developed the policy framework for the GES, and the ATA, which spelt out the roles and responsibilities of key actors. In the process, the Federal Government engaged the buy-in of the key actors, including the intermediary associations, agro-dealers, suppliers, state governments, and financial institutions, in the design of the Scheme. The Federal Government also awarded the contract for developing and managing the GES database management system to Cellulant. Hence, the dominant functions of the design episode were the provision of the direction of search and advocacy.

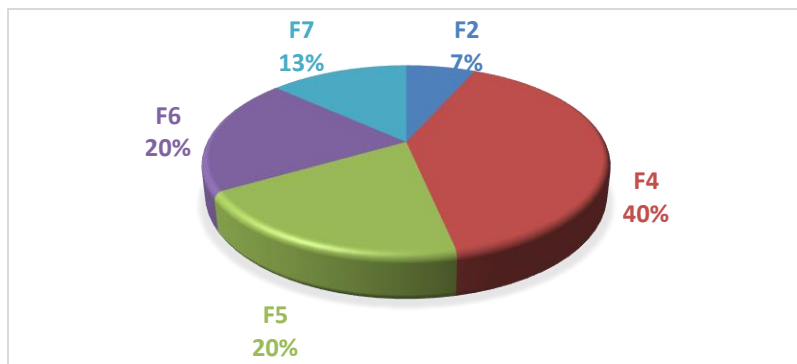


Figure 7-4: Functional analysis of the design episode

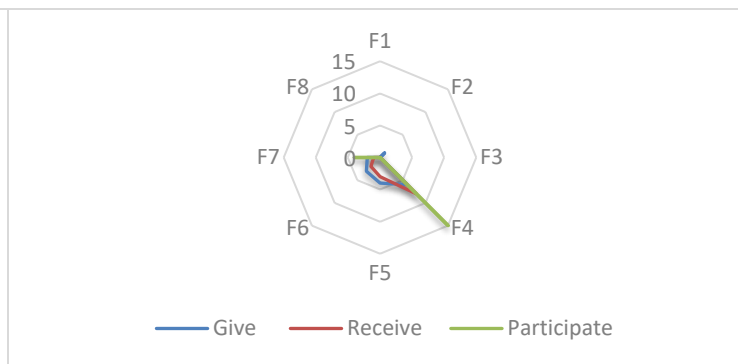


Figure 7-5: Functional interaction map of the design episode

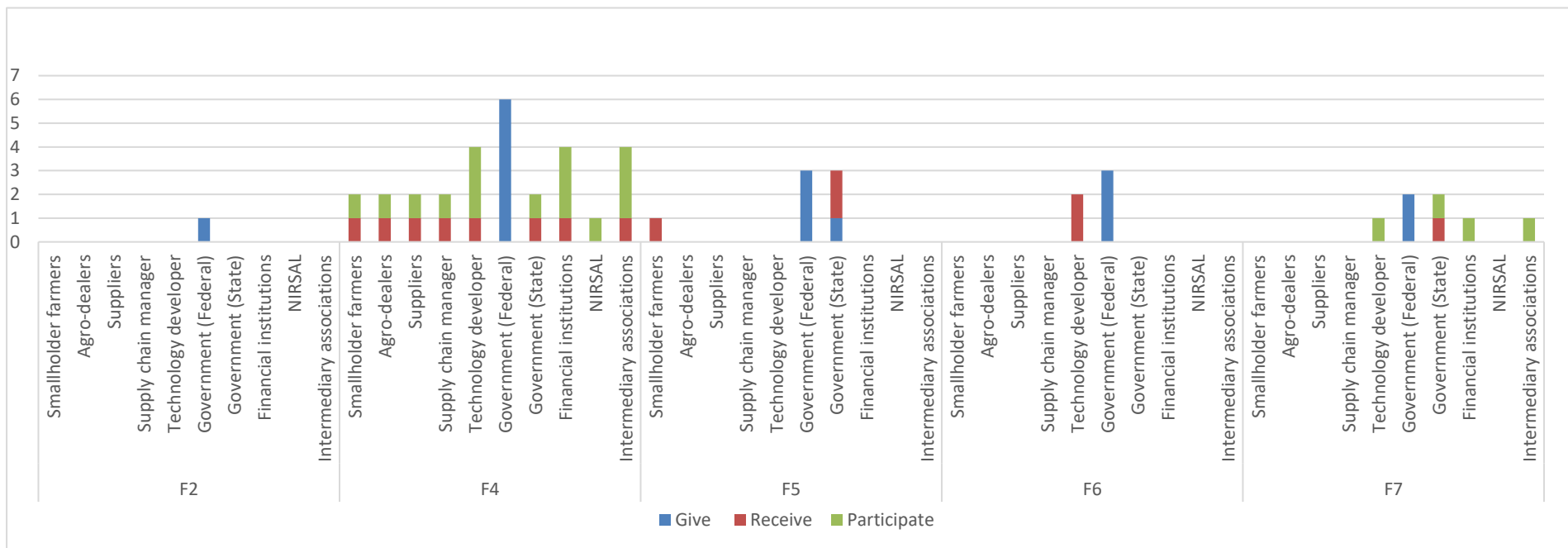


Figure 7-6: The functional give-receive-participate map of the design stage and the actors that performed them

The next step is undertaking the interaction pattern by examining the relationships between the given, received and participate functions. This helps to depict any logical sequence in the fulfilment of the functions and contributes to explaining any pattern of interaction that may enhance the build-up or breakdown of the I4ID system. Internally, the main activities in the episode included primarily planning, preparation, target-setting, defining roles and responsibilities and seeking alliances and the buy-in of key stakeholders. The dominant function was the guidance of search (F4/GOS) led by the government (Figure 7-7). This is expected because, in the I4ID system, private-sector participation is weak at inception because of the perceived unprofitable business model of the BoP market. They only become strong with incentives facilitated by the government. In addition, other functions such as market formation, resource mobilisation, advocacy coalition, and knowledge diffusion were also prominent. The role of entrepreneurial activities, knowledge development and positive externalities are either weak or absent at this stage.

The government started with the development of the overall policy framework (F4/GOS), which led to a series of stakeholder engagements (F3/KDF) to design the operational framework (F4/GOS) and set targets (F4/GOS). These created a coalition of actors (F7/LEG) and facilitated the buy-in of different stakeholders (K3/KDF) while leading to better awareness about the Scheme (F3/KDF). These led to commitments by State and Federal Governments to subsidise the programme (F6/RES), enhance obligatory patronage (F5/MKT) and stimulate the necessary resources (F6/RES). Furthermore, administrative structures to manage the Scheme were established (F4/GOS), as well as the human resources critical to the success of the Scheme (F6/RES). Therefore, the prominence of guidance of search, especially by the government, leads to a conclusion that the cumulative causation is a demand-pull motor.

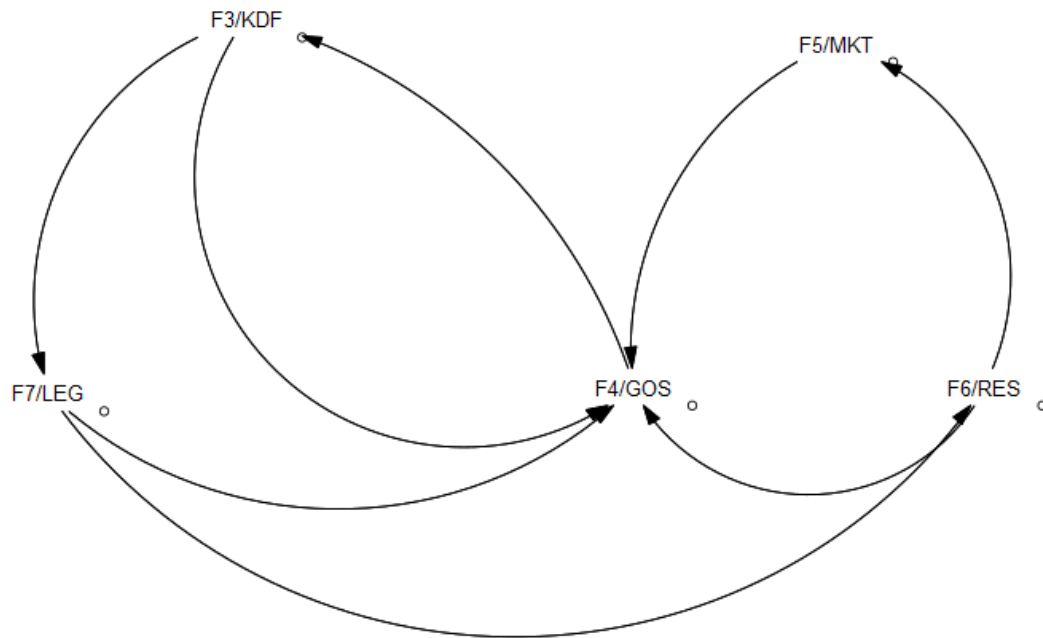


Figure 7-7: Functional dynamic of episode 1 – demand-pull motor

Further investigation was undertaken to examine the drivers, barriers and impacts of the demand-pull motor on the I4ID structures. These are illustrated in Table 7-8. The new political leadership in government, whose agricultural policy was aimed at reducing high food imports, drives the activities in the design episode. The main external driver of this period is the increased government revenue arising from the high price of crude oil in the international market. Also, Nigeria's high import food bill led to a government plan to formulate the ATA to support the transformation of agriculture and food systems as a tool for food security and job creation. By providing inputs to farmers at subsidised rates for a period, it is expected that these farmers will develop the capacity to transition from peasant to mechanised agriculture, thereby enhancing their livelihoods. To achieve this, the government formulated the ATA, which translated agricultural procurement and distribution from the public to the private sector. The barriers in the design episode are the poor telephone infrastructure to support the deployment of GES. Also, poor ownership of mobile phones among smallholder farmers. The main impact of the design episode is the high enthusiasm among the actors, especially the state government and the private sector, to participate and support the programme.

Table 7-8: Drivers, barriers and impact of the demand-pull motor on I4ID structures

	Actors	Institutions	Interactions	Infrastructure
Drivers	<ul style="list-style-type: none"> • High price of crude oil provided the needed revenue to support the high cost of subsidies • Huge market for agro-inputs supply in Nigeria (demand-side) • Government driving the process through strong political leadership at FMARD • Buy-in of critical stakeholders • Commitment to obligatory use by state governments leading to near monopoly in the agro-input supply system • Selection of Cellulant as the database management system • Low market entry conditions for smallholder farmers 	<ul style="list-style-type: none"> • Formulation of a new agricultural policy • Clear delineation of roles, responsibilities and targets under ATA • Agricultural policy aimed to transit procurement from the government to the private sector • Development of Input Lending Framework by FMARD and the CBN to enable sustainable funding to actors in the GES • Formulation of Seed buyback policy to ensure the development of breeder and foundation seeds. 	<ul style="list-style-type: none"> • The state governors were engaged through a series of meetings to support the Scheme • Formation of a National Working Group at the Federal level and a State Working group in each of the States to constantly monitor the progress of the Scheme 	<ul style="list-style-type: none"> • Pledge of funds by the government to subsidise the inputs

Barriers	<ul style="list-style-type: none"> • Low competence among agro-dealers on seed handling • Low trust, especially among smallholder farmers, due to the failure of previous interventions 	<ul style="list-style-type: none"> • The programme in its design was blind. The marginalised were treated as a homogenous group, whereas women, aged were more disenfranchised 	<ul style="list-style-type: none"> • Low awareness of the GES by some actors, especially smallholder farmers 	<ul style="list-style-type: none"> • Poor roads in the rural areas • Poor telephone network in rural areas • Poor ownership of telephones among rural farmers
Impact	<ul style="list-style-type: none"> • Enthusiasm among critical actors and stakeholders except for the smallholder farmers 	<ul style="list-style-type: none"> • Development of the first National Farmers' Database for the country 	<ul style="list-style-type: none"> • Strong commitment by actors to implement the rollout of subsidised inputs through the GES Scheme 	<ul style="list-style-type: none"> • Establishment of NIRSAL - a particular vehicle for de-risking agriculture lending

7.5.2. Episode 2: Emergence and Experimentation (2012)

The trend pattern is analysed through the functions fulfilled in the episode. The most critical activity in this episode is the redemption of subsidised agro-inputs. This led to a rise in activities under the GES, making the entrepreneurial function (F1/ENT) the most prominent function in the emergence and experimentation episode (Figure 7-8). The prevalence of F1/ENT is due to the activation of business activities in the GES Scheme - the roll-out of subsidised inputs. Prominent entrepreneurial activities included the entry of firms through the activities of the agro-dealers, suppliers, etc., monitoring and evaluation by government officials, registration of smallholder farmers and redemption of inputs by smallholder farmers. These led to the fulfilment of other functions such as resource mobilisation (F6/RES), creation of legitimacy (F7/LEG) and knowledge diffusion (F3/KDF).

The roles of actors in the fulfilment of the emergence episode are depicted using the give-receive-participate framework shown in Figure 7-9 (F2/KDV and F8/ENT were missing from the graph because their activities were either insignificant or missing). This reveals that the most given functions by actors were F1/ENT, while F1/ENT, F7/LEG, F6/RES and F4/GOS were the most received functions. In addition, F3/KDF was the function mostly participated by actors. Further, the role of the actors in the functional fulfilment was analysed using the give-receive-participate framework (Figure 7-10). The analysis reveals that the Federal Government continued to play a significant role in driving the activities of the emergence episode by performing the 'giving' role in F1/ENT, F3/KDF, F4/GOS, F5/MKT, F6/RES and F7/LEG. However, the episode witnessed the rise of other actors in the 'given' role, with Cellulant playing an essential role in F1/ENT and F6/RES, as well as agro-dealers and financial institutions in F1/ENT. The Federal Government facilitated the entry of new firms through the accreditation of agro-dealers, and suppliers, portfolio expansions through the expansion of farmer's lists and introduction of new variants of GES, as well as monitoring and evaluation activities through officials of FMARD. In addition, to enhance the smooth operation of the GES, the Federal Government continued to mobilise and lobby critical actors to build legitimacy for the Scheme. Cellulant enlisted new actors such as smallholder farmers, agro-dealers and suppliers on the GES database and provided regular reports to support the monitoring and evaluation activities. The high point of the emergent episode, the redemption of inputs by smallholder farmers, was facilitated by agro-dealers who provided the information at the redemption centres.

Smallholder farmers and agro-dealers mostly performed the receiving role. This is because of the importance of F1/ENT in the episode characterised by the entry of firms and portfolio expansions. Also, these same actors performed important receiving roles in the F6/RES function. Agro-dealers received and deployed inputs and technologies to manage the operations at redemption centres, while smallholder farmers received SMS on the e-wallets on their mobile phones.

The next step in the analysis is to examine any logical sequence in the fulfilment of the functions that contribute to explaining the pattern of interaction that may enhance the build-up of the I4ID system. Overall, four functions drove the episode. These are entrepreneurial function (F1/ENT), creation of legitimacy (F7/LEG), resource mobilisation (F6/RES) and diffusion (F3/KDF) (Figure 7-11). At the heart of this episode is the government playing a central role in enabling the rollout of inputs (F1/ENT). Because the GES at this episode is in an experimental mode, the government needed to build a coalition (F7/LEG), engage different stakeholders (F3/KDF) and mobilise financial, technological and human resources (F6/RES) to enhance the rapid diffusion of the Scheme. These went a long way to overcome the initial distrust of the Scheme among other stakeholders (F4/GOS), especially the private sector players, and facilitated their participation (F1/ENT). Because this is an experimental mode for the rollout of inputs, the experience of actors provided appropriate feedback (F2/KDV), which further enhanced the operational efficiency of the Scheme, this episode was implemented in four phases, with different functions dominant in each of the phases. Though different, each interacted with the next phase in a complementary manner as follows: Phase 1, coalition formation (F7/LEG) and sensitisation and preparation activities (F3/KDF); Phase 2, the redemption of inputs (F1/ENT; F6/RES); and Phase 3, reconciliation (F1/ENT). Phase 4, continuous monitoring (F1/ENT), meanwhile permeated all the three preceding phases. This episode can therefore be termed as entrepreneurial motor because its overall goal is to roll out subsidised inputs, and all the activities in the episode were geared towards achieving this.

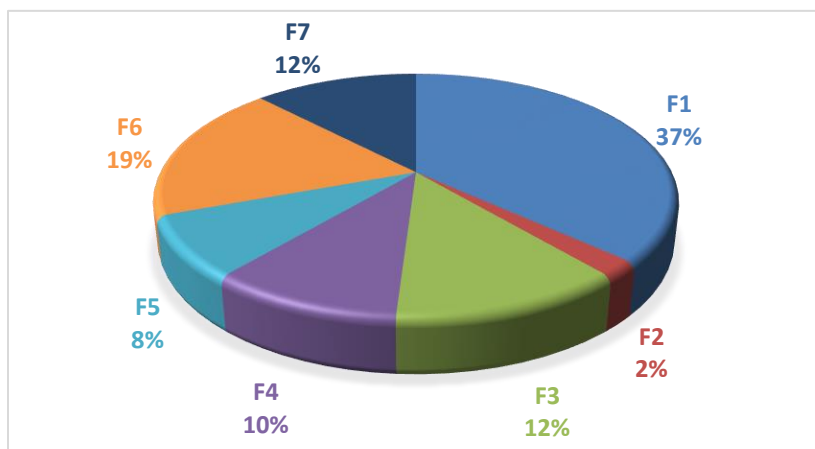


Figure 7-8: Functional analysis of the emergence stage

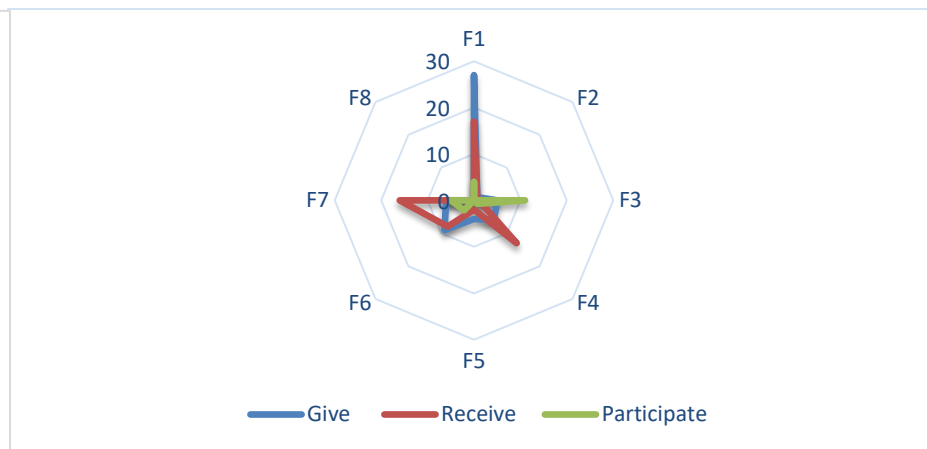


Figure 7-9: Functional interaction map of the emergence episode

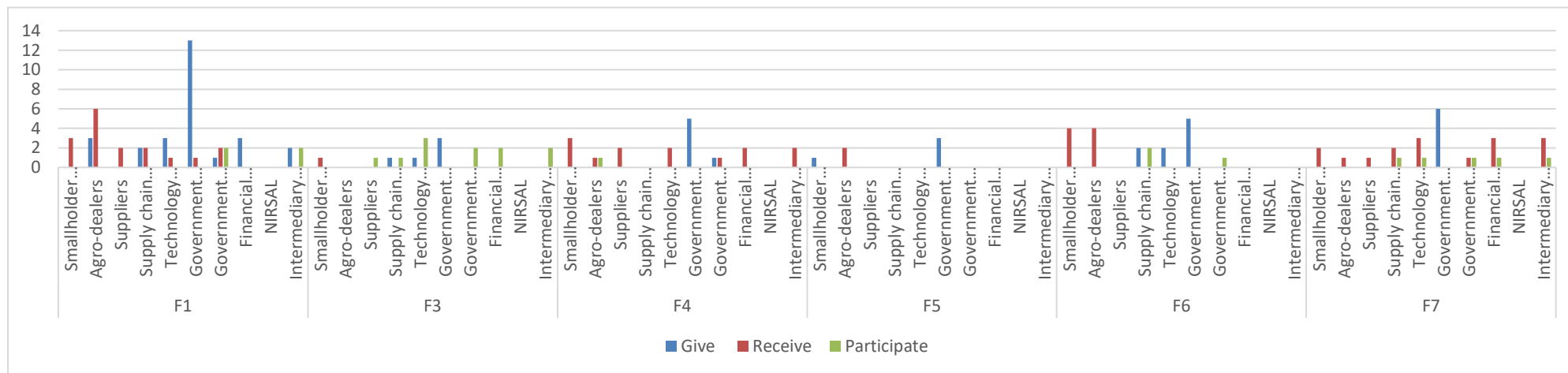


Figure 7-10: The functional give-receive-participate map of the emergence stage and the actors that performed them

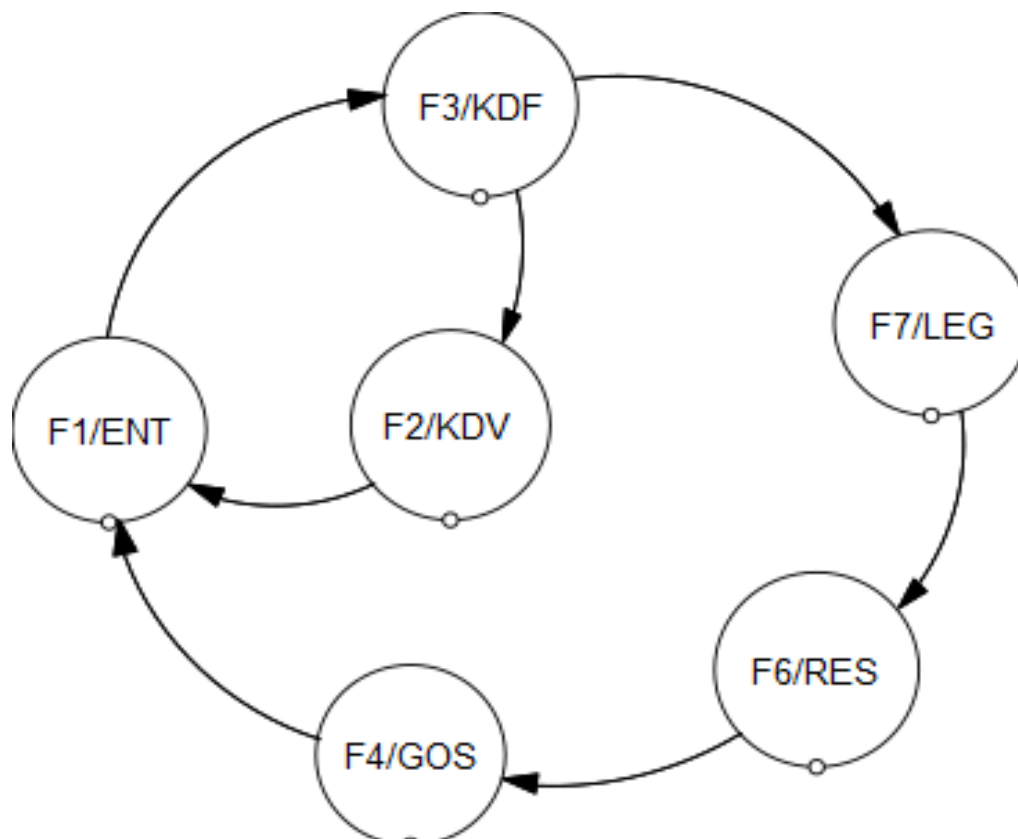


Figure 7-11: Functional dynamics of episode 2 – entrepreneurial motor

Further investigation was undertaken to examine the drivers, barriers and impacts of the entrepreneurial motor on the I4ID structures (Table 7-9). The activities in the entrepreneurial function were driven by the commitment of the stakeholders, especially the private sector players and government, to support the Scheme. The delineation of activities between the government and the private sector was aimed at complementing the strength of the actors. While the private sector leveraged its culture of efficiency to enhance input delivery, the government coordinated and focussed on continuous monitoring, learning and evaluation of the programme. These helped to confer legitimacy on the Scheme. The government's constant monitoring, evaluation, and learning helped introduce innovations that tackled emerging challenges during the implementation. Using an electronic wallet as a platform for the redemption of inputs also helped to enhance efficiency in the distribution of agro-inputs.

Structural barriers in the emergence episode occurred mainly in the form of infrastructure deficit in rural areas regarding poor transportation and telephony services. These negatively affected the logistics of input delivery of the Scheme. The poor telephony services in the rural areas negatively

affected the redemption of inputs leading to long queues and sometimes the inability to redeem the subsidised inputs. Despite detailed planning and buy-in of the private sector players, the lack of trust among smallholder farmers negatively affected the redemption in this episode, leading to the government's inability to meet the target. There was reluctance among the farmers to register and participate in the Scheme due to negative experiences with previous interventions by the government. This episode also witnessed noticeable impacts on the I4ID structures. These included the development of the first national farmers' database for Nigeria, creating market opportunities for suppliers, mainly small-scale suppliers, closer collaboration between suppliers and agro-dealers, job creation at the redemption centres, and increased awareness of the Scheme among the significant actors. The success in input delivery to the smallholder farmers helped to increase trust among smallholder farmers and enhanced participation in the subsequent stage of the Scheme.

