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## ARTICLE

# Digital innovations and institutional barriers in agricultural input subsidy programmes in sub-Saharan Africa: Evidence from Nigeria

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## Abstract

**Motivation:** Agricultural input subsidy programmes are crucial for improving agricultural productivity in sub-Saharan Africa (SSA). However, there is little empirical evidence on how second-generation input subsidy programmes (SISPs) based on information and communication technology (ICT) are implemented and the institutional challenges that undermine their effectiveness.

**Purpose:** This article assesses the implementation of ICT-based SISPs and their challenges in SSA using the Nigerian e-wallet input subsidy programme as a case study. We draw on a conceptual framework that integrates the national innovation system (NIS), contingency theory, and new institutional economics.

**Approach and methods:** We analysed expert interviews and participatory qualitative data from Process Net-Maps and focus group discussions (FGDs) using content and Process Net-Map analyses.

**Findings:** The results show that over 20 public, private and community actors were involved in implementing the e-wallet SISP across five stages. The programme increased private-sector participation, reduced corruption, improved recipient targeting, and speeded up input delivery compared to first-generation input programmes. However, weak institutional arrangements (such as poor funding, restricted

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institutional collaborations, and stakeholder capability gaps) undermined the innovation aspect of the e-wallet SISP. The programme also faced five main challenges: policy inconsistency, poor information flow and weak reporting, moral hazards such as “round-tripping,” input leakage and diversion, and elite capture. The study concludes that institutional constraints, rigid organizational structures, and a narrow focus on solving first-generation programme challenges limited the ability of actors to adapt to new and evolving challenges.

**Policy implications:** Effective SISPs and input policies require supportive institutional environments that allow actors from all sectors to function effectively. Programmes should thus be designed and managed with flexible and organic structures that foster collaboration among private, public, and community stakeholders. Continuous, stage-specific evaluations and smart governance tools, such as real-time mobile data collection and buy-back initiatives, can strengthen monitoring, input tracking, accountability, and input use incentives.

#### KEYWORDS

Africa, agricultural inputs, e-wallet growth enhancement support scheme (GESS), input subsidy programme, institutional challenges, Nigeria, Process Net-Maps

## 1 | INTRODUCTION

Agricultural subsidy programmes are crucial to increasing productivity and reducing poverty among small-scale farmers in sub-Saharan Africa (SSA) (Jayne et al., 2018; Jayne & Rashid, 2013; Kos et al., 2023; Ngoma et al., 2021; Pan & Christiaensen, 2012). In the early 1970s, first-generation input subsidy programmes (FISPs) were introduced across SSA to overcome failures in input markets and meet a wide range of economic, social and political objectives (Liverpool-Tasie & Takeshima, 2013; Wiggins & Brooks, 2012). These programmes relied on the public sector to procure and distribute subsidized agricultural inputs, such as fertilizer and seeds, to small-scale farmers. However, FISPs proved largely ineffective. In Nigeria, over 50% of distributed inputs failed to reach the intended farmers (Liverpool-Tasie & Takeshima, 2013), while 30%–40% of inputs were illegally diverted in Zambia and Malawi (Jayne & Rashid, 2013). The programmes faced costly and burdensome administrative processes, widespread diversion and leakages, and lengthy bureaucratic tendering processes that delayed input delivery (Jayne et al., 2013; Liverpool-Tasie, 2014a; Wiggins & Brooks, 2012).

By 2010, following Malawi's success, Nigeria and eight other African countries introduced “market smart” input subsidy programmes (ISPs).<sup>1</sup> These second-generation ISPs (SISPs) were designed to promote private-sector

<sup>1</sup>To be “market smart,” ISPs must promote private-sector growth, appropriately target beneficiaries not yet using modern inputs but who could benefit from them, be part of a broader strategy encouraging complementary inputs and markets strengthening, have a clear exit strategy, and promote free entry and competition among actors (Jayne et al., 2018; Jayne & Rashid, 2013; Pan & Christiaensen, 2012).

involvement and address FISP failures. Unlike the state-controlled FISP, SISP was jointly financed and implemented by the federal government and interested states through counterpart financing (Jayne et al., 2018; Wossen et al., 2017), with local communities involved in targeting and distribution. Input vouchers were introduced to better target beneficiaries, attract private agro-dealers, and improve efficiency in public procurement, coordination, and distribution (Jayne et al., 2013).<sup>2</sup> Some countries also introduced an ecosystem involving information and communication technologies (ICT) into SISPs to ease bottlenecks in input targeting and delivery (Kijima, 2022).

The Nigerian growth enhancement support scheme (GESS) is an ICT-based SISP (Benjamin et al., 2021; Wossen et al., 2017), established between 2012 and 2015, to offer small-scale farmers low-cost fertilizers and other inputs (such as seeds). The scheme uses a unique design that incorporates new ways for input development, procurement, and distribution. It also introduces an electronic voucher system (e-wallet) for “smart targeting” of recipients and input delivery.<sup>3</sup> Fifteen states (12 maize producing states) participated in the GESS (Liverpool-Tasie et al., 2017), making it a major agricultural policy that spanned all government levels and regions of Nigeria. Additionally, it signifies an example of a strengthened, nationally scalable SISP similar to other African SISPs (Liverpool-Tasie, 2014a; Liverpool-Tasie & Takeshima, 2013). However, the scheme was also deemed inadequate due to the challenges posed by institutional and political failures, necessitating a thorough analysis to advise policy-makers on the best course of action (Kijima, 2022; Liverpool-Tasie, 2014b; Tiri et al., 2015).

In response, Nigeria switched to the Presidential Fertiliser Initiative (PFI) in 2015. This reduced the government's role in input procurement and distribution, resulting in subsidy removal and support for private-led input market development. However, the ICT-based ISP still supports other safety net programmes such as social cash transfers (Faith et al., 2024; Garcia & Moore, 2012). For example, direct social cash transfers rely on ICT-based ISP data for farmers' background and contact information. Despite the growing importance of ICT, its role in ISPs and other development programmes remains unclear. Specifically, how the ICT-based SISP was implemented is poorly understood, as are the value (or challenges) ICT offers for SISP management and whether the ICT-based SISP has been successful in reducing bottlenecks and improving farmers' access to modern technologies in SSA.

Several studies have evaluated ISPs in SSA (Liverpool-Tasie, 2014b; Liverpool-Tasie et al., 2017; Mason et al., 2013; Olomola, 2015; Takeshima & Liverpool-Tasie, 2015). However, research on the implementation of ICT-based SISPs remains limited. Most studies focus on the impact of ISPs, particularly the Nigerian Growth Enhancement Scheme. Wossen et al. (2017) analysed the productivity and welfare effects of e-voucher-based ISPs in Nigeria, while Benjamin et al. (2021) examined their impact on different extension service delivery systems. Useful studies by Olomola (2015) and Michael et al. (2018) assessed the scheme's performance and challenges but mainly used data from a few key implementors and secondary sources. Their studies did not comprehensively assess and map the full range of actors, their interactions, or the specific steps involved in implementing the scheme—from policy design through innovation development to delivery. Jayne et al. (2013) emphasize the need to better understand the programme's design, its implementation process, and the challenges encountered during input production, distribution, and delivery phases.

Similarly, the role of ICT in SISP, especially in the design, implementation, and impact evaluation of the scheme, is still poorly understood. This is important, as the current evidence on SISP effectiveness and its impact on agricultural productivity in SSA remains mixed (Kijima, 2022; Ngoma et al., 2021; Wossen et al., 2017).<sup>4</sup> The lack of

<sup>2</sup>Since few African countries produce modern and finished inputs such as agrochemicals and fertilizers, private agro-dealers participate in the input market by either importing finished products or raw materials that are later blended locally. Thus, most private agro-dealers participate at the midstream as local retailers who sell inputs to beneficiaries at government-approved depots and subsidized rates.

<sup>3</sup>A larger proportion of the input subsidy budget was earmarked for fertilizer, making it the country's main subsidized agricultural input (Jayne et al., 2013; Jayne & Rashid, 2013; Liverpool-Tasie & Takeshima, 2013).

<sup>4</sup>Some view the ICT-based SISP as marginally cost-effective and capable of improving targeting and boosting agricultural productivity (Benjamin et al., 2021; Jayne et al., 2018; Wossen et al., 2017). Others find them ineffective due to challenges like elite capture and political targeting (Jayne et al., 2013; Jayne et al., 2018; Pan & Christiaensen, 2012; Takeshima & Liverpool-Tasie, 2015).

clarity regarding specific ICT roles, where bottlenecks occur in the scheme, and how they affect SISP implementation and outcomes, calls for further research. Hence, insights from this study will be crucial for designing ICT-based developmental programmes, which are increasingly common in Nigeria and other SSA countries (Akpan-Obong et al., 2023; Garcia & Moore, 2012; Olumekor et al., 2025).

This study addresses the knowledge gap by assessing the implementation process and challenges of the ICT-based SISP in SSA. Using the case of the Nigerian e-wallet SISP, we ask four key questions: How was the e-wallet SISP implemented? What did new technologies mean for programme management? What opportunities and challenges arose, and who benefited from these challenges?

The study makes three contributions to the ISP literature in SSA. First, we apply the NIS framework (Lundvall, 1999, 2007) to identify the full range of stakeholders and organizational structures involved in the development, procurement and distribution of modern agricultural inputs through Nigeria's ISPs. The NIS framework offers a holistic lens for identifying and mapping the full range of innovation actors and their interactions, fostering a comprehensive understanding of the innovation process that is lacking in previous studies (Michael et al., 2018; Olomola, 2015).

Second, unlike earlier studies (Michael et al., 2018; Olomola, 2015), we use the Process Net-Map approach to present a detailed account of how an ICT-based SISP was implemented. This allows us to clearly track the policy design and the steps taken in developing, procuring, distributing, and using innovations such as fertilizers and hybrid seeds in the e-wallet SISP. To our knowledge, this is the first study to fully document e-wallet SISP implementation in SSA.

Third, we outline and discuss the implications of ICT incorporation for the programme's management and phase-specific challenges that impede effective implementation of the e-wallet SISP. Building on Chelliah et al. (2016), we employ contingency theory (Lawrence & Lorsch, 1967) to identify key bottlenecks that restricted SISP implementation and examine how the actors identified from various organizational structures overcame these challenges to ensure successful implementation and benefit realization of the programme. Existing research notes some challenges but does not link them directly to where they emerge in the implementation process.

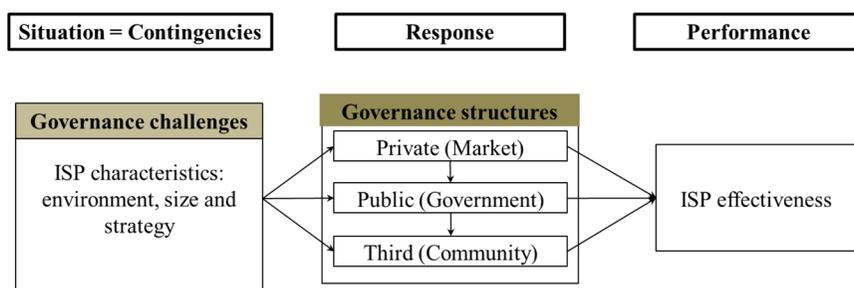
This article presents the conceptual framework and literature review on the typical challenges faced by ISPs in Section 2. It describes the research methodology in Section 3 and presents the results and discussion in Sections 4 and 5, respectively. The study ends with the conclusion and policy recommendations in Section 6.

