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ACTORS, ROLES AND INTERACTIONS IN THE INNOVATIONS DEVELOPMENT PROCESS FOR SMALLHOLDER FARMER AGRICULTURAL FINANCING SOLUTIONS IN UGANDA

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ABSTRACT

In Africa, financial institutions involved in agricultural financing are challenged by smallholder farmers' low consumption of agricultural finance facilities. This leads to marginal investments that translate into low agricultural productivity, low gross domestic product, and limited employment opportunities that lead to inconsistent community development. Introducing collaboratively driven innovations through actor networks in the innovation development process for financing solutions for smallholder farmers facilitates the development of competencies that improve performance through effective communication between the actors and end-users. Therefore, this study aims to assess the innovation development process that led to the development of smallholder farmer financing solutions (Innovations) for smallholder farmers' consumption of agricultural finance. The authors adopted the qualitative research design, specifically through case studies to gather detailed and contextual insights from respondents about the actor's involvement and/or experience in the financial solutions development process for financial solutions and how the process addresses the consumption of agricultural finance. Data collection was conducted through focus group discussions and key informant interviews. Findings indicate that smallholder farmers, as the ultimate users of these financial solutions required greater involvement in the development process to ensure that the resulting innovations effectively met their needs. Various actors exhibited different roles and interests throughout the process, highlighting the power dynamics present within the Financial Solutions Development network. Notably, the Centenary Bank and the World Bank emerged as the most influential entities, significantly impacting the selection of participants in the development process. The study underscored the immense value of diverse actor networks in fostering successful innovation development.

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INTRODUCTION

Introducing innovation ecosystems and cooperative frameworks aimed at developing solutions to address evolving societal challenges marked a pivotal moment in the quest for viable societal responses. (Hartley et al., 2013; Torfing, 2019). The capacity of these innovation collaborations to purposefully align organizational strategies to societal challenges enhances competitiveness and promotes the utilization of their products and services. (Adner., 2017; Autio and Thomas,

2022; Baldwin, et al. 2024). Actor collaboration and interdependencies depend on actor importance, and it is, therefore, the reason why diverse actors are included to realize the innovation and are the foundation of collaborative innovation. (Klijn and Koppenjan., 2004; Meijer et al., 2014; Torfing, 2019). Leveraging transdisciplinary collaboration between different actors, each contributing with their knowledge, capabilities, and resources, is critical for innovation development. (Meynard et al., 2012; Hermans et al., 2013; Busse et al., 2014). Innovation is now perceived not merely as an isolated occurrence but as an ongoing process that customizes various innovations within the agricultural sector. (Lundvall, 2016; Balafoutis et al., 2017). Such innovations encompass advancements in farming technologies and agricultural financing solutions designed to boost smallholder farmers' access to financial resources, with implementation varying based on specific farm contexts and technologies involved. (Kernecker et al., 2021). Agricultural innovations can stem from collaborations among multiple actors, with their roles and interactions likely shaping the nature of new agricultural financing practices. Understanding who participates and how in these innovation processes can yield deeper insights into how innovations cater to the varying needs and contexts of different actors. (Klerkx et al., 2020; Wittmayer et al., 2017). This understanding can potentially mitigate uncertainties related to technologies or resources that may arise during innovation processes. (Klerkx et al., 2010). Therefore, financial institutions transitioning towards developing innovations in agricultural finance must explore the actors' roles in the innovation development processes shaping agricultural innovations. The study considers the financing solutions for smallholder farmers as an example of agricultural innovation owing to the involvement of digitization, which merits in-depth analysis. (Klerkx et al., 2012; Carolan, 2018a). The innovation development process was examined through the lens of the agricultural innovation system framework, which operates as a network of actors categorized by their interactions.

Innovation processes are sustained by actors and their roles in the innovation network that underpins the social approach. Under the social approach, multiple actors with differing resources apply new practices and bring new benefits to users. (Almekinders, 2011; Hawkins et al., 2009). This approach focuses on integrating various stakeholders, their resources, and knowledge, just like the Agricultural Innovation Systems thinking vouches for institutions coordinating actions and practices in the innovation process. (Spielman et al., 2010) argue that the efficiency and effectiveness of actors interacting in a given innovation system and or network will largely determine the future of technological development and the financial system. In line with this approach, the Bank of Uganda has emphasized the need to involve multiple stakeholders to meet regulatory requirements as innovative forms of financing development. Agricultural finance plays a vital role in financing the local production activities of smallholder farmers. A significant level of interconnectedness within the network facilitates effective exchange of information throughout the actor network and is associated with the development of influence via social capital and trust (Bodin et al., 2017; Hu et al., 2022; Yi, 2018). This influence is derived from the contributions of actors and the responsibilities they are anticipated to fulfil in the process of innovation development, particularly those of farmers, who are crucial participants in these processes and typically serve as the end users of the innovations. (Dolinska and d'Aquino, 2016; Hoffmann et al., 2007; Meynard et al., 2012). Consequently, the roles of actors may evolve, allowing them to assume multiple roles throughout the innovation process. (Wittmayer et al., 2017; Hall et al., 2017).