Table 7-9: Drivers, barriers and impact of the entrepreneurial motor on I4ID structures

	Actors	Institutions	Interactions	Infrastructure
Drivers	<ul style="list-style-type: none"> • Utilisation of the private sector in procurement and distribution of inputs • High price of crude oil provided the needed revenue to support the high cost of subsidies • 	<ul style="list-style-type: none"> • Informal contractual system guaranteeing inputs supply system to agro-dealers • 50% subsidy on fertiliser and 100% on seeds stimulated the early growth of the GES • Input Lending Framework and seed buyback policy provided the needed incentives for financial institutions and seed companies, respectively 	<ul style="list-style-type: none"> • Strong collaboration between agro-dealers and suppliers • Stronger interaction between research institutions, government and industry leading to the development and production of new varieties of seeds and seedlings used under the GES • Regular review meetings of critical actors in the GES • Regular and continuous training of critical actors • Experiential learning through the DUI mode 	<ul style="list-style-type: none"> • Introduction of e-wallet technology for input distribution enhanced operational efficiency of the system
Barriers	<ul style="list-style-type: none"> • Lack of trust among smallholder farmers to participate in the Scheme leading to enrolment in the first year • Poor capacity among helpline officers 	<ul style="list-style-type: none"> • Government rules guiding initial farmers' registration were weak; • Conditions for credit access too stringent for small actors • Poor IPR framework put in place between research institutes and seed companies to protect the development of breeder 	<ul style="list-style-type: none"> • Poor sensitisation • Poor coverage in mass media, especially in local languages, • Late mobilisation of actors • Mismatch between seed supplied and needs of farmers across different agro-ecological zones; 	<ul style="list-style-type: none"> • Capacity gap among the key actors of the GES • Logistics issues such as the late supply of inputs, long distance to redemption centres • Poor telephone network in rural areas

	seeds by research institutes was unsuccessful	<ul style="list-style-type: none"> • Inability of small actors, especially agro-dealers, to access credit from banks • Inadequate finance model to take care of concerns of BoP • Challenges with the NFDB • Poorly articulated demand of BoP needs and supporting ICT infrastructure 	
Impact	<ul style="list-style-type: none"> • Increase in trust among smallholder farmers • Development of the first national farmers' database for Nigeria • creation of market opportunities for suppliers especially, small scale suppliers 	<ul style="list-style-type: none"> • The development of the National Farmers Database provided empirical evidence on the size and nature of the marginalised (smallholder farmers) in the Nigerian agricultural sector • Setting up of commercialisation unit in agricultural R&D institutions 	<ul style="list-style-type: none"> • Increase awareness of the Scheme • Closer collaboration between suppliers and agro-dealers • Creation of a nationwide structure for the redemption of agro-inputs at the grassroots

7.5.3. Episode 3: Scaling and Acceleration (2013 – 2014)

The first step is to assess the functional analysis of the third stage of the EHA process – the scaling stage. The research shown in Figure 7-12 indicates that F6/RES, F4/GOS and F5/MKT were the most dominant functions in the episode. The scaling episode is similar to the emergent episode, the only difference being the scale and intensity of activities. Hence, entrepreneurial activities (F1/ENT) play an essential role. The rise of the knowledge development (F2/KDV) function was also noticeable. While entrepreneurial activities by smallholder farmers, agro-dealers and suppliers continue to drive the episode, the continuous monitoring, learning and evaluation role of the government necessitates a need to regularly intervene through the introduction of new technologies and other non-technological innovations (F6/RES) as well as the creation of institutions and agencies (F4/GOS) to tackle emerging challenges and enhance efficiency.

The give-receive-participate framework was used to analyse the actors' role in fulfilling the functions (Figure 7-13). The analysis reveals that the most given functions by actors were F4/GOS, F1/ENT, F5/MKT and F6/RES, while F6/RES, F4/GOS, F5/MKT and F1/ENT were the most received functions. Similarly, F2/KDV and F6/RES were the functions that mainly were participated by actors.

Further analysis of the give-receive-participate framework reveals a similar pattern to the entrepreneurial motor in that the Federal Government continues to provide most of the given role. At the same time, smallholder farmers and agro-dealers performed most of the receiving role (Figure 7-14). However, differences occurred in the F5/MKT and F6/RES functions where the financial institutions, especially NIRSAL, the new financial support vehicle, performed a significant given role. Another important consideration is the given role of the suppliers in generating externalities F8/EXT. This arises from the entrance of new firms and suppliers, especially international seed and fertiliser companies, as well as growth in seed companies due to a positive rating of the scheme.

The next step in the analysis is to examine any logical sequence in the fulfilment of the functions that contributed to explaining any pattern of interaction that may enhance the build-up of the I4ID. As noted earlier, the activities in the scaling episode were built on and similar to those of the second episode; hence, they exhibit similar activities. The only difference is the deepening of the creation of appropriate structures that enhance the rapid diffusion of and high intensity of the

activities of entrepreneurs in the GES market. The episode can therefore be termed market motor (Figure 7-15). Prominent functions in the episode included market formation, entrepreneurial activities, resource mobilisation, the guidance of search, knowledge development and knowledge diffusion. In addition, there was the manifestation of positive externalities function. The efficiency in input delivery in the first year (F1/ENT) has raised awareness (F3/KDF) and increased the confidence and trust (F4/GOS) about the Scheme. These consequently led to higher participation of actors (F1/ENT). Also involved in this episode are the knowledge development activities (F2/KDV), driven by continuous monitoring, learning and improvement. Feedback from actors' experience (F2/KDV) and commissioned review of the rollout in the first year (F2/KDV) increased learning (F2/KDV). It led to innovations in market formation (F5/MKT), intense entrepreneurial activities (F1/ENT), and higher resource mobilisation (F6/RES).

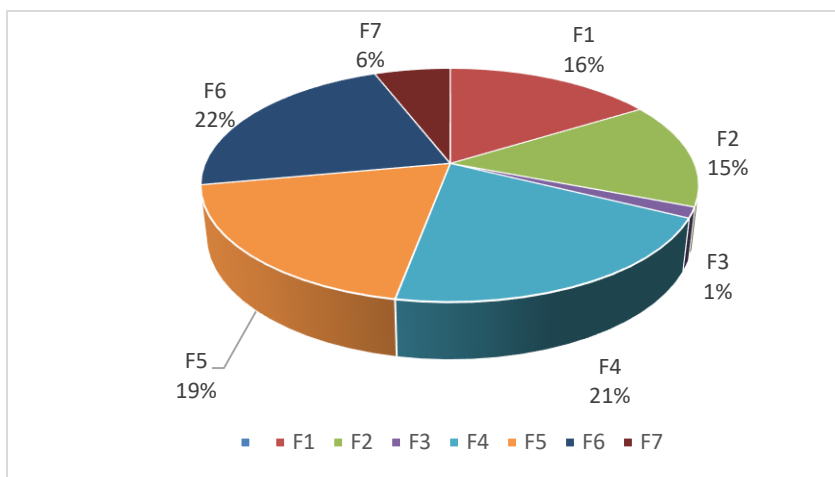


Figure 7-12: Functional analysis of the scaling stage

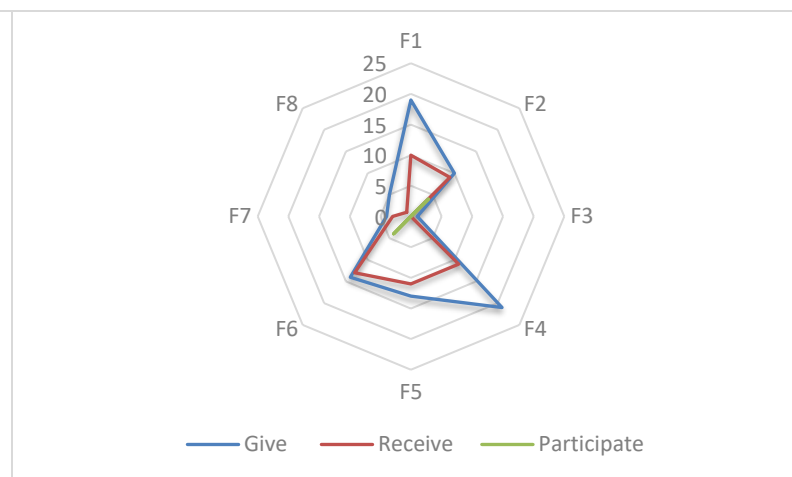


Figure 7-13: Functional interaction map of the scaling episode

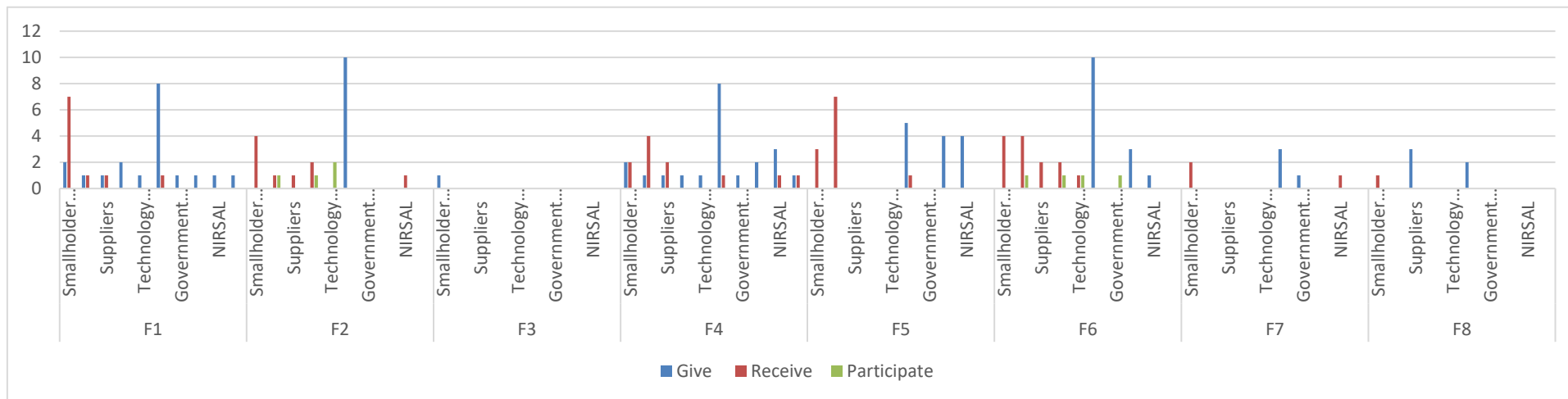


Figure 7-14: The functional give-receive-participate map of the scaling stage and the actors that performed them

The learning process was primarily driven by experience and feedback from key actors in the GES. These establish the importance of the DUI mode of learning in the BoP market. Different structural changes were made in implementing the programme with local and international support (F6/RES). These resulted in positive spillover effects (F8/EXT) on other actors in the GES. While the market was not functioning optimally, challenges with infrastructure to support the I4ID system still existed while the law to guarantee sustainability was not yet in place; however, the market environment was already created, and all functions found relevance except the role of creation of legitimacy. This is because advocacy activities are minimal in established markets. This episode can therefore be termed a market motor.

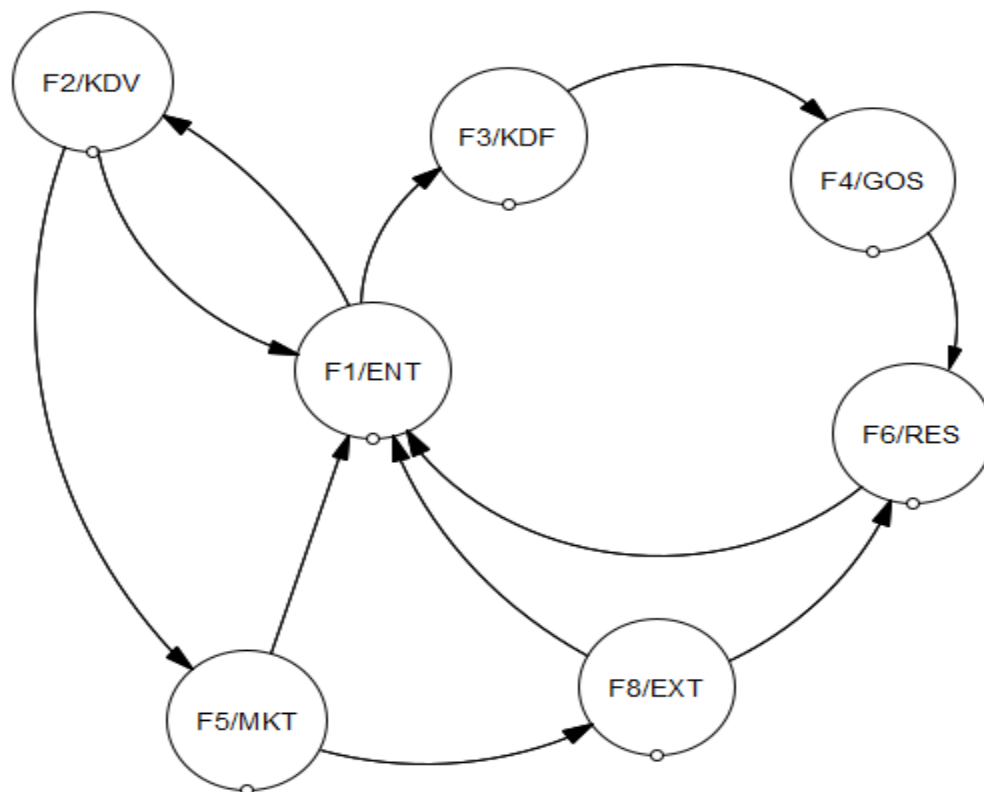


Figure 7-15: Functional dynamics of episode 3 – market motor

To understand the factors influencing the episode's development, further investigation was undertaken to examine the drivers, barriers and impacts of the market motor on the I4ID structures (Table 7-10). The primary driver of growth was the wide acceptability of the scheme among stakeholders, especially the smallholder farmers who had previously expressed reluctance to

participate. These led to implementing new initiatives, structures, and institutions to tackle the growth challenge. For instance, the introduction of NIRSAL by the government led to an increase in credit facilities by actors in the GES. In addition, introducing new technologies helped overcome the challenges experienced during the emergent episode. Such technologies included TAP for redemption and OMR for farmers' registration. The support of international partners such as the DFID led to technology spillover, which led to the creation of TAP. However, specific barriers continued to limit the functionality of the structural elements. For instance, while the introduction of NIRSAL enhanced credit access to actors, smaller actors experienced challenges in access to credit due to stringent requirements. The redemption process continued to face challenges of poor telephone networks, especially in rural areas; an attempt to introduce the TAP technology to overcome the challenges, though successful, was slow in deployment. Due to the weakness of IPR laws in Nigeria, an attempt to introduce initiatives to strengthen the IPR regime in the seed failed. Another challenge was the mismatch between the seed supplied and the needs of farmers in some agroecological zones, which led to the rejection of the seeds provided in some areas. The episode also witnessed poor vertical interaction among actors such as seed companies and research institutes, as well as the marginalised group and research institutions.

Despite the challenges, there were some significant positive impacts on the structural actors in the episode. For instance, some multinational seed and fertiliser companies that left the country returned while the seed industry witnessed a strong performance in production and profitability. The entrepreneurial activities helped forge a closer interaction between agro-dealers and smallholder farmers and between agro-dealers and suppliers. At the same time, the introduction of TAP technology revealed a new technology with the possibility to release the untapped potential in agriculture in rural areas in the future through the power of ICTs.

Table 7-10: Drivers, barriers and impact of the market motor on I4ID structures

	Actors	Institutions	Interactions	Infrastructure
Drivers	<ul style="list-style-type: none"> • High price of crude oil provided the needed revenue to support the high cost of subsidies • Wide acceptance of the scheme among actors due to the success of the first year • Outsourcing of supply chain management to the private sector • Introduction of OMR form for farmers' registration • Use of mass media in disseminating information in local languages to smallholder farmers • Support from international donors in terms of technical support and capacity building, e.g. AGRA, DFID 	<ul style="list-style-type: none"> • Input Lending framework providing credit access to companies, especially the big companies in the sector which until that time found credit access to agriculture difficult • 50% subsidy on fertilisers and 100% on seeds 	<ul style="list-style-type: none"> • Support from international donors such as DFID led to technology spillover from British technology firms • Regular review meetings of critical actors in the GES • Regular and continuous training of critical actors • Experiential learning through the DUI mode • Introduction of new technologies and innovations to tackle emerging challenges 	<ul style="list-style-type: none"> • Introduction of TAP technology for redemption to overcome the challenges of poor technologies in rural areas • Establishment of NIRSAL led to the enhancement of credit access to the actors
Barriers	<ul style="list-style-type: none"> • Poor capacity among helpline officers • Sharp practices among some farmers and agro-dealers to circumvent quality control processes 	<ul style="list-style-type: none"> • Certain regulations are stringent for small firms to participate • Weak laws protecting intellectual property rights on breeder seeds • Inability to access credit by agro-dealers due to stringent conditions 	<ul style="list-style-type: none"> • Mismatch between seed supplied and needs of farmers across different agro-ecological zones; • Poor vertical interaction among actors such as seed companies and research institutes, marginalised and research institutions 	<ul style="list-style-type: none"> • Slow rollout of NAPI and TAP • Inadequate telephony and other connecting infrastructure • Late introduction of biometrics technology for farmers' registration • shortage of seeds, especially maize and rice, leading to

			<ul style="list-style-type: none"> • Poor lending to small actors especially agro-dealers who are mostly SMEs • Distrust among agro-dealers to access credit facilities from banks due to high interest and low tenor 	<p>the rationing and sharing of seeds among farmers</p>
<p>Impact</p>	<ul style="list-style-type: none"> • Return of multinational seed and fertiliser companies to Nigeria • Growth in the seed industry with a dramatic increase in the production of certified and foundation seeds • The capacity of local input suppliers was enhanced to support the supply of inputs in the special value chain GES such as livestock, aquaculture, cassava, etc • Research institutions in the agricultural sector started establishing spin-off companies to commercialise seed production to meet the rising demand for seed due to the GES Scheme. 	<ul style="list-style-type: none"> • Review of Input Lending Framework resulted in a more robust and more effective framework for credit access to actors in the agro-input supply system 	<ul style="list-style-type: none"> • Stronger interaction between agro-dealers and smallholder farmers as well as between agro-dealers and suppliers • Research institutions in the agricultural sector started establishing spin-off companies to commercialise seed production to meet the rising demand for seed production. 	<p>The introduction of TAP shows the opportunity to implement technologies that can overcome the limitations of poor telephony in rural areas.</p>

7.5.4. Episode 4: Uncertainty Suspension and Final Termination (2015 – 2018)

The analysis of the final episode reveals the dominance of F7/LEG and F6/RES. There was also a reflection of positive externalities F8/EXT (Figure 7-16). Contrasted to the preceding scaling episode, this stage was characterised by the low level of entrepreneurial activities F1/ENT by firms and other actors, especially smallholder farmers and government, as well as a low level of target-setting, standardisation and expectations (F4/GOS). The functional interaction analysed through the give-receive-participate framework used to analyse the actors' role in fulfilling the functions influencing the episode (Figure 7-17) indicates that the function given mostly by actors was F7/LEG. In contrast, the most received functions were F7/LEG and F6/RES. While the Federal Government continued to be the primary 'giver' of the other functions, intermediaries played the given role in the F7/LEG (Figure 7-18). Also, the government was the leading receiver of the F7/LEG function. Taking together, these imply a general low entrepreneurial activity. The rise in lobbying and advocacy by intermediaries was aimed at protecting the interest of their members, especially smallholder farmers and agro-dealers. The advocacy and lobbying activities were targeted primarily at the Federal Government.

The fourth episode went through several phases of uncertainty, suspension, re-emergence and final termination in 2018. The episode commenced in 2015 with the withdrawal of many state governments from the Scheme, leading to declining entrepreneurial activities. The withdrawal resulted from the negative impact of the fall in crude oil prices, which led to a sharp decline in government revenue. Two paths can be mapped out (Figure 7-19). First, the decreased funding (-F6/RES) led to unfulfilled promises in terms of payment of subsidy (-F4/GOS), which led to a reduction in entrepreneurial activities with the stoppage of supply of inputs by the different companies (-F1/ENT). These led to the subsequent suspension of the Scheme in 2015 (-F1/ENT). The second path can be traced to 2015, with the new administration continuing to make promises of continuation with the Scheme (F4/GOS), which was reflected in the new government policy for the agricultural sector, the Agricultural Promotion Policy (F4/GOS). Coupled with increased advocacy for the return of the Scheme (F7/LEG), a review was commissioned (F2/KDV), and the outcome led to the reintroduction of the Scheme in 2016 with resources provided by the Federal government alone (F6/RES); however, with new operational guidelines that emphasised the reduction in scope and scale (F5/MKT). This could not guarantee market formation (-F5/MKT) as many stakeholders were sceptical of government plans (-F4/GOS) and failed to participate in the

Scheme (-F1/ENT). These led to a reduction in entrepreneurial activities (-F1/ENT) and subsequent termination of the programme in 2018 (-F1/ENT). This episode can thus be described as a motor of decline - cumulative causation resulting in a standstill and later complete termination of the Scheme. This emergence of the motor resulted from the high cost of maintaining subsidies, accumulated debts, and unfulfilled promises in terms of untimely payment of subsidies, thereby leading to the withdrawal of the suppliers.