## 2 | CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

### 2.1 | Theoretical framework

The study is premised on the NIS and contingency theory (see Figure 1). NIS provides a holistic framework for identifying, mapping, and assessing how stakeholders interact within a system (Lundvall, 1999). It employs a chainlike model to capture the interplay among actors from various subsystems (e.g., public, private, and community sectors). NIS emphasizes the economic structure by depicting what the key sectors, organizations, and institutions are and how they interact to create, diffuse, and utilize innovations. It also highlights institutional environments as the foundation of an innovative system. Meanwhile, knowledge, information, and the learning process are regarded as the main resources driving successful innovative processes (Lundvall, 2007). We leverage these elements to identify key stakeholders in the ICT-based SISP and assess how they interact, learn, and transmit knowledge to ensure effective implementation.

Following Lundvall (2007), we implemented the NIS in four steps. First, we identified the key stakeholders involved in designing and implementing the ICT-based SISP. Second, we assessed their roles and competencies in developing innovations, such as new seed varieties and ICT-based input distribution methods. Here, we



**FIGURE 1** Conceptual framework based on national innovation system and contingency theory. *Source:* The authors.

analysed the institutional environment by examining laws and regulations that guide stakeholders' behaviour and influence along the SISP (Adetoyinbo et al., 2022; Röling, 2016). Third, we used Process Net-Map to visualize how stakeholders interact from input development to delivery, revealing potential rivalry and cooperation. At this stage, we also examined institutional and political arrangements that shape policy design and implementation, alongside the influence of stakeholders in the success of SISP. Finally, we assessed the organizational structures to which stakeholders belong (e.g., public, private, and community sectors). This analysis clarifies which subsystems are critical to producing or procuring, subsidizing and innovatively delivering modern agricultural inputs through ICT to end users.<sup>5</sup>

However, the NIS framework only helps to identify stakeholders and explain their interactions. It lacks the necessary flexibility to fully capture the challenges stakeholders from different sectors face and how they adjust to address them or leverage these challenges. To address this gap, we apply contingency theory (CT) (Lawrence & Lorsch, 1967). CT holds that organizational effectiveness arises when systems, structures, and processes align with contingencies (see Chelliah et al., 2016, for CT application to institutional challenges). Contingencies, hereafter referred to as ISP challenges, are external conditions beyond organizational (or managerial) control that influence activities and performance (Donaldson, 2001). Organizational theory highlights three main contingencies: the *environment* (where organizations operate and tasks are performed), *strategy* (nature of tasks managed), and *size*. The CT framework centres on three dimensions: *situation* (external conditions such as ISP challenges—further described in Section 2.2), *response* (organizational adjustments that stakeholders make to address these challenges or leverage opportunities, and *performance* (outcomes of SISP implementation) (Lawrence & Lorsch, 1967). [Figure 1](#) presents the final conceptual framework, showing that ISP challenges trigger reactions from interconnected stakeholders across governance structures identified through the NIS. These reactions then determine ISP effectiveness.

## 2.2 | Organizational challenges in input subsidy programmes

The ISPs involve three types of organizational structure ([Figure 1](#)): government (state), private (market), and third (community-based) sectors, each with its idiosyncratic challenges. While state and market sectors dominate, the third or community sector, which includes non-governmental organizations (NGOs) and farmer groups, intervenes when public and private sectors fail to effectively implement ISPs. Using a new institutional economics perspective and an extensive review of the literature, we present a summary of the challenges faced by each sector in [Table 1](#).

<sup>5</sup>Understanding ICT innovation adoption is vital. However, as this is not the focus of this study, readers should refer to the review by Ayim et al. (2022) for more details.

TABLE 1 Overview of organizational challenges in ISPs.

Sectors	Reasons for organizational challenges	Organizational challenges	Effects	References
Market failure (Private sector)	Nature of the market, goods, and exchange	Externalities	ISP drives the adoption and application of agricultural inputs and leads to higher demand and positive externalities (e.g., improved soil fertility, higher farm yields, and improved food security) that overwhelm private markets. Conversely, negative externalities, such as pollution/acidification and loss of arable land, can result in a reduction in demand for agricultural inputs and economic viability for private actors.	(Adetoyinbo et al., 2022; Birner et al., 2010; Chinsinga & Poulton, 2014; Chirwa & Dorward, 2013; Holden, 2019; Liverpool-Tasie, 2014b; Liverpool-Tasie et al., 2017; Liverpool-Tasie & Takeshima, 2013; Pan & Christiaensen, 2012; Steiner & Atterton, 2015; Wossen et al., 2017)
		Exclusion	The geographical marginalization of rural farmers and the lack of accurate data can lead to ambiguity in market supply and demand. In addition, unprofitable investments and skewed targeting of beneficiaries may arise due to the presence of geographically distant recipients and higher transportation and transaction costs.	
		Political instrument	Since ISPs are seen as political instruments, governments are incentivized to participate in input markets. This makes upscaling, downscaling, and exiting of ISPs difficult. Government intervention can encourage rent seeking, farmers' strong preference for cheap subsidized inputs, and political manipulation, undermining the functioning of input market systems.	
		Long learning process	At the initial stage, input demand is lower because expected benefits and initial returns are low. However, as agricultural inputs become affordable and farmers are exposed to their use and efficiency, farmers can be induced to participate in the private input market and demand higher subsidized inputs beyond the supply capacity of the private sector.	
		Oligopolistic input market	Farmers rely on a few agro-dealers in an oligopolistic input market system. This exacerbates principal-agent problems since agro-dealers have higher market power. Information asymmetry and ineffective supplier-buyer relationships may further hinder the effective evaluation of the authorized quantity and quality of subsidized inputs.	

TABLE 1 (Continued)

Sectors	Reasons for organizational challenges	Organizational challenges	Effects	References
Government failure (state sector)	Political and institutional ineffectiveness	Inadequate institutional environment  Weak institutional arrangement	Financial deficiencies, such as the sustainability of fiscal expenses, budget harmonization, and funding timelines, are a hindrance to ISPs. ISPs are often constrained by the financial burden they place on governments' fiscal expenses account in SSA.  Divergent goals, lengthy bureaucratic procedures, poor distribution systems, and a lack of information flow around ISPs are consequences of ineffective coordination and collaboration. Suitable recipients are often excluded because of ineffective institutional settings, while state interventions can be too generic and ineffectual due to a lack of up-to-date agricultural data.	(Adetoyinbo et al., 2022; Cadoni & Angelucci, 2013; Chinsinga & Poulton, 2014; Chirwa & Dorward, 2013; Daum & Birner, 2017; Holden, 2019; Liverpool-Tasie & Takeshima, 2013; Mason & Ricker-Gilbert, 2013; Pan & Christiaensen, 2012; Stenholm et al., 2013; Takeshima & Liverpool-Tasie, 2015; Tiri et al., 2015)
Community failure (third sector)	Limited capacity and the nature of the organization	Weak institutional arrangement and environment  Elite capture and exclusion  Limited capacity and financial capital	The tendering process by state-led actors is vulnerable to bribery, while farmers often make kickback payments to acquire subsidized inputs. A common problem in many state-led programmes is kickbacks at the port and checkpoints, alongside elite capture, clientelism, and political targeting. The selection of target areas and the allocation of benefits are often politically decided, with effective market actors often replaced by political actors.  Community organizations (COs) and farm-based organizations (FBOs) are often not properly integrated into the design and execution of development programmes. Therefore, participants often face unequal access to information relating to such programmes, particularly about the scope and calibre of receivable benefits.  High-performing, well-regarded middle-class farmers and rural elites dominate COs and FBO-led programmes, taking advantage of and excluding socially marginalized actors like small-scale farmers and women.  Most COs, FBOs, and NGOs lack the capacity and financial base to handle the high transaction costs of implementing development programmes that would serve communities in SSA.	(Adetoyinbo et al., 2022; Birner & Anderson, 2007; Daum & Birner, 2017; Hendersson et al., 2020; Lubungu & Birner, 2018; Pan & Christiaensen, 2012)

Source: The authors, based on a literature review.

### 3 | RESEARCH METHODOLOGY

This study used an explorative qualitative research method to assess the implementation process and challenges of ICT-based SISP in SSA. This method offers an effective depiction of stakeholders' implicit knowledge about complex SISP processes and concepts, such as organizational challenges, which are sensitive topics among the stakeholders involved (Daum & Birner, 2017; Ilukor et al., 2015; Lubungu & Birner, 2018). By employing qualitative approaches such as participatory FGDs and Process Net-Maps, the SISP's processes, institutional and political arrangements, and its challenges could be effectively mapped and analysed.

#### 3.1 | Sampling

This study was conducted with farming populations and other experts involved in the implementation of the Nigerian GESS, with guidance from academic researchers and ministry experts. The focus was on three states: Kaduna, Oyo and Lagos. Kaduna and Oyo were selected due to their participation in the SISP and the high proportion of the population involved in maize farming and maize production (FMARD, 2011b). Lagos was selected because it houses key agro-dealers, a port, and blending facilities (Liverpool-Tasie & Takeshima, 2013).

We used purposive snowball sampling to systematically identify and connect with key stakeholders involved in the SISP, overcoming the challenges in reaching them. University researchers and experts identified the first set of participants in each state; these participants then identified respondents for subsequent interviews and FGDs. All participants were sampled based on their roles, experiences, and familiarity with e-wallet SISPs. An overview of sampled participants is presented in [Table 2](#).

#### 3.2 | Data collection

We collected primary qualitative data between June and August 2015. In the first stage, we combined FGDs and Process Net-Map to identify stakeholders and map the steps involved in purchasing, subsidizing, and distributing agricultural inputs through the e-wallet SISP. We also pinpointed where challenges appeared within this process. We conducted key informant interviews in the second stage to build on insights from FGDs and Process Net-Maps, and to understand institutional and political arrangements within the programme. Here, we examine how the NIS and actors in different organizational structures responded to or took advantage of opportunities created by SISP challenges. Taken together, we conducted nine FGDs, eight Process Net-Maps, and 21 interviews with 69 participants ([Table 1](#)).

##### 3.2.1 | Focus group discussions

Nine FGDs were conducted with 48 stakeholders in the Nigerian e-wallet ISP ([Table 2](#)). Participants were informed of the study's objectives, and informed consent was obtained to record the discussions. Semi-standardized questionnaires with open-ended questions were used to obtain information on the sociodemographic characteristics and knowledge of government policies that support maize farmers.<sup>6</sup> For example, we asked, "What agricultural subsidy policies have been implemented by the government in recent years, and what does each policy entail?" We then explored the NIS and the e-wallet SISP implementation process to understand its

<sup>6</sup>Two types of guidelines were designed with diverse questions for farmers and field experts.

TABLE 2 Overview of participants in the interview and focus group discussion.