According to the principles of the Agricultural Innovation System, a vital component of an innovation network is the interaction among various participants. Within this co-innovation framework, stakeholders collaboratively pinpoint challenges and devise specific solutions through a collective learning experience that emphasizes knowledge exchange (Nederlof et al., 2011; Dogliotti et al., 2014). Consequently, innovations do not emerge in a vacuum, nor are the innovators the exclusive drivers of progress. Numerous other elements are essential, including policies, regulations, infrastructure, financial resources, and market trends. (Klerkx et al., 2012). The value of collaboration or co-innovation in advancing agricultural development is now recognized on a global scale. (FAO, 2014) and is also reflected in the policy discussions within the European Union. Due to the significance of interactions among actors, digital platforms have been created to enhance these interactions, which might otherwise be overlooked during the innovation process in a society that is

becoming increasingly fragmented. (Castells, 2000; Geuijen et al., 2017). This advancement highlights the necessity for strategic partnerships and collaborations between organizations to optimize value. (Agger and Lund, 2017; Bommert, 2010). A critical element of actor interactions is the sharing of knowledge within the network. Much of the innovation related to on-farm technology or food retail occurs through knowledge exchange among actors in the value chain, particularly those in the private sector, such as input suppliers and food processors. (Swinnen and Kuijpers, 2019). Additionally, knowledge sharing between farmers. (Johns et al., 2007; Oreszczyn et al., 2010) and various other stakeholders (Hamunen et al., 2015) can promote co-innovation.

The nexus for the innovations development process and smallholder farmer consumption of agricultural finance.

The financial solutions development process for Centenary Bank was a process that resulted in the development of financial solutions to increase the consumption of agricultural finance by smallholder farmers. Financial solutions were an improvement and replacement of the legacy financial products that were consumed less by smallholder farmers. As expected, the consumption of innovations depends on the ability of the innovation process to generate value for end users through different stakeholders and other actors in the value network (Stier et al., 2017). Conceptually, innovation through the developed financial solutions influences smallholder farmers' consumption of agricultural finance facilities. The financial solutions development process was considered an innovation because it was effective and added value through the refinement and creation of financial solutions that replaced the legacy agriculture products that were effectively and widely availed to smallholder farmers across the country to solve their financing needs for increasing productivity in their farms.

Centenary Bank thus developed the financial solutions development process to address the quality of product innovations emerging from this process, address smallholder farmer needs, and thus increase smallholder farmers' consumption of agricultural finance facilities. Despite the involvement of actors in delivering their roles in the innovation development process to create well-suited, user-friendly innovations for smallholder farmers (Hoffmann et al., 2007), consumption by smallholder farmers remains disappointingly low. (BoU Annual Report, 2023). The utilization of agriculture finance accounts for 11% of total industry lending and 14% of total lending at Centenary Bank. (BoU, 2020; Centenary Bank annual reports, 2021; FinScope, 2023). The inability of innovative processes to deliver appropriate products to increase consumption is attributable to the minimal traction and successful implementation of farmer involvement. (Hoffmann et al., 2007; Klerkx et al., 2019; Carolan, 2018a; Langbroek and Verhoest, 2024), Inability to accurately determine the extent to which integrating essential actors and their roles in collaborative arrangements results in innovative and consumable outcomes. Some scholars attribute the limitation of consumption of such innovations to fragmented innovation networks lacking in that lack conceptual coherence, hindering the establishment of a cohesive theoretical framework. (Phillips and Ritala, 2019; Gomes et al., 2020; Autio and Thomas, 2022; Carst and Hu, 2023; Baldwin et al., 2024). Additionally, issues concerning data ownership and trust (Jakku et al., 2018), accessibility to and benefits derived from innovations. (Fleming et al., 2018; and Regan, 2019), as well as the identities and roles of farmers as users of innovations. (Lioutas et al., 2019; Kling-Eveillard et al., 2020), further complicate the situation. Similarly, the dynamics between new and existing actor networks play a significant role. (Cofré-Bravo et al., 2019). Consequently, the existing understanding of innovation ecosystems is inadequate in addressing key inquiries, such as identifying the essential actors in a network and their configuration. (Fischer et al., 2022), the distinct roles of these actors within the network (Dedehayir et al., 2018); Carst and Hu, (2023), and the nature of their interactions. The integration of essential actors and their varying contributions and interactions in the value network is crucial for comprehending the dynamics among these actors and their impact on the ecosystem's performance and results (Thomas and Ritala, 2022; Paasi, et al., 2023; Carst and Hu, 2023; Baldwin et al., 2024). Advancements in agricultural finance could stimulate consumption among smallholder farmers, thereby boosting agricultural output, facilitating adaptation to climate change, enhancing income stability, and enabling riskier yet potentially more lucrative investments for income diversification. (Mapanje et al., 2023). Structural improvements in

innovations and development processes, such as that for smallholder farmer products, are inevitable in agricultural development. (Walter et al., 2017; Klerkx and Rose, 2020).