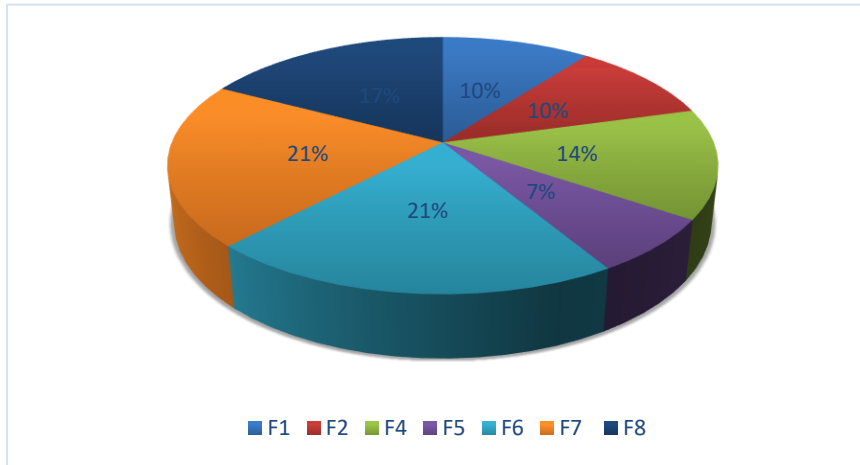


Figure 7-16: Functional analysis of the decline episode

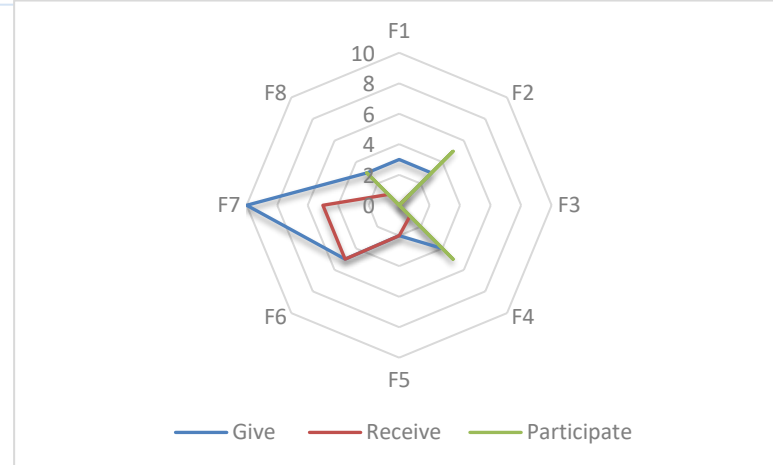


Figure 7-17: Functional interaction map of the decline episode

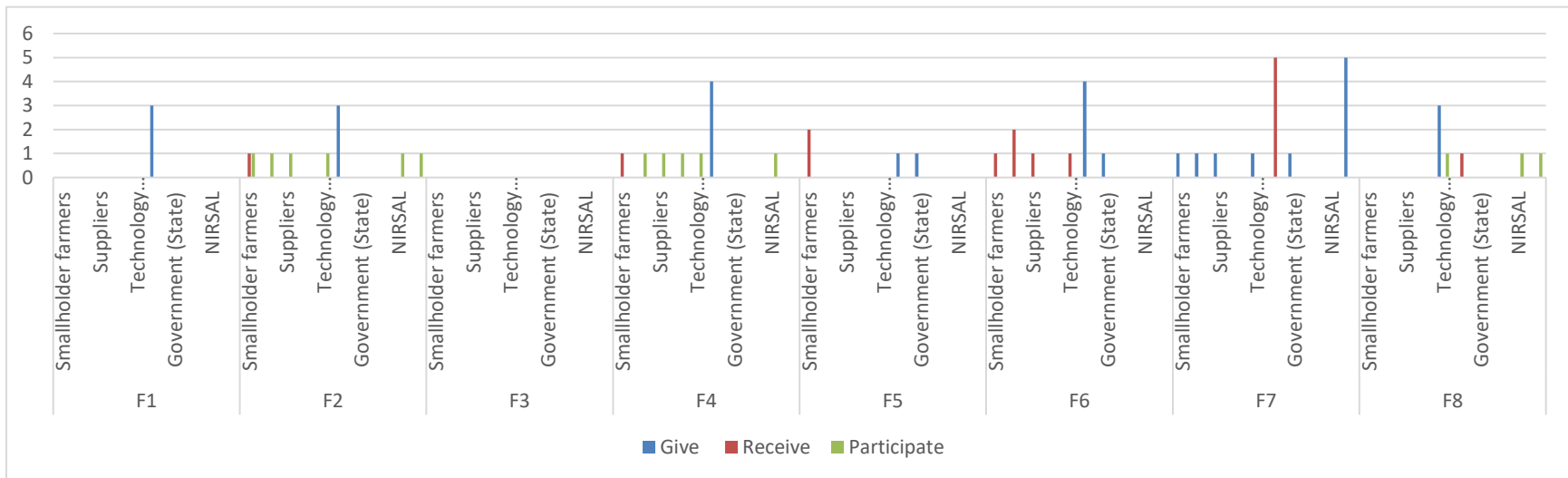


Figure 7-18: The functional give-receive-participate map of the decline stage and the actors that performed them

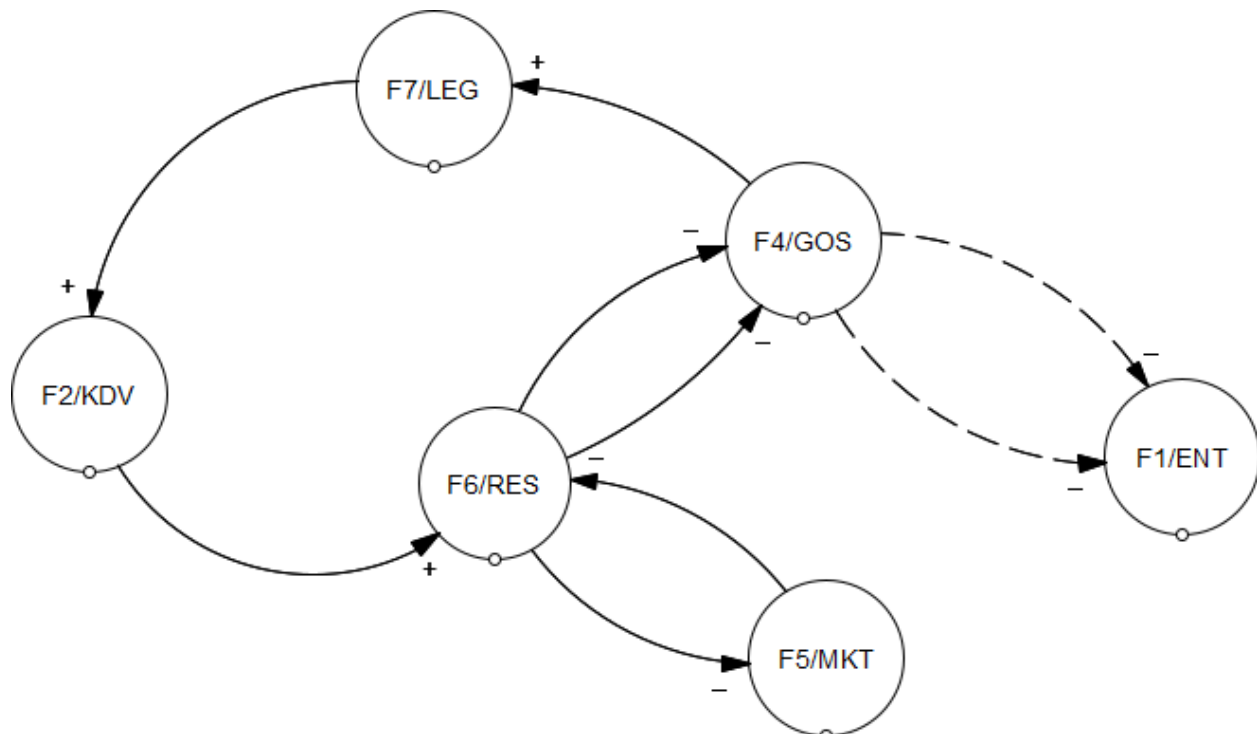


Figure 7-19: Functional dynamics of episode 4 – the motor of decline

The drivers of the episode were external factors, especially the crash in oil revenue leading to a substantial cut in government subsidies and the political transition leading to change in government. These led to the stifling of entrepreneurial activities and the eventual suspension and termination of the programme. The external factors stimulated internal challenges to the development of the GES. For instance, the cut in funding from state governments resulted in high debt because of unpaid subsidies to agro-dealers. Another external barrier was the change in government in 2015 arising from national elections. The new government, which campaigned on the ground of anti-corruption, viewed the high level of debt from unpaid subsidy claims with suspicion.

Despite the termination of the Scheme, the decline motor had a significant impact on the I4ID structures in that it enhanced interaction among some structural actors that were otherwise weak (Table 7-11). For instance, smallholder farmers continued to maintain strong collaboration with agro-dealers developed even after the termination of the Scheme. The high level of lobbying activities of intermediaries necessitated by the decline motor helped to forge a close relationship between intermediaries such as farmers and agro-dealers associations with other actors in the GES such as policymakers and government officials.

Table 7-11: Drivers, barriers and impact of the decline motor on I4ID structures

	Actors	Institutions	Interactions	Infrastructure
Drivers	<ul style="list-style-type: none"> • Strong advocacy and lobbying by intermediaries 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Challenges encountered forced closer interaction between crucial actors such as agro-dealers and policymakers 	<ul style="list-style-type: none"> • Renewal of contract of technology provider, Cellulant
Barriers	<ul style="list-style-type: none"> • Late payment of subsidies; • Lack of political commitment due to change in political leadership • Withdrawal by State Governments 	<ul style="list-style-type: none"> • Failed attempt to get legislative backing for institutionalising the GES; • Reduction in subsidies paid on seed • Reduction in scope of the Scheme 	<ul style="list-style-type: none"> • High mounting debt • Poor entrepreneurial activities arising from the withdrawal of all the significant actors due to non-payment of subsidies 	<ul style="list-style-type: none"> • Poor telephone infrastructure in rural areas • Withdrawal of financial support by state governments
Impact	<ul style="list-style-type: none"> • Enhanced capacity for lobbying and advocacy by intermediaries 	<ul style="list-style-type: none"> • Establishment of new structures and institutions for agriculture such as NIRSAL 	<ul style="list-style-type: none"> • Improved vertical relationship between agro-dealers and smallholder farmers and suppliers 	<ul style="list-style-type: none"> Expansion of infrastructure in rural areas

7.6 CHAPTER SUMMARY

Chapter Seven presents the outcome of the EHA of the GES Scheme. The EHA provides an opportunity for undertaking the component-function analysis and identifying the systemic problems with the evolution of the GES.

The EHA revealed the different stages of growth of the GES. Referred to as episodes, they are organised according to the specific trajectory of events that drive the activities of the lifecycle of the GES. Through this, the trend and interaction patterns in each episode were identified. These reveal the functions driving each episode, the relationship between them, cumulative causation, motors of innovation, and the drivers, barriers and impact of the motors on I4ID structures. The EHA was categorised into four episodes based on the chronological evolution of the GES, following which the activities of the GES were mapped using the functions of innovations. Furthermore, CLDs were used to assess the cumulative causation for each episode of the EHA.

Following this Chapter is the identification of systemic goals and the instruments for enhancing the performance of the I4ID system.

CHAPTER EIGHT : IDENTIFICATION OF SYSTEMIC GOALS AND INSTRUMENTS FOR I4ID SYSTEM

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	
					Summary and conclusions		

8.1 INTRODUCTION

This chapter presents stages 5 and 6 of the process of application of the framework to the I4ID system (Please, see Chapter Five for details of the analytical framework). This follows the EHA, a method used to carry out the component-function analysis. In undertaking the EHA, the barriers to systems structures were analysed. Problems with structural elements are indicators of the dysfunctionality of the processes that go on within the IS. Hence, this chapter provides further details of the problems associated with the functions of ISs. Through this, a holistic assessment of the performance of the innovation system is undertaken.

In other to complement the EHA, further insights were developed into the systemic problems influencing the performance of the I4ID system. The analysis in this chapter, therefore, gives further details of the systemic problems hindering the performance of the I4ID system, the systemic interventions and the goals of the intervention. The process was undertaken by examining each function from the perspective of the four structural elements (whether present or not) or their properties (quality, capacity, capabilities, intensity etc.). The aim is to enable policy to create an environment where functions can take place or be strengthened by altering the structural elements. Throughout the process, excerpts and quotations from qualitative analysis of interviewees of critical actors in the GES Scheme are used to triangulate the different steps of the analysis.

8.2 SYSTEMIC ANALYSIS AND INTERVENTIONS

The process in this section includes the identification of systemic problems (Step 4), identification of systemic goals (Step 5) and suggestions of systemic interventions in the form of instruments (Step 6) that can be used to address the challenges (please refer to Section 5.3). Systemic problems are associated with the system's structural elements but negatively affect the system's overall functioning. This section, therefore, identifies the functional problems that hinder the performance of the I4ID system and propose the systemic instruments that can be used to address the problems. The problems were identified from both the outcome of the EHA and the qualitative analysis. The framework for problem identification and interventions follows after Table 8-1 (Wieczorek and Hekkert, 2012; Botha, 2017; van der Merwe, 2017).

Table 8-1: Framework for systemic problems and instruments identification

Functions	Systemic Problems	Type of systemic problems	Description	The goal of systemic instruments
F1 – F8	Actor problems	Presence	Missing actors	Stimulate and organise the participation of relevant actors
		Capabilities	Weak absorptive capacity	Create spaces for actors' capabilities development
	Interaction problems	Presence	Missing interactions	Stimulate necessary interactions between diverse actors
		Quality	Strong or weak network problems	Block ties that are either too strong or too weak
	Institution problems	Presence	Missing institutions	Stimulate the presence of hard and soft institutions
		Quality	Stringent or weak institutions	Prevent too weak and too stringent institutions
	Infrastructure problems	Presence	Missing infrastructures	Stimulate the presence of different infrastructure
		Quality	Insufficient or poor infrastructure	Ensure adequate quality of infrastructure

8.2.1. Entrepreneurial Activities

The GES provided the opportunity to transform the agricultural sector through an inclusive approach that involves the marginalised in the process and focus of the intervention. Focusing on the private sector as the enabler of inclusion helps drive entrepreneurial activities in the sector. This is because of the efficiency associated with similar private-sector-led initiatives in

the agricultural sector (Olomola, 2015; GrowAfrica, 2016). Despite this, the programme implementation faced challenges, such as poor actors' capabilities, weak infrastructure, and an often-exploited inefficient registration process. Other challenges include the late supply of inputs, long distance to redemption centres, the mismatch between seed supply and the need at different agroecological zones and fraudulent activities on the part of some farmers (Olomola, 2015). A Federal policymaker and a supply chain manager identified problems with the implementation of the entrepreneurial activity of the GES as follows:

“When we started, the telephone network was the major challenge. We discovered that the majority of the rural areas had no telephone network. This affected our operation because our programme was built on an electronic platform, the e-wallet. Our Minister (Agriculture) had to meet with the Minister of Communications. We were prepared to support our farmers with inputs through the e-wallet but were incapacitated because there was no telephone network in many villages.”

“[...] Another challenge we had was that some suppliers were alien to the environment they were supplying. This affected our planning and logistics deployment. If you don't know the area you are supplying to, you put excessive pressure on available resources [...].”

The analysis also revealed a capacity gap among the key actors of the GES. Hence, there is the need to enhance the capacity of key stakeholders, strengthen the interaction between critical actors, and address specific policies and regulations that can hinder the development of innovations meant for the BoP market in a way that can enhance inclusive development. To achieve this, efforts should be put into introducing new technologies that can enhance entrepreneurial activities. This will help overcome the challenges associated with intervention projects to strengthen the BoP markets in developing countries. In the case of the GES Scheme in the Nigerian agricultural system, the introduction of biometrics in farmers' registration assisted in developing a reliable database of farmers, thereby enhancing the effectiveness of input supply to the marginalised. A policymaker explained this as follows:

“The use of biometrics to capture farmers' data was introduced later around 2014 to tackle some of the problems associated with the implementation of the GES, especially during registration and redemption.”

Another intervention that aided entrepreneurial activities under the GES is the provision of access to funding to seed companies which assisted in procuring seed processing facilities.

Before the advent of the GES Scheme, it was difficult for seed-producing firms to get funds to acquire the necessary technologies. However, the interventions under the GES provided access to credit at a single interest rate. A staff of NASC explained this as follows:

“[...]We witnessed improvements on the seed testing facilities because of the funding we were getting, but at the beginning, many seed companies did not have seed processing facilities[...].”

Table 8-2 gives a detailed breakdown of the problems encountered during the implementation of the GES and the interventions needed to strengthen entrepreneurial activities in the BoP market of the agro-input supply system.

Table 8-2: Systemic problems, type of systemic problems and systemic interventions (entrepreneurial activities)

Systemic Problems (Description)	Type of systemic problems	Systemic interventions
Actor problems	Capability problem	Create spaces for actors’ capabilities development
Less involvement of marginalised as innovators rather than as consumption of innovation; inclusion of non-farmers in the database; duplication of names on farmers' register; slow rollout of biometrics; unethical practices by farmers such as input racketeering; late redemption of inputs by farmers; late kick-off of programme.	Actors’ lack of capacity and competence to learn and effectively utilise resources	A bottom-up approach to policy design and implementation of I4ID models; education and training programmes; introduction of new technology/platforms
Interaction problems	Quality/intensity problem	Stimulate necessary interactions between diverse actors
Weak interaction between the formal and informal actors. Vertical interaction between agro-dealers and suppliers based on the supply of goods on credit; financial credit favours big-time	Weak network problems; Internal orientation favouring the incumbent set-up and relationships	Strengthen actor’s association to serve as an effective intermediary

players or actors with an existing relationship		Prevent too strong interactions Financial incentives targeting the BoP
Institution problems Government rules guiding initial farmers' registration are weak; insufficient programme planning; conditions for credit access are too stringent for small actors.	Capacity related problems Weak institutions (processes); Certain regulations are stringent for small firms to participate; appropriability trap – stringent institutional provisions favouring big, strong actors.	Prevent too weak and too stringent institutions Reform credit incentive provisions to favour the small actors; strengthen programme policy; participatory planning.
Infrastructure problems Inadequate ownership of mobile phones by smallholder farmers; Poor quality of telephone in rural areas. Inadequacy in finance model to take care of concerns of BoP	Quality related problems Inadequate or insufficient infrastructure	Stimulate the presence of different infrastructure New models for infrastructure development Ensure adequate quality of infrastructure New technologies/technology platforms are suitable for rural areas.

8.2.2. Knowledge Development

The development of the GES was aimed at tackling the established corruption within government-led procurement and distribution of agro-inputs to farmers. Using the incentivised private-sector-led system was premised on evidence of a culture of efficiency that the private sector brings to governance. This proved largely successful and can serve as a model for interventions in the BoP market. Despite this, the insufficiency of research and weak research outcome that underestimated the challenges of infrastructure in the rural areas negatively affected the roll-out of the Scheme. Also, the knowledge used to improve the system came from the feedback from actors' experiences with limited knowledge driven by research. There

is also weak IPR law to protect the research outcomes aimed at the boP market in the agricultural sector. The strong vertical relationship between actors in the system was limited to business relationships, while it was non-existent between government and formal and informal actors in the business sector. Hence, there is a need to incentivise activities that can drive interaction between the research community and actors in the business sector in Nigeria's agro-input supply system. The summary of the systemic problems and interventions that influenced the knowledge development in the I4ID context is presented in Table 8-3. A policymaker captured the problems with knowledge development in the seed sub-sector is captured as follows:

"[...] At the beginning of the programme, most of the agro-dealers were not knowledgeable about seed handling. They were used for agrochemicals and fertilisers, and seeds, being living entities, cannot be warehoused in the same facility with chemicals and fertilisers. Some of the challenges with seed, like the seed not germinating, arose from improper handling, not from the quality of the seed".

[...] we introduced the Genetic Access and Transfer Scheme during the GES period. When a research institute develops a new variety of a seed, a seed company can approach the research institute and enter into a contractual agreement with them to license the variety. They expected to start paying royalty to the breeder and the institute after some years. We did that for a year, but it did not work.

Table 8-3: Systemic problems, type of systemic problems and systemic interventions (knowledge development)

Systemic (Description)	problems	Type of systemic problems	Systemic intervention
Actor problems		Presence –	Stimulate and organise the participation of actors
Lack of research centres on I4ID issues; Poor knowledge on seed handling/storage by agro-dealers; Lack of evidence about the size of the BoP.	Missing actors' problem	Capability –	Encourage the involvement of marginalised actors as essential stakeholders in the research process
	Weak capacity to identify and articulate needs		Create spaces for actors' capabilities development

		Use of intermediary associations as platforms for capacity building;
Interaction problems Limited learning through research on I4ID issues; Weak vertical relationship between knowledge institutions and the private business actors in the I4ID context	Quality problem Weak network problems (complementarity problems)	Stimulate necessary interactions between diverse actors Introduce incentives to stimulate interactions between knowledge institutions and industry such as change of reward system in promotion, high royalties on commercialised R&D outputs Prevent too strong or too weak ties Tax incentives to strengthen weak interaction;
Institution problems – Specific regulations are stringent for small firms to participate	Capacity related Weak institutions/IPR to incentivise research on the I4ID system	Prevent too weak or stringent institutions Review of regulations/policy to remove stringent portions
Infrastructure problems Insufficient or poor knowledge of telephony infrastructure supporting the implementation of GES in rural areas	Quality related Poor articulated demand	Ensure adequate quality of infrastructure New technologies/technology platforms suitable for rural areas

8.2.3. Knowledge Diffusion

Knowledge development is insufficient to drive inclusive development if there are no effective strategies for diffusion. Training, meetings, stakeholder engagement, performance reviews, and mass media constituted the leading platforms for disseminating knowledge during the GES Scheme. Despite the multi-strategy approach, different challenges were encountered at the

commencement of the Scheme. However, several strategies were initiated to resolve these as the programme evolved. The challenges include poor sensitisation, poor coverage of mass media, especially in local languages, late mobilisation, and weak interaction among some actors. These threatened the implementation of the Scheme (Table 8-4).

The challenge with this is that the poor telephone infrastructure, especially in rural areas, negatively affected the delivery of the e-wallet. Since there was no provision for reaching farmers without a mobile phone, some farmers never received the messages, while in some instances, the messages were received late. Attempt to use the e-wallet to procure mobile phones for farmers without mobile phones at a subsidised rate was stopped due to negative public reaction fueled by corruption allegations. Another challenge was the incompleteness of the messages sent by Cellulant through the e-wallet. According to Olomola (2015), the SMS was supposed to come in four batches but, in most cases, was not.

Some of the challenges with the diffusion of knowledge included difficulties in working relationships between the agro-dealers and some of the fertiliser and seeds companies. These arose from logistical arrangements and payments. A policymaker with the ADP highlighted this:

“Initially, when we started, people were not responding because of lack of awareness, and the turnout was poor[...].”

This was buttressed by an agro-dealer and a farmers’ association leader:

“I did not get the information then; somebody else was enrolled. The information came very late. The company that was to handle Ibadan North, because of the limited time and lack of familiarity with the area, could not deliver. I think he had a logistic problem at the end of the day; the performance was abysmal”.

“[...] they did not give us enough time to ask farmers who were qualified to take part in the programme to come out and register for it [...].”

Table 8-4: Systemic problems, type of systemic problems and systemic interventions (knowledge diffusion)

Systemic problems	Type of systemic problems	Systemic intervention
Actor problems Poor awareness and sensitisation at commencement; short or late mobilisation time	Capacity problem Lack of competence by actors and lack of capacity to learn or utilise available resources	Create spaces for actors' capabilities development Regular and continuous capacity building
Interaction problems Weak interaction between the marginalised and knowledge institutions	Quality related - Weak network failure - Dynamic complementarity failure/transition/learning failure.	Stimulate necessary interactions between diverse actors Empower the intermediaries to play a more critical role in brokering interaction between the marginalised and the knowledge institutions
Institution problems Weak policies encouraging interactions between knowledge institutions and other actors	Presence Necessary institutions are missing	Stimulate the presence of hard and soft institutions Empower the intermediaries through appropriate policy actions and legislations to interface between the marginalised actors and knowledge institutions
Infrastructure problems Poor infrastructural logistics in organising training; weak infrastructure to support the e-wallet	Quality related Insufficient or poor infrastructure	Ensure adequate quality of infrastructure Enhance the capacity of intermediaries to mobilise and train the marginalised; improve on telephony network for mass distribution of information to the marginalised.

8.2.4. Guidance of Search

The central features of this function are the formation of expectations, targets and visions, and regulative alignment (Bergek, Jacobsson and Sandén, 2008). The different actors' targets, roles, and responsibilities are spelt out in the ATA. Though ambitious, the target setting of reaching 5 million farmers with inputs annually was achieved. A major challenge to implementing the GES at the commencement was the trust deficit and scepticism among stakeholders about the project. Many stakeholders have low expectations because of the failure of previous government intervention projects in the sector despite the government's ambitious targets. Hence, the target of reaching 5 million farmers in the first year could not be attained due to low awareness and mistrust. However, the efficiency in input delivery in the first year led to a positive rating and high participation in subsequent years. Hence, the programme was oversubscribed in subsequent years. This was revealed from the outcome of the EHA, which shows that only 32% of the intended target, about 1.6million farmers, was reached in 2012 compared to about a 5.9million in 2013. An official of NASC explained the process as follows:

“We were given a target of enlisting 20 million farmers at the end of the project. At the beginning of the GES, 5 million farmers were registered, but with the clean-up and redemption, only 1.2 million were given input that year. The next year, an additional 5 million were added to the list. By the end of the project for the seed component, a total of 14,310,780 farmers benefited from the programme.”

Other challenges included mismatch between needs and supplies, especially regarding seeds in some agroecological zones, lack of capacity to adopt new technologies or inputs, lack of legislative backing to enhance sustainability etc. There is, therefore, the need to improve the capacity of the marginalised to be innovative in adopting new technologies and strengthen laws and policies that can drive learning. See Table 8-5 for a summary of the problems and interventions that can enhance the guidance of the search. A farmers' leader narrated his experience in the first year of the Scheme:

“[...]because most of the time, the government will say that they will do something and truthfully they will not do it. This usually costs us too many resources because to tell our members that they should come out for another programme was difficult. They will say that's the way the government used to do it. So, it did not make many farmers participate in the programme.”

On allocating farmers to redemption centres, a policymaker at FMARD described the experience.

“[...] We mapped a minimum of 3,000 farmers to a centre where the agro-dealer operated. Based on the input package agreed upon, we will now assign the quantity and type of inputs to supply so that the agro-dealer can source it.”

Table 8-5: Systemic problems, type of systemic problems and systemic interventions (guidance of search)

Systemic problems	Type of systemic problems	Systemic intervention
Actor problems Supplier’s failure to meet targets; mismatch between seed supplied and needs of farmers across different agroecological zones	Capacity problem – Actors lack the capacity to develop visions and strategies; lack competence and capacity to learn or utilise new technologies.	Create spaces for actors’ capabilities development Enhance the capacity of farmers on new varieties and seedlings; education and training
Interaction problems Lack of trust in government programmes	Quality Weak network problems are caused by weak connectivity between actors, which hinders interactive learning, and innovation.	Stimulate occurrence of interaction Consensus building; involvement of the marginalised groups in regular review meetings
Institution problems Weakness in some aspects of the ATA policy; lack of legislative backing; Certain regulations are stringent for small firms to participate.	Capacity related Weak institutional problems may hinder innovation, for instance, by insufficiently supporting the diffusion of new technologies	Prevent too weak and too stringent institutions Legislative backing; review of policy framework to remove stringent areas
Infrastructure problems The poorly articulated baseline of BoP infrastructure and supporting ICT infrastructure	Quality related Inadequate infrastructure	Ensure adequate quality of infrastructure

8.2.5. Market Formation

Two major factors affected the implementation of the programme: a sharp decline in government revenue due to a crash in crude oil prices in the international market starting in 2014. This made it difficult to sustain the payment of the subsidy. Second, the change in government in 2015 led to the loss of commitment by the new government. Others included late payment of subsidies, stringent conditions for SMEs to access credit, and poor technological infrastructure, among others, posed significant obstacles to the scalability and sustainability of the Scheme. Policy interventions that can enhance market formation include reforming policies and instruments on financial credit for the marginalised, enacting inclusive laws and policies aiming at sustainability and gender sensitivity, and continuous engagement with the actors (Table 8-6). An agro-dealer summarised the challenge with transportation as follows:

“[...]Then logistics, you know we have not grown up to a level that we can provide our logistics. The cost of transportation is too high. The cost of transporting a fertiliser truck from here to Otu (a remote village) was enormous, and the government was not looking at it from that perspective. They paid the same money for the person that redeemed in Ibadan as a person that redeemed at Otu.”