Respondents	Acronyms	#FGDs	#Process		#Participants
			Net-Maps	#Interviews	
NARI: Field Office	NARI-FO1-2	1	1		2
NARI: Research Department	NARI-RD1-4	1	1		4
NARI: Breeding Department	NARI-BD1			1	1
IITA: Breeding Department	IITA-B1			1	1
FDA: Field Office	FDA-FO1-2	1	1		2
OYSMA: Permanent Secretariat	OSMoA-PS1			1	1
OYSMA: Agricultural Directorate	OSMoA-AD1-2			2	2
OYSMA: Extension Office	OSMoA-EPM1			1	1
Small-scale farmers – Saki	SFS1-15	1	1		15
Small-scale farmers – Ilorra	SFI1-3			3	3
Large-scale farmer – Oyo	LFO1			1	1
OYSMA – ADP	OSMoA-ADP1-10	1	1		10
NFRA	NFRA1-2			2	2
Academic Institutions: University	AIU1-6	1			6
Farmer group – Oyo	FGO1			1	1
KSMA – ADP	KSMoA-ADP1			1	1
KSMA: Field Office	KSMoA-FO1-2	1	1		2
Farmer group – Kaduna	FGK1-2	1	1		2
Large-scale farmer – Kaduna	LFK 1			1	1
FIIRO	FIIRO1-5	1	1		5
Agro-dealers	AD1-2			2	2
Expert 1	Expert1			1	1
Cellulant	Cellulant			1	1
IFDC	IFDC			1	1
NASC	NASC			1	1
Kaduna State		2	2	2	6
Oyo State		6	5	11	52
Lagos State		1	1	4	7
Others		0	0	4	4
Total		9	8	21	69

Source: The authors. FDA = Federal Department of Agriculture; FIIRO=Federal Institute of Industrial Research Oshodi; NARI=National Research Institute; IITA = International Institute of Tropical Agriculture; OYSMA = Oyo State Ministry of Agriculture; KSMA = Kaduna State Ministry of Agriculture; NFRA = National Food Reserve Agency; International Fertilizer Development Center = IFDC; NASC=National Agricultural Seed Council.

ecosystem, following the four steps described in Section 2.1. First, participants were asked to identify stakeholders involved in the implementation and management of e-wallet GESS, from policy design to input procurement and input use by end users. Next, they discussed interactions among these identified stakeholders while assessing the organizational structures to which they belong. We paid particular attention to collaboration, rivalry, and influence within the innovation system. These themes were probed with questions such as “Who are the main actors involved in the implementation of this scheme, and what type of interactions exist among them?”

We also asked participants to debate the roles of the actors in the SISP. Finally, we used the Process Net-Map to visualize the implementation process, stakeholder positions, and bottlenecks in the SISP.

### 3.2.2 | Process Net-Maps

The study used Process Net-Map (see application in Birner et al., 2012; Ilukor et al., 2015; Raabe et al., 2010; Schiffer & Hauck, 2010) to sequentially depict the programme's steps. We applied it to visualize actors' roles and trace the steps taken to implement SISP, highlighting where challenges arose. Process net-mapping involves six steps: 1) explaining the procedure to participants; 2) identifying and naming all actors in the scheme by participants<sup>7</sup>; 3) describing the scheme's implementation procedures, responsible actors, and interactions<sup>8</sup>; 4) identifying possible rivalry and collaboration along the SISP ecosystem; 5) using the contingency perspective to recount challenges faced during the SISP and the effectiveness of each organizational structure in achieving predetermined objectives; and 6) identifying changes in the SISP processes to understand how actors in various governance structures (that is, market, government and community) adapted to or took advantage of each challenge. Visualization facilitated discussions about the emergence of challenges and the adjustments made by each actor. At every step, participants shared and discussed their ideas until they reached consensus, improving the validity of the data obtained. Overall, eight SISP Process Net-Maps were produced.

### 3.2.3 | Expert interviews

Twenty one interviews were conducted with experts from various types of organizations and at different stages of the implementation of the Nigerian e-wallet ISP. Respondents included: private actors (e.g., farmers and agro-dealers); government institutions involved in the design and implementation (e.g., researchers, academic institutions, extension agents, field officers); and community stakeholders (e.g., farmer organizations). Secondary data, such as policy papers, existing literature on the effectiveness of the Nigerian SISP, and statistical data, were obtained to triangulate data from expert interviews, improving the validity and confirmability of our results. The interviews and FGDs were held in English, except for sessions with small-scale farmers, which were in the local language (Yoruba and Hausa) and subsequently translated. Important details were recorded using audio recorders and jotters, which improved data reliability. The interviews and FGDs, which included Process Net-Mapping, lasted between 30 and 150 minutes. Finally, we reviewed and validated our results with Cellulant, the International Fertilizer Development Center (IFDC), university researchers, and other ISP experts.

## 3.3 | Data management and analysis

The Nigerian e-wallet SISP implementation process was mapped using the Process Net-Maps data. We then combined information from FGDs, Process Net-Maps, and interviews to analyse the challenges facing the e-wallet SISP and identify adaptation strategies to overcome these challenges and improve the scheme's effectiveness. Qualitative data were transcribed into separate Microsoft Word files and subjected to content analysis following Mayring's (2015) five-step procedure: (1) deductive selection of eight themes to depict SISP

<sup>7</sup>Actors' names were written on paper stickers and glued to A1-sized cardboard.

<sup>8</sup>Each stage was depicted using numbered arrows drawn and connected on the cardboard. A legend box was created below the map to describe each stage. The Process Net-Map was continuously revised when participants identified new actors until the whole process was mapped.

processes and analyse challenges based on our theoretical framework<sup>9</sup>; (2) coding relevant themes into “nodes” using NVivo software; (3) revising these nodes and creating sub-nodes. For example, two sub-nodes, “Organizational Challenges” and “Affected Points,” were created under the “Challenges” node; 4) working through the data and sorting codes, texts, and metaphors to form meaningful narratives by linking themes, sub-categories, and passages; and (5) analysis and interpretation of items in step 4 alongside the Process Net-Maps. We also reviewed policy documents, reports, and statistics to complement and validate our qualitative findings.

## 4 | FINDINGS

### 4.1 | National innovation system for modern agricultural inputs

Figure 2 shows the interaction between eight public and private stakeholders involved in the Nigerian e-wallet GESS. However, this is simplistic, as more actors across three innovation subsystems—*political*, *knowledge*, and *input value chain*—were involved in developing, distributing, and using subsidized agricultural inputs in Nigeria (see Figure 3). The political subsystem includes government agencies managing policy-making, regulation, and supervision of input innovations and distribution. The *knowledge* subsystem comprises organizations that develop and disseminate innovations such as new varieties, fertilizers, and their related information. It has two components: *knowledge generation*, involving academic and research institutions; and *knowledge application and diffusion*, comprising extension agents and agribusiness firms. Although there are private actors, publicly owned institutions dominate this subsystem.

The third subsystem—*input value chain*—represents the business side of the NIS. It includes private actors such as farmers, agro-dealers/SMEs, middlemen, and importers. Within the Nigerian ISP, this subsystem focuses on supplying inputs to small-scale farmers in rural areas. These farmers are aged 18 years or above, hold land of three hectares or less, and are organized through community- or farmer-based groups. They access modern inputs through multiple channels, including private (market) (i.e., agro-dealers and retailers) or public (state) channels (i.e., extension and research institutions), or most commonly, distribution channels involving public-private collaboration (Liverpool-Tasie & Takeshima, 2013). The e-wallet SISP uses a method based on public-private partnerships. We elaborate on actors' roles and the implementation of the programme in the following subsections.

### 4.2 | Implementation of Nigerian e-wallet GESS

The Nigerian SISP involved more than 20 stakeholders executing 43 activities (Figure 4a,b). Each step is numbered and explained below the maps. The e-wallet SISP began with the policy framework, set out in 2011 through the agricultural transformation agenda (FMARD, 2011a, 2011b) (step 1). This phase involved information exchange and financial agreements among public institutions within the political subsystem, particularly between state governments and the federal government,<sup>10</sup> represented by the Federal Ministry of Agriculture and Rural Development (FMARD).<sup>11</sup> The roles and implementation rules of the actors were established here.

<sup>9</sup>The themes included (i) supporting policies in the Nigerian maize sector; (ii) stakeholders along the ISP, focusing on their innovativeness, core competencies, interactions, and trust; (iii) stakeholders' roles and property rights along the SISP; (iv) governance structures, their capability and influence to drive ISP objectives; (v) ISP performance measures; (vi) inherent challenges and their points of occurrence; (vii) contingent adaptation of SISP's governance structures; and (viii) strategies to overcome challenges and address affected points.

<sup>10</sup>This is the first of its kind, as previous ISPs in Nigeria were generally implemented by the federal government without state government support.

<sup>11</sup>Now, the Federal Ministry of Agriculture and Food Security.

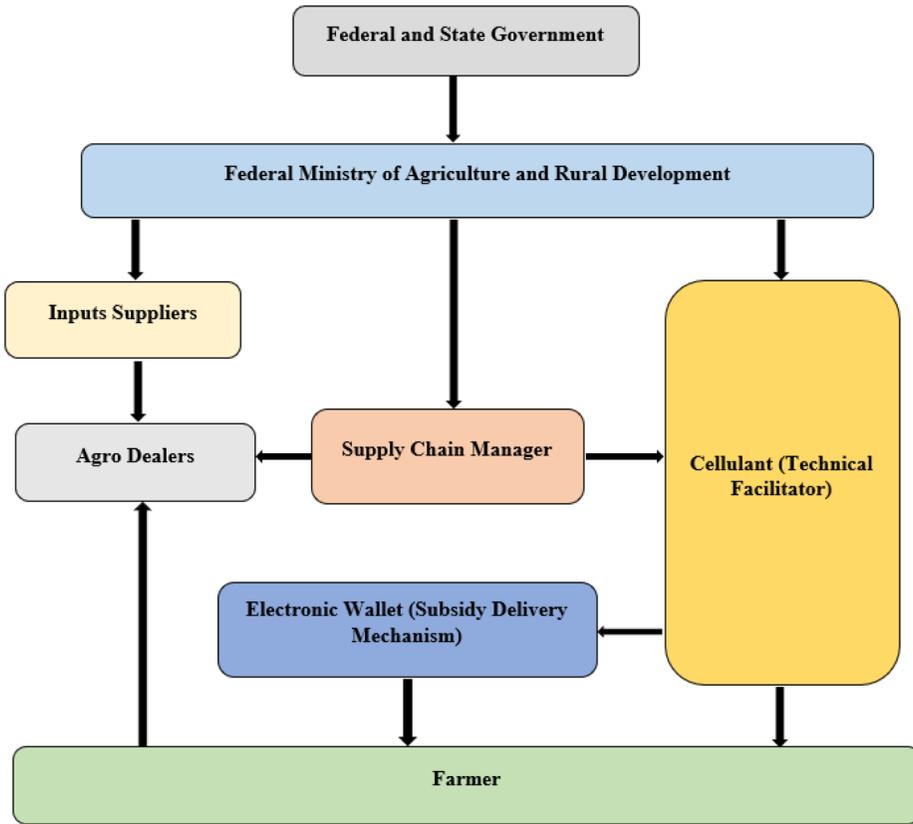


FIGURE 2 Framework showing the main stakeholders involved in e-wallet GESS. Source: The authors based on Cellulant report.

