Agricultural information exchange and service delivery within social networks: evidence from Uganda's banana value chain actors

Stella Kiconco [a, b]; Joseph Benjamin Stevens [b], Kenneth Akankwasa [a] & Jerome Kubiriba [a]

[a] National Agricultural Research Organisation, Entebbe, Uganda; [b] Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Pretoria South Africa

Abstract

Purpose

This study assesses the available networks and linkages for effective information exchange and service delivery among actors in banana value chain and develops a set of specific recommendations for policy, institutional and human resource development.

Methodology

We used an exploratory case study design using Focus group discussions and Key informant interviews for data collection. Data were analysed using Social Network Analysis (SNA) to establish the actors who were influential in facilitating information exchange and service delivery in banana value chain.

Findings

We identified farmer groups and regulatory bodies as the most influential actors for facilitating information exchange and service delivery. However, they were more of recipients than determinants of information and services. Network density results (0.256-

0.283) show low cohesiveness among the actors, implying that less than 30% of the potential linkages are utilised for information exchange and service delivery.

Practical implications

Extension and other practitioners should aim at network building taking advantage of existing knowledge and service linkages with the farmers as mechanisms to help expand and sustain their last-mile reach.

Theoretical implications

SNA is relevant for assessing the contribution of various actors in exchange of appropriate information and services. It recognizes potential networks which hinder or contribute to information and service delivery among the actors.

Originality This paper contributes to literature on systems approaches and institutional development to address the challenges of information dissemination and service delivery among the actors in banana value chain.

Key words: Agricultural Innovation Systems; Banana actors; Social learning theory; Social network analysis; Technology development; Technology promotion

1 Introduction

The African agricultural sector employs 65-70% of the labour force and accounts for 30-40% of Gross Domestic Product (GDP) (The World Bank 2013). Therefore, agricultural growth has a potential to transform Africa's economies through increased food availability, improved nutrition and income of those employed by the sector. Critical to this is the generation, promotion and uptake of improved technologies and practices that increase agricultural productivity (FAO et al., 2021; Zeweld et al., 2018). This implies that there should be

mechanisms in place to facilitate communication and service delivery in order to create awareness, access to, and utilization of technologies.

Despite the multiplicity of available technologies, the growth of agricultural productivity in Africa has been disappointingly low (Breisinger et al., 2011; Pingali, 2012; Matsumoto et al., 2013; Weyori et al., 2017; Thomas, 2020). Several studies partly attribute this to the low use of improved technologies (Pingali, 2012; Weyori et al., 2017; Zeweld et al., 2018). Many authors note that the use of technologies is influenced by access to information and support services, household socioeconomic characteristics, and characteristics of technologies and the village (Sumberg, 2005; FAO et al., 2015; Ndah et al., 2015). The studies give little evidence on the role of actor social networks in facilitating timely access to information and services for utilising agricultural technologies. The use of social network approaches for understanding access to agricultural technologies is relevant because the relationships within social networks affect individual attitudes and behaviours to utilize a technology (Thuo et al. 2014). Moreover, with the increased recognition of public-private partnerships, social networks give a clear position of the key actors with the potential to support and sustain the distribution of technologies (Filippini et al. 2020). In addition, social networks among value chain actors are recognised for providing linkages for information and support services leading to value creation and markets (Kilelu et al., 2017; Mapanga et al., 2017). Such linkages help smallholder farmers to participate in value chain interventions for profitable agricultural investments.

Ngambeki et al (2010), Nowakunda et al. (2010), (Ariho et al. 2015) and Nalunga et al. (2015) identified a number of actors in the Ugandan banana value chain. They can be categorized as: farmer groups, researchers, processors, traders, extension, financial service providers and media. Such actors form a potential network through which access to banana technologies, information, resources and services could be improved. Banana is one of