The primary research question underpinning this study was: "How does the innovation development process for agricultural finance solutions address smallholder farmers' consumption of agricultural finance, and with what implications?". The study, therefore, discusses how the financing solutions development process addressed actors' dynamics and their contribution to the smallholder consumption outcome. It thus contributes to literature the profound appreciation of actors and their interactions in the innovation development networks and how they might change during the development of financial solutions. It underscores the necessity to dissect the Financial Solutions Development Process as a dynamic element, appreciating its evolutionary aspect that, in turn, influences smallholder farmer consumption of agricultural finance facilities. It illuminates the actor roles in the Financial Solutions Development Process, making connections between analytical frameworks and suggesting a theoretical proposition that advances the conversation regarding how smallholder farmers utilize agricultural finance. Analyzing the solutions development process offers valuable insights that can shape and affect the adoption of financial innovations.

METHODOLOGY

Study design

This study employed a qualitative research approach (Sarantakos, 2013); (Yin, 2013) to assess how the development process of financial solutions, actor roles, and stakeholder interactions affect agricultural finance consumption. A qualitative research design was most relevant as it helped better understand the constructed reality of the innovation's development process and how reality is shaped in different contexts. The case study of Centenary Bank offers a thorough description and analysis of the financial solutions development process, emphasizing the involved parties, their interactions, and their perspectives. This study is from the category of case study tools Stake, (1995).

Study area

The research was conducted at Centenary Bank's headquarters at Mapeera House in central Uganda and Centenary Rural Development Bank's branches in Mbale and Kapchorwa in eastern Uganda. The headquarters was carefully selected to engage with the head office members of staff, who are and were directly involved in the innovative lending development process and have the necessary information on innovative lending. Mbale and Kapchorwa branches were selected because they contributed to increasing the number of agricultural finance consumers. A potential assessment report prepared by the Bank's strategy department points to the untapped potential of agricultural finance in eastern Uganda, citing the need for production and processing finance. In addition, the eastern branches contribute 40 per cent of the interest income from the agricultural finance portfolio. Understanding the perceptions of smallholder farmers will increase the Bank's community-generated business in its Mbale and Kapchorwa branches. In eastern Uganda, there is widespread indifference to smallholder borrowing, which explains the large discrepancy between high agricultural financing potential and the actual low consumption. In contrast to western Uganda, where the average loan size is over 15 million shillings, the average loan size for eastern Uganda is less than 5 million Uganda shillings, and up to 80% of its borrowers are smallholder farmers. (Business Credit Commission Report, 2022).

Population and sample size

The study population included Centenary Bank staff and some representatives of key players in the innovative lending development process. Agrifin project documentation, including Memoranda of Understanding, project work plans and reports, was reviewed, and a preliminary meeting was held with the Centenary Bank Headquarters team to guide the selection of the study population. The actors include The Bank, church, development agencies, regulators, and smallholder farmers. Apart from the head office staff engaged as individuals, the relevant business units included the Bank's agribusiness division, the Bank's communications and marketing division, the Bank's credit division, the Mbale branch and the Kapchorwa branch. Each stakeholder representative was specifically selected for their experience, commitment and knowledge of the process that led to the innovative financing. Actors were identified and listed in each category to form a sampling frame. A total sample size of 20 respondents aligned

with the minimum size of qualitative studies was selected. These studies such as Rijnsoever (2017), Young and Casey (2018) and Wutich et al. (2024) imply that the minimum sample size in qualitative research varies due to the type of saturation attained, where theme saturation will be realized by way of 6-9 interviews. In other words, saturation requires 16-24 interviews, and theoretical saturation needs 20-30+ interviews, all equally hinting at the fact that, indeed, context, methodology, and information power come into play with sample size.

Data Collection

The data collection tool was developed after an extensive documentation review and related literature obtained from the Bank. To ensure content validity, the toll was examined by experts in agricultural finance to assess whether the items on the tool were representative of the constructs they aimed to measure to cover the full range of the concept. In addition, the tool underwent professional review by expert colleagues and university supervisors regarding their opinions on the representativeness and adequacy of the questions. Criterion-related validity was achieved by comparing the results of the tool against established measures to ascertain if similar results emerged. Construct validity for the tool was achieved by reviewing its ability to capture the theoretical concepts it was designed to measure truly. Reliability was achieved through triangulation, leveraging multiple sources, data and perspectives to enhance the credibility and validity of the research findings.

Data was collected using qualitative methods, including in-depth interviews with 20 key informants, including the agribusiness employees at Centenary Bank headquarters, branches, marketing, catholic church, and regulators involved in the innovative lending development process. A semi-structured tool with open-ended questions was applied as an interview guide, intertwining the predetermined questions alongside the opportunity to propose and ask follow-up questions. The semi-structured instrumental format also allowed for extensive research, a wide range of responses, and the emergence of different perspectives (Cox and Sseguya., 2015). Interviews were conducted face-to-face with the respondents describing their experience in the process. With the respondent's consent, a digital voice recorder was used to protect recorded notes during interactions with interviewees.