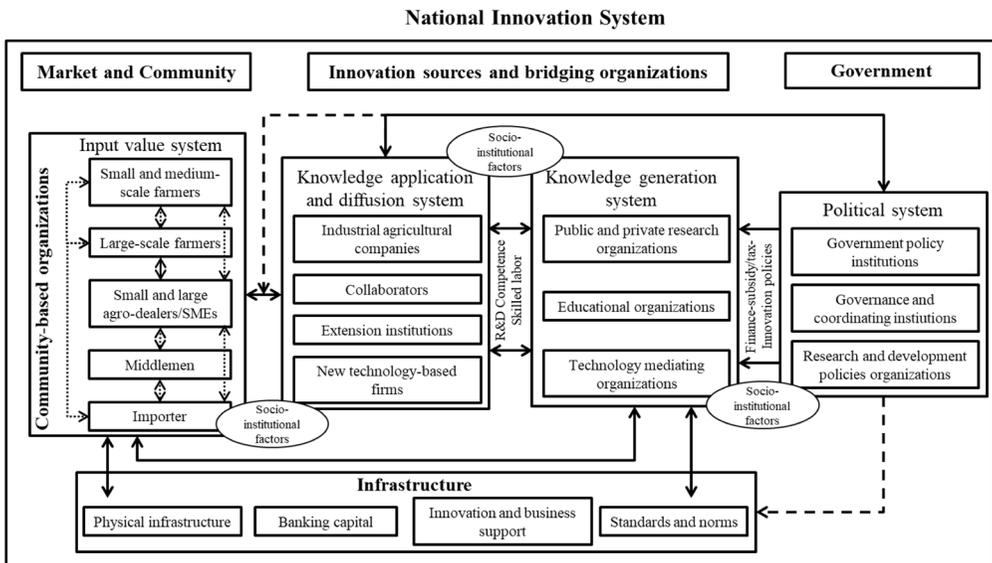
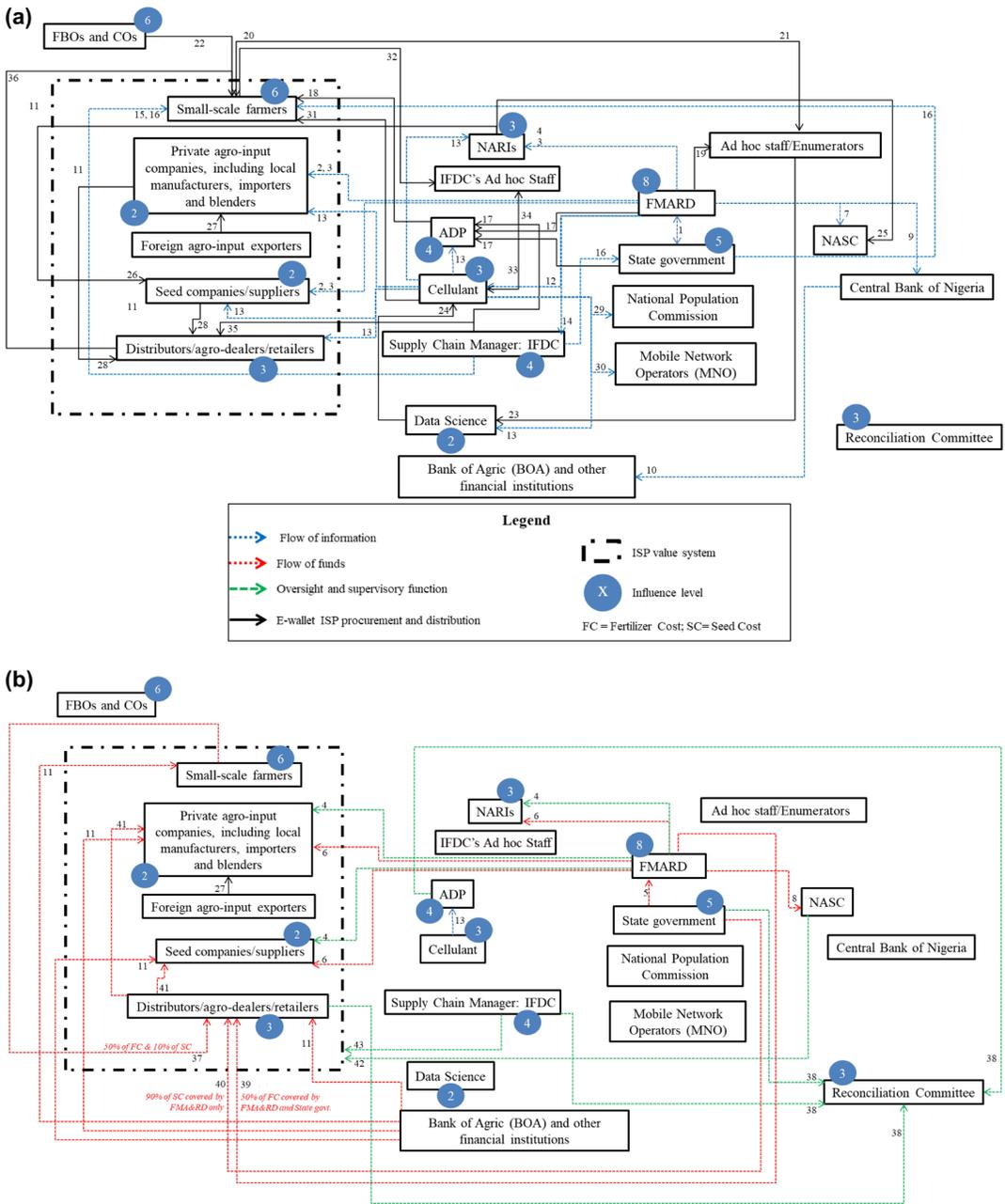


FIGURE 3 Typical NIS of the Nigerian agricultural input sector, adapted from Adetoyinbo et al. (2022). Source: The authors. NB: Broken lines represent weak links.



**FIGURE 4** (a) Process Net-Map of the Nigerian second-generation e-wallet ISP showing input procurement and distribution processes and information flow. (b) Process Net-Map of the Nigerian second-generation e-wallet ISP showing supervisory roles and fund flow. The combined map is shown in [Figure A1](#) in the supplementary file. Source: The authors.

Steps 2–4 form the pre-procurement phase, where FMARD tendered agro-input manufacturers and suppliers. In step 3, FMARD informed private agro-input and seed companies of the government plan, urging them to boost local production and establish functional procurement and distribution centres. The National Agricultural Research Institutes (NARI) and selected agro-firms were briefed as to input requirements and supervised to ensure compliance with quality and policy guidelines.

1. FMARD and State governments finalize agricultural policy strategies and ISP implementation processes
2. FMARD identifies suitable agro-input companies and suppliers
3. FMARD facilitates local production, procurement and distribution of inputs
4. Specify and regulate input type, quality and quantity
5. State governments provide counterpart funding for ISP
6. FMARD ensures appropriate budget allocation and releases fund for various input production and procurement activities
7. FMARD directs expedite certification of new seed varieties
8. Releases fund for certification committee
9. Coordinates with CBN for private sector funding
10. CBN directs Bank of Agriculture (BOA) and other financial institutions to provide financial support e.g. low-interest credit to private firms participating in the ISP system
11. BOA and other financial institutions provide financial support
12. FMARD employs Cellulant and directs to design and build ISP ecosystem
13. Cellulant integrates all other stakeholders into the system and eases private sector entry and participation
14. FMARD employs Supply Chain Manager: IFDC
15. FMARD identifies target farmers in collaboration with IFDC and support from State governments and ADP
16. Provides storage facilities close to target farmers
17. IFDC sensitizes farmers, performs radio jingles, and authorizes ADP to inform farmers about second-generation ISP with approval from FMARD and State governments
18. ADP informs farmers
19. FMARD employs adhoc-staff/enumerators
20. Gives targeted farmers registration form and/or make the registration
21. FBOs and COs informs farmers, registers in the system and support farmers' registration
22. Farmers return filled registration form
23. Filled registration form sent to Data science
24. Data science converts to electronic format and sends to Cellulant
25. Releases new seed varieties on behalf of FMARD for expedite certification by NASC
26. Distributes new seed varieties to seed companies and suppliers for multiplication
27. Produces and/or imports and blend stated fertilizer type and quantity
28. Agro-inputs distributed to selected private distributors/agro-dealers/retailers through distribution partners
29. Cellulant validates farmers' information with the national population database
30. Coordinates with MNOs to finalize channels and tariffs and ensure availability of network to targeted farmers
31. Cellulant pushes text message with a unique code to farmers' mobile phone and invitation to visit a agrodealer
32. Farmers visit agro-dealers at the redemption center (and in some case, IFDC's adhoc staff). The farmer can redeem the inputs with or without the supply chain manager staff
33. IFDC's adhoc staff sends message (farmers' code) to Cellulant to ascertain farmers' identity
34. Cellulant replies IFDC's adhoc staff
35. IFDC authorizes registered distributors/agro-dealers/retailers to give the inputs to farmers with the code number
36. Distributors/agro-dealers/retailers give input to farmers
37. Farmers pay distributors/agro-dealers/retailers 50% and 0/10% of the cost of fertilizer and seed received, respectively
38. Reconciliation committee made of distributors/agro-dealers/retailers, IFDC, ADPs and state governments meets
39. FMARD and state governments pay agro-dealers/retailers 50% (25% each) of fertilizer costs delivered to farmers
40. FMARD pays agro-dealers/retailers 90% of the seed cost delivered to targeted farmers
41. Agro-dealers/retailers pay private agro-input companies and seed companies
42. IFDC monitors and evaluates the effectiveness of ISP
43. NASC and other regulatory bodies e.g. Standard Organization of Nigeria (SON) ensures that quality and certified inputs are distributed

FIGURE 4 (Continued)

The production and procurement phase (steps 5–11) involved releasing counterpart funds by federal and state governments as specified in step 1. FMARD disbursed funds to NARIs and seed companies for seed development and multiplication, and to agro-input companies for fertilizer manufacturing, importation, and blending. The Central Bank of Nigeria (CBN) and FMARD instructed the Bank of Agriculture (BOA) and other financial institutions, such as the National Sovereign Investment Authority, to provide low-interest loans to the private sector for fertilizer-related activities. In step 7, FMARD tasked the National Agricultural Seed Council (NASC) with expediting seed certification, releasing funds to the seed certification committee to finalize the approval of new varieties.

Steps 12–16 form the design phase. FMARD used Cellulant Nigeria Limited to design, build, and integrate all stakeholders: 17 local fertilizer manufacturers, 2,500 agro-dealers/retailers, and NARIs. Cellulant provided essential resources and information to support their functions. FMARD also engaged the International Center for Soil Fertility and Development (IFDC) as supply-chain manager,<sup>12</sup> responsible for stakeholder capacity-building and coordinating timelines and activities. With support from Agricultural Development Programme (ADP) extension agents, IFDC estimated the number of small-scale farmers eligible as beneficiaries, using Cellulant reports based on the national farmer database and state government directives. In step 16, IFDC urged state governments to establish affordable storage facilities for agro-dealers. This recommendation was designed to address challenges

<sup>12</sup>Other supply-chain managers in other states are Jetlink Nigeria Ltd. and Ecalpemos Technologies Ltd.

such as poor roads, high transport costs (50%–60% of input cost), and limited financial capacity, all of which restricted rural input market presence.

The registration phase spanned steps 17–24. After FMARD and the state governments approved the e-wallet SISP rollout, IFDC authorized ADP to notify potential beneficiaries meeting federal and state criteria. Local mass registration was encouraged, with the assistance of FBOs and COs. Unlike FISP, FMARD used ad hoc enumerators to register potential beneficiaries using a standard registration form.

In steps 23–24 (Figure 4a), enumerators collated completed forms and screened farmer data (e.g., farm size, crops grown, and location) to verify eligibility as small-scale maize farmers in approved states. Eligible farmer forms are sent to “Data Science” for digitalization, and unique codes are generated with the help of the National Identity Management Commission. The electronic data are then returned to Cellulant for further processing, with a text sent in English to the farmer's phone: “You are now registered for GES program so that you can get fertilizer & improved seeds at reduced prices. Your GES farmer identification number is xxxxxxxx.”

Steps 25–30 (Figures 4a–b) denote the production and procurement phase. In 2012, NARIs released maize seed varieties for certification and sent them to seed companies and suppliers for multiplication. NARI-BD1 said: “By 2012, we released Ife hybrid 3 and 4, which are purely hybrid with high provitamin A levels. In 2012, we released Ife hybrid 1 and 2, white maize varieties with higher yield potentials than older varieties.”