Uganda's priority crops for sustaining food security (MAAIF 2016). The National Agricultural Research Organization (NARO) and partners have been involved in several initiatives to generate and promote technologies to enhance banana productivity. However, the persistent decreasing trends of banana productivity are still reported in Uganda irrespective of the abundance of technologies (Kalyebara et al., 2007; Katungi, 2007; Akankwasa et al., 2013; Kagezi et al., 2013; Kubiriba et al., 2016; Sanya et al., 2018). Several studies to establish factors affecting banana productivity in the country identified low adoption of new technologies, attributes of banana technologies, farm and farmer characteristics and markets as the major ones (Barekye et al., 2011; Kagezi et al., 2013; Akankwasa et al., 2013; Nalunga et al., 2015; Sanya et al., 2020). In such studies, there is scanty information on the role of social networks in facilitating exchange of information and services for adoption of banana technologies. Social networking among actors improves information exchange and service delivery through creation of linkages for understanding the market trends and drivers; fostering trust and subsequently connect traders and processors to reliable producers (Kilelu et al., 2017; Blum et al., 2020). In this paper, we conducted a network study to identify the key actors in the Ugandan banana value chain and linkages for information exchange and service delivery among them as possible channels of spreading relevant banana technologies.

The rest of the paper is structured as follows: Section 2 presents the theoretical framework in which the study is embedded, Section 3 presents the methodology including the study area, population, design, data collection and analytical methods. Section 4 presents results and discussions with emphasis on mapping banana value chain actors, strengths of connections among them, their centrality and information needs. Section 5 covers the conclusions and implications for agricultural information exchange and service delivery among banana value chain actors.

2   Theoretical framework

This study is embedded within the Social Learning Theory (SLT). SLT puts emphasis on how groups, individuals and social organisations acquire knowledge through interaction and collaboration (Moschitz et al. 2015). SLT is applicable in facilitation of innovation through learning groups such as; researchers-researchers, farmer-farmer, researchers-farmers, and farmers-processors (Stevens and Letty 2014). The relationships created during interactions, could be sources of information and support services such as marketing and financing necessary to take up improved technologies (Perdomo et al., 2010; Davis & Sulaiman, 2015; Saravanan & Suchiradipta, 2017).

We integrate the Agricultural Innovation Systems (AIS) framework to identify the actors in the banana value chain and existing relationships among them. The framework suggests that each of the actors in the system has a potential to provide information and or services necessary for innovation to take place (World Bank, 2006; Agwu et al., 2008). We regard the relationships among banana value chain actors as sources and channels of information and services necessary for innovation to take place. The Social Network Theory (SNT) analytical framework was applied in mapping and identifying the intermediary actors and the extent to which they facilitate linkages for information exchange and service delivery among the actors. We apply SNA to establish the current linkages and their potential to facilitate effective communication among actors in the banana value chain.

3   Methodology

3.1   Study area and population

This study was conducted from January to March 2020 in Central, Mid-Western and South Western Uganda; specifically, in Nakaseke, Bunyangabu and Isingiro districts respectively. The districts were purposively sampled because they represent the historical banana

producing and consuming areas in the country but where banana productivity has been gradually declining (Gold et al. 1999). Consequently, NARO and partners are promoting various technologies in these areas to improve the banana productivity which was hitherto generally low. Furthermore, there is a number of banana actors in the area including; farmer groups, export farmers, traders, processors, research, extension and community-based organisations (CBOs) who could potentially contribute to improving banana productivity in these districts (Ngambeki, Nowakunda, and Tushemereirwe 2010).

The sampling approach for export farmers, research agents, extension agents, CBO representatives and processors was purposive based on whether they were operational in the study area. Stratified random sampling approach was used to select participant traders for KIIs and FGDs. The strata among traders were bicycle/motorcycle banana traders, wholesalers and retailers. Thus, the approach ensured representation of all groups in the selected sample (Acharya et al. 2013). Respondents from each group were selected by lottery method from the lists of traders provided by the chairpersons of banana markets (Suen, Huang, and Lee 2014).

The sampling procedure for selection of banana farmers was systematic random sampling from farmer lists provided by the chairpersons of banana farming groups (Acharya et al. 2013). The summary of sampling procedure and total number of respondents per category is presented in Table 1.