Data Analysis

Qualitative data were collected in English using a digital recorder and transcribed for analysis. Following Braun and Clarke (2006), open codes were assigned to the individual narratives, which were grouped into categories and later constituted themes that shaped the study results. Data were analyzed using thematic content analysis using Nvivo software and the Network visualizer, and the network analysis was done using UCINET software. The analysis leveraging the software provided output including emerging themes such as the actors, actor roles and actor diversity, anecdotal evidence, supporting narratives provided and network maps to understand the nature of interactions between actors, centrality measures including the network density, average degree and average path length were used to measure the strength of actor interactions and utilization of potential relationships in the innovations network.

Ethical Consideration of the Study

Makerere University, Uganda and the College of Agricultural and Environmental Sciences research ethics committee approved the study and engagement with respondents as required for all research involving human respondents. Smallholder farmer and Centenary Bank staff participation in this study was voluntary. Consent was obtained from each respondent, along with Centenary Bank's permission. The Centenary Bank consent was critical because the study uses confidential primary and secondary data for Centenary Bank clients. Interviews were carried out in both English and Swahili. Before data collection, the purpose of the study was explained to the respondents, and they were assured that the data collected would be treated confidentially, analyzed anonymously, and used for research purposes only. Based on this, the interviewees were asked for their verbal informed consent to participate.

RESULTS AND DISCUSSION

The research highlights three fundamental themes that are central to the financial solutions development process. These themes encompass the nature of the actors, actor roles, and actor interactions, which are

examined in conjunction with the identified gaps related to the various stages of the process.

The nature of actors and roles in the Solutions Development Process

The financial solutions development process for agricultural finance products was a complex, linear six-stage process presided over by diverse actors with incomprehensive roles. Different activities with various outcomes were executed at the different nodes, as described in Figure 1. As per the agricultural innovation system's thinking, missing actors within the research domain include national, private, and international research.

Organizations

Other missing actors include private companies, tenable in the Enterprise domain; trade farmer associations and education systems domiciled under the support systems domain; and professional networks of farmer associations under the support structure domain of the agricultural innovation system. Innovations development actors alongside the missing actors are described in Figure 2.

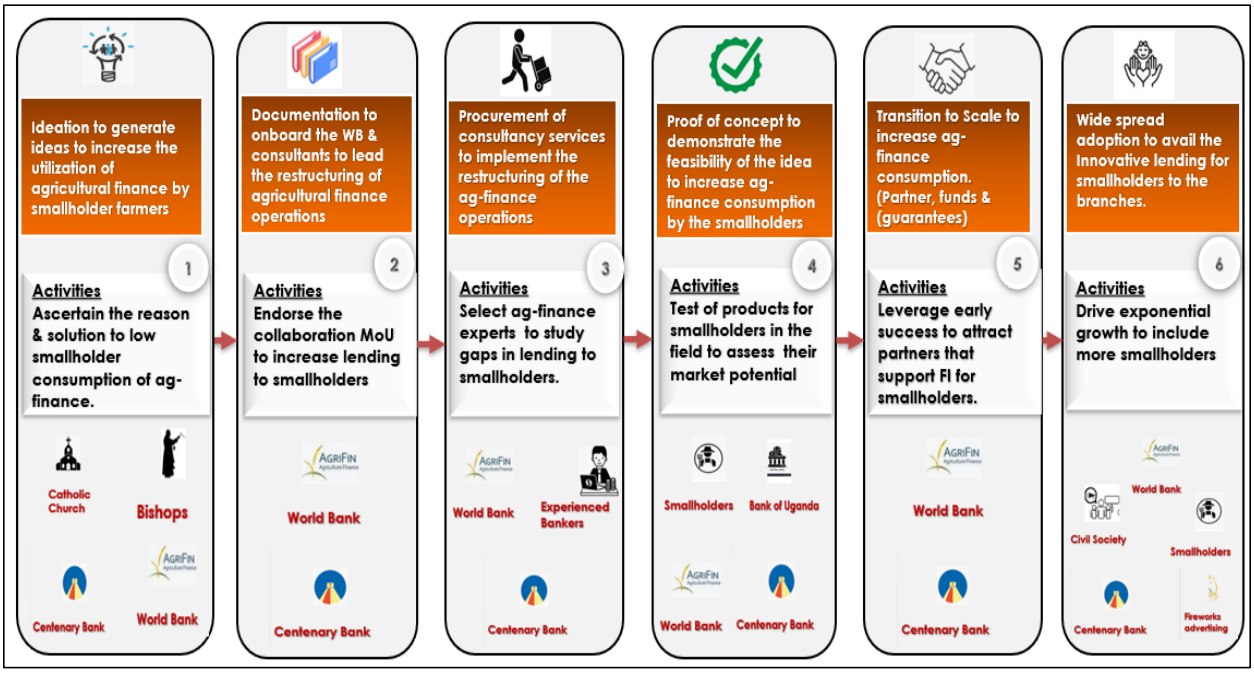

Figure 1. Actors, actor roles, and activities in the innovation development process for financing solutions for smallholder farmers.