On incentives to enhance local seed production, an official of NASC described the intervention as follows:

“[...]In the seed sector, we identified one major challenge that could hinder the implementation of the programme - the issue of seed buyback. In seed production, there is what we call direct production and indirect production using the network of out-growers. Some seed companies gave their production to trained seed producers, usually farmers. They gave them foundation seeds, and they buyback the certified seed from those farmers. If at the point of harvest, when the seed companies were supposed to return and get their seeds, they have no money to buy and may sell the seeds for grain to meet their basic needs. By the time the seed companies return, they have sold the seeds. So, the government intervened in that area to address the buyback issue. NIRSAL guaranteed 75% of the loan given by the commercial banks. At the same time, the insurance company, the National Insurance Commission (NIC), provided a 10% subsidy so that the seed producers would be exposed only to the risk of 15%.

On financial incentives for market formation, a Federal policymaker described the process of de-risking agricultural lending as follows:

On the financial aspect, there was a banking arrangement to create a market for agro-dealers and input producers. The loan was given at a single-digit interest rate which they can only access after they have finished paying it. That is why NIRSAL was established, meaning they will be derisking lending to the sector.

Also, on the inclusiveness of the Scheme, a policymaker at FMARD highlighted as follows:

“[...] they didn’t take those factors (age, gender, etc.) into consideration at all. I need to be sincere; there was no consideration for that.”

Table 8-6: Systemic problems, type of systemic problems and systemic interventions (market formation)

Systemic problems	Type of systemic problems	Systemic intervention
Actor problems Late supply of inputs to agro-dealers; late payment of subsidies; lack of political commitment due to change in political leadership	Capacity related– Actors lack competence; lack of capacity to buy into vision and strategies.	Create spaces for actors’ capabilities development Continuous stakeholders’ engagement; improved and inclusive logistics planning
Interaction problems A mismatch between the supply and demand of inputs, especially seeds	Quality Weak network problems are caused by weak connectivity between actors, which hinders interactive learning and innovation.	Stimulate occurrence of interaction Consensus building; involvement of the marginalised groups in regular planning meetings
Institution problems Lack of appropriate legislative backing; overall policy is gender-blind	Presence The necessary institution is missing Capacity Weak institutions neglect the heterogeneity of the BoP	Stimulate the presence of hard and soft institutions Enact laws to enhance sustainability; review policy to be gender-sensitive

		Prevent too weak and too stringent institutions
		Review policies towards financial incentives for the marginalised;
Infrastructure problems	Quality related	Ensure adequate quality of infrastructure
Inaccessibility of rural communities; long distance to redemption centres; high operational cost by suppliers due to uniform price structure	Insufficient or inadequate infrastructure	Improve on investments in connecting infrastructure to support the BoP market

8.2.6. Resource Mobilisation

The reliance on the state and federal governments as the principal financier of the programme made it difficult for the programme to withstand any significant external shock. This happened towards the end of 2014 when the government experienced a sharp drop in revenue resulting from a crash in crude oil prices. This led to a reduction in the budgetary provision and a delay in payment of subsidies, which ultimately resulted in the inability of the agro-dealers and suppliers to continue to mobilise resources to support the programme. In addition, the reduction in State revenue led to their withdrawal from the programme, which put the burden of payment of subsidies on the Federal government. The inability of the Federal government to meet this obligation resulted in accumulated debts, which affected the programme's scalability, and led to its suspension and the final termination.

Before 2014, challenges were witnessed mainly in the operations of the Scheme. Although this negatively affected the ability to mobilise resources but was overcome with the right interventions. The challenges included the inability to access credit by agro-dealers due to stringent conditions, inadequate physical infrastructure, poor technological infrastructure, especially telephone, and poor ownership of mobile phones among smallholder farmers. Specific interventions to enhance resource mobilisation in the BoP market should embrace smart subsidies, reduced inefficiencies and operational costs, and diversified income sources (Table 8-7). Findings from the qualitative analysis also revealed problems associated with resource mobilisation. Different actors identify these as follows:

“[...]The issue of biometrics capturing was implemented to a large extent in 2014. The objective is to capture the biometrics of farmers and issue them with ID cards with their biometrics on them. This was meant to eliminate the sharp practices associated with farmers’ registration and redemption. However, there were two main challenges with the idea. First, it came towards the end of the programme and NIMC that was in charge of citizens registration was slow in biometric capturing and rollout of the ID card ”
(Federal Policymaker_2)

“you know, when it comes to government; they don’t usually pay on time. When it pleases them, they will pay the input supplier, and when the input supplier collects their money, they will pay us.” (Agro Dealer_2)

“[...] do you know the variation in dollars from that time? Who pays? The government was owing us more than 2 billion Naira. 2 billion in 2014 is not 2 billion in 2019”
(Input Supplier_3).

Table 8-7: Systemic problems, type of systemic problems and systemic interventions (resource mobilisation)

Systemic problems (Description)	Type of systemic problems	Systemic intervention
Actor problems Late introduction of biometrics technology for farmers registration; delayed payment of subsidies; discriminate lending to actors; accumulation of debts due to withdrawal of States.	Capacity problem Actors lack the competence and capacity to learn, identify and articulate their needs.	Create spaces for actors’ capabilities development Enhance operational efficiency; reduce inefficiencies
Interaction problems The inability of banks to lend credit to SMEs	Quality related Transition failure - Strong network failure - Myopia due to internal orientation favouring the incumbent set-up and relationships and thus blocking the necessity to open up	Block ties that are either too strong or too weak Enhance targeted solutions to the poorest

Institution problems Inability to access credit by agro-dealers due to stringent conditions	Capacity related Hard institutional failure: Appropriability trap - Stringent institutional problems favouring big enterprises	Prevent too weak and too stringent institutions - Remove or replace stringent requirements hindering credit accessibility by agro-dealers, such as equity participation.
Infrastructure problems Shortage of seed processing facilities; Inadequate distribution of agro-dealers; poor electricity supply; inadequate ownership of mobile phones by smallholder farmers; Poor quality of telephone network in rural areas	Quality Insufficient or poor Infrastructure	Ensure adequate quality of infrastructure Provide the necessary incentives to encourage private sector participation in infrastructure provision in the BoP market.

8.2.7. Creation of Legitimacy

Legitimacy is one of the two functions that explain the overall dynamics of the I4ID system. This is because it goes a long way to drive the other functions in the system. It concerns the social acceptance and compliance with relevant institutions of the new technology. This is important in order to mobilise resources, enhance market formation as well as influencing demand articulation (Bergek *et al.*, 2007). While there was a high level of mistrust about the programme at the beginning, the success in the first year helped confer legitimacy on it, thereby enhancing market formation, entrepreneurial activities, and resource mobilisation. The role of actors' associations assisted in the coalition formation and helped to minimise the mistrust among the marginalised and other actors. The impact on the marginalised's livelihoods and the business's profitability further lent credence to legitimisation. However, the decline in legitimacy started with financial problems, which resulted in late payment of subsidies and accumulated debt, among others. Policy options to enhance the legitimacy of the GES are to redefine programme operations to reduce cost, review rules to focus on sustainability, and reduce operational costs (Table 8-8).

Some of the problems associated with legitimacy are identified below by two different agro-dealers as follows:

“[...] Then, the other challenge is that some of these companies that assisted us couldn't get their money at the right time, so it became a big problem.”

“In Africa, we lack continuity. If a programme is good and people enjoy it, it is proper to continue it. Unfortunately, after the exit of the Jonathan administration, the programme was stopped. Up till now, the farmers are still expecting it.”

Table 8-8: Systemic problems, type of systemic problems and systemic interventions (legitimacy)

Systemic problems (Description)	Type of systemic problems	Systemic intervention
Actor problems Political withdrawal by Governments	Presence related Missing actor by State	Stimulate and organise the participation of actors Explore opportunities to bring in new actors such as development partners as sponsors
	Capacity problem Lack of competence and capacity to learn or effectively utilise available resources	Create spaces for actors' capabilities development Reduce inefficiencies and operational cost
Interaction problems Poor experience with previous government interventions in the agricultural sector. Weak coalition formation among critical actors	Quality Strong or weak network problems	Block ties that are either too strong or too weak Encourage coalition forming among critical actors within agro-inputs sub-sectors
Institution problems Lack of sustainability due to cost ineffectiveness; modification in conditions of	Capacity related Weak institutional problems hinder innovation, for instance, by insufficiently	Prevent too weak and too stringent institutions Redefine policies to enhance smart targeting of inputs. Use

subsidy of the GES leading to a reduction in subsidies	supporting technologies.	new	heterodox	policies and incentives to diversify funding of interventions in the BoP market.
Infrastructure problems	Quality			Ensure adequate quality of infrastructure
Poor telephone infrastructure in rural areas	Insufficient infrastructure	or	poor	Encourage the involvement of the private sector in the provision of infrastructure in the BoP market through appropriate policies and incentives.

8.2.8. Development of Positive Externalities

Aside from legitimacy, the development of positive externalities is used to assess the overall dynamics of an I4ID system, and its performance is evaluated through other functions. The externalities, in terms of local and international recognition, the entrance of new companies from abroad, the creation of new industries, and the seizing of new opportunities by existing actors, further assisted in improving entrepreneurial activities, market formation and resource mobilisation. This further conferred legitimacy on the Scheme and helped to resolve any uncertainties that initially accompanied it.

Some of the externalities as described by some agro-dealers are as follows:

“First and foremost, it boosted the network of the agro-dealers. It opened other opportunities for those that participated under the GES. Farmers continued to patronise us for other inputs the government did not supply. Second, it empowered the agro-dealers because most agro-dealers continued to use the network established with suppliers to get products even after the expiration of the GES.”

“It enlarged the capacity of the agro-dealers; it brought us into the limelight. The GES let the farmers know our location, enhancing our businesses.”

Other externalities witnessed included job creation and the development of local capacity for seed production. Two federal policymakers highlighted these as follows:

“Many jobs were created. This covers the entire value chain of the crops. In the cotton industry, from seed production to crop production, eventually to ginnery. If you take rice, from planting to harvesting, threshing, pre-cleaning, processing it with the machine, and finally bagging. All these generated additional jobs.”

“We witnessed increased productivity, and the uptake for seed also increased tremendously. Before the advent of the GES, seed production was below two thousand metric tonnes per annum. Only a few seed companies were into production, maybe 34. At the beginning of the GES, the 34 companies, taken together, did not produce up to two thousand metric tonnes. So, we had to design a new programme to build local capacity. The agricultural Transformation Agenda of that regime was not just about input administration; it was also to build the capacity of local industries. About 34 seed companies were licensed. Then, we had to work with Africa Rice and some NGOs in our neighbouring countries to see that the varieties promoted under the GES in Nigeria were multiplied. We imported early generation seeds, breeder and foundation seeds for two years and developed the local capacity to about one hundred thousand metric tonnes. Since then, we have maintained that threshold.”

The systemic problems identified with the development of externalities are those negatively influencing the entrance of new actors, such as late subsidy payment, which discourage commitment from new actors; too stringent laws hindering the participation of the marginalised; and weak IPR inadequate infrastructure. Suggested policy interventions include regular interaction between the actors through associations, incentivisation of interaction through strong IPR regimes, tax incentives and government procurement that favour seed production companies and policy review to protect the marginalised Table 8-9.

Table 8-9: Systemic problems, type of systemic problems and systemic interventions (positive externalities)

Systemic problems	Type of systemic problems	Systemic intervention
Actor problems	Capacity	Create spaces for actors’ capabilities development
Lack of trust in government programmes by the marginalised; delay in subsidy payment.	Actor’s lack of capacity to develop visions and strategies;	Regular capacity building through trusted intermediary networks

Interaction problems	Quality	Block ties that are either too strong or too weak
Poor vertical interaction among actors such as seed companies and research institutes, marginalised and research institutions.	Weak ties based on strong internal organisation; weak network problems (complementarity problems)	Incentivise interaction through strong IPR, tax incentives, and procurement laws.
Institution problems	Capacity	Prevent too weak and too stringent institutions
Failure of government programmes and policies to protect the interest of the BoP; weak laws protecting intellectual property rights on breeder seeds	Weak institutional failure	Policy review to protect the marginalised
Infrastructure problems	Quality	Ensure adequate quality of infrastructure
Inadequate telephony and other connecting infrastructure	Insufficient or poor infrastructure	New technology platforms to overcome the challenges with infrastructure in the rural areas

Table 8-10: The analytical framework applied to the I4ID system

Stage 1: Define system boundaries	Stage 2: Identify I4ID components	Stage 3: component-function analysis	Stage 4: Identify systemic problems	Stage 5: Identify goals of systemic instruments	Stage 6: Suggest systemic instruments
<ul style="list-style-type: none"> • Circular approach • Identifying the structural elements • Purpose of the I4ID system • I4ID system as related to the SIS 	<p>Actors</p> <ul style="list-style-type: none"> • Smallholder farmers • Agro-dealers • Input suppliers • Seed breeders • Intermediary associations, e.g. farmers' association • Technology provider – Cellulant Solutions • Policymakers at the Federal Ministry of Agriculture and Rural Development • Extension agents and Agricultural Development Officers (ADP) officers • National Agricultural Seed Council • Supply Chain Managers • Financial institutions, e.g. 	<p>Entrepreneurial activities</p> <ul style="list-style-type: none"> • Entry of firms • Portfolio expansion • Monitoring & evaluation • Seek or exploit opportunities from the market & networks <p>Knowledge development</p> <ul style="list-style-type: none"> • Actors' experience • Research studies <p>Knowledge diffusion</p> <ul style="list-style-type: none"> • Meetings • Awareness campaigns • Training <p>Guidance of search</p> <ul style="list-style-type: none"> • Setting policy targets • Defining expectations • Designing favourable 	<p>Actors:</p> <p><i>Presence</i></p> <ul style="list-style-type: none"> • Non-involvement of BoP in design; • lack of research on I4ID issues; <p><i>Capabilities:</i></p> <ul style="list-style-type: none"> • Weak competence to utilise the system; • Inability to adequately quantify needs; • Inadequate capacity to utilise resources; • Lack of capacity to buy into vision and strategies. <p>Interactions:</p> <p><i>Presence</i></p> <ul style="list-style-type: none"> • Absence of laws to protect intellectual property rights <p><i>Capacity</i></p> <ul style="list-style-type: none"> • Weak interaction between the formal and informal actors; • Financial credit favours big companies; • Weak vertical interaction between agro-dealers and banks; between research 	<p>Actors:</p> <ul style="list-style-type: none"> • Stimulate and organise the participation of relevant and marginalised actors. • Create spaces for actors' capabilities development <p>Interactions:</p> <ul style="list-style-type: none"> • Stimulate necessary interactions between diverse actors. • Block ties that are either too strong or too weak <p>Institutions:</p> <ul style="list-style-type: none"> • Stimulate the presence of hard and soft institutions 	<p>Actors</p> <ul style="list-style-type: none"> • Bottom-up approach to policy design • New forms of Public-Private Partnerships • Fiscal incentives such as tax holidays or rebates • Regular training and capacity-building sessions • Explore diversification in funding by bringing new actors <p>Interactions</p> <ul style="list-style-type: none"> • Establishment of innovation platforms • Strengthening and enabling social capital platforms, e.g. farmers' to serve as effective intermediaries

	<p>commercial banks, NIRSAL</p> <p>Interactions</p> <ul style="list-style-type: none"> • DUI mode of learning based on actors' experience • Collaborative networks and partnerships • Informal networks and social capital (trade/farmers association) <p>Institutions</p> <ul style="list-style-type: none"> • ATA – Overall government policy (replaced by APP) • Input Lending Framework guiding lending • Existing informal relationship • Fiscal incentives <p>Infrastructure</p> <ul style="list-style-type: none"> • Subsidies on agro-inputs • POS, mobile phone connectivity • Deployment of e-wallet 	<p>regulations & policies</p> <ul style="list-style-type: none"> • Creating new working groups, institutions, and organisations <p>Resource mobilisation</p> <ul style="list-style-type: none"> • Subsidies • Loans • Technological infrastructure • Provision of physical infrastructure • Investments through the budget provision • Recruit human resources <p>Market formation</p> <ul style="list-style-type: none"> • Commitment to the obligatory use • Financial incentives such as bank guarantee • Instituting regulations supporting niche markets • Reforming regulations & 	<p>institutions and private companies;</p> <ul style="list-style-type: none"> • Input supply market dominated by big companies <p>Institutions: <i>Presence</i></p> <ul style="list-style-type: none"> • Weak incentives to stimulate research on the I4ID system; • Lack of government law backing ATA; • Non-inclusiveness of some aspects of ATA, e.g. gender-insensitivity <p><i>Intensity</i></p> <ul style="list-style-type: none"> • Weak rules guiding farmers' registration; • Too stringent terms for accessing credit by SME agro-dealers; • Modification in terms of credit and subsidy; • Weak IPR laws protecting breeder seeds <p>Infrastructure: <i>Presence</i></p> <ul style="list-style-type: none"> • Inadequate ownership of mobile phones by smallholder farmers; 	<ul style="list-style-type: none"> • Prevent too weak and too stringent institutions <p>Infrastructure:</p> <ul style="list-style-type: none"> • Stimulate the presence of relevant infrastructure • Ensure adequate quality of infrastructure. 	<p>Institutions</p> <ul style="list-style-type: none"> • Reform policies and laws to enable credit access to BoP • Incorporate informal norms and practices • Legal backing for laws and regulations on the I4ID system to enhance sustainability • Make I4ID system laws to be gender-inclusive • Incentivise strong interaction through good IP policies, procurement and tax incentives <p>Infrastructure</p> <ul style="list-style-type: none"> • Government investments in physical infrastructure • Fiscal and monetary interventions, e.g. subsidies, tax rebates/holidays, etc.
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		<p>programme structure</p> <p>Creation of legitimacy</p> <ul style="list-style-type: none"> • Advocacy coalition • Lobbying • Awareness creation <p>Development of positive externalities</p> <ul style="list-style-type: none"> • Emergence of new actors, industries • Positive spillover effect e.g. financial inclusion for the unbanked • Return of multinational corporations • Explore new business opportunities • Recognition locally and internationally 	<p>Quality</p> <ul style="list-style-type: none"> • Poor quality of telephone infrastructure in rural areas • Inadequacy of financial models to provide access to BoP; • Poor training logistics; • poor connecting infrastructure such as roads in rural areas, and • High operational cost for suppliers due to uniform price structure 		<ul style="list-style-type: none"> • New technology platforms suitable for BoP needs
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8.3 CHAPTER SUMMARY

This chapter presents stages 4, 5 and 6 of the application process of the analytical framework to the I4ID system. Using the problems identified, the systemic instruments and the goals for enhancing the performance of the I4ID system were highlighted.

Suggestions for solving the systemic problems involved tinkering with the four structural elements: actors, institutions, interaction and infrastructure. These were undertaken by examining the presence or attributes of each component in terms of their capacity/quality. Evidence from the qualitative study was used to triangulate the process.

A follow-up to identifying systemic problems is identifying systemic goals to address the challenges. The systemic goals were identified using the eight suggestions from the study by Smits & Kuhlmann (2004) and adapted to the I4ID context following literature in a similar context (van der Hilst, 2012; Botha, 2017; van der Merwe, 2017). The systemic goals are: stimulate and organise participation of relevant actors; create space for actors' capability development; enable the occurrence of interactions; prevent too strong and too weak ties; the secure presence of hard and soft institutions; prevent too weak and too stringent institutions; stimulate physical, financial and knowledge infrastructure; and ensure adequate quality of infrastructure.

The next chapter builds on this by examining the role of policy in influencing the development and growth of the GES and offers policy suggestions that can enhance the performance of the I4ID system.

CHAPTER NINE : INNOVATION FOR INCLUSIVE DEVELOPMENT SYSTEM AND THE ROLE OF POLICY

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
					Summary and conclusions		

9.1. INTRODUCTION

This chapter seeks to assess the role of policy in driving the I4ID system. Policy in this concept is used to mean a broad range of formal institutions guiding the development and diffusion of the I4ID system. In doing this, the actions of state actors in driving inclusive development are considered. The analysis of the I4ID system from the previous chapters has revealed the importance of policy to the evolution or emergence of IS. To provide insight, evidence around the link between policy and the I4ID system is synthesised and presented in this chapter.

This chapter inductively draws lessons from the Nigerian GES scheme to paint a picture of the role of policy in the emergence of the I4ID system. It also interacts with literature to contextualise these and provide critical insights into the broader narrative of the role of policy and wider institutions in I4ID context. The broader institutional framework for I4ID systems considers the role of both formal and informal institutions and how these interact in I4ID systems. Consequently, the chapter sheds more light on objective 6 of this study which seeks to analyse the role of policy in the development and evolution of the I4ID system in Nigeria's agricultural sector and suggest policy responses to strengthen the I4ID system performance.

9.2. POLICY AND THE I4ID SYSTEM

Government policy intervention generates an institutional force that shapes human behaviour (Foster and Heeks, 2013a, 2016). Therefore, conceptualising policy can be analogous to 'public policy' where policy is "viewed not only as laws and legislative rules but as wider courses of action and emphasis including activities of state-sanctioned bodies" (Foster, 2013, p. 228). This

can manifest in rules, regulations, funding of support organisations or support for global initiatives. In undertaking this, the policy experience guiding the evolution of the GES Scheme is analysed. This becomes an essential instrument in tackling the different failures associated with IS framework (Bergek *et al.*, 2008).

The approach utilised in this chapter follows Foster (2013), which assesses the role of policy from two broad dimensions: 1). The role of policy elements in influencing the emergence and growth of the I4ID system; and 2). A broader institutional analysis of how policy influences the implementation of innovations in the BoP market. This chapter, therefore, seeks to investigate these. The experience of the different actors gathered during the qualitative analyses of the GES scheme is used to shape the analysis. Due to the limited literature on policy around the I4ID context, a framework illustrated by Foster and Heeks (2016) is adapted to analyse policy around the I4ID system. This examines the four critical policy dimensions and their roles in influencing the I4ID system. These are:

- Regulation;
- Supply-side;
- Demand-side; and
- Policy and small enterprises

A fifth dimension, the role of policy in influencing intermediaries, is included in this framework (Figure 9-1). This is because intermediaries, networks and associations are critical in driving I4ID in the BoP market.

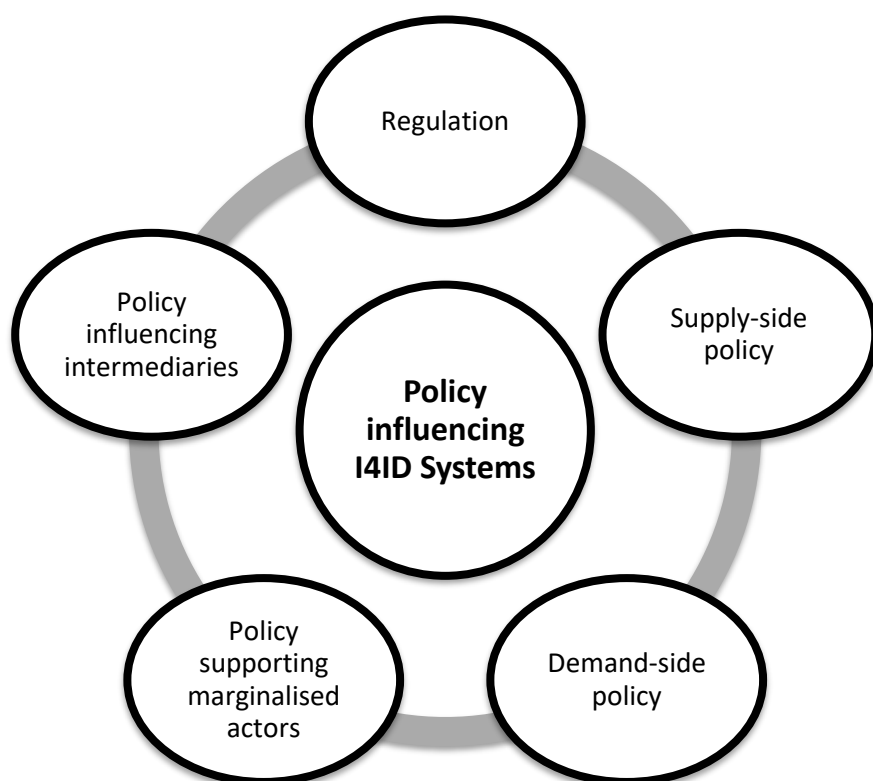


Figure 9-1: Role of policy in influencing the I4ID system

9.2.1. Regulation

Regulation implies the underlying sectorial rules which have been crucial in allowing the emergence of a comparatively stable sector or innovation system (Foster and Heeks, 2016). The government uses different instruments such as price, standard, and ownership ceilings to achieve economic objectives. These include promoting competition, increasing efficiencies, preventing excessive competition, protecting consumers and maintaining standards (OECD, 2002). This implies that regulation is not necessarily a one-shot process; it requires continual adjustment and persistence in emerging markets (Foster, 2013). This manifests in the emergence of the GES scheme. While the Scheme was introduced in 2011, the role of policy in shaping its emergence is traceable to activities dating back to some years before.