Table 1: Summary of data collection methods, categories and number of respondents and sampling procedure followed

Data collection method	Categories of actors interviewed	No. of respondents per district			Total respondents	Sampling procedure
		Nakaseke	Bunyangabu	Isingiro		
	Research/ CBOs	2	2	2	6	Purposive

KIIs						
	Public extension	2	2	2	6	Purposive
	Processors	0	6	6	12	Purposive
	Export farmers	0	3	3	6	Purposive
	Banana wholesalers	6	6	6	18	Simple random
	Bicycle/ Motor bike banana traders	6	6	6	18	Simple random
FGDs		**No. of FGDs per district**			**Total FGDs**	
	Banana traders	2	2	2	6	Simple random
	Banana farmers	2	2	2	6	Simple random

3.2 *Study design and data collection*

The study used exploratory case study design (Yin 2012) covering three banana growing districts. This design was appropriate because of the study's emphasis on comprehensive understanding of interactions and relationships for the diffusion of information and services among the banana value chain actors per district. Thus, each of the districts was treated as a case. Data were collected through Key Informant Interviews (KIIs) with the agents of research, extension and CBOs, Processors, Banana traders and Export farmers while Focus Group Discussions (FGDs) were also conducted with banana traders and farmers. Checklists were developed to guide KIIs and FGDs to capture data on who the actors in the banana value chain were; who they exchanged information and services with and the type of information and services needed in order to take up new technologies. Open discussions were allowed among the participants of the FGD (Onwuegbuzie et al. 2009).

3.3 *Data analysis*

Data used in the analysis were from KIIs and FGDs conducted in the three districts. The data were transcribed and imported into Atlas.ti. for thematic coding and analysis (Friese 2019).

The inductive approach was used to assign open codes to individual narratives, which were then grouped into classes. The various classes later constituted two broad themes: (i) the actors in the banana value chain and linkages among them with regards to the flow of information and services; and (ii) the type of information and support services needed by the banana value chain actors to facilitate dissemination and adoption of technologies.

The linkages among actors were analysed using Social Network Analysis (SNA) software Gephi 0.9.2 (Grandjean 2015) and were established basing on who they exchanged information and services with. Data were collected from individual actors and representatives of organizations in each of the case studies. However, analysis was conducted by aggregating individual actors into groups. This was intended to identify which groups held similar positions across the case studies. The identified groups are: Input suppliers, Farmer groups and associations, Export farmers, Export companies, Local banana traders, Processors, Cooperative Union, CBOs, Regulatory bodies, Media, Research, Extension and Financial service providers. Therefore, the groups were regarded as actors during data analysis. Each actor was represented as a node while the joining lines (ties) represented linkages (relationships) among them to form network maps for each case study. The maps were essential to visualise the strength of actor linkages whether weak or strong. The strength of relationships is usually based on the number and frequency of interactions, and interchange of services among actors (Wasserman & Faust, 1994; Hanneman & Riddle, 2005; Sykes et al., 2009). However, in this study, we measured the strength of relationships based on the extent to which the ties were reciprocated which reflects the extent to which the actors mutually exchange information and services. We illustrated strong linkages on network maps as red double arrows while weak linkages are in black single arrows. As a form of triangulation, there were common questions for KIIs and FGDs such that data from KIIs was helpful to

establish the linkages which were not mentioned during FGDs. Therefore, if a linkage was said to exist, it must have been mentioned at least once during data collection.

Quantitative indicators which were used to describe the exchange pattern of information and services among actors are betweenness and degree (in- and out- degree). Degree centrality shows the number of ties directly connected to each actor. The ties can either be inbound or outbound in which case are called in-degree or out-degree respectively (Borgatti et al. 2009). The direction of a tie shows whether an actor is influential and can supply information or provide a service to other actors, or is a passive recipient of information and services. Therefore, in-degree shows popularity while out-degree shows the influence of an actor. In this study, the influence of a node is visualised by its size such that the bigger the size, the more influential the actor is in facilitating exchange of information and services in the banana value chain.

Betweenness centrality is the number of times an actor links other actors in the social network using the shortest paths between them. In other words, there is no direct linkage observed between the two actors except through the third one (Freeman, Roeder, and Mulholland 1979). Betweenness measures the ability of the node to control information flow or the capacity to link together unconnected nodes (Borgatti et al., 2009; Crespo et al., 2014). In this study, we computed and used relative betweenness in order to make comparisons of actors across the three case studies.