According to the Agricultural Innovation System, national, private, and international research organizations produce codified knowledge relevant to improving the innovation process and its outcomes. Private companies provide the market for smallholder farmers' produce through bulking agents, whereas farmer associations support the bulking process and seek competitive markets for farmer produce. These two actors could have provided market contexts for smallholder produce and the confidence through agricultural value chains to de-risk lending to farmers and thus increase the consumption of smallholder loans against their strength.

Owing to the linearity of the financial solutions development process, it emerged that recursive feedback loops among the actors, especially the smallholder farmers, were needed to foster informed consensus within the innovation network actors, as expected in the agricultural innovation system thinking.

> *"I do not recall the involvement of farmers at the initial stages of the development process. A few of them were contacted after products were developed."*
> *Agribusiness Manager, Livestock at Centenary Bank H.O.*

Agricultural Innovation Systems represent a collaborative method for generating innovations, where stakeholders within a specific area engage with one another to interact, collaborate, and coordinate their efforts. This collective endeavor aims to produce new knowledge, technologies, and practices that facilitate desired transformations. Co-innovation strategies are more effective in promoting various changes that necessitate the reorganization of production systems and value chains compared to traditional linear methods. (Saravanan and Suchradipta, 2017). Contrary to AIS thinking, which requires the innovation process to generate and select opportunities for farmers (Girotra et al., 2010), the process focused more on local artisans and trading firms, with a limited focus on farmers.

> *"I do not recall the involvement of farmers at the initial stages of the development process. A few of them were contacted after products were developed."*
> *Agribusiness Manager, Livestock at Centenary Bank H.O.*

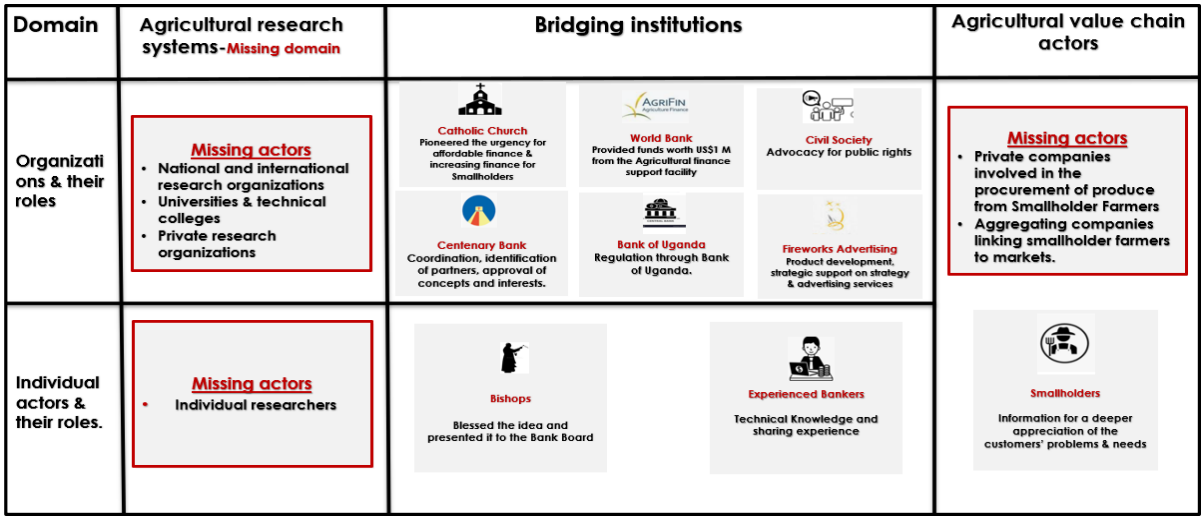

Figure 2. Innovations development process actors alongside the missing actors in the financing solutions development process in the consumption of agricultural finance.

It is thus not surprising that the outcomes of the financial solutions development process were unable to increase agricultural finance consumption. Leveraging the value from the agricultural research actors would have improved the innovation process for financing solutions and, therefore, smallholder farmers' consumption of agricultural finance. As expected in the AIS, bridging institutions in the Financial Solutions Development Process comprised the public sector (Central Bank), private sector (World Bank, Abi finance, consultants, fireworks), and civil society.

Missing roles and their importance in the innovations development process

The roles and activities in the Financial Solutions Development Process were incomprehensive, as shown in Table 1. The roles and, therefore, executable activities of the Agricultural research system actors, agricultural advisors and facilitators were not included. The absence of the critical tasks above implies that the smallholder farmer demand was never established, and there would be challenges with developing and diffusing the innovations emerging from the process, which explains the low consumption of agricultural finance by smallholder farmers. According to the AIS, agricultural advisors engage with various stakeholders, including producer organizations, private sector participants, agricultural research institutions, educational systems in agriculture, suppliers of inputs and services, and providers of financial services. Conversely, the Agricultural Innovation System (AIS) emphasizes the critical role of facilitators. These facilitators enhance the co-production of innovation by identifying the appropriate network of stakeholders, defining the activities and roles involved, clarifying the vision and objectives to be achieved, and organizing participants to ensure the network operates

effectively through negotiation and ongoing alignment. Innovation brokers are essential within these innovation networks, as they help farmers connect with diverse service providers and other stakeholders in the system. The responsibilities of an innovation broker encompass assessing the context of innovation systems, articulating needs, forming networks, and facilitating interactions (Klerkx and Gildemacher, 2012).