The tone for the government intervention in the agricultural input sector in Nigeria was set at the 2006 Africa Fertiliser Summit in Abuja, a meeting of African Ministers of Agriculture and partners and donor organisations in the sector. AUDA-NEPAD convened the Summit with support from The Rockefeller Foundation and other donors (GrowAfrica, 2016). The primary outcome of the summit was the call on the Member States to commit to increasing fertiliser use from 8 kilogrammes to 50 kilogrammes of nutrients per hectare by 2015 (AUDA-NEPAD, 2011). Nigeria's estimated average fertiliser use was 13kg/hectare compared to the World

average of 100Kg/hectare and 150Kg/hectare for Asia (Federal Ministry of Agriculture and Rural Development, 2011). The resolution identified 12 strategic interventions for raising fertiliser utilisation by member countries. These are:

1. Establishment of policy and regulatory frameworks;
2. Enhancing capacity for quality control;
3. Elimination of taxes and tariffs;
4. Development of agro-dealer networks;
5. Distance travelled to purchase fertilisers;
6. Increase in the proportion of farmers using chemical fertilisers;
7. Increasing market size;
8. Introducing targeted subsidies;
9. Introducing national financing facilities for importers and agro-dealers;
10. Introducing regional procurement initiatives;
11. Improving access to complementary inputs; and
12. Establishment of the Africa Fertiliser Financing Mechanism (AFFM)

Following the Abuja Declaration, the IFDC revitalised the paper voucher fertiliser programme initiative launched in 2008. The programme was redesigned in 2009 to involve the private sector as a significant distributor of inputs using targeted subsidies in two states, Kano and Taraba. Similarly, IFDC secured a grant to build agro-dealers capacity around the same period. The launching of the ATA in 2011 was the icing on the cake as it provides a comprehensive policy and regulatory framework for agricultural intervention in Nigeria, where the agro-input supply plays a prominent role. In designing the policy, the major resolutions of the Abuja Declaration expected to be implemented by member States were integrated.

The ATA document referred to the success of IFDC private-sector-led intervention as follows (Federal Ministry of Agriculture and Rural Development, 2011):

“In the private sector distributed fertiliser support system, utilising input vouchers; fertilisers are sold directly to farmers at the market price ‘minus’ the fertiliser voucher discount provided by the government. In effect, 94% of the targeted farmers received the subsidised fertiliser under the voucher program. It should be pointed out that the private sector’s procedure for distributing fertiliser vouchers to targeted farmers is being coordinated by the federal and state governments. This fact is based on the Taraba state’s experience, where the voucher program reaches 94% of farmers while

the existing government system reaches an estimated 11% of farmers. Due to cost sharing with the private sector, the programme costs less than 50% to run. In addition, in the voucher system, farmers receive fertiliser 10% cheaper due to more efficient private sector distribution systems. More so, as opposed to the government distribution system that crowds out the private sector, the voucher program encourages the development of a strong private sector with the number of dealers increasing by 41 in Taraba state.”

Under the ATA, the government undertook holistic agricultural sector reforms through policy, program, and legislative changes. This led to the transfer of the production, procurement and distribution of inputs from the government to the private sector (World Bank, 2013).

To achieve this, the government undertook reforms in the sector, which led to the enactment of some regulations, in other instances, deregulation. The seed and fertiliser liberalisation policies also enabled the development of the GES scheme. Under the GES scheme, the government undertook reforms in the seed sector by removing the state monopoly on the production and distribution of breeder and foundation seeds. This allows for the participation of private sector players and actors, creating a competitive industry. To achieve this, an amendment to the National Agricultural Seeds Act of 1992 was passed in 2011, which redefined the role of the NASC in regulating the seed industry in Nigeria to solely focusing on coordination, quality control and assurance while the private sector focus on breeding, multiplication, and distribution.

Table 9-1: Highlight of regulations supporting the development and diffusion of the GES

Timeline	Major reforms
2006	Africa Fertiliser Summit in Abuja – a summit of African Ministers of Agriculture and partners and donor organisations in the agricultural sector
2008	IFDC secured a grant from AGRA to pilot the Fertiliser Voucher Program (FVP) in Kano and Taraba states
2008	AGRA awarded IFDC a grant to conduct the three-year project to boost the capacity of private sector agro-dealers to provide more quality inputs and services to farmers
2010	FVP extended to Bauchi, Kaduna, Kwara states
2011	Launch of the Agricultural Transformation Agenda of the Federal government establishing the GES
2011	The amended National Agricultural Seeds Act of 1992 was passed, liberalising the activities of the seed industry.

2011	The Gas Industrialization Plan was launched to harness the country's vast gas reserves and develop a petrochemical and fertiliser industry.
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With the vast fertiliser market in the country, there was a shift from importation to local fertiliser manufacturing through the import substitution policy aimed at encouraging domestic production. To actualise this, the government introduced new incentives to induce private sector investments in the agricultural sector. These include removal of restrictions on areas of investment and full equity ownership in investment by foreign investors, removal of foreign exchange controls, zero percent duty on agricultural machinery and equipment imports, pioneer tax holiday for agricultural investments, duty waivers based on the use of local raw materials and constitutional guarantees against nationalisation/expropriation of assets. In addition, the government launched the Gas Industrialization Plan in 2011. The main goal of the Plan is to harness the country's vast gas reserves and develop a petrochemical and fertiliser industry.

As a result of these incentives and opportunities, multinational companies such as Dangote Group, Notore Chemical Industries, Indorama Eleme Petrochemicals Limited and Nagarjuna Fertiliser and Chemical Limited made significant investments in establishing fertiliser and urea plants in the country. This would make Nigeria self-sufficient and a net exporter of fertiliser globally. Although this dream has not been fully actualised, there has been a significant improvement in developing local capacity in fertiliser production with the completion of urea plants by Notore, Onne, Rivers State (2009), Indorama Eleme (2016) and Dangote Industries (2021).

Akinwumi Adesina explained this in a published newspaper interview in May 2014:

“... Look at the fertiliser industry. Before, the fertiliser companies simply sold fertilisers to a government warehouse. There was no incentive for them to invest; the government ran everything. So you just sell to the government – including selling half sand and half fertiliser to the government. Today all that has changed. As of last year, we were able to get the private sector to invest the US \$5 billion into fertiliser manufacturing in Nigeria. That comes from three companies. Dangote is putting \$2.5 billion into fertiliser manufacturing. Indorama is putting in well over \$1.3 billion. Notore, the largest urea plant in the country, is putting, I think, US \$1.3 billion into fertiliser manufacturing.”

Although not directly linked to the development of the GES scheme, the liberalisation of the telecommunication sector in 2001 led to the introduction of the GSM technologies on which the GES was built. Hence, it would have been inconceivable to implement such a programme without high penetration of mobile phones in Nigeria. In essence, the GES scheme was one of the positive externalities derived from the deregulation of the telecommunication sector. Dr Adesina referred to this when arguing for the procurement of mobile phones for farmers at the inception of the GES Scheme. In an interview with Channels television on January 2013, Dr Adesina was quoted as saying:

“[...] We found that 71 percent of farmers sampled did not have cell phones. This shows that many of our farmers in rural areas are quite poor and are excluded from the benefits of the mobile phone revolution going on in Nigeria. These farmers cannot access the GES scheme without cell phones, and we must find a way to include them. They must not be left behind.”

Because of the implementation of the GES scheme, the government took action to institutionalise the Scheme by enacting a law, the NAGESP, which would have insulated it from political interference and ensured its sustainability. The then Minister of FMARD, *Akinwumi Adesina*, alluded to this during a stakeholders’ meeting on the draft bill to consolidate the GES Scheme in Abuja in January 2015.

“GES must continue, irrespective of who is in power; this bill seeks to institutionalise the GES scheme and give it a life of its own so that it will no longer be a discretionary programme,”

However, the bill was never passed by the National Assembly; hence, the GES lacked appropriate legal backing to enhance its sustainability.

9.2.2. Supply-side Policy

Supply-side policies are used by the government to increase productivity and efficiency in the economy, the overall goal, when successful, is to enable higher economic growth in the long run. These policies can manifest in the form of free-market or interventionist policies. Under the GES scheme, the government used supply-side policies to attract critical stakeholders important for developing and diffusion the I4ID system. These manifest in policy incentives to stimulate the participation of supply-side actors such as suppliers, credit institutions, producers and other private-sector players, locally and internationally, in developing the GES scheme from the formative stage to the growth stage. Locally, the federal government formulated

specific policies and financial instruments that incentivise the supply side of the GES scheme. These include the input lending framework, which is a comprehensive framework for funding the Scheme; the commitment to obligatory use by State governments, which confer a monopoly of agro-input supply on the GES; and support for local manufacturing of inputs (fertiliser, seeds and other inputs).

These incentives stimulated the interest of agro-input producers and suppliers in the market opportunities presented by the GES scheme. By this, state governments committed not to run a parallel input procurement and distribution programme outside the GES scheme, guaranteeing the programme a near monopoly of agro-inputs supply in Nigeria. This monopoly provided a vast market and compensated for a smaller profit margin. An input supplier captured this as follows:

“The market price for Urea was around 5200 or 5300 Naira, while NPK goes for almost 5400, and we still have to pay 200 Naira per bag agro-dealers while maintaining a fixed price of 5500 Naira. Since we were considering the volume within a short period the programme would run, we felt we could cope with the small profit margin.”

Another incentive supporting the supply side is the input lending framework. Under this, the government introduced a credit framework for suppliers, which guaranteed credit facilities at a single-digit interest rate of 9% compared to the over 20% prevailing rate. For commercial banks, the government, through NIRSAL, provided a guarantee of up to 75% in case of default. These instruments provided the necessary incentives for the participation of suppliers and commercial banks in the Scheme.

A policymaker at FMARD captured this as follows:

“On the financial aspect, there was a banking arrangement to create a market for the agro-dealers and input producers. The loan was given out at a single-digit interest rate. That is why NIRSAL was established to de-risk lending to the sector.”

As part of the input lending framework, the government introduced incentives to support the seed buyback in the seed sub-sector. This helps to provide the necessary funds for seed companies to procure seeds from farmers after maturity. In the words of another policymaker from NASC, the support to seed companies by the government assisted in providing the necessary credit incentives that led to the rapid growth of the seed industry.

“In seed production, there is what we call direct production and indirect production using the network of out-growers. Under the out-grower scheme, seed companies outsourced the production of seeds to trained seed producers, usually farmers. They give them foundation seed and buyback the certified seed. If at the point of harvest, when the seed companies were supposed to go back and get their seed, they have no money to buy, and these farmers may be in trying to satisfy their needs, the basic needs can sell the seed for grain, and by the time, the seed company will go back, they have sold their seed. The government intervened to address the challenge by incentivising credit from commercial banks to seed companies at a single-digit interest rate. In case of loan default, NIRSAL provided credit guarantee up to 75% of loans while the Nigeria Insurance Corporation (NIC) guaranteed up to 10% so that the banks will be exposed to the risk of only 15%.”

The government also provided funds to public agricultural research institutes to undertake R&D activities to develop new seed varieties to support the GES scheme. This ensures the development of new varieties of quality seeds and seedlings to meet the high demand for seeds under the programme. A policymaker at NASC identified some of the agricultural research institutes that developed new varieties of seeds/seedlings under the GES scheme as follows:

“[...] for rice, the National Cereals Research Institute, Badeggi developed the seeds under the GES. For maize, we have two research institutes mandated to produce the seeds - the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria and the Institute for Agricultural Research and Training, Obafemi Awolowo University. For Soya beans, the same institutes developed the seeds. Cassava and IAR also developed the cotton seeds, while the Lake Chad Research Institute, Maiduguri, developed seeds for millet and wheat. We have the National Root Crops Research Institute, Umudike and the International Institute for Tropical Agriculture (IITA) for cassava. The National Root Crops Research Institute developed the breeder and foundation seeds of cassava.”

Up until the introduction of ATA, public agricultural research institutions in Nigeria only focussed on R&D in the development of breeder seeds, neglecting the development of foundation seeds. However, at the inception of the GES, the government encouraged public agricultural research institutions under FMARD to commercialise their research outputs by setting up seed companies. This complements the efforts of private seed companies in

developing the required seeds to meet the demands under the GES. A policymaker at NASC emphasised this:

“[...] In the case of research institutes, they registered their Seed Unit with the Council (NASC). These Units are run like commercial entities. They procure breeders from the research institutes and multiply them into foundation seeds, and the government buys some from them. The seed companies buy from Seed Council for proper coordination and traceability of this variety.”

The government, through NASC, developed an intellectual property framework, the Genetic Access and Transfer Scheme, for the protection and commercialisation of new seed varieties, thereby guaranteeing rewards for inventors. However, the policy did not succeed and was consequently abandoned. A staff of NASC described the process:

“[...] we introduced the Genetic Access and Transfer Scheme during the GES period. When a research institute develops a new variety of a seed, a seed company can approach the research institute and enter into a contractual agreement with them to license the variety. They were expected to start paying royalty to the breeder and the institute after some years. We did that for a year, but it did not work.”

International actors and donors also played essential roles in enabling the supply side of the GES Scheme. These primarily focused on capacity building, funding and technical support. IFDC, for instance, played a prominent role in building agro-dealers capacity and piloting a paper voucher agro-input system in Nigeria. At the same time, AGRA provided technical support to the CBN in establishing NIRSAL (Onuoha, 2014). Also, the British government, through the DFID, supported the introduction of TAP technology developed by Consult Hyperion, a UK-based company. The innovation developed by the company made it possible to redeem inputs offline, thereby assisting with overcoming the limitations of redeeming inputs in remote areas and villages where telephone infrastructure was inadequate or lacking. Several global bodies such as the FAO, World Bank, and WFP provided technical and funding support for the Scheme.

9.2.3. Demand-side Policy

Demand-side policies help the government to identify, create and stimulate demand for a specific innovation (Edler *et al.*, 2012). The underlying motivation is an assumption that request can trigger and accelerate the production and diffusion of innovation with complementary production of scientific knowledge upstream and forward-looking markets

downstream (Edler *et al.*, 2012). The rise in the use of demand-side policies is to take care of the limitations of supply-side policies in evaluating innovation performance and provide a comprehensive approach to understanding the innovation process taking into cognisance non-R&D activities (OECD, 2011). Right, appropriate pricing to meet latent or unmet demands has been the traditional tool used to stimulate demand for innovation; however, demand-side policies have become more targeted, narrower interventions in specific sectors or industries of public interest. These have expanded to include public procurement, regulation, standards, consumer policies and user-led innovation initiatives to address market and system failures (OECD, 2011). Edler and Georghiou (2007) categorised demand-side policies into four main groups: systemic policies, regulation, and stimulation of private demand. These policies are implemented through government instruments such as public procurement of innovation, direct or indirect financial support, subsidies and training that enhance actors' capacity to absorb innovation (Edler and Georghiou, 2007; Edler *et al.*, 2012; Foster, 2013). Edler *et al.* (2012) further classified it into four:

- Policies to mitigate deficiencies in the flow of information between buyers and suppliers;
- Policies to improve the capabilities of those engaged in transactions to factor in innovation;
- Policies which subsidise procurement to offset additional risks taken on by purchasers of innovations (also in this category are guarantee or insurance-based schemes); and
- Policies that structure the market to favour innovations (regulations and standards).

In the context of the I4ID system, these policies help to stimulate demand among the BoP. They helped overcome the initial reluctance and scepticism, thereby increasing the rate of adoption of the Scheme. The central demand-side policy under the GES is the inputs subsidy. These are the 100% subsidy on seeds, 50% subsidy on fertiliser and different levels of subsidies on inputs for other value chains.

Two policymakers at FMARD gave a comprehensive overview of the subsidies provided under the GES scheme.

“During the programme, each farmer was given two bags of fertiliser: farmers paid for one, and the government paid for the other. For fertiliser, the Federal government and State government collaborated; they shared the payment of the extra bag per farmer. For seeds, initially, when we started, the seed used to be free, 100% free, and

borne by the Federal Government. But you know, as one Yoruba adage says, ‘Ogun ti a ko ba fi owo se, eyin aro lo ngbe’ translated as, “medicine that we don’t pay for will not be valued”. We realised that after taking the seed, most farmers will not plant it, and some will just abandon it... that was when the government introduced a 10% payment on arable seeds and 20% for cash crops.”

“For the poultry GES, farmers were given 100 birds per farmer for free, at 100 percent subsidy. The package includes free vaccination and 5bags of feeds for which they paid a token. For aquaculture, farmers were given 500 fingerlings per farmer at 100% subsidy and 5bags of feeds, which they also paid a token for. For sheep and goats, were given feeds, additives, salt lick, and concentrate. I think each farmer paid 30%. They were also given ten bags of feed. The dairy farmers, apart from the feeds, were given colostrum. The milk was free; they were given free vitamins. Everything was free except for the feeds that they paid 30%. They were given cassava stem free, 50 bundles per farmer for the cassava value chain.”

9.2.4. Policy Supporting Intermediaries

The concept of intermediaries in literature encompasses the social actors mediating between people who know differently and know different things or between communities and diverse sources of knowledge; such communities have difficulties grasping and integrating their knowledge and actions (Cozzens and Sutz, 2012). The role of policy in collective action can manifest in two aspects: stimulating the participation of people in collective action and leveraging collective action to drive social change and inclusive development (Louis, 2009). This dissertation is rather particular about the latter – the ability of collectives in the form of associations of critical stakeholders to use their platform to drive inclusive development in the I4ID context. The definition of collective action by Diprose *et al.* (2020) is adapted to suit this study. Collective action is therefore described as actions undertaken by collectives, groups and networks, predominantly by actors in the GES Scheme that seek to create positive changes in their activities. In this study, the role of policy in enabling collectives as a critical player in driving the implementation of the GES Scheme is therefore essential to the emergence of the I4ID system.

Generally, intermediaries in conventional ISs comprise professional associations, chambers of commerce, community organisations, and different forms of governance networks (Dossou-yovo and Tremblay, 2012). They can operate either in the private or public sector (Intarakumnerd and Chaoroenporn, 2013). In the context of the I4ID system, collectives

manifest as intermediaries performing the role of bridging institutions in BoP markets and informal settings (Petersen *et al.*, 2016). They are actors' associations providing support services needed to diffuse innovation (Cozzens and Sutz, 2012). These facilitate the innovation process by serving as a bridging institution between the supply and users (van der Hilst, 2012). Their primary responsibilities include promoting trust among members, diffusing technology know-how and information, assisting members in upgrading manufacturing technologies, and expanding international marketing ability and operational management (Intarakumnerd and Chaoroenporn, 2013). These include farmers' associations, agro-dealer associations, and supplier associations. Collectives utilise the following strategies in their *modus operandi* for achieving change: enforcement of rules through robust external monitoring and sanctioning or internal enforcement through negotiations (Petersen *et al.*, 2016). In the GES scheme, these groups use a mix of these strategies to drive participation and contribute to achieving the goals of the Scheme. Hence, the government's deliberate policy was to engage the intermediaries as a platform for collective action to enhance the success of the Scheme.

In developing and deepening the diffusion of the GES scheme, the government utilised different instruments and actions to enable the intermediaries to perform a critical role in driving social change and inclusive development. Intarakumnerd and Chaoroenporn (2013) identified two essential areas for policy intervention to enhance the role of intermediaries in innovation systems in developing countries. These are mobilisation and trust building as well as capability development. In addition, intermediaries in the I4ID system ensure quality control in the innovation process. These are expressed under the GES scheme as follows:

9.2.4.1. Capability Development and Facilitating Information Flow

Recognising their essential role in the capacity development of their members, the government identified intermediaries as a significant partner in the GES scheme and therefore put in place policy to strengthen the capacity of the marginalised through the capability development of intermediaries. Hence, regular stakeholders' engagement and train-the-trainer workshops were undertaken with the leadership of the intermediaries. They were expected to step these down to their members. In addition, intermediaries utilised their platforms to stimulate collective action by mobilising their members to participate in the Scheme. They organised their members and ensured that feedback from using the GES scheme was passed to the government and other actors. These strengthened the intermediaries as an effective platform for empowerment and information flow between government and the different actors, especially the smallholder farmers and the agro-dealers. A leader of the farmers' association stated this:

“We went to mobilise farmers in the villages, working with the Osun State Agricultural Development Programme (OSSADEP). We were used to contacting farmers.”

Some leaders of the agro-dealers association also lent credence to this:

“The history of GES started in 2011. They (the government) invited agro-dealers to a meeting in Abuja during the era of Minister of Agriculture, Dr Akinwumi Adesina. I was lucky to be part of the meeting. They informed us that the government wants to intervene in farmers’ problems and erase them by giving some inputs to farmers. We planned everything together in Abuja at that time.”

“I am one of the leaders of WAIDA (West Agro Input Dealers Association), our umbrella association ... As one of the leaders of the association, we have to embrace any programme or initiative from the government”

They also assisted the government in selling the Scheme to their members who were disillusioned by failure of previous interventions. An offshoot of this policy is positioning intermediaries to ensure quality control of the process of implementing the GES scheme. During registration, membership in an association was one of the criteria for enlisting agro-dealers and suppliers. Different stakeholders attested to these:

“Apart from presenting CAC registration, you have to show evidence of belonging to the association, that is, WAIDA during registration” (Agro-dealer_7)

“We were selected through agro data, agro-dealer database. That is what they used to pick us. The Ministry of Agriculture later wrote us a letter seeking our interest in participation. We replied that we were interested.” (Agro-dealer_3)

“In selecting suppliers, the government utilised a mix of strategies, including consulting the intermediaries. In some instances, FMARD worked with farmers association to select reputable suppliers” (FMARD Policymaker_4)

“In selecting the agro-dealers, we partnered with the agro-dealers association, like WAIDA. Apart from that, we equally used the Nigerian Agricultural Cooperative (NACO); we have some agro-dealers from that forum too” (FMARD Policymaker_2)

9.2.4.2. Quality control

The intermediaries also assisted in performing quality control function by authenticating the genuineness of farmers. While the selection of smallholder farmers that participated in the

generic GES scheme was made through open registration, the government consulted intermediary associations before enlisting beneficiaries for the specialised GES scheme. Some of the respondents interviewed attested to this:

“We got the data of the farmers (that participated in the specialised GES) from the associations. Apart from that; we got it through our registration.” (FMARD Policymaker_2)

“I enrolled through the Fish Farmer’s Association in Oshogbo... They told us that we should submit our names in the association that government want to give us some intervention” (Fish Farmer)

“I got enlisted through my umbrella organisation. WAIDA coordinated in Oyo state because it is the umbrella association of agro-dealers. We know ourselves; we know our location. It was by being a member, a credible, reliable, and trusted member that you can participate in the GES” (Agro-dealer_8)

“[...] as long as they appear (physically for registration), we will register them. But there are some questions that we asked them, for instance, do you belong to any farmer’s association?” (FMARD Policymaker_3)

“[...] No, we attached some conditions to it (registration). Part of the conditions is that we asked them (the farmers) to show their AFAN (All Farmers Association of Nigeria) ID card” (FMARD Policymaker_2)

The involvement of the intermediaries was not successful in some instances. As earlier noted, many banks did not support the small actors with credit despite several interventions from the agro-dealer association. A leader of WAIDA expressed the frustration in seeking financial support from banks as follows:

“In our state, the government encouraged banks to lend us money, but our association's efforts, i.e. WAIDA, were unsuccessful. We could not receive loans from the banks because we could not meet the conditions they attached to the loans.”

Despite this, participating in the scheme as a stakeholder enhanced the visibility of the agro-dealers associations and strengthened their capacity to influence their members. These make it possible for them to solicit or enforce the cooperation of their members and subsequent trust building. This helps to confer legitimacy on the Scheme, according to a leader of WAIDA:

“[...] well, first and foremost, it (the GES) boosted the network of the agro dealer; I mean, it makes them more popular.”

9.2.5. Policy Targeting Marginalised Groups

In the I4ID context, the focus of policy shifts to marginalised actors as inclusive development is driven by innovation. The policy can therefore propel these actors to be the focus of innovation, benefit from the implementation of innovation or enable their active participation in the innovation process. As noted earlier, the smallholder farmers are the primary marginalised actors in addition to the small and micro agro-dealers. This section consequently assesses the role of policy in enabling the participation of these actors in the GES Scheme.