During this period, private input suppliers produced and blended fertilizers (as specified in step 4), while importers procured fertilizers. The inputs were transported to private warehouses for sorting and storage until distribution began. Cellulant prepared for distribution by confirming farmers' demographic data (i.e., name, gender, and occupation) using the National Population Commission's database. It also partnered with mobile network operators (MNOs) to confirm mobile network coverage in targeted areas. Contracts on tariffs and delivery channels were finalized to push electronic vouchers to recipients' mobile phones.

The penultimate stage, steps 31–36 (Figure 4a), involved the distribution of subsidized agro-inputs. Maize seeds and fertilizers were moved from private warehouses to local storage facilities at the redemption centres, established by Cellulant in collaboration with state governments. Cellulant sent four texts to recipients' phones at different intervals, containing information about the input and vouchers, unique codes, an invitation to visit an agro-dealer at a specific redemption centre, and a reminder to redeem inputs. IFDC representatives are expected to be present at redemption centres. According to Cellulant, the texts sent to recipients were:

1. You are entitled to 2 bags of 50kg of fertilizer, 1 bag of Maize (20kg), 1kg of agrolyser, and 50kg of crystallizer.
2. Please proceed to ..... (redemption center) with xxxxxxxxxx (amount) cash to collect your fertilizer and improved seeds.
3. Your Cellulant control number is xxxxxxxx. It will be used for verification and confirmation of transactions.
4. This is to remind you to proceed to buy fertilizer and improved seeds before the subsidy period ends. The last date for the purchase is dd-mm-yy.

At the redemption centre, farmers presented their codes, which the IFDC staff verified with Cellulant. After confirmation, farmers were notified via text about which agro-dealers they could collect subsidized inputs from, including the specific quantities linked to a code. During the 2012/2013 season, farmers visited agro-dealers to collect the agricultural inputs identified in step 4. Quantities depended on the GESS type: under generic GESS, provided once a year before the rainy season (around April), farmers received two 50kg bags of NPK fertilizer (fertilizer containing Nitrogen, Phosphorus, and Potassium) and 10kg of maize seeds. During the dry season, they received three 50kg bags of NPK fertilizer and 20kg of maize seeds. The distribution stage concluded with farmers paying agro-dealers/retailers 50% of fertilizer costs and 10% of seed costs.

Steps 38–43 cover reconciliation and supervision. The reconciliation committee verified that the quantities and costs of the delivered inputs matched the budgeted amount.<sup>13</sup> If they matched, it was recommended that FMARD and state governments proceed with payments to agro-dealers. The federal government covered 90% of seed costs, while federal and state governments each paid 25% of fertilizer costs (50% in total). Agro-dealers reimbursed input suppliers and seed companies supplying inputs in step 28. Meanwhile, in steps 42 and 43, IFDC monitored and evaluated the programme. NASC and other regulators, such as the Standards Organisation of Nigeria (SON), ensured that certified inputs were distributed.

### 4.3 | Achievements of the Nigerian e-wallet SISP relative to FISP

The e-wallet SISP, unlike FISP, fostered collaboration between private companies and public organizations to fund hybrid seed development and release. This attracted private actors, leading to many seed companies entering the market and frequent seed release committee meetings from 2011 to 2015, which increased the number of hybrid varieties released. NARI-BD1 noted:

All the varieties that I released in the last 4–5 years are not because these materials were not on the shelf before, but nobody has the kind of money to carry out multi-location and on-farm trials that are required to release them ... With increased awareness, I secured a USD 185,000 Bill Gates Foundation grant between 2010 and 2014 to evaluate and release varieties ... we hope that things will change for better now because more seed companies are entering the country, as some of the hybrids we just released have been licensed to 10 companies. We are preparing to release the parental seed materials to them for multiplication, distribution, scaling-out, and trading.

Unlike FISP, where the public sector led input procurement and distribution, SISPs involved over 23 input suppliers and 2,500 agro-dealers nationwide. This approach boosted input supply and rural coverage, according to Cellulant, KSMoA-ADP1, and FDA-FO1-2.

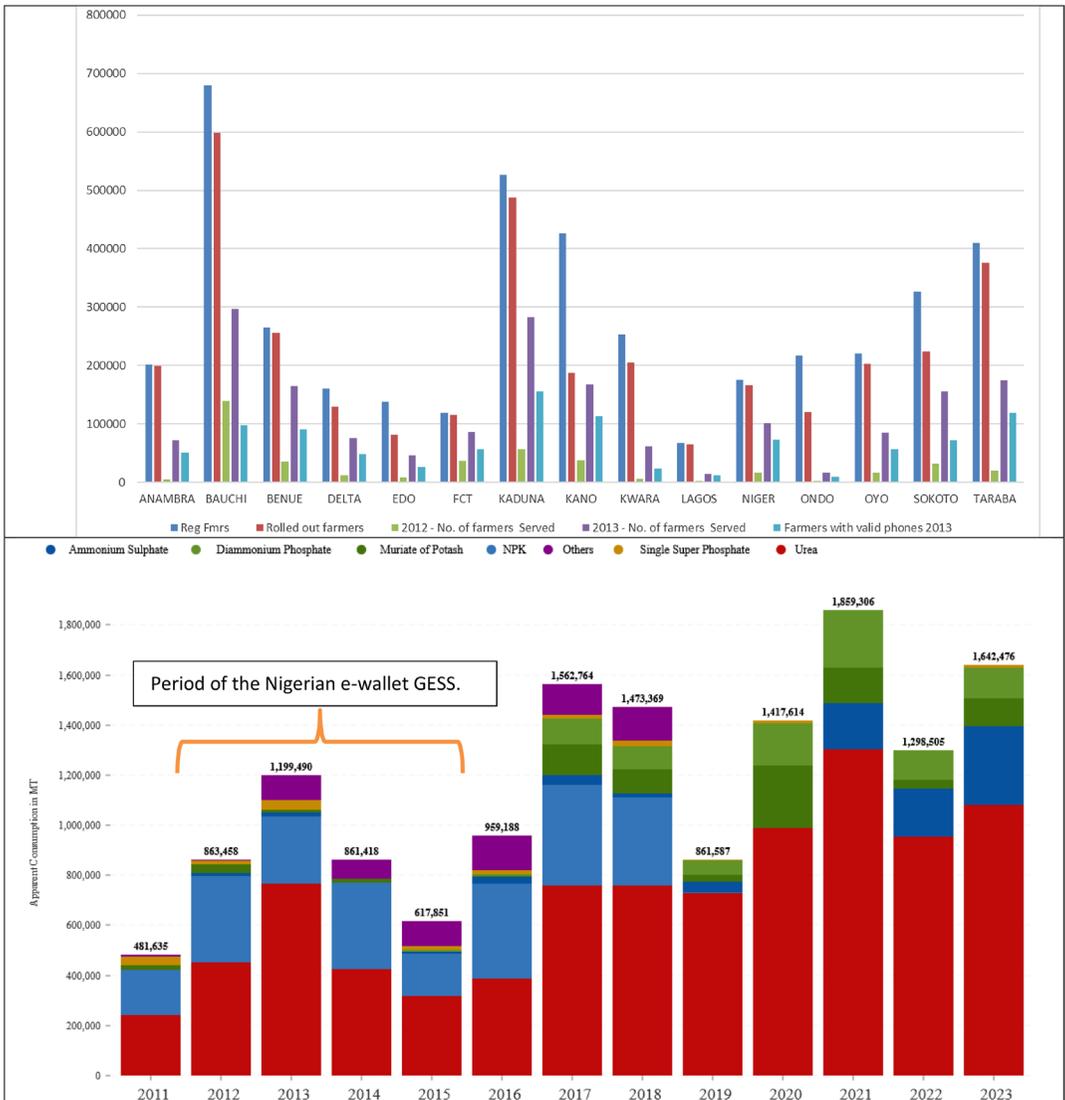
Early organizational challenges, such as corruption and financial misappropriation by political stakeholders, declined due to better tendering and the replacement of the public ISP ecosystem builder with a private actor (Cellulant). The ICT, in particular, allowed for the introduction of checks and balances across various phases of the scheme. These included digital matching of orders, input delivered, and waybills by the reconciliation committee, as well as monitoring by supervisory agencies. The Nigerian e-wallet was relatively cost effective, spending NGN 82.38 billion on 7.2 million farmers, who received more input quantities and types in 2014, compared to 6.65 billion naira (NGN) on 729,000 farmers in 2012. FDA-FO1-2 explained:

You can see that we have a series of checks and balances ... IFDC and its ad hoc staff see whatever agro-dealers want to receive with the waybill before they (inputs) are received. Agro-input companies know they cannot supply less or more than they have been told. Hence, that channel for corruption is blocked. For the payment process, the reconciliation committee sits down to review whatever the agro-dealers receive. The 66 redemption centres (in Oyo State) call IFDC ad hoc staff and agro-dealers to defend their figures. Apart from having them on the ground, we (FDA) also conduct daily monitoring between 8 a.m. and 5 p.m. to ensure transparency and accountability.

Figure 5 shows that farmers benefited from improved access to high-yielding varieties, better targeting, and timely input delivery, leading to increased demand, modern input use, productivity, and welfare gains. With the ICT, the

<sup>13</sup>Consists of agro-dealers/retailers, IFDC, ADPs, and state government representatives

number of farmers served increased by 320% between 2012 and 2013 (428,000 compared to 1,800,000), while the redemption rate increased from 52% to 78% during the same period. As shown in Figure 5, fertilizer consumption increased by 28%–149% between 2012 and 2015, when there was an election and a change of government. Between 2011 and 2014, over 12 million farmers benefited, with 73% of targeted farmers receiving subsidized inputs. Nationally, more than 14.5 million bags of NPK and urea fertilizers were distributed, including 257,000 bags to 128,000 farmers in Oyo State and about 917,000 bags to approximately 418,000 farmers in Kaduna State, resulting in an increase of 20.1 metric tonnes in domestic food production. The e-wallet improved transparency and enabled performance tracking, allowing effective monitoring, lower costs, and reduced corruption through digital reconciliation of procurements and deliveries.



**FIGURE 5** Performance of the Nigerian second-generation e-wallet ISP across states in Nigeria. *Source:* The first figure is based on the Cellulant report, while the second is sourced from Fertilizer Technical Working Group, with the analysis done by AfricaFertilizer. The second figure shows the amount of various fertilizers consumed in metric tonnes.

The programme has been a laudable one because it helps farmers. I could remember in 2013 when it was flagged off at Ilora, there was this very old man crying and saying that since he has been farming, he has never laid his hand on a bag of fertilizer, not to talk of two. He said all he does yearly is buy in modus (small bowls) ... At the same time, the programme has increased their level of production due to access to fertilizer and hybrid seeds ... you can see that we have a series of checks and balances ... IFDC and its ad hoc staff see whatever agro-dealers want to receive with the waybill before they are received. Agro-input companies know they cannot supply less or more than they have been told. Hence, that channel for corruption is blocked. For the payment process, the reconciliation committee sits down to review whatever the agro-dealers receive. The 66 redemption centres (in Oyo State) call IFDC ad hoc staff to defend their figures. Apart from having them on the ground, we (FDA) also conduct daily monitoring between 8 a.m. and 5 p.m. to ensure transparency and accountability. [FGD with FDA-FO1-2]

Many farmers said it was the first time they had ever received government-supplied fertilizer. The products reached the intended communities. Previously, fertilizer would often disappear, never reaching the farmers at all ... I think I prefer the e-wallet thing because it actually worked ... When reconciling records, we [the reconciliation committee] often found that claims by agro-dealers about the number of redemptions far exceeded the actual transactions recorded in the system. This contributed to payment delays of four or five years for some agro-dealers ... We had to close some agro-dealer stores because of such practices (adulteration and round tripping) and reroute farmers to more reliable centres [Interview with IFDC].