Network density was used as a measure of solidity and cohesion, implying trust relationships among the actors (Crespo et al., 2014; Filippini et al., 2020). It can also indicate the network's closeness as a completely connected network, less open to the inclusion of new members capable of bringing new information (Crespo, Suire, and Vicente 2014).

4   Results and discussions

4.1 Actor identification and mapping in the banana value chain

Results from FGDs and KIIs across the study area revealed a multiplicity of actors in banana value chain each with a different and specific contribution to the exchange of information and services. The network maps in Figures 1, 2 and 3 reveal connections, strength of connections and the influence of each node in information exchange and service delivery among actors in each of the three case studies.

4.1.1 Case 1: The actors and relationships in Bunyangabu

The results revealed that there were strong and weak relationships for exchanging information and services among 12 actors in Bunyangabu banana value chain. Of these, only processors, CBOs and traders had strong relationships with the farmer groups while research, extension, media, financial providers, export farmers and regulatory bodies had weak relationships with the farmer groups (Figure 1). Research too had strong relationships with extension, regulatory bodies and input suppliers. Granovetter (1973) suggests that the nature of social ties whether weak or strong affect the quality and the process of information flow within social networks. Therefore, the strong relationships of farmer groups with CBOs, traders and processors reflect reciprocated information and service delivery regarding on-farm production and marketing of processed and non-processed banana products. Such relationships are an important source of information and knowledge exchanged through informal social learning networks such as processors-farmers, farmers-traders and CBOs-farmers (Stevens and Letty 2014). This implies that farmers in Bunyangabu, through such networks have access to information and services to enable them innovate, upgrade and participate in other value chain activities such as processing and trading. It also reflects farmers' awareness of qualities of products acceptable on markets and for processing purposes. This could be an indicator that they are likely to adopt technologies related to such. However, in order to improve farmer group position in the value chain network, it is

important to build capacity of farmer groups to articulate their needs to which the service providers align themselves (Chindime, Kibwika, and Chagunda 2016). On the other hand, extension and research, the traditional sources of agricultural information were weakly connected to the key value chain actors such as the farmer groups, processors and not at all with the traders (Figure 1). Their position reflects a one-way communication characterised by limited involvement of the key actors in technology generation and dissemination processes. Such processes are more likely to produce irrelevant technologies with low receptibility among the end users.
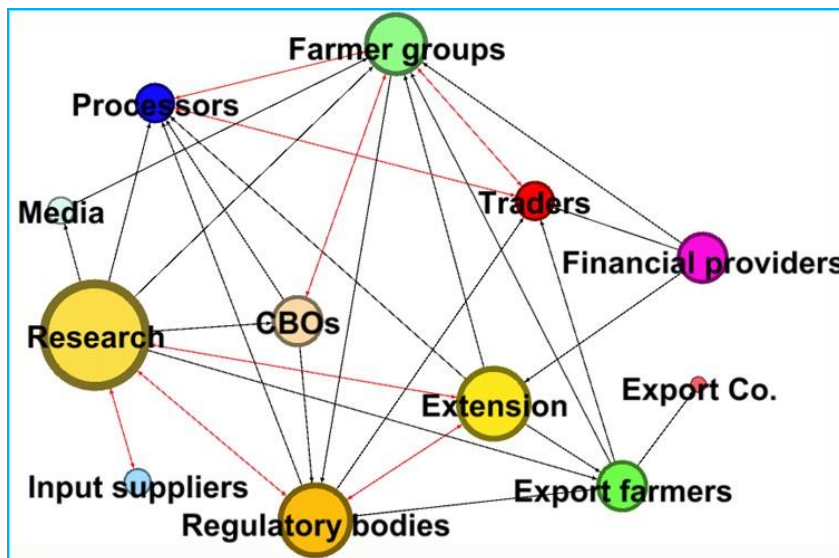

Figure 1: Actor networks in Bunyangabu district

Key:

⟷ Reciprocated linkages (Strong relationship)