9.2.5.1. Agro-dealers and Local Suppliers

One of the ways policies was used to enable the participation of micro, and small agro-dealers in the GES scheme is to include business registration with CAC as one of the criteria for registration. Before the Scheme, many of these dealers were small actors, operating as informal actors serving farmers on open streets across the country. Registration was the first step in formalising their processes as it helps to have a better business structure. In addition, they were asked to open a bank account near their business operation. This opened them to different opportunities available from financial inclusion, such as access to credit, capacity building etc. One of the agro-dealers described the registration process as follows:

“[...] First, you have to be an existing agro-dealer registered with the Corporate Affairs Commission (CAC). After this, you are qualified to register with the government to participate in the GES. During the registration process, you must present a tax receipt, that is, evidence of tax payment... that is all. If you have these, you are qualified to apply to participate in the GES.”

The empowerment of agro-dealers through an earlier intervention by IFDC in partnership with the government prepared the agro-dealers to take advantage of opportunities under the GES. The NADS intervention covered training, institutional strengthening of the intermediaries, technology transfer, and financial support for the business development of 2,300 agro-dealers (International Fertiliser Development Center, 2011; Olomola, 2014). The government provided technical support for the programme. Some agro-dealers described this as follows:

“[...] one of the reasons why IFDC has been empowering WAIDA is to enable the association to play a major role in fertiliser distribution. Ahead of this time, IFDC has

been empowering and building the capacity of the agro-dealers by educating them through in-service training and workshops.”

“[...] Yes, we interacted before the commencement of the programme. We had meetings, seminars, and workshops, on different issues such as record keeping. Other stakeholders - redemption officers and value chain managers – were at the meetings.”

Despite this, many agro-dealers still lacked the capacity and organisation to cope with the significant input market offered by the GES (Olomola, 2014). Being predominantly SMEs, they also lacked the financial ability to provide the inputs at the scale required under the GES. According to Olomola (2014):

“Over the years, though there have been attempts to develop the agro-dealership, the level of organisation and capacity improvement attained is far from adequate for agro-dealers to cope with the responsibility required for effective distribution of inputs. The weaknesses in their financial and technical capacity came to the limelight when many could not provide the financial backing for their role in the distribution of inputs under the GES scheme. They are also not adequately equipped, organised, or buoyant enough to be able to access loan facilities from commercial banks.”

This is because the over 2,300 agro-dealers trained under NADS may not constitute the critical mass required to guarantee the needed change in the agro-input supply system in Nigeria. This led to the IFDC recommending the provision of funds to train additional 20,000 agro-dealers under the GES Scheme (International Fertiliser Development Center, 2011).

To use the GES as a strategy to empower local producers, especially in the specialised value chains, priority was given to local producers to supply inputs for aquaculture, fishery, sheep and goat and others. This supports the government’s local content policy, which uses public procurement to stimulate learning, job creation and economic growth. Some policymakers at FMARD stated:

“In selecting the suppliers for aquaculture, local and indigenous farmers with capacity were selected to supply juveniles to fish farmers.”

“[...] but those (local producers) were picked within the state. All those suppliers, especially the agro-dealers, were indigenous dealers in the state.”

9.2.5.2. *Smallholder Farmers*

The overall policy goal behind the GES is to empower smallholder farmers, thereby transitioning them from peasant farmers to commercial farmers. The introduction of inputs at a subsidised rate is supposed to enable value addition as they move up the value chain. A policymaker at FMARD described the underlying philosophy behind the GES as follows.

“[...] Invariably, what we want to achieve with the GES is that we want to grow the smallholder farmers after some years to move to medium scale farmers, and then we move the medium scale farmers to large scale and commercial farmers. Therefore, there is a growth system within the value chain That is why it is called the Growth Enhancement Support (GES) scheme.”

The GES also played an essential role in enabling financial inclusion among smallholder farmers. The government provided registered farmers a chip-based identity card with an e-wallet linked to a mobile phone through NAPI. In addition to providing a unique identity to overcome some of the operational challenges encountered during input redemption, it also offered complimentary, value-added service by serving as a debit card. Farmers could make easy payments for services, linking them to new markets. This, therefore, assisted in enhancing financial inclusion among the largely unbanked farmers before the introduction of the GES.

The abrupt ending of the GES led to the inability of the NAPI to fully achieve the objectives despite pilots in two states showing high potential for financial inclusion. The range of policies utilised to drive the GES is summarised in Table 9-2.

Table 9-2: Policy-mix guiding the I4ID system used under the GES Scheme

Policies guiding the I4ID system	Policy interventions
Regulations	<ul style="list-style-type: none"> • Liberalization of the telecommunication sector in 2001 • Abuja Declaration on fertiliser in 2006 • Agricultural Transformation Agenda – the transition of procurement and distribution from the government to the private sector • Import substitution policy on fertiliser • The 2011 amendment of the National Agricultural Seeds Act of 1992 liberalised the seed industry by bringing private sector players into seed breeding, multiplication and distribution. • Launching of the Gas Industrialization Plan in 2011, providing incentives to harness the country’s vast gas reserves and develop a petrochemical and fertiliser industry

Demand-side policy	<ul style="list-style-type: none"> • Subsidies on fertiliser, seeds and other inputs • Capacity building
Supply-side policy	<ul style="list-style-type: none"> • Credit at a single interest rate • loan guarantee up to 75% • monopoly of the input-supply system through a commitment to obligatory use by the government • Research grant to public agricultural research institutions • Setting up of seed commercialisation units by research institutions • Development of IP framework for commercialisation of R&D outputs • Capacity building • Technical support by international partners
Policy targeting marginalised actors	<p>Agro-dealers</p> <ul style="list-style-type: none"> • Business formalisation • Capacity building <p>Smallholder farmers</p> <ul style="list-style-type: none"> • Empowerment • Financial inclusion
Policy supporting intermediaries	<ul style="list-style-type: none"> • Capacity building • Mobilisation and trust building

9.3. POLICY LESSONS FOR ENHANCING I4ID SYSTEM PERFORMANCE

9.3.1. Right and Appropriate Use of Innovation Policies Can Induce Inclusive Development

As noted earlier, the appropriate selection of the appropriate policy incentives can help stimulate the growth of the I4ID systems. Maintaining a balance between demand-side, supply-side innovation policies and other complementary policies targeting key actors such as marginalised actors and intermediaries, therefore, is essential in enhancing the effectiveness and efficiency of the I4ID system. As shown in the strategic agricultural policy document, the ATA, and with empirical findings from this study, evidence from the GES scheme shows that with appropriate identification, selection and utilisation of suitable policy instruments, government-led, large-scale interventions to support the I4ID system can be successful. Literature shows that before the implementation of the GES scheme, input subsidy reached only between 11 – 30% of intended targets. However, with the introduction of GES, this was oversubscribed after the first year of inputs rollout (NASC, 2016). The emphasis of policy in implementing the GES scheme was on enhancing synergy between different critical government and industry stakeholders, leveraging their strength to implement shared visions

and plans for the marginalised. This helps to stimulate the participation of the private sector to play a leading role in the procurement and distribution of inputs in the BoP market. At the same time, the government coordinates and monitors progress.

9.3.2. Policies targeting I4ID System Should Focus on Wider Societal Impact

The focus of policies aimed at the I4ID system should be well defined and targeted to meet the needs of the marginalised. Foster and Heeks (2016) identified two broad goals for the I4ID system: inclusivity in process and inclusivity in output. The overall goal should be to implement policies that will introduce innovations that help create sustainable livelihoods, reduce poverty and unemployment, and bridge widening inequality rather than introducing frontier, “new-to-world” technologies (Utz and Dahlman, 2007). This could be achieved by developing and diffusing affordable and adapted technologies. More emphasis should be placed on addressing the distributional effects of STI policies (Altenburg, 2008). Innovation policies should focus on sectors with a critical mass of the marginalised, especially in agriculture. This is where I4ID programmes and policies can have the most significant impact on meeting the goals of poverty, unemployment and inequality. Evidence from the GES scheme shows the applicability of this. With an enrolment of and reaching out to 20 million smallholder farmers through smart subsidy induced by ICT, the programme provides a success story of how large-scale innovations can target the critical mass of the BoP. This comes with potential challenges to sustainability, as discussed below; however, these can be minimised if the right framework conditions are considered.

9.3.3. Sustainability of I4ID Policies Should Factor in the Political Economy of the State

According to Altenburg (2008), there is a high risk of government failure in policies aimed at I4ID systems if the State’s role is too dominant. Policies may be channelled toward satisfying vested interests leading to an unending cycle of inefficiencies and corruption which provides a stimulus to continuously expand the scope and duration (Altenburg, 2008). The political class see government interventions as a means to reward party loyalty; hence, the potential political gains from subsidy rents are very high compared to other income opportunities. Therefore, the incentives for political manipulation are strong (Baltzer and Hansen, 2012). Aside from these, the capacity of government to develop and implement science and innovation policies that can optimise transformative and sustainable change is in doubt. Hence, science and innovation policies are constantly subjected to government failure. The potential for failure is higher in developing countries due to weak institutions that can maintain checks and balances. These

incentive structures favour rent-seeking behaviour, scarce resources with competing demands, and a culture of corruption arising from state control or capture. Experience from Nigeria's political climate shows that a shift of focus to election matters around the election cycle. Hence, only programmes and projects that have electoral value get attention. This affected the funding of the GES in 2014 as attention shifted to national polls in early 2015.

An essential factor in this context is the over-reliance on government as the sole funder of large-scale interventions for I4ID systems, especially in most developing economies whose main source of revenue is from the export of primary commodities such as crude oil. The inability to withstand shock from distortions in the price of primary commodities could lead to revenue loss, adversely affecting I4ID programmes. Heterodox solutions that emphasise diversified funding for I4ID programmes and competition from suppliers should be developed. Targeted subsidies stimulate entrepreneurship, innovation, competition, and a competitive input market (Baltzer and Hansen, 2012).

In implementing I4ID policies, policymakers must manage the contesting interests reflecting the broad political economy where it operates. This involves aligning with government priorities and political realities, as well as with institutions and policies run by different ministries, departments, and agencies (MDAs) – operating at different levels of government (Stiglitz, 1996; Andreoni and Chang, 2019). The GES scheme shows an active collaboration between several MDAs such as the Ministry of Finance, Ministry of Communications, Central Bank, National Orientation Agency, NIMC, etc. at the Federal level and State Governments through their ADPs. Balancing these actors' competing interests portends a potential landmine source for I4ID policies if not well managed. Understanding the political structure in Nigeria requires that any intervention on the concurrent legislative list in the constitution, such as agriculture, will require the cooperation between the sub-nationals, the 36 state governments, and the Federal government to succeed. This made the then Minister of Agriculture utilise the platform of NEC to seek the support of the governors and the Central Bank to endorse the Scheme. In addition, state governments committed to providing a 25% subsidy and not undertaking any parallel subsidy programme on agricultural inputs. Without these commitments and support, the GES would not have succeeded. More so, the events that led to the termination of the scheme started with the withdrawal of the States because of low revenue resulting from a crash in crude oil prices.

The strategic coordination of structural interdependencies requires the government to set up different institutions and deploy various policies (Chang and Andreoni, 2019). It is through these institutions that industrial policy can be designed, implemented, and enforced. These are also relevant for I4ID policies today. Andreoni and Chang (2020) identify three important institutional issues government has to resolve in utilising industrial policies to implement structural changes in the economy. The first is how government can implement structural changes through its strategic coordination role in the I4ID system by not only setting up different types of institutions and policies but also doing so in a coherent and complementary manner. Second is the capacity of the government to continuously monitor and implement modifications and adjustments to policies and institutions in a timely and efficient way to keep the I4ID system on track to achieving its goals. This is to ensure that policymakers identify and remove institutional bottlenecks that can hinder the growth of I4ID systems as they unfold. Thirdly, the introduction of new institutions and policies should be done in a way as to reinforce complementarities among them and avoid situations in which they contradict or undermine each other. The government's capacity to undertake such institutional interventions is crucial to the success of I4ID policies. This is because, in many cases, targeted policies may require improved administrative capabilities (Andreoni and Chang, 2019). In this regard, the government's power must be strengthened in I4ID systems.

In the GES scheme, the government was able to create new institutions appropriate to the diffusion of the programme. These include the formulation of the ATA, input lending framework, and amendment to the National Agricultural Seeds Act of 1992, among others. These were designed in synergy with the overall national development plan, the Transformation Agenda and other sectoral policies such as the National Gas Masterplan and the National Industrial Policy. The continuous tracking of the implementation of the GES scheme necessitated the creation of new or modification of existing institutions to meet emerging challenges. These include the design of NIRSAL to tackle the challenge of lending, review of input lending framework from back-loading to front-loading, creation of the GES Charter, Complaints Desk and failed attempt to pass a law at the National Assembly to institutionalise GES. Building the capability of the government to undertake institutional interventions and negotiate the potential landmines peculiar to the political economy of each State is essential to the success of I4ID policies.

9.3.4. Government Remains Central to I4ID Systems but ...

The centrality of government in driving ISs is not in doubt. Utz and Dahlman (2007) identify some of the critical actions that the government can take to support I4ID systems. These are disseminating information, supporting grassroots innovators, creating specific incentives for researchers to provide knowledge inputs to the poor, or setting up funds to acquire rights to pro-poor technologies. The challenge is maintaining a balance between governments as an enabler and playing a central role. Lall (2000) argues that the solution to making innovation policies more responsive is strengthening the government's capabilities to play a more active role in the innovation process. According to Lall (2000, p. 34), "it is the strengthening of governments that is needed to make markets work properly." This will allow the government to deploy the necessary tools to correct the market failures associated with implementing innovations. The notion that strengthening government capabilities to provide an expanded role in governance is the way forward needs to be put in proper context. In what ways should the government be strengthened? In what way should the government's role be expanded?

Insights from literature and this study show that this should be situated within the general notion of the role of government in ISs, which is usually depicted with the statement that has become cliché, 'provision of enabling environment'. The 'provision of enabling environment' role can be interpreted along a broad spectrum as minimal government intervention where the market functions optimally or assumes a bigger role in sub-optimal and inefficient markets. In many developing countries, which are characterised by inefficient markets and fragmented ISs, the role of the State becomes more prominent in enhancing innovative performance, especially in BoP markets. This has led to the failure of many large-scale interventions in BoP markets (Baltzer and Hansen, 2012). How then can the State be strengthened to play a better role without leading to government failure? Insights from the GES scheme indicate that this can be operationalised in two ways: 1. Institutionalisation of market reforms that complement the growth of I4ID systems; and 2—creating an institutional framework that guarantees a shared responsibility based on complementing the strength and substituting the weakness of the government and the private sector. Under the GES Scheme, the government focused on creating an efficient and competitive market through policy and coordination. At the same time, the procurement and distribution of inputs were left to the private sector. This ensures efficiency and equity of the input subsidy programmes, thereby avoiding the traps of corruption, wastages and inefficiencies associated with previous interventions where the government undertook procurement and distribution of inputs. Therefore, the strengthening of

government should not be interpreted as domineering but within the broad framework of undertaking market and institutional reforms to complement the development of a strong I4ID system. These include incentivising lending to BoP sectors, improving ease of doing business, and ensuring competition. This is because the best governments, even in developed economies, can be burdened by inefficiency, additional red tape and crowding out of private service providers (Altenburg, 2008).

For a holistic evaluation, policy should be viewed from a comprehensive perspective of addressing market, institutional and network failures, which hinder or influence the growth of I4ID systems at the level of the entire system (Carlsson and Jacobsson, 1997). While the ISs framework tries to focus on other weaknesses outside the market failures, neglecting market weaknesses may hinder the optimal performance of the I4ID system at a systemic level (Altenburg, 2008). This is because the innovation and diffusion processes are influenced by the competence, capabilities and capacities of actors, institutions and networks and by market-related characteristics.

9.3.5. Sustainability of Policies Aimed at I4ID Should Focus on Spillover Impact

The high cost associated with innovation programmes implemented in the I4ID context indicates that such programmes must be undertaken as a temporary intervention. It is therefore essential to weigh the cost of intervention vis a viz the expected benefits from corrected market failures. This is important in developing countries where there is intense competition for scarce resources among competing demands. There is also the possibility of being hijacked to serve vested interests. Following the smart subsidy approach (Baltzer and Hansen, 2012), policies aimed at the I4ID system should aim to introduce interventions that take into consideration the following issues:

- Targeted – focused on the marginalised. Have an effective system of identifying and selecting the marginalised;
- Market-based solution – utilise the platforms of private-sector led input supply system to procure and distribute inputs rather than the public system; and
- Clear exit strategy – have a clear plan and timeline for ending the programme.

Lessons from the analysis of the GES scheme show that in conceptualisation and design, the programme considered the three components. However, operationally, many challenges limit its success, especially in targeting marginalised actors. The open registration system of smallholder farmers was susceptible to exploitation and inefficiency. In some instances, non-

farmers were registered as farmers only for them to sell the subsidised inputs in open markets. Also, small actors, especially the agro-dealers and local suppliers, faced challenges of lack of access to credit as the programme failed to stimulate lending to them.

Sustainability, therefore, should be measured by the spillover impacts that can empower the marginalised actors to withstand future market failures. The analysis of the GES scheme as a case for the I4ID system points to such positive spillovers despite the limited number of years of implementing the programme. Aside from immediate gains in productivity and profitability for the agro-dealers and smallholder farmers, there were associated spillovers to the different actors in capacity building, enhancement of managerial and technological capabilities, and strengthening of vertical linkage. The vertical linkages between the agro-dealers and suppliers and between smallholder farmers and agro-dealers were strengthened. Also, new markets were created for the suppliers, especially local suppliers, through connection with agro-dealers and smallholder farmers and their associations. The capacity of the agro-dealers and local suppliers was enhanced to provide improved services. New market channels for sourcing inputs were opened to agro-dealers and smallholder farmers. In addition, the relationships developed during the implementation of the GES scheme ensure that actors continue to leverage the social capital to access inputs on credit even after the end of the programme. These positive spillovers are supposed to contribute to equipping the actors with the capacity to withstand the effect of any potential market failures in the agro-input supply system after the end of the programme.

9.3.6. Strengthening Non-state Actors Is Key to Success of I4ID Policies

Following Peter Evan's taxonomy of developmental state, intermediaries serve two functions: midwifery (awareness creation) and husbandry (facilitate support) (Evans, 1995). This means that they do not only connect consumers to innovators, but they sometimes are innovators. They adapt and assist in the diffusion of innovations in a way acceptable to the BoP. Within the GES scheme, associations played a similar role by standing as a bridge between the different actors and the marginalised, assisting in diffusion and creating a platform for learning and capacity building. They also served as the central voice for agro-dealers, suppliers and farmers to protect, support, and develop the agro-input sector.

While having limitations in resource mobilisation and knowledge, these associations serve as effective brokers between the different actors and government due to the level of trust and power over their members (Intarakumnerd and Chaoroenporn, 2013). In the GES scheme, associations such as AFAN, SEEDAN, and WAIDA played important brokerage roles, including mobilisation, demand articulation, building trust, resolving conflicts and providing

capacity and competence-building platforms. The policy to strengthen these actors is essential to the diffusion of innovations in the BoP market. More importantly, intermediaries should be recognised as critical partners by integrating them in conceptualising, designing and implementing I4ID policies and projects. This will further assist in enhancing their visibility and, consequently, allow them to play their role of mobilisation and building trust of members towards the success of I4ID programmes and policy.

9.3.7. Assessing Multiple Institutional Paths to Innovation Can be Central to I4ID

System

Institutions are used broadly to refer to legal and regulatory changes, norms, and culture (Jacobsson and Bergek, 2006a). Institutions have influences on decision-making which can be observed in the patterns of behaviour of rural development actors but are not necessarily explicit in their public explanations of their actions (High, Pelling and Nemes, 2005). While government develops formal institutions in terms of policies, rules, laws and regulations, informal institutions shape behaviour and interactions within BoP markets. Informal institutions, comprising norms, culture and beliefs, are believed to change relatively slowly, and are deeply entrenched among informal actors. The formal and informal institutions play a central role in determining the success or otherwise of any innovation. The general perception in the I4ID system context is that due to regulatory and policy failure, firms only leverage informal institutions embedded in trust-based networks at the expense of formal institutions. While this holds in some instances, recent evidence has also shown that the interaction between formal and informal institutions can be complementary (Saka-Helmhout, Chappin and Vermeulen, 2020). The challenge for policy supporting the I4ID system is to have a deeper understanding of the interactions between formal and informal institutions to create multiple paths to innovations in the BoP market (High, Pelling and Nemes, 2005). In implementing innovation activities in developing economies, informal institutions have been found to play a complementary role to strong formal institutions or substitute weak formal institutions in the absence or presence of firm-level resources. In addition, weak informal institutions can also accommodate strong formal institutions in implementing innovations (Saka-Helmhout, Chappin and Vermeulen, 2020).

This was found in the GES scheme, where agro-dealers leveraged their social capital through established vertical networks and trust to access resources from suppliers. This substitutes for the failure to access credit from commercial banks. The intermediaries also played a prominent role in conflict resolution by putting pressure on the government and mediating between the

marginalised actors when there was a delay in subsidy payment. By depending on intermediaries to mediate, marginalised actors utilised network relations to compensate for weak contract enforcement mechanisms, thereby reducing transaction costs in factor and product markets. This highlights organisational resilience or the ability to adapt to changes in an unstable or weak institutional environment (Castellacci, 2015). Also, intermediaries utilised their platforms to organise and enhance the capacity of their members to complement government efforts at capacity building. A deeper understanding of the complementary or substitutive nature of relations between formal and informal institutions will further assist in devising appropriate policies that stimulate innovation in BoP markets.

9.3.8. Addressing Market-driven Producer Prices is Important to Guarantee Lasting Impact for Interventions Aimed at the Marginalised

The relationship between appropriate producer pricing, farmers' income and subsidies is mixed. Some authors argue for subsidies as a means of improving agricultural productivity and the income of farmers (McCloud and Kumbhakar, 2008; Awotide *et al.*, 2011). For instance, McCloud and Kumbhakar (2008) found that subsidies drive productivity through technical efficiency and input elasticities in Nordic countries. Other studies have however found a negative impact of subsidies on productivity because it causes allocative and technical efficiency losses (Rizov, Pokrivcak and Ciaian, 2013; Minviel and Latruffe, 2017). They therefore argue that subsidies will become irrelevant if the right market conditions that enable the commercialisation of agricultural produce are implemented. The aim should be to determine an appropriate pricing system for agricultural products that can guarantee commensurate income for farmers.

One of the characterisations of smallholder agriculture in Africa is its subsistence – the inability to operate commercially. An observable symptom is the incapacity of smallholder farmers to estimate input and output prices (Maddison, Marita and Kurukulasuriya, 2007) and consequently determine profit. Even when they do, their profits are usually small. They have limited market opportunities; hence, they are usually constricted to selling at the farm gate to middlemen at very low prices. This translates to insufficient income to improve their production in the following farming season.

The factors contributing to low-profit maximisation among smallholder farmers include low capital input into production, low level of education, the low price level of farm produce, and poor accessibility to credit facilities, among others (Olawepo, 2010). This limits the capacity of farmers to acquire important technologies and inputs for agricultural activities. This is

because the prices of agricultural inputs may be higher than the total output value in a season. For example, the price of fertilizer is often higher than the price of a bag of corn (Che, Strang, and Vajjhala, 2020). This sets up a chain reaction that ultimately influences their welfare and standard of living. Poor productivity reduces the capacity to generate higher income and subsequently reduces their living standard. Hence, it is argued that sufficient producer prices of agricultural commodities would make subsidies of inputs such as fertilizers, unnecessary.

Under the GES Scheme, the Federal Government fixed the prices of the inputs close to market price, subsidised and mobilised the private sector, leveraging on crowding-in effect and high sales volume, to procure and distribute the inputs. The utilisation of the e-wallet system, as well as the use of the private sector in procurement and distribution, ensures greater efficiency and effectiveness in the programme. At the end of the intervention period, the regulated price-fixing system was expected to transit to a market-driven pricing system.

This makes the GES scheme an important programme not just for providing farmers access to inputs but also to empower them. While the short-term objective of the programme was to deliver inputs to farmers efficiently through an e-wallet system and raise agricultural production and farmers' income, the ultimate goal is to transit peasant farmers to commercial farmers through the direct intervention of provision of subsidized inputs within a 4-year period. The ATA forecasts a return on investment in increased production of between five to ten times and a benefit/cost ratio of 16:1 (Federal Ministry of Agriculture and Rural Development, 2011). While this is laudable, it is important to point out that for an efficient supply of inputs to catalyse the transition from subsistence to commercial agriculture, it should address other market-related factors necessary to create a conducive and stable macroeconomic environment that can lead to the commercialisation of smallholder agriculture in Nigeria. These include institutional reforms that focus on access to credit, access to modern technologies, fostering interaction between the different actors, provision of adequate infrastructure in rural areas, enhanced capacity for value addition, and facilitating access to the market (Jayne and Rashid, 2013; Uduji *et al.*, 2019). The ATA also recognises this by anchoring the transition model from subsistence agriculture and high poverty level into a commercialized system on private sector-driven fertiliser procurement and distribution, marketing institutions, financial value chains and agricultural investment framework. The aim is to develop a market oriented/market surplus approach facilitated by NIRSAL, trade and competitiveness (Federal Ministry of Agriculture and Rural Development, 2011).