The outcomes suggest that the e-wallet SISP outperformed FISP in several respects, but struggled to reach all rural farmers, with coverage under 80% and redemption below 75%. It also faced issues with timely delivery and meeting the expected agricultural productivity.<sup>14</sup> The next subsection details these challenges.

#### 4.4 | Challenges in the Nigerian e-wallet SISP

We draw on the qualitative data and Process Net-Maps in [Figure 6](#), which use red circles to mark where challenges arose in the e-wallet SISP. Although the ICT-based SISP achieved some successes, we observed eight challenges: inconsistent institutional environment (e.g., fluctuating political support); inadequate funding; weak institutional arrangements (e.g., limited collaboration and stakeholder capacity); farmer and infrastructural constraints (e.g., ICT-related problems); moral hazards such as input leakage and adulteration, elite capture and exclusion; and corruption. These challenges appeared throughout the lifecycle of the SISP, affecting both its NIS and its implementation phases. The following subsections detail the main challenges.

##### 4.4.1 | Main organizational challenges

We identified five main challenges according to their intensity, flexibility, and impact on SISP procedures: inconsistent institutional environment; weak institutional arrangement; input leakage, adulteration, and diversion; elite capture and exclusion; and inadequate funding flow (summarized in [Table 3](#)). These challenges affected both

<sup>14</sup>Figure 4's second panel suggests the PFI might exceed e-wallet GESS in fertiliser consumption, owing to more private sector investment in domestic fertiliser production, particularly urea. "Although it is without direct subsidy, the government still absorbed some costs such as currency risk and financing costs, which can be considered indirect subsidies" [Expert1]. However, it remains unclear if small-scale rural farmers increased fertiliser consumption under the PFI, unlike the e-wallet GESS, which focuses on them.

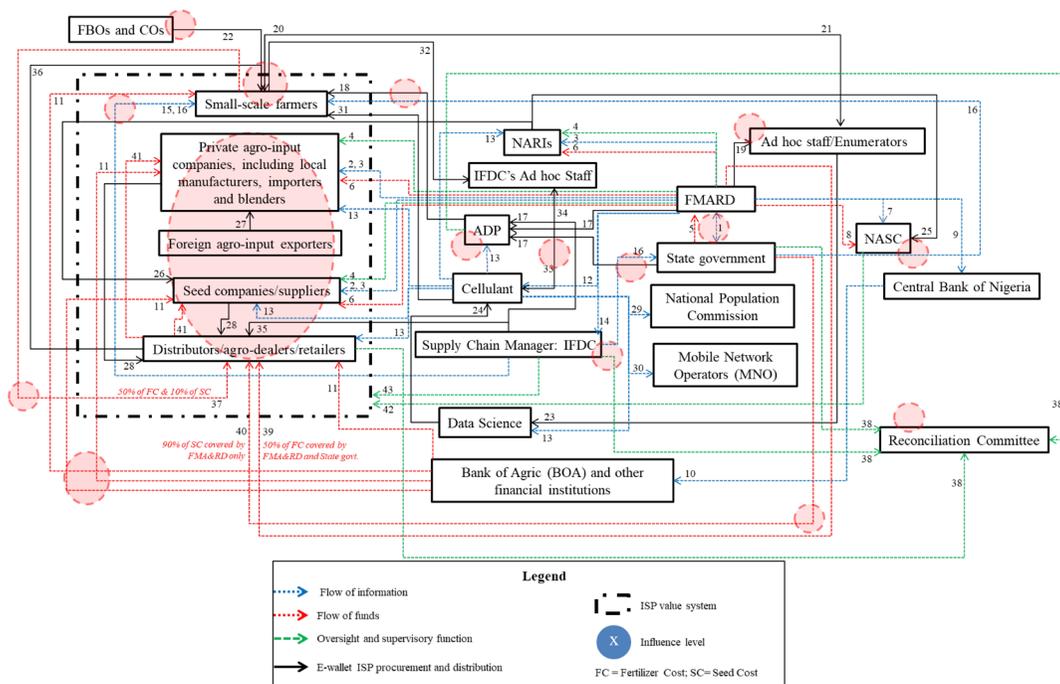


FIGURE 6 Organizational challenges and bottlenecks in the Nigerian e-wallet ISP. Source: The authors. Figures 4a-b are combined into Figure A1 to show the areas where the challenges occurred.

private and state actors (see Table 1 in subsection 2.2), covering the scheme's environment, strategy, size, and the nature of the requisite tasks.

4.4.1.1 | Inconsistent institutional environment

Respondents reported that unfavourable institutional environments hampered the SISP design phase, which comprises policy development, input production, and procurement. Unlike FISPs, which are implemented without a state (regional government) sponsor, state governments sometimes use the SISP for political purposes, complicating policy coordination and nationwide scheme implementation. Some states affiliated with different political parties showed initial reluctance or withdrew after initial agreement, reducing their involvement and further undermining federal–state collaboration. This lack of coordinated effort hindered the success of the SISP, which depends on cooperation at both the federal and state levels. Instead of building storage and redemption facilities near farming communities for private agro-firms, some state governments repurposed old, distant buildings, confronting recipients with higher transportation and logistics costs.

4.4.1.2 | Weak institutional arrangement

The e-wallet SISP also suffered from weak institutional arrangements and limited capacity. Registration processes were hampered by poor integration of local COs and FBOs, making registration and targeting unsystematic. In places where COs and FBOs were better linked, particularly Northern Nigeria, high transaction costs for organizing input supply remained a significant challenge. Poor infrastructure, such as inadequate roads and limited mobile networks, further restricted the ability of these organizations to share information and conduct regular meetings.<sup>15</sup>

<sup>15</sup>[FGO1; SFS1-15; SFI1-3]

TABLE 3 Organizational challenges in the Nigerian GESS showing their frequency, flexibility, and impact on SISP effectiveness.

Organizational challenges	Occurrence points	Occurrence frequency	Flexibility	Impact on ISP effectiveness	Consequences	Expert identification
Inconsistent institutional environment (e.g., political support)	SISP design and input distribution	Common	Flexible	Major	<ul style="list-style-type: none"> <li>• Difficulty synthesizing and aligning policy and coordinating nationally</li> <li>• Delayed administrative processes and activities</li> <li>• High policy uncertainty discouraged private actor investment, leading to a cash-and-carry policy</li> <li>• High recipient transportation and logistical costs during delivery</li> </ul>	FDA-FO1-2; NARI-FO1-2; NARI-RD1-4; NARI-BD1
Inadequate flow of funds	All phases	Common	Somewhat flexible	Severe	<ul style="list-style-type: none"> <li>• Ineffective knowledge and information dissemination, particularly to farmers during registration</li> <li>• Untimely implementation of other administrative/supervisory activities</li> <li>• Hindered research and delayed seed variety approval, multiplication, and release</li> <li>• High financial risks and uncertainty deter private investment</li> <li>• Delayed input procurement by private firms</li> <li>• Irregular meetings of various reconciliation committees, leading to delayed payment of input companies and agro-dealers</li> </ul>	FDA-FO1-2; NARI-FO1-2; NARI-RD1-4; NARI-BD1; NASC

TABLE 3 (Continued)

Organizational challenges	Occurrence points	Occurrence frequency	Flexibility	Impact on ISP effectiveness	Consequences	Expert identification
Weak institutional arrangement (e.g., weak collaborations and limited capacity)	SISP design, input production, and procurement stimulation phases	Continuous	Very flexible	Major	<ul style="list-style-type: none"> <li>• Unsystematic targeting and registration</li> <li>• Difficulty evaluating input quantity and quality by farmers</li> <li>• Lack of reporting systems or feedback mechanisms</li> <li>• Higher farmer transaction costs due to uncertain information</li> <li>• Weak SISP innovation systems</li> <li>• Inefficient registration</li> <li>• Inadequate storage and redemption centres</li> </ul>	NARI-FO1-2; NARI-RD1-4; NARI-BD1; IITA-B1; OSMoA-AD1-2; OSMoA-EPM1
Farmer-related constraints (e.g., low education and literacy level)	Registration and delivery phases	Common	Inflexible	Moderate	<ul style="list-style-type: none"> <li>• Opportunity for farmer exclusion and moral hazards (e.g., input leakage and adulteration)</li> <li>• Increased farmers' logistical and transaction costs</li> </ul>	FGK1-2; FGO1; SFS1-15; SFI 1-3; LFO 1; OSMoA-ADP1-10
Infrastructural and ICT-related constraints	The registration, input procurement, and delivery phases	Common	Inflexible	Minor	<ul style="list-style-type: none"> <li>• Chaos and tension at redemption centres due to undelivered e-wallet texts</li> <li>• Difficulty verifying eligible farmers and estimating adequate budget</li> <li>• Higher transport and logistical costs for farmers and companies due to remoteness and poor road conditions</li> <li>• Delayed input stocking in some areas</li> <li>• Opportunities for exclusion, elite capture, manipulation, corruption, and bribery</li> </ul>	AD1-2; AIU1-6; OSMoA-PS1; IFDC

(Continues)

TABLE 3 (Continued)

Organizational challenges	Occurrence points	Occurrence frequency	Flexibility	Impact on ISP effectiveness	Consequences	Expert identification
Input leakage, adulteration, and diversion (i.e., from agro-dealers and farmers)	Input handling, distribution, and delivery, post-handling, and -delivery	Occasional	Very Flexible	Severe	<ul style="list-style-type: none"> <li>• Distribution of low quantity and quality inputs</li> <li>• Input market distortion</li> <li>• Low agricultural productivity among smallholders</li> <li>• High food insecurity among smallholders</li> </ul>	FDA-FO1-2; AIU1-6; Cellulant
Elite capture and exclusion	Registration and delivery phase	Continuous	Flexible	Severe	<ul style="list-style-type: none"> <li>• Low percentage of served-to-targeted beneficiaries</li> <li>• Low agricultural productivity, particularly among smallholders</li> </ul>	FGK1-2; FGO1; LFK; 1SFS1-15; SFI1-3; LFO1
Corruption and bribery	Procurement and handling phase	Occasional	Somewhat flexible	Minor	<ul style="list-style-type: none"> <li>• High logistical costs for input companies due to bribery</li> <li>• Higher input costs during the delivery phase</li> <li>• Delayed ISP processes and subsequent programme when input companies and agro-dealers engage in corruption and are vetted by the redemption committee</li> <li>• High logistical costs for farmers when old redemption centres are closed due to corruption and new ones are established in distant areas</li> </ul>	AD1-2; IFDC

Source: The authors. Frequency is occasional, common, or continuous, reflecting the number of times the challenge was identified. Flexibility captures whether organizational challenges affected multiple points of the chain and whether there are variations in affected points relative to what remains in the old scheme. The impact on ISP effectiveness could be minor (light orange), moderate (yellow), major (orange), or severe (red) and was illustrated based on the perceptions of the participants.