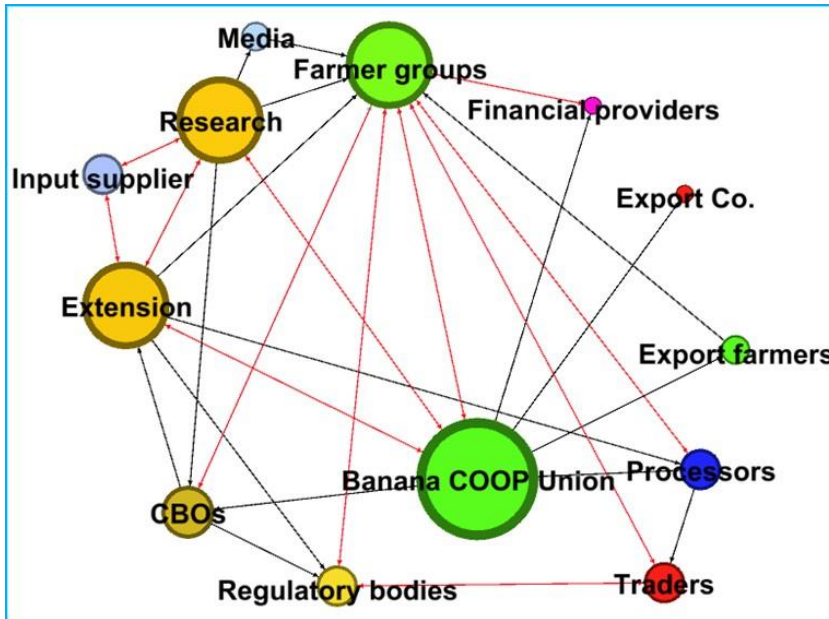→ One-way linkage (Weak relationship)

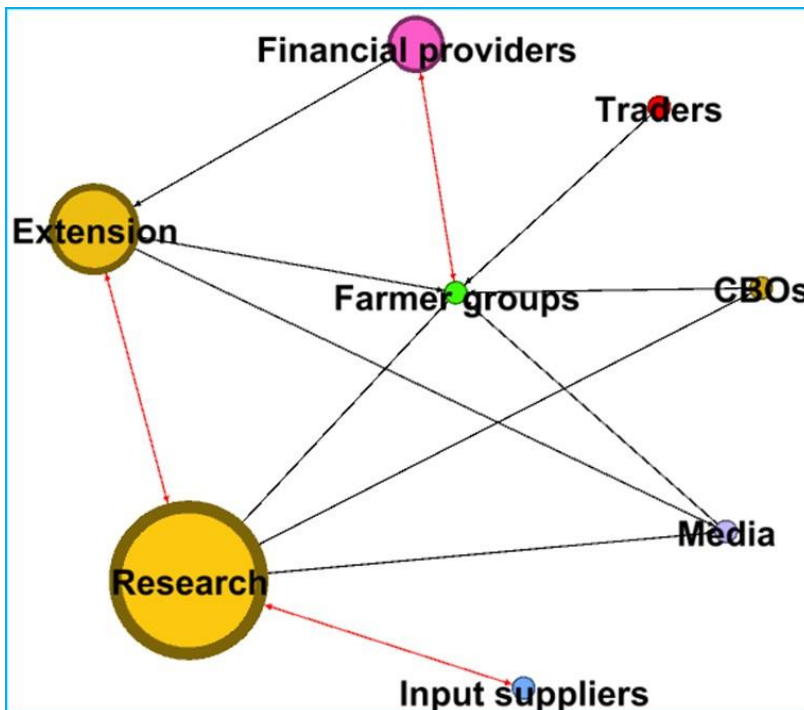**Figure 2: Actor networks in Isingiro district**

Figure 3: Actor networks in Nakaseke district

4.1.2   Case 2: The actors and relationships in Isingiro

Our results show that Isingiro banana value chain consisted of 13 actors with fairly distributed ties and connected to the farmer groups. Compared to Bunyangabu and Nakaseke cases, the farmer groups in Isingiro were connected to the most actors in banana value chain.