While evidence from the literature suggests that the first objective of efficient delivery of inputs to farmers was achieved (Wossen *et al.*, 2017; Uduji *et al.*, 2019), there is a lack of evidence to support the transition from subsistence to commercial agriculture. Sufficient evidence points to increased productivity and profitability as a result of the intervention, the lasting impact of transformation to commercial agriculture is unfounded. Wossen *et al.* (2017) found out that farmers who participated in the GES scheme increased their maize yield by 26.3% and income by ₦19,730. In terms of welfare outcomes, the GES scheme has a positive and statistically significant effect on per-capita total, food, and non-food consumption expenditures. Uduji *et al.* (2019) therefore argue that for government intervention such as the GES scheme to have lasting impact, it should integrate ‘important enablers’ of rural farmers such as effective transportation and access to information. These enablers, which link smallholder farmers to formal markets and agricultural development, are needed to create appropriate pricing mechanisms for farmers. Without attending to these factors, guaranteeing a lasting impact for farmers and developing a functioning I4ID system will be a mirage.

9.3.9. ICTs Remain the Powerful Tool for Driving I4ID Systems

The failure and transformative power of ICTs in the BoP market are well documented. When it succeeds, it facilitates access to information, enhances financial inclusion, increases decision-making capacity, helps governance and empowerment, and the inclusion of the marginalised (Andres, Amavilah and Asongu, 2017; Asongu and Nwachukwu, 2018; Gao and Liu, 2020). This is catalysed by the rapid diffusion of ICTs, especially the internet, mobile phones and digital solutions, which have opened new opportunities for the marginalised (Nan and Markus, 2019; Gao and Liu, 2020). On the other hand, failure is often defined by lack of infrastructure, lack of skills in intended beneficiary communities, the poor conceptualisation of needs, and a poorly definition of the intended developmental outcome (Diniz, Bailey and Sholler, 2014; Chipidza and Leidner, 2019)

This implies that the impact of ICT-enabled innovations is not always positive and should not be taken for granted. The story of M-Pesa and M-Shwari in Kenya depicts a conflicting narrative of digital innovations’ impact on enhancing inclusive development. While M-Pesa won global acclaim for its success, M-Shwari isn’t that successful (Foster, 2013; Suri and Jack, 2016; Nan and Markus, 2019). Although M-Shwari is commercially successful, its impact on enhancing financial inclusion among the marginalised is limited. Without appropriate policy interventions, Nan and Markus (2019) argued that M-Shwari might stagnate or reverse earlier gains in the Kenyan financial inclusion landscape by widening the inequality between the rich

and the poor, further marginalising the poor. This shows that for developing countries to optimise the benefits of ICTs in driving inclusive development, the policy has to be deployed to improve formal institutions and enabling infrastructure for ICT adoption (Andres, Amavilah and Asongu, 2017). Analysis of the GES scheme shows that many of the challenges with the Scheme were experienced during the input redemption period. Not necessarily because the e-wallet was difficult to use but because of poor infrastructure, especially mobile phone networks in rural areas. For ICTs to drive inclusive development, policies and institutional interventions that deepen ICT infrastructure should be designed and implemented in BoP markets.

9.4. CHAPTER SUMMARY

The role of policy as a tool for driving structural change has been well documented. Policy in this context is used broadly to imply government rules and legislative actions as well as the activities of her different organs. In the context of I4ID systems, limited studies have been undertaken. In this chapter, the role of policy in developing and implementing large-scale innovations aimed at the BoP market is analysed using the case of the GES scheme in Nigeria's agricultural system. Findings from the study show that deliberate policy instruments have to be deployed to shape the emergence of I4ID systems. This includes systematically and coherently selecting and implementing a broad range of policies - demand-side, supply-side, regulations, and policies supporting the marginalised actors and the intermediaries - to achieve developmental objectives.

Appropriate policy actions for driving I4ID systems were identified, considering lessons from the GES scheme. This centres on building the capabilities of policymakers to implement multi-path institutional interventions considering the complementarity and substitutive relations between informal and formal institutions. Understanding the political economy of each country state is essential in devising such policies while ensuring that sustainability is conceived in terms of enhancing marginalised actors' capacity to withstand market failure in the future. By taking a more comprehensive institutional approach to policy in I4ID systems, the government can stimulate the private sector to play a more prominent role in introducing innovations that can enhance inclusive development in the BoP markets. This, however, requires strengthening the government's capabilities to play a significant role in the I4ID system.

CHAPTER TEN : SUMMARY AND CONCLUSIONS

Phase I		Phase II		Phase III	Phase IV		
Problem analysis: CFA Stage 1		Literature review: CFA Stage 1-3		Framework development: CFA Stage 4-6	Framework application: CFA Stage 7-8		
Background, Problem statement, Objectives	Research design	Traditional literature review	Systematic literature review	Analytical framework development	Boundary definition	Component-function analysis	Identify goals of systemic instruments
					Identification of system structures	Identification of systemic problems	The suggestion of systemic instruments
Summary and conclusions							

10.1. INTRODUCTION

This chapter summarises the essential findings and the conclusions derived from the study. The chapter also identifies further research directions emerging from this research, which can improve studies in the field of I4ID systems. Finally, the chapter ends with limitations and contributions to knowledge in innovations and inclusive development.

10.2. SUMMARY OF MAJOR FINDINGS

The summary of significant findings is highlighted along the line of the research objectives in this study.

10.2.1. Status of Studies on Innovation and I4ID Systems

Two objectives illustrate this. The objectives are expressed as traditional and systematic reviews of the literature on innovation and I4ID systems and are presented in Chapter Three and Chapter Four of the dissertation. Significant findings indicate a rapidly but evolving growth in studies in the field of I4ID systems. These aim to achieve a similar goal – how ISs approach can, in addition to promoting economic growth, cater for the needs of the marginalised groups in society. This is by innovating in a way that their welfare is enhanced. This led to the emergence of different concepts - inclusive, frugal, pro-poor, grassroots innovation, and I4ID. Analysis of literature shows that while the other concepts are clearly delineated and well conceptualised, inclusive innovation system (IIS) and I4ID are used interchangeably. The thin line between the two is that while IIS aims to expand the structural elements and functions to accommodate peculiarities of developing countries, I4ID focuses on reorientating the IS framework to tackle the challenges of development. This study however tries to develop an analytical framework that focusses on the two. Another important observation is the object or

target of I4ID systems. These are referred to as the BoP, perceived mainly as people at the lowest rung of the economic ladder who live daily between USD1 – 2. However, recent studies have sought to explain the BoP through the concept of marginalisation. Contextualising inclusion along marginalisation provides a broad framework for deepening the understanding of inclusivity in I4ID systems. This expands the BoP to include different categories of people marginalised in ISs and development, such as women, youth, aged, or physically challenged.

Another important finding from the systematic literature review is the recommendation of the component-function approach, broadly, as the most promising technique for assessing I4ID system performance. This follows an extensive analysis of 10 evaluation approaches from 60 works of literature selected for the systematic review. Although the majority of the studies utilised the component approach to analysing the performance of I4ID systems, recent studies have embraced the adoption of a mixed approach of combining the component, functional or any other similar approaches in a way that provides a holistic evaluation of I4ID systems. The evolving nature of the field of I4ID systems indicates that early studies are either conceptual or theoretical. However, with improving understanding, there appears to be a shift towards empirical studies, although with a preference for case studies or exploratory studies. This is because studies in this field are still in the infancy stage; hence, the case study approach, which seeks to provide understanding in different contexts, is widely adopted. While expectedly, most studies on I4ID systems focused on Africa, most of the studies were undertaken by authors affiliated with institutions outside the African continent, especially in Europe. This calls for the need for institutional capacity building and supports to develop capabilities for researching innovation on issues bordering the continent's development challenges.

10.2.2. I4ID System Framework Development

As noted earlier, the study adopts the case study research design which is expressed through the CFA, a qualitative procedure of building and evaluating conceptual frameworks based on GT methodology. This is because of the study's exploratory nature, which focuses on the I4ID system's framework building and application. Conceptually, the ISs approach serves as a heuristic tool for assessing economic growth and development; however, two broad challenges necessitated the development of a framework for assessing the performance of the I4ID system in this dissertation. First is the limitation of the IS framework as it is presently constituted to tackle the challenges in the context of developing countries, thereby limiting its applicability. There is, therefore, the need to continuously adapt the framework by modifying the structures and functions as well as reorientate the goal of the framework to reflect the dynamics and

peculiarities of the BoP market and tackle development challenges (Chapter Five). Second, there is the need to utilise appropriate frameworks that capture holistically the dynamics of ISs rather than just the structural or functional issues separately. Adapting the systemic policy approach to develop the I4ID system's framework ensures that the two broad challenges are addressed. The systemic policy approach was modified into a 6-stage process. The approach provided a holistic framework for insights into the functional dynamics and performance of ISs by integrating four different evaluation approaches – component, functions of innovation system, systemic problem and systemic instrument framework. The 6-stage process consists of the following: defining the system boundaries, mapping the structural elements; performing component-function analysis; identifying systemic problems; identifying systemic instrument goals and designing systemic instruments to achieve the goals.

Within the context of ISs, this study is situated within the sectoral innovation system approach. Although the case study, the GES scheme, was implemented among actors whose interactions are guided by institutions, norms and policies within the country's boundary, these were confined to a sector, the Nigerian agricultural system. In doing this, the study adopted the circular approach for boundary definition. This focuses on mapping the structural elements responsible for the development and diffusion of the GES scheme in Nigeria. It however assumes a dynamic process of boundary adjustments, which is modified as the understanding of the system deepens. Undertaking the component-functional analysis allows researchers to adjust the structural elements of ISs based on the study of the weaknesses of specific functions. The analysis was guided by a set of diagnostic questions mapped from the literature on ISs and adapted to I4ID systems following examples (van der Hilst, 2012; Wieczorek and Hekkert, 2012; Botha, 2017; van der Merwe, 2017). Consequently, the systemic problems were identified, and instruments for addressing them were proposed.

To adapt to the I4ID system's context, relevant components and functions were identified and adapted. The four structural elements – actors, institutions, interaction and infrastructure – were identified. While actors, institutions and interactions are widely accepted as elements of IS, the place of infrastructure is debatable. However, including infrastructure (physical, knowledge and financial) as a structural element of IS is critical to inclusive development, especially in developing countries with a dearth of supporting infrastructure for innovation. Generally, the challenge to I4ID systems is to reorientate system structures to develop new or adapt existing innovative capabilities in a way as to meet the challenge of the BoP market. Eight functions of ISs were adopted. These are entrepreneurial activities, knowledge development, knowledge

diffusion, the guidance of search, resource mobilisation, market formation, creation of legitimacy and development of positive externalities. The development of positive externalities was included because the adoption and diffusion of innovations within I4ID systems have the potential for positive externalities and spillover effects to other actors in the system. While the first six functions depict specific activities of the I4ID system, the creation of legitimacy and the development of positive externalities serve as a measure of the overall performance of the IS.

10.2.3. I4ID System Framework Application

To explore and develop critical insights into the performance of I4ID systems, the developed framework was applied to the case of the GES scheme in Nigeria's agricultural system. This was undertaken in three ways: event history analysis (EHA), qualitative analysis, and consultation of experts. The diagnostic questions guided the functional analysis. In addition, the questions helped to form the 'coding' structure for the qualitative analysis process. Before the qualitative analysis, the EHA of the GES scheme was undertaken. The EHA is used for performing the component-function analysis and, in the process, identifying the functions, the relationship between them and hindering the systems' performance. It provides a method for understanding the historical evolution of an intervention by analysing the activities leading to the build-up or breakdown of the system. The EHA revealed the different stages of growth of the GES scheme. Referred to as episodes, they are organised according to the specific trajectory of events that drive the activities of the lifecycle of the GES scheme. Through the episodes, the cumulative causation, motors of innovation, drivers and barriers to the evolution of the GES were analysed (Section 7.5).

Following the EHA, interviews were conducted with 53 actors in the GES system. The exploratory and framework-building nature of the study informs the use of qualitative techniques through interviews (KII and IDI). This allows the researcher to undertake an in-depth analysis of the case study. Through the qualitative analyses, a detailed structural and functional analysis of the I4ID system using the case of the GES scheme was undertaken (Chapter Eight). The problems associated with each function were identified and analysed based on the capabilities or presence of the actors, presence or quality of interactions, institutions and infrastructure. This is because systemic problems are linked to the system's structural elements but adversely affect the system's overall functioning. Solutions to the problems involve tinkering with the structural elements of the I4ID system to enhance its performance. This, therefore, allows for a comprehensive systemic assessment of the I4ID

system, leading to the identification of systemic goals and interventions (instruments) to strengthen the system's performance. The instruments are designed as policy interventions aimed at addressing the systemic problems identified in such a way as to achieve the goal of enhanced inclusivity. Throughout the process, excerpts and quotations from qualitative analysis of interviewees of critical actors in the GES Scheme are used to triangulate the outcome of the EHA.

10.2.4. Factors Shaping and Influencing I4ID Systems

With the component-function analysis, it becomes imperative to explore the performance of I4ID systems by assessing how the different structural elements interact to perform activities that engender inclusive development in the BoP markets. The EHA revealed the factors influencing the diffusion of the I4ID system (Chapter Seven and Chapter Eight). The EHA further revealed the inducement and blocking factors that influenced the evolution of the system and the motors of innovation – internal and external factors essential to the scheme's operations. For instance, externally, the high price of crude oil and high food import dependency in Nigeria created incentives for introducing the Scheme. The huge market for agricultural activities, strong and competent political leadership, multi-stakeholder partnership in design and implementation, power of ICTs as well as a well-articulated policy framework were internal factors that engendered the buy-in of critical stakeholders in both the private and public sectors. These helped to overcome the initial resistance arising from failures of previous government interventions in the BoP market. Scaling and expansion of the scheme were driven by the successes of previous years, a continuous learning process leading to the introduction of innovations to tackle emerging challenges, and targeted incentives for different stakeholders. However, political instability, economic recession, and over-reliance on government were major inhibiting factors influencing the I4ID system. The system is positively impacted when there exists a strong interaction between the actors. The success of any I4ID programme, therefore, should encourage close interaction between different actors such as the government, the private sector, the marginalised and the intermediaries. The I4ID system should be implemented to leverage each stakeholder's strength, thereby enhancing the system's overall effectiveness. For instance, in implementing the GES scheme, the government focussed primarily on policy, coordination and monitoring while the private sector was in charge of procurement and distribution of inputs. This arrangement leveraged the efficiency in operational processes in the private sector, removing corruption associated with production and distribution in the public sector.

The component-function analysis also revealed the blocking mechanisms of the I4ID system. For instance, the blocking factors hindering the development of entrepreneurial activities included the weak capacity of actors to learn and utilise resources, internal orientation favouring the incumbent, stringent institutional provisions favouring big, strong actors, and inadequate or insufficient infrastructure to support scale-up. Undertaking this kind of analysis for the eight functions reveals the systemic problems associated with the activities of the I4ID system. By combining the two approaches, the structural elements were modified to tackle the problems associated with each function while suggesting the systemic interventions necessary for enhancing the overall performance of the I4ID system.

10.2.5. Policy and the Evolution of the I4ID System

In addressing Objective 6, a detailed policy analysis implemented during the GES scheme was undertaken (Chapter Nine). Policy in this concept is used broadly to capture a range of formal institutions, public action, laws and regulations guiding the development and diffusion of I4ID systems. The role of policy in developing and implementing large-scale innovations aimed at the BoP market was analysed using the case of the GES scheme in Nigeria's agricultural system. In doing this, the state actions in driving inclusive development were considered. The study adapts the framework developed by Foster and Heeks (2016) to analyse a mix of policies that drive inclusivity in I4ID systems. The policy was assessed from the following perspectives: regulation, supply-side policies, demand-side policies, policies supporting marginalised actors and policies aimed at intermediaries. Lessons from the analysis indicate that careful selection and implementation of appropriate policy instruments in a coordinated manner are needed to shape the emergence and diffusion of I4ID systems. Insights from the GES scheme indicate that this can be operationalised by institutionalisation of market reforms that complement the growth of I4ID systems. In addition, there is the need to create an institutional framework that guarantees a shared responsibility based on complementing the strength and substituting the weakness of critical actors, especially the government and the private sector. This helps to stimulate the participation of the private sector to play a leading role in the procurement and distribution of inputs in the BoP market. At the same time, the government coordinates and monitors progress. The informal intermediaries were empowered to serve as an effective broker between the marginalised actors and the government due to their trust and power over their members. One of the critical considerations for implementing policies aimed at I4ID systems in developing countries is the need for policymakers to manage the contesting interests among different stakeholders. The high cost of I4ID interventions, competition for scarce resources

and the possibility of hijacking to serve vested interests point to the fact that such programmes must be undertaken as a temporary intervention. Sustainability, therefore, should be measured by the extent of spillover effects on the marginalised actors. This should empower them to withstand future market failures that may occur after the end of such interventions. While the government continues to play a central role in ISs, policy to strengthen I4ID systems should focus on overcoming government failures by enhancing the capacity of government MDAs in three areas that will lead to structural changes in I4ID systems. These are implementing a wide range of institutions and policies in a coherent and complementary manner, focusing on continuous monitoring and adjustments of institutions in a timely and efficient manner; and the introduction of new institutions and policies in a way as to reinforce complementarities. In doing this, policymakers must assess multiple institutional trajectories that coopt formal and informal institutions. A deeper understanding of the complementary and substitutive nature of interactions between formal and informal institutions is essential to tackling the challenges associated with I4ID systems. In addition, there is a need to create an enabling environment for the participation of the private sector in the BoP market through appropriate incentives and instruments that will lead to an efficient and competitive market. While ICTs represent the most important innovations and drivers of inclusive development, their impact may be limited unless appropriate policy interventions strengthen formal institutions, deploy critical infrastructure and align the needs and priorities of different stakeholders.

10.3. CONTRIBUTIONS TO KNOWLEDGE

This study makes some significant contributions to evolving literature on the dynamics of I4ID systems. These are summarised along four themes as follows:

Contribution 1: Attempts at evaluating the systemic performance of innovation systems using the systemic policy approach have been documented. In recent years, efforts have been made to expand this approach to evaluating the systemic performance of I4ID (Botha, 2017; Grobbelaar, Tijssen and Dijksterhuis, 2017; van der Merwe, 2017; van der Merwe and Grobbelaar, 2018; van der Merwe, Grobbelaar and Bam, 2020; Maarsingh *et al.*, 2021). The challenge is that none of these studies focussed on agriculture, an essential mainstay of the African economy and necessary for the livelihood and wellbeing of the BoP. The study by Van der Hilst (2012) in the case of Vietnam comes close. This study was limited to evaluating the performance of intermediaries through the component-function approach. It also did not explore the potential of systemic goals that are meant to support policy design and the selection of tools that can address the problems identified in an integrated manner. This study, therefore,

attempts to fill the gap by expanding the narrative on ISs to explore the performance of and provide insights into I4ID systems using the case of a popular programme utilised by millions of smallholder farmers in Africa's most populous country, Nigeria.

Contribution 2: The use of the EHA as a systemic tool for evaluating performance at the firm level or of specific TIS has been well documented in the literature (Hermans *et al.*, 2019). However, in the context of I4ID systems, using EHA to assess the functional dynamics is limited. Only one study was found using the method in the ICT4D in South Africa (Maarsingh *et al.*, 2021). Therefore, the EHA should be expanded to assess IS's performance in other sectors important to the BoP. In this study, the EHA is used to explore the performance of an I4ID system by constructing a historical narrative of its evolution through the events that map the activities of an agricultural programme (GES scheme) essential to the BoP market in Nigeria. Through this, it becomes practicable to assess the interaction of system functions in a way that sets up a cumulative causation process towards a build-up or breakdown of the GES. This study, therefore, contributes to the growing literature on assessing the functional dynamics of ISs in a development context. In addition, the typology of motors of sustainable innovation is expanded to cover two new motors relevant in the I4ID context: demand-pull and interaction motors. It is the belief that the use of motors of innovation in the I4ID system's context will contribute to the theoretical underpinnings of the emerging literature on the systemic evaluation of ISs.

Contribution 3: The place of policy in driving conventional ISs has been well documented. Few studies have analysed policy drivers, inhibitors and suggestions in the context of I4ID systems (Altenburg, 2008; Foster and Heeks, 2016). This study attempts to expand the narrative on the role of policy in the development and growth of I4ID systems by expanding the framework developed by Foster and Heeks (2016) to include the role of policies targeting intermediaries (Chapter Nine). This is because of the important role played by intermediaries in implementing innovations, enhancing collective action and facilitating brokerage function (van der Hilst, 2012). Learning from the analysis of the GES Scheme, the study makes comprehensive policy suggestions to strengthen the development and diffusion of innovation in the BoP market.

10.4. LIMITATIONS OF THE STUDY AND DIRECTION FOR FUTURE RESEARCH

The study faced some limitations, which are not unusual for PhD studies, whose breadth and depth are usually characterised by time and budget constraints. The limitations are described under two broad headings: methodology and conceptualising inclusivity. Despite these, the study contributes to emerging literature and evidence of innovation and inclusive development. The limitations are described below:

10.4.1. Methodology

The limitations associated with the methodology in the study can be categorised along the line of the qualitative technique and case study approach.

A methodological limitation is the use of systematic literature review in choosing the appropriate evaluation method and evidence synthesis for the study. This comes with advantages of transparency, objectivity and replicability. On the other hand, there is a limitation to using limited literature selected through the search terms.

Another methodological limitation can be found in the case study research design. Due to the emerging nature of the field of I4ID systems, the study is conceptualised as exploratory. This necessitates the use of a qualitative approach to framework development and application. Using a qualitative technique has its limitation, especially regarding the issue of representativeness of the sample and, subsequently, the generalisation of the findings in the context of I4ID systems. However, this is not surprising, as many of the studies in the field of I4ID systems are exploratory, seeking to understand the emerging concepts in the field. Future direction should seek the utilisation of a mix-method approach where the survey is administered to a representative sample of key actors. This would complement the qualitative studies' outcomes and engender the outcome's generalisability.

In addition, using a single case study in an agricultural sector in a single country also has a limiting implication for generalising the outcomes in a broader context for the sector and I4ID systems. This is despite the size of the intervention and the agricultural sector in Nigeria. Since Nigeria is a vast country with a sizeable agricultural system, adopting more than one case in a sector would have provided a broader view of understanding ISs in a developing country context. Another perspective would have been to investigate multiple cases in different sectors with implications for I4ID, such as agriculture, health, education, etc. While Nigeria represents the largest African country by population and GDP, there is the temptation to view studies in

the country as representing views from SSA. However, a sectoral analysis in a multi-country setting will provide a holistic view of I4ID systems within the continent. This is because ISs are path-dependent, and in developing countries, they are heterogenous - the size, level of growth and maturity, infrastructural development and socio-economic and institutional contexts differ across countries. Therefore, using the component-function to explore the performance of I4ID systems from a multi-country perspective will allow researchers and policymakers to understand a wide range of contextual issues and formulate policies that can strengthen ISs in developing countries at the systemic level.

10.4.2. Perspective around Inclusivity

Inclusivity in this study is conceptualised broadly on how the innovation process can accommodate the structural elements and functions peculiar to development as well as how innovations can lead to inclusive development. In addition, it includes how the marginalised and their peculiarities can be mainstreamed in the entire system supporting the development and diffusion of innovation. This brings to the fore issues surrounding the aspects of the innovation process in which the marginalised can participate. Heeks *et al.* (2013) conceptualise a comprehensive and holistic perspective to defining inclusivity in the ‘ladders of inclusive innovation’. This conceives inclusivity along six areas (steps): intention, consumption, impact, process, structure and post-structure, with intention being the lowest and post-structure the highest of the steps. Each step of the ladder is designed to subsume the lower steps. When viewed from the ‘ladders of inclusive innovation’ paradigm, this study seems to focus on a step of the ladder – impact, with lower steps of intention and consumption also included. It can be said to sufficiently address issues relating to intention, consumption, impact and a large extent, the process of inclusivity. These are reflected in the outcomes of the EHA as well as the systemic analysis of the case. This study didn’t sufficiently address the issues of structure and post-structure in the I4ID system. With these, the inclusivity of innovation is assessed from the structure, frame of knowledge and discourse by which the I4ID system is created. Hence, future studies should examine the necessity for change in social networks, social discourse and frames of knowledge within which I4ID is situated. This will broaden the I4ID system’s studies to consider issues of gender, social exclusion, and power relations in the interactions between the different actors and their impact on inclusivity.

While the study seeks to analyse the role of policy in the design, emergence and diffusion of the I4ID system (Chapter Nine), future research needs to examine the broader policy structures, especially the political economy of the state and its influence on the performance of I4ID

systems. Research should also investigate the role of specific policy instruments, such as public procurement, and standardisation, in driving the performance of I4ID systems.