Farmers faced substantial information asymmetry because links with other stakeholders were weak or lacking, making it difficult to judge input quantity and quality. With no feedback loops, farmers had no way to report problems about selection and procedural issues, since all information was one-way, from implementors through mobile phones. There was no customer service to engage farmers and respond to farmers' complaints. Consequently, delivery schedules were uncertain, forcing farmers to make repeated trips to redemption centres. These extra visits increased their participation costs, reduced incentives to redeem and use the inputs, and ultimately weakened the effectiveness of the SISP.

Moreover, registration efficiency suffered due to the limited capacity of ad hoc enumerators, who often had to hand over forms to farmers. Many uneducated farmers struggled to fill in key details, such as mobile numbers, leading to a risk of high levels of exclusion. More farmers were excluded because enumerators could not reach eligible recipients due to limited capacity. Some registered farmers were omitted during the digitization process due to oversight by enumerators or Cellulant, the e-wallet provider. Farmers with limited experience and education often relied on educated large-scale farmers for help, which allowed those individuals to manipulate entries and benefit fraudulently. Farmers also faced additional transport and logistical costs, as returning forms and unvetted entries meant additional corrections and outlay that discouraged participation.<sup>16</sup>

Likewise, government changes to input delivery meant that private actors struggled to situate facilities near target areas due to limited financial and physical capacity. As a result, storage facilities and redemption centres (about 1,466) were too small in number and too distant from communities (roughly 30–70 km), making access difficult.<sup>17</sup>

The pre-procurement stage, mainly recipient registration, was further hindered by limited capacity among stakeholders such as ADP, which, like other public actors, grappled with staff and resource shortages, similar to those experienced by FISP. Notifying farmers about the new ISP was challenging, worsened by a farmer-to-extension agent ratio of roughly 1:800,<sup>18</sup> and by unpaid staff seeking alternative sources of income. Although CO and FBO collaboration helped, challenges peculiar to community-led programmes, such as limited capacity and financial base, rendered such collaboration insufficient. Consequently, many farmers learnt about registration only while visiting redemption centres or after other farmers had received inputs, causing tension in some redemption centres.<sup>19</sup>

#### 4.4.1.3 | *Input leakage, round-tripping, adulteration, and diversion*

As shown in [Figure 4](#), the distribution process faced rampant input leakage, round-tripping, and diversion, including underweight inputs. Agro-dealers often diverted subsidized inputs, particularly fertilizers, to traders and non-farmers in local and cross-border markets, taking advantage of limited supervision and costly rural delivery. Oversight by NASC, SON, and IFDC was minimal due to their limited capacity. As a result, input quantity and quality checks for 1,466 redemption centres, particularly those in peri-urban and rural areas, were weak.<sup>20</sup> Agro-dealers thus adulterate or reduce input weight after receiving the inputs from seed and fertilizer companies (step 28): “Sometimes, the bags were underweight—for example, bags labelled 50 kg actually contained just 35–38 kg” [Interview with IFDC].

Another challenge involves the principal–agent problem described in subsection 2.2, which fuelled moral hazard among agro-dealers. These dealers round-tripped and diverted inputs to recover costs when farmers could not pay for subsidized inputs. According to Cellulant, “some agro-dealers gave farmers money to redeem inputs, then bought the inputs back from the farmers in the process of round-tripping.” Agro-dealers often

<sup>16</sup>[FDA-FO1-2; SFS1-15; SFI1-3]

<sup>17</sup>[NARI-FO1-2; NARI-RD1-4; FDA-FO1-2; NARI-BD1; FGK1-2; SFS1-15; SFI1-3; Cellulant]

<sup>18</sup>[NARI-FO1-2; NARI-RD1-4; OSMoA-AD1-2; OSMoA-EPM1; OSMoA-ADP1-10; KSMoA-ADP1]

<sup>19</sup>[AIU1-6; FGO1; SFS1-15; SFI1-3; Cellulant]

<sup>20</sup>[NARI-FO1-2; NARI-RD1-4; FDA-FO1-2; NARI-BD1]

resell these inputs to the highest bidder, including wealthy farmers and non-farmers waiting at redemption centres for this opportunity. Some farmers, exploiting information and supervisory gaps among SISP stakeholders, also registered primarily to resell inputs at market rates rather than use them as intended. FGO1 observed that:

The ultimate goal of the e-wallet SISP is that farmers must use the received inputs to plant ... it is when they plant, and we see the crop and yield at the harvest that we say the e-wallet has done its job ... But we found out that some farmers get the inputs and sell.

Delays in input delivery, especially if these occurred after the planting season, encouraged this practice among farmers. According to FDA-FO1-2: "ISP was implemented as planned in the second year, unlike in the first year, where there was a delay in distribution of inputs in the southern part where rainfall usually begins much earlier compared to the northern part."

Another factor is that commercial buyers at redemption centres offered resale prices twice or three times higher than the subsidized input prices. This was too great a temptation for many to resist, given the high risks and uncertainties of agricultural production. Even farmers not interested in expanding production registered to resell subsidized inputs and meet financial obligations. According to NARI-BD1: "The subsidy is not getting to the farmers. If you give them two bags of fertilizer, you want them to go and produce. However, they get the inputs to their house, which are about 50% cheaper, and then, resell them because they paid just 50% of the cost and want to pay some bills."

Overall, the e-voucher ISP failed to improve productivity or food security because moral hazards such as input diversion, round-tripping, and adulteration prevented beneficiaries from receiving and using the subsidized inputs as designed. The scheme also distorted the input market by making farmers lean towards subsidized products over other input brands, ultimately deterring private investment. However, the financial burden of the subsidy, inflated by this challenge, was high and unsustainable, as the government budgeted about NGN 14 billion in 2012 but had to pay over NGN 30 billion in 2013.

#### 4.4.1.4 | *Elite capture and exclusion*

Elite capture and exclusion severely undermined the e-wallet SISP in Nigeria. Despite improvement in the tendering process, "briefcase entrepreneurs," who are not real agro-dealers, were found to be registered in the scheme. Challenges with elite capture and exclusion of recipients also existed. The private sector, especially enumerators, lacked the capacity to register recipients effectively. As a result, registration (steps 17–24) was decentralized, relying on third-sector organizations like COs and FBOs to register farmers. Registration forms were given to CO and FBO leaders, middle-class farmers, and rural elites.<sup>21</sup> However, these individuals often registered both themselves and family members as full-time subsistence farmers, excluding the intended recipients. Since registration was manual (paper-based) and self-reported, this system allowed data manipulation, elite capture, and the exclusion of targeted farmers during delivery.

#### 4.4.1.5 | *Inappropriate funding*

Another major challenge was irregular and late financial disbursement by political actors (e.g., federal and state governments) to subsystems responsible for knowledge generation, application, and diffusion. Federal funding supported knowledge generation (e.g., NARIs), while state governments funded application and diffusion bodies (e.g., ADPs). The lack of harmonized funding protocols for these public agencies led to uncoordinated finance and related activities within SISP. This resulted in poor knowledge and information dissemination to farmers during registration and also delays in administrative and supervisory tasks (steps 25–36). NARIs, seed companies, NASC

<sup>21</sup>[AIU1-6; FDA-FO1-2; KSMoA-ADP1; SFS1-15; SF1-3]

and its seed certification committee also faced inadequate and delayed funding early on, hindering research and delaying seed variety multiplication and release.

Procurement was also delayed by inconsistent government commitment. Support from state governments was often uncertain and unsustainable, prompting private actors to delay input procurement until counterpart funds arrived. Private firms also struggled due to limited financial capital and poor access to financial support. The involvement of financial institutions in SISP was minimal. The support of the Federal Ministry of Finance, BOA, and CBN was insufficient to reduce lending risks, especially for local input suppliers and agro-dealers, as the policy framework lacked clear financial backing. Some firms resorted to expensive loans with interest rates exceeding 15%, while others relied on distribution partners for credit.<sup>22</sup> However, harsh macroeconomic conditions, such as high foreign exchange fees and unstable import regulations, discouraged private investment. Farmers similarly had weak financial ties to commercial banks, limiting their access to loans and their ability to cover additional costs related to registration and reception.

Reconciliation committees, which comprise state governments, ADPs, agro-dealers, and IFDC, struggled to harmonize redemptions across local areas (step 38) due to insufficient funding for members' time and logistics. These committees were responsible for validating electronically transferred input data between IFDC and Cellulant and for overseeing input distribution and delivery by agro-dealers to registered beneficiaries. Weak financial flows and the states' reluctance to commit additional funds hindered regular meetings at 1,466 redemption centres.<sup>23</sup>

Despite these severe challenges, policy-makers and political actors overlooked them during the implementation phase. This is because addressing such issues would require increased financial support from federal and state governments for public stakeholders across other subsystems, a commitment viewed as less politically advantageous than simply procuring and distributing subsidized agro-inputs.

#### 4.4.2 | Minor organizational challenges

Other challenges include constraints related to infrastructure and ICT. Building an integrated ISP ecosystem required adequate data, which was lacking. Unlike FISP, which targeted all farmers, SISP aimed only at full-time subsistence farmers with less than 5 ha. However, no reliable survey or database existed to verify eligibility, estimate the number of eligible farmers, or determine the budget. The vague criteria used in policies and surveys made it difficult to distinguish non-farmers from full-time farmers, and subsistence from large-scale farmers. Although small-scale farmers with landholdings of 5 ha or less were listed as primary targets (FMARD, 2011b), the criteria overlooked crop-specific plot sizes, ownership types (individual vs. family vs. communal), and the proportion of land under active cultivation. Such oversight created room for elite capture and manipulation.

Several bottlenecks also ensued because the programme relied heavily on mobile phones for input delivery. Farmers were required to present e-voucher texts with unique codes, sometimes more than a year after registration, to claim subsidized inputs (steps 17–24). Those who lost or damaged their mobile phones or SIM cards and could not show these texts were excluded in some areas. In others, farmers could redeem inputs with their registration confirmation slip. Additionally, many registered farmers never received the e-wallet texts due to poor network coverage, which reduced farmer coverage and redemption rates. Since messages were not in local languages, many uneducated farmers struggled to recognize the English messages from Cellulant and often deleted or ignored them.<sup>24</sup>

<sup>22</sup>[AD1-2; IFDC]

<sup>23</sup>[NARI-FO1-2; FDA-FO1-2; NARI-BD1]

<sup>24</sup>[NARI-FO1-2; FDA-FO1-2; NARI-BD1; KSMoA-ADP1; SFS1-15; SFI1-3]

In later stages, poor infrastructure (such as road and terrain conditions) and distant storage and redemption centres increased farmer logistics and transaction costs. This discouraged many from participating in the scheme and monitoring delivery activities. With limited farmer oversight, agro-dealers exploited the gap by altering input quantities and prices, adulterating products, and supplying substandard inputs.

Farmer-related constraints also existed. Many targeted farmers lacked the funds to pay for subsidized inputs, which sometimes exceeded the initial estimates in step 1. This financial gap led to their exclusion and encouraged input leakage, exploited by agro-dealers in conjunction with commercial actors and non-farmers.

In Nigerian ports, outdated amenities, inefficient customs clearing and sub-par haulage systems caused delays in fertilizer procurement and blending.<sup>25</sup> Only 10% of shipments were cleared within two days; most took two to three weeks. Although the government reduced tariffs and tightened regulations, these measures failed to speed procurement or clearance. Fertilizer transport costs were also high due to long distances and poor infrastructure. Since the main ports were in Lagos, input companies had to transport agro-inputs over long routes, increasing risks of theft, accidents, and vehicle maintenance costs.<sup>26</sup>

Corruption and bribery also hampered SISP. Bribes were common at ports to speed clearance. Transporters using unbranded trucks bribed police at frequent checkpoints (about every 6 km). Those who refused faced impoundment or long delays, which slowed SISP operations and caused stockouts at redemption centres. These illegal costs led companies to inflate subsidized prices (step 36).