The farmer groups had strong relationships with Uganda Banana Producers' Cooperative Union, traders, processors, financial service providers, CBOs and regulatory bodies (Figure 2). This reflects farmers' access to vast information and services. Farmer groups' strong wide network in Isingiro could be attributed to the cooperative union which is operational in the area. The Union's agenda is to institutionalize banana farmers' influence with regards to the flow of information and services for innovation in the banana value chain. It is also worth noting that farmer groups had weak relationships with key actors such as research, extension, export farmers and media with unidirectional ties. The results show that research and processors are not connected at all, indicating that processors hardly receive information on new technologies such as availability of new varieties and their characteristics, which poses a constraint to the receptivity of technologies.

4.1.3   Case 3: The actors and relationships in Nakaseke

Compared to other case studies, Nakaseke banana value chain consisted of the least number of actors (only eight) of which farmer groups were strongly connected to the financial service providers only. The results show that research, extension, traders and CBOs had weak relationships with the farmer groups. Compared to other sites, some value chain actors such as processors, export farmers and companies were missing (Figure 3). Aguilar-Gallegos et al. (2015) and Thuo et al. (2014) suggest that the linkages within and beyond network boundaries create engagements with external agencies to obtain useful resources to facilitate adoption and network support. Therefore, the situation of Nakaseke reflects lack of diversity of value chain information networks for farmers' reference. In addition, Nakaseke is located near major urban centres where non-farm sector is widely developed, therefore; farmers' strong connections with financial providers and few actors implies that the potential farm labour force could be allocated to other self-employment activities other than farming.

The linkages among actors in each of the case studies indicate which ties need to be strengthened to create a cohesive and interactive network especially regarding feedback on the different banana technologies and practices promoted. In all the three cases, research had strong linkages with extension and input suppliers indicating technical support of one another in terms of information and resources for experimentation with farmers. However, the weak linkages of farmer groups with extension and research show lack of feedback from the farmers to inform the technology development and promotion process. Similarly, the lack of direct connection between farmers and input suppliers shows that farmers have limited information and are not yet using such inputs on farms. The farmers only access them through extension and research for research and experimentation purposes (Figures 1, 2 and 3).

4.2 The strength of ties and network density

These indicate the speed with which information flows among the actors in the network.

4.2.1 The strength of network ties

Results show that there were 28 connections among 12 actors in Bunyangabu, 28 connections among 13 in Isingiro and 12 connections among 8 actors in Nakaseke district. Of these, the percentages of reciprocated connections were 28.57% in Bunyangabu, 42.86% in Isingiro and 25% in Nakaseke district (Table 2). Reciprocated connections are regarded as strong relationships, implying dependency of actors on one another for information and other services (Borgatti et al. 2009). At the same time, Fritsch & Kauffeld-Monz (2010) described strong ties as beneficial and associated with exchange of complex knowledge. Hansen et al. (2020) also suggest that strong relationships reflect the presence of social attributes such as cooperation, trust, exchange of opinions and power balance among the actors. Therefore, the situation of small percentage of reciprocated connections in the three districts reflect the dominancy of a one-way communication characterised by limited discussions, cooperation

and feedback among the actors in the value chain. However, for Isingiro network, the percentage of strong connections was relatively higher which implies that there is improved distribution of information and resilience in Isingiro network compared to the two (Table 2).

Table 2: The number of connections and network density

	Districts		
Network measure	Bunyangabu	Isingiro	Nakaseke
No. of actors	12	13	8
No. of existing connections	28	28	12
Percentage of strong connections	28.57	42.86	25.00
Network density	0.280	0.256	0.268

4.2.2   Network density

The results across the three case studies revealed that network densities among the value chain actors were 0.283, 0.256 and 0.268 in Bunyangabu, Isingiro and Nakaseke districts respectively (Table 2). This suggests that of all the potential relationships that could be present, only 28% were actually present in Bunyangabu, 25.6% in Isingiro and 26.8% in Nakaseke.

These results indicate existence of very weak relationships among value chain actors and that many of them were working in isolation, which limits the possibility of innovating together. According to Sanya et al (2018), information and knowledge move more accurately and timely in networks where there are intense and direct linkages among the actors. Therefore, the situation of weak linkages among value chain actors in the three districts portrays underutilisation of potential relationships for dissemination of valuable knowledge, information and services necessary for generating and adoption of relevant banana technologies for improved productivity.