In implementing interventions aimed at I4ID systems, a holistic risk management framework that identifies the potential blocking factors and designs the appropriate response mechanism, should be developed. This should carefully be designed to manage external shocks, respond to conflicting internal interests, enable diversified funding, and strengthen interactions between the key actors of the I4ID system. In addition, understanding the political economy of each context will assist in selecting appropriate institutions that will help navigate the potential landmines where the system operates.

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APPENDIX A: LITERATURE USED IN THE SYSTEMATIC REVIEW

S/N	Authors	Title	Year Published
1	Hekkert M.P., Suurs R.A.A., Negro S.O., Kuhlmann S., Smits R.E.H.M.	Functions of innovation systems: A new approach for analysing technological change	2007
2	Woolthuis, R. K., Lankhuizen, M., & Gilsing, V.	A system failure framework for innovation policy design.	2005
3	Jacobsson S., Johnson A.	The diffusion of renewable energy technology: An analytical framework and key issues for research	2000
4	Lundvall B.-Å.	National innovation systems - Analytical concept and development tool	2007
5	Liu X., White S.	Comparing innovation systems: A framework and application to China's transitional context	2001
6	Hekkert M.P., Negro S.O.	Functions of innovation systems as a framework to understand sustainable technological change: Empirical evidence for earlier claims	2009
7	Weber K.M., Rohracher H.	Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework	2012
8	Cozzens, S., & Sutz, J.	Innovation in informal settings: Reflections and proposals for a research agenda.	2012
9	Wieczorek A.J., Hekkert M.P.	Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars	2012

10	Chaminade, C., Lundvall, B. Å., Vang, J., & Joseph, K. J.	Designing innovation policies for development: towards a systemic experimentation-based approach	2009
11	Negro S.O., Hekkert M.P., Smits R.E.	Explaining the failure of the Dutch innovation system for biomass digestion-A functional analysis	2007
12	Chang P.-L., Shih H.-Y.	The innovation systems of Taiwan and China: A comparative analysis	2004
13	Edquist C.	Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures)	2011
14	van Mierlo B., Leeuwis C., Smits R., Woolthuis R.K.	Learning towards system innovation: Evaluating a systemic instrument	2010
15	Musiolik J., Markard J., Hekkert M.	Networks and network resources in technological innovation systems: Towards a conceptual framework for system building	2012
16	Lee T.-L., Von Tunzelmann N.	A dynamic analytic approach to national innovation systems: The IC industry in Taiwan	2005
17	McKelvey, M., & Orsenigo, L.	Pharmaceuticals as a Sectoral Innovation System	2001
18	Foster C., Heeks R.	Conceptualising inclusive innovation: Modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers	2013
19	Lundvall, B. Å., Vang, J., Joseph, K. J., & Chaminade, C.	Bridging innovation system research and development studies: challenges and research opportunities	2009
20	Chen K., Guan J.	Measuring the efficiency of China's regional Innovation systems: Application of network data envelopment analysis (DEA)	2012
21	Soni P., & T. Krishnan, R.	Frugal innovation: aligning theory, practice, and public policy.	2014

22	Schut M., Klerkx L., Rodenburg J., Kayeke J., Hinnou L.C., Raboanarielina C.M., Adegbola P.Y., van Ast A., Bastiaans L.	RAAIS: Rapid Appraisal of Agricultural Innovation Systems (Part I). A diagnostic tool for integrated analysis of complex problems and innovation capacity	2015
23	Hillman K., Nilsson M., Rickne A., Magnusson T.	Fostering sustainable technologies: A framework for analysing the governance of innovation systems	2011
24	M Iizuka	Innovation systems framework: still useful in the new global context?	2013
25	Kauffeld-Monz M., Fritsch M.	Who Are the Knowledge Brokers in Regional Systems of Innovation? A Multi-Actor Network Analysis	2010
26	Nasierowski W., Arcelus F.J.	Interrelationships among the elements of national innovation systems: a statistical evaluation	1999
27	Lamprinopoulou C., Renwick A., Klerkx L., Hermans F., Roep D.	Application of an integrated systemic framework for analysing agricultural innovation systems and informing innovation policies: Comparing the Dutch and Scottish agrifood sectors	2014
28	Lee P.-C., Su H.-N.	Investigating the structure of regional innovation system research through keyword co-occurrence and social network analysis	2010
29	Altenburg T	Building inclusive innovation systems in developing countries-why it is necessary to rethink the policy agenda.	2008
30	Köhler J., Schade W., Leduc G., Wiesenthal T., Schade B., Espinoza L.T.	Leaving fossil fuels behind? An innovation system analysis of low carbon cars	2013

31	Lei X.-P., Zhao Z.-Y., Zhang X., Chen D.-Z., Huang M.-H., Zhao Y.-H.	The inventive activities and collaboration pattern of university-industry-government in China based on patent analysis	2012
32	Szogs, A., Cummings, A., & Chaminade, C.	Building systems of innovation in less developed countries: the role of intermediate organisations	2011
33	Reichardt K., Negro S.O., Rogge K.S., Hekkert M.P.	Analyzing interdependencies between policy mixes and technological innovation systems: The case of offshore wind in Germany	2016
34	Vasseur V., Kamp L.M., Negro S.O.	A comparative analysis of Photovoltaic Technological Innovation Systems including international dimensions: The cases of Japan and the Netherlands	2013
35	Markard J., Hekkert M., Jacobsson S.	The technological innovation systems framework: Response to six criticisms	2015
36	Zhang J., Liang X.-J.	Promoting green ICT in China: A framework based on innovation system approaches	2012
37	Daka, E., & Toivanen, H.	Innovation, the informal economy and development: The case of Zambia.	2014
38	Joseph, K. J., Das, K., Kurian, N., & Vivekanandan, J.	Institutions and innovation systems: Understanding exclusion in India.	2010
39	Arora S., Romijn H.A., Caniëls M.C.J.	Governed by history: Institutional analysis of a contested biofuel innovation system in Tanzania	2014
40	Pansera, M., & Owen, R.	Framing inclusive innovation within the discourse of development: Insights from case studies in India.	2018
41	Grobbelaar, S., Tijssen, R., & Dijksterhuis, M.	University-driven inclusive innovations in the Western Cape of South Africa: Towards a research framework of innovation regimes.	2017

42	Sonne, L	Innovation in Finance to Finance Innovation: Supporting pro-poor entrepreneur-based innovation	2011
43	van der Hilst, B. J. G.	Inclusive Innovation Systems: How Innovation Intermediaries can Strengthen the Innovation System	2012
44	Adolwa I.S., Schwarze S., Bellwood-Howard I., Schareika N., Buerkert A.	A comparative analysis of agricultural knowledge and innovation systems in Kenya and Ghana: sustainable agricultural intensification in the rural–urban interface	2017
45	Grobbelaar S.S.S., Gwynne-Evans N., Brent A.C.	From enterprise development to inclusive innovation - A systemic instruments framework for regional innovation support	2016
46	Botha L., Grobbelaar S., Bam W.	Towards a framework to guide the evaluation of inclusive innovation systems	2017
47	Botha, L.	The evaluation of innovation for inclusive development projects	2017
48	Daniels, C. U., Ustyuzhantseva, O., & Yao, W.	Innovation for inclusive development, public policy support and triple helix: perspectives from BRICS	2017
49	Van Der Merwe E., Grobbelaar S.S.S.	Evaluating inclusive innovative performance: The case of the eHealth system of the Western Cape Region, South Africa	2016
50	de Paiva Britto, J. N. and and Marco Antonio Vargas	A systemic innovation policy with an inclusive perspective: the evolution of the Brazilian policy to the pharmaceutical sector.	2015
51	Chinseu, Edna L; Dougill, Andrew J; Stringer, Lindsay C	Strengthening Conservation Agriculture innovation systems in sub-Saharan Africa: lessons from a stakeholder analysis	2021
52	Mohammad Esmailzadeh, Siamak Noori, Alireza Aliahmadi, Hamidreza	A Functional Analysis of Technological Innovation Systems in Developing Countries: An Evaluation of Iran’s Photovoltaic Innovation System	2020

	Nouralizadeh and Marcel Bogers		
53	Hornum, Sebastian Toft and Bolwig, Simon	A functional analysis of the role of input suppliers in an agricultural innovation system: The case of small-scale irrigation in Kenya	2021
54	Wandera, Faith Hamala	The innovation system for diffusion of small wind in Kenya: Strong, weak or absent? A technological innovation system analysis	2020
55	Aluko, Yetude A; Okuwa, Oluwakemi	Innovation for inclusive development among specialized universities: the case of a community-based farming scheme in FUNAAB	2018
56	Botha L., Grobbelaar S., Bam W.	Developing an evaluation framework for university-driven technology-based, innovation for inclusive development (UTI4ID) projects	2019
57	Sara S Grobbelaar and Mauricio Uriona-Maldonado	Using technology to improve access to healthcare: The case of the MomConnect programme in South Africa	2019
58	Berno Maarsingh, Sara S. Grobbelaar, Mauricio Uriona-Maldonado and Marlien Herselman	Exploring functional dynamics of innovation for inclusive development: event history analysis of an ICT4D project	2021
59	Edward van der Merwe & Sara S (Saartjie) Grobbelaar	Systemic policy instruments for inclusive innovation systems: Case study of a maternal mHealth project in South Africa	2018
60	Edward van der Merwe, Sara Grobbelaar & Wouter Bam	Exploring the functional dynamics of innovation for inclusive development innovation systems: a case study of a large scale maternal mHealth project in South Africa	2019

APPENDIX B: SAMPLE GES FARMERS' REGISTRATION FORM



FEDERAL REPUBLIC OF NIGERIA Federal Ministry of Agriculture and Rural Development FARMERS REGISTRATION

INSTRUCTIONS: Write in CAPITAL LETTERS. Write each letter or figure in a separate box, before marking. Use HB pencil ONLY and mark like this

1 FARMER'S NAME (write SURNAME first, leave a blank space, then write the FIRST NAME, space then the middle initials)																									
(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)	(B)
(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
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(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)	(H)
(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)	(I)
(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)	(J)
(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)	(K)
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(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)	(Q)
(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)
(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)
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(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)	(Y)
(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)	(Z)

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3 FARMER AGE
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4 EDUCATIONAL LEVEL
MARK ONE ONLY
Primary <input type="checkbox"/>
Secondary <input type="checkbox"/>
Tertiary <input type="checkbox"/>
Other <input type="checkbox"/>
None <input type="checkbox"/>

5 FARM SIZE (Hectare)
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2-3 <input type="checkbox"/>
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7-8 <input type="checkbox"/>
8-9 <input type="checkbox"/>
9-10 <input type="checkbox"/>

6 LANGUAGE OPTION
MARK ONE ONLY
Hausa <input type="checkbox"/>
Igbo <input type="checkbox"/>
Yoruba <input type="checkbox"/>
Efik <input type="checkbox"/>
Pidgin <input type="checkbox"/>
Kanuri <input type="checkbox"/>
Ibibio <input type="checkbox"/>
English <input type="checkbox"/>
Arabic script (ajami) <input type="checkbox"/>
Other <input type="checkbox"/>



7 DO YOU HAVE A PHONE?
Farmer's Phone Number
Yes <input type="checkbox"/>
No <input type="checkbox"/>
If Yes, write and shade your phone number in the box on the right
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8 MARK WHAT YOU GROW/REAR		
In the column for your primary activity (P), mark ONE box only. In the column for your secondary activity (S), mark a maximum of TWO boxes		
CROPS	LIVESTOCK	FISHERIES
Maize <input type="checkbox"/> P <input type="checkbox"/> S	Cattle <input type="checkbox"/> P <input type="checkbox"/> S	Cattfish <input type="checkbox"/> P <input type="checkbox"/> S
Cocoa <input type="checkbox"/>	Sheep <input type="checkbox"/>	Shrimps <input type="checkbox"/>
Rice <input type="checkbox"/>	Goats <input type="checkbox"/>	Tilapia <input type="checkbox"/>
Sorghum <input type="checkbox"/>	Pigs <input type="checkbox"/>	Tarpon <input type="checkbox"/>
Cotton <input type="checkbox"/>	Rabbits <input type="checkbox"/>	Heterotis <input type="checkbox"/>
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Citrus <input type="checkbox"/>	Broiler <input type="checkbox"/>	
Cassava <input type="checkbox"/>	Layer <input type="checkbox"/>	
Yam <input type="checkbox"/>	Turkey <input type="checkbox"/>	Aquaculture <input type="checkbox"/>
Sweet Potato <input type="checkbox"/>	Quails <input type="checkbox"/>	
Ginger <input type="checkbox"/>	Ducks <input type="checkbox"/>	
Sugar Cane <input type="checkbox"/>	Other <input type="checkbox"/>	
Other <input type="checkbox"/>		Artisanal <input type="checkbox"/>

9 FARMER IDENTIFICATION DOCUMENT	
Type of ID	ID Number
National ID <input type="checkbox"/>	<input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9
Driver's License <input type="checkbox"/>	<input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9
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GENERAL INFORMATION																																																													
<p>10 DO YOU HAVE A BANK ACCOUNT?</p> <p>Do you have a bank account? Yes <input type="checkbox"/> No <input type="checkbox"/></p> <p>If Yes, who with?</p> <table style="width: 100%; border: none;"> <tr> <td>Access <input type="checkbox"/></td> <td>GTB <input type="checkbox"/></td> <td>Union <input type="checkbox"/></td> </tr> <tr> <td>Bank of Agric <input type="checkbox"/></td> <td>Jaiz Inter <input type="checkbox"/></td> <td>UBA <input type="checkbox"/></td> </tr> <tr> <td>Citi <input type="checkbox"/></td> <td>Keystone <input type="checkbox"/></td> <td>WEMA <input type="checkbox"/></td> </tr> <tr> <td>Diamond <input type="checkbox"/></td> <td>Mainstreet <input type="checkbox"/></td> <td>Zenith <input type="checkbox"/></td> </tr> <tr> <td>Eco <input type="checkbox"/></td> <td>Stanbic IBTC <input type="checkbox"/></td> <td>Other <input type="checkbox"/></td> </tr> <tr> <td>Enterprise <input type="checkbox"/></td> <td>Sterling <input type="checkbox"/></td> <td></td> </tr> <tr> <td>Fidelity <input type="checkbox"/></td> <td>Standard Chartered <input type="checkbox"/></td> <td></td> </tr> <tr> <td>First Bank <input type="checkbox"/></td> <td>Skye <input type="checkbox"/></td> <td></td> </tr> <tr> <td>FCMB <input type="checkbox"/></td> <td>Unity <input type="checkbox"/></td> <td></td> </tr> </table>	Access <input type="checkbox"/>	GTB <input type="checkbox"/>	Union <input type="checkbox"/>	Bank of Agric <input type="checkbox"/>	Jaiz Inter <input type="checkbox"/>	UBA <input type="checkbox"/>	Citi <input type="checkbox"/>	Keystone <input type="checkbox"/>	WEMA <input type="checkbox"/>	Diamond <input type="checkbox"/>	Mainstreet <input type="checkbox"/>	Zenith <input type="checkbox"/>	Eco <input type="checkbox"/>	Stanbic IBTC <input type="checkbox"/>	Other <input type="checkbox"/>	Enterprise <input type="checkbox"/>	Sterling <input type="checkbox"/>		Fidelity <input type="checkbox"/>	Standard Chartered <input type="checkbox"/>		First Bank <input type="checkbox"/>	Skye <input type="checkbox"/>		FCMB <input type="checkbox"/>	Unity <input type="checkbox"/>		<p>11 ARE YOU A MEMBER OF A GROUP?</p> <p>Farmer cooperative <input type="checkbox"/></p> <p>Marketing cooperative <input type="checkbox"/></p> <p>Farmers Organization <input type="checkbox"/></p> <p>Other <input type="checkbox"/></p>	<p>12 WHAT IS THE WARD OF OPERATION?</p> <p>Write the name in the box below and shade the code in the box on the right</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 80%;"></td> <td style="width: 5%; text-align: center;">c0</td> <td style="width: 5%; text-align: center;">c1</td> <td style="width: 5%; text-align: center;">c2</td> </tr> <tr> <td></td> <td style="text-align: center;">c1</td> <td style="text-align: center;">c2</td> <td style="text-align: center;">c3</td> </tr> <tr> <td></td> <td style="text-align: center;">c2</td> <td style="text-align: center;">c3</td> <td style="text-align: center;">c4</td> </tr> <tr> <td></td> <td style="text-align: center;">c3</td> <td style="text-align: center;">c4</td> <td style="text-align: center;">c5</td> </tr> <tr> <td></td> <td style="text-align: center;">c4</td> <td style="text-align: center;">c5</td> <td style="text-align: center;">c6</td> </tr> <tr> <td></td> <td style="text-align: center;">c5</td> <td style="text-align: center;">c6</td> <td style="text-align: center;">c7</td> </tr> <tr> <td></td> <td style="text-align: center;">c6</td> <td style="text-align: center;">c7</td> <td style="text-align: center;">c8</td> </tr> <tr> <td></td> <td style="text-align: center;">c7</td> <td style="text-align: center;">c8</td> <td style="text-align: center;">c9</td> </tr> </table>		c0	c1	c2		c1	c2	c3		c2	c3	c4		c3	c4	c5		c4	c5	c6		c5	c6	c7		c6	c7	c8		c7	c8	c9
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<p>13 HAVE YOU EVER USED?</p> <p>Fertilizer <input type="checkbox"/></p> <p>Improved seeds <input type="checkbox"/></p> <p>Fish Feed <input type="checkbox"/></p> <p>Animal Feed <input type="checkbox"/></p> <p>Livestock Feed <input type="checkbox"/></p> <p>Others <input type="checkbox"/></p>	<p>14 GES RECEIVED LAST YEAR</p> <p>Yes <input type="checkbox"/></p> <p>No <input type="checkbox"/></p>	<p>15 YOU ARE PRODUCING FOR</p> <p>Sale <input type="checkbox"/></p> <p>Consumption <input type="checkbox"/></p> <p>Both <input type="checkbox"/></p>	<p>16 HOW DID YOU KNOW WHERE TO SELL YOUR PRODUCTS?</p> <p>Friend <input type="checkbox"/></p> <p>Fellow Farmer <input type="checkbox"/></p> <p>Cooperative <input type="checkbox"/></p> <p>Cooperative Agent <input type="checkbox"/></p> <p>Others <input type="checkbox"/></p>																																																										
<p>17 FOR SPECIAL COMMENTS (WRITE IN BLOCK LETTERS)</p> <div style="border: 1px solid black; height: 20px;"></div>																																																													
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<p style="text-align: center;">20 ATTESTATION</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 33%;">FARMER: Name:</td> <td style="width: 33%;">Signature/Thumbprint:</td> <td style="width: 33%;">Date:</td> </tr> <tr> <td>ENUMERATOR: Name:</td> <td>Phone No.:</td> <td>Signature: Date:</td> </tr> <tr> <td>SUPERVISOR: Name:</td> <td>Phone No.:</td> <td>Signature: Date:</td> </tr> </table>				FARMER: Name:	Signature/Thumbprint:	Date:	ENUMERATOR: Name:	Phone No.:	Signature: Date:	SUPERVISOR: Name:	Phone No.:	Signature: Date:																																																	
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APPENDIX C: SAMPLE INTERVIEW GUIDE



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvenoot • your knowledge partner

STELLENBOSCH UNIVERSITY CONSENT TO PARTICIPATE IN RESEARCH

Dear Manager,

My name is David Adeyeye, and I am a doctoral candidate at the Centre for Research on Evaluation, Science and Technology (CREST), Stellenbosch University, South Africa. I want to invite you to participate in a research project entitled, **“Evaluating Inclusive Innovation System Performance: A Study of the Nigerian Agricultural Innovation System.”**

The study's objective is to investigate innovations' performance for inclusive development. To actualise this, this study uses the Growth Enhancement Support (GES) programme in Nigeria's agricultural system as a case. I will be interviewing the stakeholders who participated in the development and utilisation of the programme in Nigeria. As a critical actor in the programme, I will seek your opinion on your role, benefits, drivers and barriers to implementing the system in Nigeria.

To comply with covid-19 regulations, the interview will be conducted on the telephone using an interview guide. To have a full transcript of the session, I will seek your approval to record the discussion. The interview will take a maximum of thirty minutes. Please, note that your participation is entirely voluntary, and you are free to decline participation. The data collected will be used strictly for research purposes; hence, the interview will be undertaken in confidence, and your identity and any information shared during the interview will be kept private. Also, note that the research is conducted by a research student, and in line with ethical policies, you will not be paid for participating in the interview.

The data from this study will be stored and will likely be presented at conferences and published in journals and theses under strict confidentiality and anonymity research ethics.

If you have any questions or concerns about the research, please get in touch with me through davidadeyeye@gmail.com or +234 8034406502 or my supervisor, Prof S. Grobbelaar through ssgrobbelaar@sun.ac.za or +27 825768123.

RIGHTS OF RESEARCH PARTICIPANTS: You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; (+27) 21 808 4622] at the Division for Research Development.

You have the right to receive a copy of the Information and Consent form.

Do you have any questions?

Do you agree to participate voluntarily in this interview?

If Yes (continue with the interview)

If No (end of interview)

INTERVIEW GUIDE FOR INPUT SUPPLIERS AND AGRO-DEALERS

1. What was your responsibility under the GES programme?
2. What was the role of your organisation under the programme?
3. How did your business enterprise enlist in the programme? Did you require any license? What were the requirements?
4. What kind of inputs did you supply under the programme?
5. What was your organisation's relationship with other actors in the programme? Was there any formal contract with the other actors?
6. Was there any issue of distrust at the inception of the programme? How did you overcome it?
7. How did your business finance its operations under the GES?
8. How easy or fast was it to scale your operations under the GES programme?
9. What kind of incentives did your organisation enjoy from the government or any other local or international partner(s) during the implementation of the programme?
10. How easy could suggestions or feedback from farmers, agro-dealers, or other actors be integrated into the GES to improve its performance?
11. What did your association (WAIDA) play under the programme?
12. What can you say were the main benefits of the GES programme?
 - a. to your organisation
 - b. smallholder farmers
 - c. other stakeholders and
 - d. the country at large

13. What were the main challenges encountered during the implementation of the GES?
- a. Resource mobilisation
 - b. Market access
 - c. Infrastructure
 - d. Collaboration with other actors
 - e. Others

THANK YOU

APPENDIX D: ETHICAL CLEARANCE FORM



CONDITIONAL APPROVAL GRANTED

REC: Social, Behavioural and Education Research (SBER) - Initial Application Form

26 June 2020

Project number: CREST-2020-15381

Project title: Evaluating inclusive innovation system performance: a study of the Nigerian agricultural innovation system

Dear Mr Adedamola Adeyeye

Your REC: Social, Behavioural and Education Research (SBER) - Initial Application Form submitted on 13 June 2020 was reviewed by the REC: Humanities and approved with certain conditions.

This conditional approval means that the researcher may proceed with the envisaged research provided that they respond or adhere to the stipulations/conditions.

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
26 June 2020	25 June 2023

REC STIPULATIONS/CONDITIONS:

1) The researcher is requested to get formal permission from the Department of Agriculture to conduct interviews with its officials. [ACTION REQUIRED]

HOW TO RESPOND:

Some of these stipulations/conditions may require your response. Where a response is required, you must respond to the REC within **three (3)** months of the date of this letter. Your conditional approval will lapse automatically should your response not be received by the REC within 3 months of the date of this letter.

For instructions on how to respond to these stipulations, please download the FAQ on how to edit your application and follow the steps carefully: [HOW TO RESPOND TO REC FEEDBACK](#).

Where revision to supporting documents is required, please ensure that you replace all outdated documents on your application form with the revised versions.

INVESTIGATOR RESPONSIBILITIES

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.

Please use your SU project number (15381) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

Document Type	File Name	Date	Version
Budget	PhD Study budget_Ethics review	01/05/2020	3
Investigator CV (PI)	Short CV template_REC application_18784186	04/05/2020	1
Non-disclosure agreement	NDA - INTERNAL - FIELDWORKERS_18784186	11/05/2020	
Data collection tool	PhD Interview guide_2	18/05/2020	
Informed Consent Form	SU HUMANITIES Consent template_Verbal_agro-dealer_18784186	12/06/2020	
Informed Consent Form	SU HUMANITIES Consent template_Verbal_farmer_18784186	12/06/2020	
Informed Consent Form	SU HUMANITIES Consent template_Verbal_intermediary_18784186	12/06/2020	
Informed Consent Form	SU HUMANITIES Consent template_Verbal_policymaker_18784186	12/06/2020	
Research Protocol/Proposal	PhD Proposal_Ethics Application_Reviewed	13/06/2020	2
Default	Response letter_Ethics Application_18784186	13/06/2020	

If you have any questions regarding this application or the conditions set, please contact the REC Secretariat at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

Secretariat: Research Ethics Committee: Social, Behavioural and Education Research (REC: SBE)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.

The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.