Over-invoicing by agro-dealers was another challenge, as they exploited loopholes to increase payments. Although reconciliation committees helped to curb this, the process delayed payments to agro-dealers, forcing agro-dealers into cash-and-carry arrangements that slowed subsequent SISP operations and programmes. Despite some improvements, bribery and corruption remained persistent bottlenecks within the SISP. However, compared to FISP, these challenges were less widespread, mainly occurring during input procurement rather than across the entire supply chain.

## 5 | DISCUSSION

The study builds on existing research (Liverpool-Tasie, 2014b; Liverpool-Tasie et al., 2017; Mason et al., 2013; Takeshima & Liverpool-Tasie, 2015) to examine the implementation of the e-wallet SISP and identify challenges that limit its effectiveness. Our results show that over 20 stakeholder groups from the public, private, and community sectors implemented the e-wallet SISP across five stages: policy design and ecosystem finalization; pre-procurement; procurement; input handling and distribution; and delivery and utilization. The ICT-based SISP attracted private actors, reduced corruption, improved targeting and transparency, and ensured the timely delivery of agricultural inputs compared to FISP. Unlike the frequent challenges observed in FISP<sup>27</sup> and similar programmes—such as fund misappropriation, bribery, procurement leakages, and other forms of corruption (Birner et al., 2011; Chinsinga & Poulton, 2014; Liverpool-Tasie & Takeshima, 2013; Lubungu & Birner, 2018; Raabe et al., 2010; Tiri et al., 2015)—this study finds that the e-wallet effectively curbed these problems where they had previously occurred in past ISPs. However, persistent obstacles remain, including an inconsistent institutional environment, weak arrangements, and inadequate funding, a critical finding overlooked by previous ISP studies (Michael et al., 2018; Olomola, 2015). While these studies identified moral hazards such as input leakage, adulteration, and diversion, elite capture, and exclusion as major issues, our study goes further. It identifies weak institutional arrangements and environments as a central challenge that allows these problems to persist. The study also pinpoints where these challenges emerge and shows that they have shifted to new stages under the e-wallet SISP. We discuss these key challenges below.

<sup>25</sup>[AD1-2; AIU1-6]

<sup>26</sup>[KSMoA-ADP1; KSMoA-FO1-2]

<sup>27</sup>See Table S1 in the supplementary file for input programmes comparison.

The study shows that poor institutional arrangements and limited stakeholder capacity in the NIS severely hindered the implementation of the scheme, mirroring the challenges documented in other developmental programmes (Adetoyinbo et al., 2022; Arevalo, 2016; Birner et al., 2012; Daum & Birner, 2017; Ilukor et al., 2015; Lillesø et al., 2018; Lubungu & Birner, 2018; Marjanovic et al., 2013; Poku et al., 2018; Raabe et al., 2010). Weak collaborations between political actors, such as state and federal governments, together with limited human, technical, and physical capacities in public agencies such as ADPs and NARIs, undermined the SISP innovation system and its implementation. This insight, largely overlooked in earlier ISP research, is further underscored by the absence of functional feedback and reporting channels. In particular, the lack of mobile call services for smallholders caused errors and delays in reports to managing actors such as IFDC and Cellulant. Consistent with previous findings (Benjamin et al., 2021; Chirwa & Dorward, 2013; Stenholm et al., 2013), such weaknesses slow administrative processes, weaken coordination, and obstruct the ability to design and adapt policies to local contexts.

Moral hazards such as input leakage, adulteration, and diversion by private and community actors also occurred, mostly during delivery, a phase different from where they appeared in the FISP. Similar challenges arose in India's NREGA programme (Raabe et al., 2010) and Uganda's post-conflict programmes, where inadequate supervision budgets allowed unchecked distribution of adulterated and substandard inputs. Contrary to the assumption that moral hazard problems end at delivery (Arevalo, 2016; Birner et al., 2011, 2012; Chirwa & Dorward, 2013; Lubungu & Birner, 2018; Raabe et al., 2010), we find that beneficiaries (smallholders) also diverted subsidized inputs. They did this either by round-tripping with agro-dealers or by reselling to other middlemen and commercial farmers.

Elite capture and exclusion by private and community actors were also prevalent, beginning at registration and continuing through to delivery. This aligns with findings by Jayne et al. (2018) and Chinsinga and Poulton (2014), which suggest that households with larger landholdings and political ties to FO and CO leaders received a disproportionate quantity of subsidized inputs, limiting farmers' overall coverage and redemption rates in SISP. Similarly, Pan and Christiaensen (2012) document how elite capture undermines targeting in Tanzania's ISP.

SISP also suffered from delayed and inconsistent public funding, paralleling problems in FISP and Zambia's livestock vaccination programme (Lubungu & Birner, 2018). Inadequate funding is a common challenge in SSA development programmes, where political actors do not provide consistent funding to public institutions (Adetoyinbo et al., 2022; Ghins et al., 2017; Poku et al., 2018). For example, Daum and Birner (2017) found that Ghana's agricultural mechanisation programme suffered market failure largely due to insufficient rural finance.

Although these challenges are well known from FISP and earlier studies (Dorward, 2009; Liverpool-Tasie & Takeshima, 2013), their unpredictable emergence in new SISP phases has been overlooked. Many challenges surfaced late in implementation due to poor institutional collaboration and weak reporting, either directly through institutional interaction or mobile call service, exposing major gaps in the e-wallet SISP. As the SISP ecosystem was primarily designed to tackle the FISP challenges related to public procurement and delivery, it created rigid structures highly dependent on public and private actors. Consequently, farmers, FBOs, and COs were not sufficiently integrated, leading to inorganic structures and processes that could not adapt to new challenges in the SISP e-wallet. In addition, the ICT solution was mainly used to improve targeting and performance evaluation, but was not applied effectively to monitor activities and reporting. This inflexibility and the narrow focus on the FISP challenges led to the neglect of new challenges and mixed results across phases. Although adoption of ICT initially improved targeting, allowed integration of private actors, and reduced corruption and financial misappropriation (Jayne et al., 2013), it ultimately gave way to low farmer coverage, low redemption rate, input diversion, round-tripping, and delivery delays (Liverpool-Tasie et al., 2017; Olomola, 2015; Takeshima & Liverpool-Tasie, 2015). These challenges could have been avoided if farmers, FBOs, and COs had been better integrated, if institutional collaboration and support had been consistent, and if ICT had been used at all stages of the scheme.

Ultimately, these rigid SISP systems and their challenges benefited three groups. First, some agro-dealers profited from input leakage and diversion, devising means to resell subsidized inputs at market prices (Liverpool-Tasie, 2014a; Olomola, 2015), while also charging farmers extra fees at delivery for immediate financial gain.

Second, elite capture allowed CO and FBO leaders and their relatives to secure more subsidized inputs through inefficient registration and delivery. Although the ICT-based SISP reduced this challenge compared to FISP, Liverpool-Tasie (2014b) found that CO and FO group leaders and their relatives received 1.6 bags of subsidized fertilizers more through e-wallet SISP than the average recipient. Third, commercial farmers and non-farmers, including agro-input traders, gained by buying subsidized inputs from farmers at redemption centres. Similar diversion patterns exist in Kenya, Malawi, and Zambia, where 33% of subsidized inputs are diverted at the wholesale level (Jayne et al., 2013), and in Nigeria, where diversion rates have exceeded 50% (Liverpool-Tasie & Takeshima, 2013).

## 6 | CONCLUSIONS AND POLICY RECOMMENDATIONS

This study examines the implementation and organizational challenges of Nigeria's e-wallet subsidy programme, one of Africa's e-smart SISPs. Content and Process Net-Map analyses identify over 20 private, public, and community actors involved in 43 activities. The scheme outperformed traditional FISP by attracting private actors, reducing corruption and financial misappropriation, and improving recipient targeting, which boosted productivity.

However, key objectives of the programme, such as reaching targeted rural farmers, increasing redemption rates, shortening time to market, and improving overall agricultural productivity, were not achieved due to five main challenges. These included inconsistent institutional environments; weak institutional arrangements among private, public, and community stakeholders (e.g., poor collaboration and limited capacity); inadequate funding; moral hazards such as input leakage, round-tripping, adulteration, and diversion; and elite capture and exclusion. Institutional constraints, such as a rigid design and stakeholders' narrow focus on eliminating only FISP-related problems, limited the programme's ability to adapt and overcome these bottlenecks. Since no single fix exists, as each organizational structure has its limitations, effective implementation requires flexible structures and complementary roles among market, state, and community stakeholders (Adu-Baffour et al., 2021; Daum & Birner, 2017; Henderson et al., 2020).

Therefore, policy-makers should foster a conducive institutional environment for NIS by clarifying the roles of stakeholders and ensuring coherent policies across government levels. Strengthening the capacity of public and private stakeholders in rural areas through increased funding to public institutions like ADP, NASC, and NARIs and enhancing technical and human capacity with training and hiring is essential. Timely fund disbursement by federal and state governments is also critical for effective programme implementation and delivery. Private actors, such as input suppliers and farmers, also need affordable loans and political support to sustain input market participation.

To improve weak institutional interaction, collaboration between FMARD, state governments, research institutions, national maize associations, and rural farmers must be improved. This will accelerate planning, tailor implementation to state and local realities, and reduce risks, encouraging impactful entrepreneurship among private actors (Adetoyinbo et al., 2022; Lillesø et al., 2018; Stenholm et al., 2013). Regular stakeholder consultations and policy meetings should be held to facilitate ongoing exchanges between public and private actors.

Considering the flexibility required to address challenges in development programmes, policy-makers and private stakeholders should hold regular meetings. These meetings should review implementation, identify new problems, and develop adaptation strategies. This will be critical for the successful implementation of the ongoing PFI in Nigeria. Establishing an adaptable multi-level innovation platform with representatives from all sectors can enable collaborative and independent problem-solving.

To curb moral hazards such as round-tripping, elite capture, and exclusion in SISP and other developmental programmes, it is vital to expand and update farmer databases. Integrating mobile technologies and providing information in local languages will make registration, input handling, and distribution "smarter" and more adaptable, minimizing data errors and reducing elite capture and manipulation. For example, enabling

agro-dealers and farmers to input data on supplied and received inputs could enable the reconciliation committees to verify ward-level progress in real time, cutting entry points for elite capture, exclusion, and diversion. Smart tools, such as Time-Tracker (Daum et al., 2019), can be adapted in ISP and other developmental programmes to track and monitor farmers' activities until input utilization. Complementary policies such as buy-back programmes and yield-based rewards can incentivize proper input use by farmers, while rural extension appraisals track on-farm activities.

From the start, the organizational structures of SISP and other input-related programmes should be flexible and organic at every stage, involving private, public, and community stakeholders. Strong partnerships between these sectors can ensure that beneficiaries receive timely information and facilitate affordable local warehouses and market systems. In addition, supply-chain managers and private service providers in development programmes must proactively address challenges and respond with practices grounded in real-world business realities.

One major limitation of this study is its dependence on qualitative data from a small number of SISP actors, most of whom operate under the same supply-chain manager. Although we validated key findings through feedback from experienced stakeholders and experts involved in the design and implementation of the programme, this weakness may limit the diversity of viewpoints and the applicability of our results in other contexts. However, the insights gained provide valuable contextual understanding that previous research or broader surveys all too often miss.

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## CONFLICT OF INTEREST

The authors have no conflict of interest to disclose.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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