Actor interaction and linkages in the Innovations development process.

The analysis of the social network indicated that there were 41 connections/ties among the ten participants in the innovations network. These connections demonstrate the presence of linkages and interactions about the flow of information and physical resources, including financial support and materials (Figure 3).

Table 1. Actor roles and missing roles in the financing solutions development process to increase agricultural finance at Centenary Bank, Uganda.

Actors	Actor domain		
	Enterprise domain	Demand domain	Support Systems
Actor roles in the ILD process	Farmers: Information and feedback to shape products.	Farmers: Feedback and consumption of agricultural finance.	Centenary Bank: Develop and extend agricultural finance to Smallholder farmers
		Bank of Uganda: Regulation to provide fair rules of the game for financial institutions lending to Smallholder farmers.	Fireworks Advertising: Marketing and advertising plans for smallholder products under agricultural finance
			Catholic Church: Pioneered the idea of affordable agricultural finance for rural dwellers, targeting smallholder farmers as the Bank's mission-critical portfolio.
			Bishop/Cardinal: Blessed the idea of affordable finance and created urgency for the Board and management to execute the idea.
			Experienced Bankers: Offered technical knowledge about agricultural financing and knowledge transfer to Bank staff.
			World bank: Provided funding worth U.S. 1M (Agricultural finance facility.)
Domain	Enterprise domain	Research & Development Domain	Support systems domain
Missing roles	Private companies: They offer a market for farmers' produce and anchor the agriculture value chain, de-risking lending to farmers.	Private research organizations: Offer knowledge for the strategy to increase agri-finance consumption.	Trade farmer associations: Encourage bulking of farmer produce to influence better pricing for smallholder farmer produce
		National & International Research: Offer knowledge to Banks to inform strategy planning and development.	Education systems: Offer training services to actors involved in the development process for agricultural finance innovations, such as the FSDP development process

From the analysis, it was found that 32 out of 41 ties (78%) exhibited reciprocity, indicating the presence of both outward (out-directed) and inward (in-directed) connections among the participants in the innovation development process. While the actors were interconnected for a variety of reasons and to differing extents, knowledge emerged as the essential element linking them together. In this context, Ramirez (2013) posits that the exchange of knowledge is integral to the interactions among the actors. This mechanism is the primary means through which networks impact and shape emerging technologies, such as the Bank's Financial Sector Development Plan (FSDP). Given the diverse nature of the information exchanged among different categories of actors and the various stages of the innovation development process, a deeper examination of the nature of actor networks at these different stages was conducted. The expanded analysis indicated that actor networks evolved as the innovation progressed. Furthermore, the requirements for information and resources varied with each stage, reflecting distinct factors related to actor interactions.

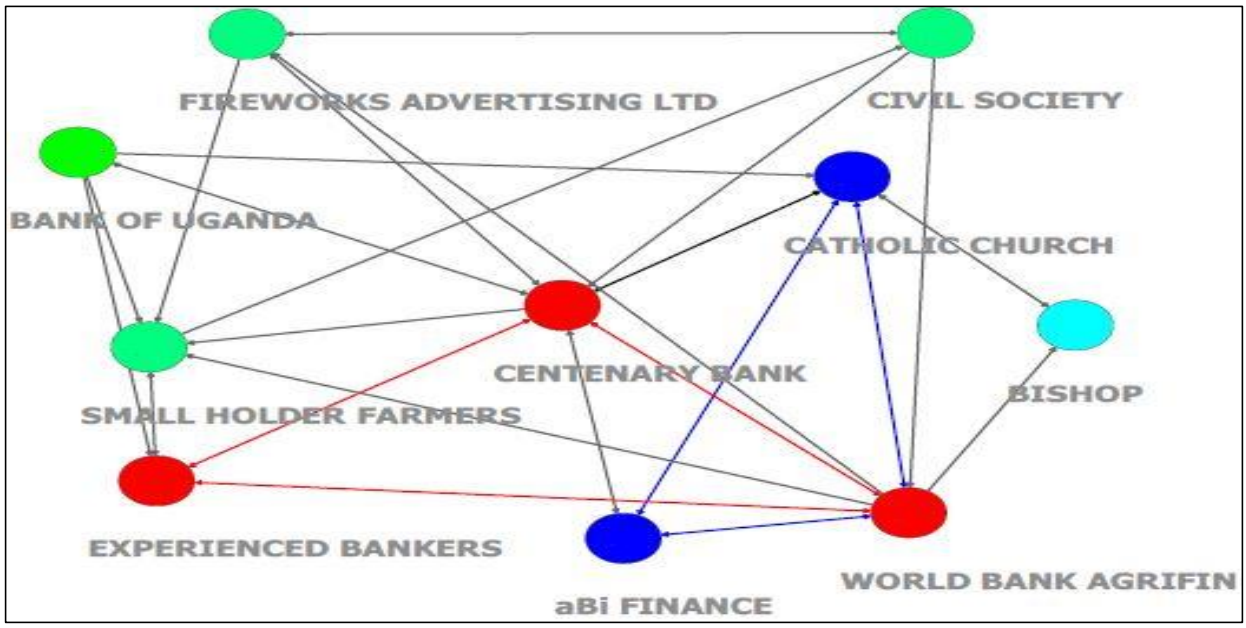

Figure 3. Network map between innovation development actors for information and tangible resources.

Structural positions of actors in the innovations development network

Analysis of the structure of the innovation development network revealed the presence of two primary cliques focused on the provision of technical knowledge and physical resources. Findings indicate that Centenary Bank played a pivotal role in the network's effectiveness and maintained strong connections with other supportive entities, including the World Bank. These organizations were highly interlinked, creating multiple connections that established the two principal cliques within the innovation development network (See Figure 4). Conversely, smallholder farmers exhibited the fewest connections within the network, suggesting their weak ties to other participants in the Financial Sector Development Program (FSDP) network. Consequently, this results in limited access to information and resources necessary for adopting new agricultural finance products, emerging from the innovation process as well as insufficient feedback from smallholder farmers to guide decisions throughout the innovation development process. Cliques within networks represent the largest number of nodes that maintain all possible connections among themselves (Spielman et al., 2010). The strength of ties in a network emerges when individuals with strong and multiple connections tend to form cohesive groups that engage frequently and establish shared norms. Dowd et al., (2014). Network cliques present both opportunities and limitations due to existing power dynamics. Hanneman, (2001). The position of individuals within the network can either enhance or restrict their capacity to exert influence.

Mulema, (2012). Actors possessing a broader range of resources and opportunities, such as development agencies and financial institutions, tend to have a greater impact on decision-making processes within the network compared to others. Likewise, actors who hold a more central position in a network are more likely to serve as significant sources of information and knowledge Ramirez, (2013). Such participants pursue their interests with minimal consideration for the interests of others within the network. This dynamic may hinder the integration of knowledge from various stakeholders, particularly end-users, which is essential for the development and application of technology. Eidt et al., (2012). As innovation is inherently a systemic endeavor, it necessitates a network approach that facilitates the involvement of different actors while allowing for the amalgamation of their varied insights (Leeuwis and Aarts, 2011). Consequently, farmers' roles within this network can both create opportunities and impose limitations concerning the utilization of agricultural finance. Currently, farmers' positions in the innovation development network indicate they face challenges such as restricted access to information and resources, limited opportunities for feedback, and fewer connections with other stakeholders. These factors are crucial for improving the utilization of agricultural finance. Implicitly, the process of innovation development is predominantly influenced by actors focused on support rather than by the end-users themselves.

The strength of links in the innovations development network

The innovation development network exhibits a density of 0.455, signifying that merely 45.5% of the possible direct connections among potential participants are present within this network. This metric reflects weak connections among the various categories of actors involved in the FSDP network. Consequently, this situation reveals that disparities in access to information and resources can negatively impact the FSDP. Actors who are closely and intensively linked within the network benefit from a more effective exchange of information and knowledge compared to those in more loosely connected networks. The relatively weak connections observed in the FSDP scenario suggest a limited exploitation of potential relationships that could otherwise enhance the advancement and utilization of agricultural finance.

> *"At implementation, we realized that the farmers complained about the duration, amounts offered and the repayment modes. Involving the smallholders would have offered the Bank more opportunities to align agricultural finance with farmers' preferences.*
> *An agribusiness specialist for Centenary Bank is attached to Eastern Branches.*

The analysis reveals an average degree of 4.0, indicative of the average number of links for each actor with another actor within the network. The geodesic distance with the longest path of 6.0 and average path length of 1.33 represents the ease with which actors can connect. The support-oriented actors exhibited strong ties and cohesiveness with each other in the network. Support-oriented actors such as the World Bank and Centenary Bank show strong ties and solidarity within the network. The World Bank and Centenary Bank had the shortest path. This is due to the central linking and bridging functions delegated to the network, as evidenced by the number of links.

Table 2. Measures of Network Density for the Innovations Development Process Network.

Measure	Value
Network density (number of ties)	0.455
Average degree (average number of ties a node has to other nodes)	4.0
Diameter (Longest geodesic distance)	6.0
Average path length (no. of links)	1.733

Agricultural finance actors (World Bank and Centenary Bank) serve as trusted sources of information and funding for the diverse actors in the network.

> *"The World Bank and Centenary Bank provided the funds for improving lending operations, so the rest of the actors were at the mercy of the two powerful institutions.*
> *Supervisor Agricultural Credit at Centenary Bank H.O.*
> *"The World Bank had a target of supporting two financial institutions in Africa. The funding was a huge incentive*

for restructuring agricultural finance in East Africa."
Manager of Agricultural Credit at Centenary Bank H.O.

Importance of actors in the Innovations development network

Results of three critical measures, including network degree, closeness and betweenness Borgatti et al., (2013), were used to determine centrality, which measures the importance of an actor in a network by capturing the level of connectedness and status. It also measures the number of ties each node possesses that assist in explaining actors' positions in a network based on them in-degree (prominence) and outdegree (influence). Closeness centrality measures the average of the shortest path link between nodes, one node to every other node in a network. In contrast, the betweenness centrality depicts the number of times an actor is situated at the shortest path of all pairs of actors who are not linked to each other directly. The lower the average shortest path link, the closer a node is to other nodes in a network, and a higher betweenness measure indicates an actor in the most favored network position. Therefore, centrality measures were used to identify the most critical actor(s) with the most direct connections and those that played the most dominant and influential role in the FSDP network.

The degree measures of centrality identify two main actors with the highest degree measures relative to other actors: The World Bank (8) and Centenary Bank (7), as described in Table 3. The World Bank had the highest degree of centrality relative to other nodes and the most direct linkages present in the network.

Table 3. Descriptive measures of centrality in the financial solutions Development process.

Actor	Indegree	Outdegree	Degree Centrality	Closeness Centrality	Betweenness
Bishop	3	2	2.00	0.04	0.00
Catholic Church	5	4	4.00	0.07	11.17
Centenary Bank	7	7	7.00	0.09	23.83
World Bank	6	8	8.00	0.09	15.00
Abi Finance	4	4	4.00	0.06	0.00
Experienced Bank	4	4	4.00	0.07	3.33
Fireworks Advert	3	3	3.00	0.06	2.83
Bank of Uganda	1	3	4.00	0.07	0.00
Small Holders	5	2	2.00	0.05	5.00
Civil Society	2	3	3.00	0.07	4.83

The World Bank had the highest outdegree (influence), while the Centenary Bank had the highest in degree (prominence) and betweenness centrality (favoured position). Bishops had the lowest average shortest path links of 0.04 due to the links with the Bank as representatives on the Board, indicating that this actor was the most closely connected to other nodes in the network. The highest betweenness value of 23.83 for Centenary Bank reflects Centenary Bank as a crucial player in the FSDP network and with the highest potential to connect and control the relations between other actors. Smallholder farmers had the second lowest degree of centrality of 2, confirming the peripheral position and the less privileged position for smallholder farmers, who are the targeted end users of the innovations.

Positions of individuals within networks can constrain or enhance their ability to exercise influence (Mulema, 2012). Actors with more opportunities, such as the Centenary Bank and the World Bank, can exert more influence in decision-making in a network relative to other actors. Additionally, actors with a higher degree of centrality in a network are more likely to be significant channels of information and knowledge (Ramirez, 2013). Centenary serves as a conduit for information among actors in the FSDP network and plays a prominent and influential role in developing agricultural finance products. Although the prominence of the support-oriented actors could be attributed to the technical nature of the process, the diminished level of other actors, such as farmers, depicts their passive role. Ganpat et al. (2009) note that in most agricultural

technology development initiatives, the active role of smallholder farmers needs to be more recognized. In most cases, technology development remains an exclusive domain of researchers, although farmers tend to have considerable interest in the process. This potentially results in a mismatch between innovation development and the consumption of innovations such as agricultural finance products.

The results conform to those of Jasper (2020), who found that input from end users was selectively used in innovation development. Their study concluded that end users, such as retailers, buyers, and hatcheries, were only valued for their input on specific products and issues. According to these studies, their information was not trusted, and it would always require validation from the network drivers, indicating that trust relations in the networks were strongly calculative.

CONCLUSION

The study revealed that process complexity and linearity limit end-user participation in information and resource sharing towards developing effective innovations to drive consumption. Although the Innovations development process was developed specifically to increase farmers' agricultural finance consumption, their participation was minimal. The smallholders should have shaped the process to align the financial solutions to their needs. Study findings further confirm that diverse actors, connectedness and equitable distribution of resources support effective innovations to drive product and service consumption by the targeted end-users. There is immense value in strong actor networks in an innovation development process. In addition, the actors' positions and roles of actors in the innovation network impact the process's performance and, therefore, affect the quality of innovations. In the FSDP, varying interests and roles reflected power relations in the network. Reflecting on the complexity, inefficiency, and process alongside the quality interactions in the innovation development process, it is thus complex for the innovation development process to achieve the desired consumption goal for agricultural finance by smallholder farmers. A pro-smallholder consumption innovation development process should be born out of more inclusive and interactive actor networks with equitable information sharing, and solutions development processes must be developed in a manner that is cognizant of the end user's opinions. Future research should focus on analyzing the perspectives of different actors in agricultural innovation development networks and how this affects their commitment to commercialization and consumption of the resultant innovations. Such studies could also assess drivers of interaction among the different actor categories in agricultural finance innovation development processes.

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DISCLOSURE

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