4.3   Banana value chain actors as intermediaries for information dissemination and service delivery

4.3.1   Case 1: Bunyangabu

SNA results show that the most central actors were regulatory bodies with relative betweenness of 1 followed by research, extension and farmer groups (Table 3). These results suggest that regulatory bodies are the major actors facilitating the flow of information and services in Bunyangabu banana value chain. Leeuwis & Aarts (2011) suggest that innovation requires a network approach which allows engagement of different actors in the process. Thus, the position of regulatory bodies is relevant to create a favourable environment for the successful information exchange and service delivery in Bunyangabu. The results revealed that local council involvement in implementation of by-laws led to the successful application of information and technologies for the control of *Banana Xanthomonas Wilt (BXW)* which was threatening the country banana production in the previous years (Kubiriba, Erima, and Tushemereirwe 2016). This was revealed during FGDs with the farmers in Kaina parish, Rwimi Sub County as one of them narrates: "*Local council and Extension workers work hand in hand to enforce laws for controlling BBW in this area. If the local council authorities see a diseased banana plant in your garden, they ask you to pay a fine yet, these days money is never readily available. In the fear of paying this expensive fine, we all clean up our plantations of the diseased plants….the disease is no longer a threat here in our area.*"

Because some regulatory bodies such as the local government are locally based, their active involvement is important in order to overcome local hurdles to the application of information and technologies.

The results further show that although research and extension were also highly connected, they had very low in-degree of 0.083, similar to that of export farmers. This suggests that only 8.3% of existing ties requesting information about innovations in banana value chain are directed to research and extension. This could be attributed to their low accessibility. For example, the extension to farmer ratio in Uganda is at 1: 5000 compared to the global

benchmark of 1:500. Besides, NARO, the public agricultural research body does not have logistical support to reach every corner of the country (Rwamigisa et al. 2017). Therefore, they are not in position to reach out to the farmers and other actors directly for professional guidance and assistance. Under such circumstances, given the growing trend in agricultural research and extension to partner with the private sector, collaboration with actors such as local government who are well positioned and locally embedded would enhance information exchange among actors in Bunyangabu banana value chain.

Whereas the banana processors, traders and financial service providers are key actors with a potential to innovate and finance some of the value chain activities, they had low relative betweenness indicating that they were mainly operating at the peripheral of the network. This was re-affirmed during KIIs with the traders at Kakooga trading centre as one of the wholesalers remarked when asked which actors, he shared banana information or services with: *"I share information with fellow traders. As wholesalers, we sit every week, discuss the available market opportunities and decide on prices to impose on the farmers and or bicycle and motorcycle banana traders."* According to this statement, it seemed to be a common practice for the traders to dictate farm gate banana prices. It reflects existing asymmetries in power and influence in accessing banana markets in Bunyangabu. However, more results show that traders are not central in information exchange and service delivery, alleging that their strong relationships with farmer groups depicted in Figure 1 could be due to fair services (access of large volumes of bananas in one place and good prices) received from one another. However still, agricultural interventions in this area should aim at providing opportunities which improve farmers' bargaining power and profitability at farm gate. This can influence the extent to which the farmers are commercially or subsistence oriented (Nakasone 2014).

4.3.2   Case 2: Isingiro

Results from SNA reveal that Research, Farmer groups, banana cooperative union and Extension were the most central actors for information exchange in Isingiro. The farmer groups had overall the highest relative betweenness of 1, highest in-degree of 0.231 and high out-degree of 0.154 (Table 3). The betweenness result implies that the farmer groups are the major actors for bridging information and services, the highest in-degree stresses that they are very prominent and 23.1% of queries about banana innovations in the value chain are directed to the farmer groups.

Table 3: Centrality of actors across the case studies

	Measures of Centrality per district								
Actors	Bunyangabu			Isingiro			Nakaseke		
	Relative betweenness	In degree	Out degree	Relative betweenness	In degree	Out degree	Relative betweenness	In degree	Out degree
Extension	0.207	0.083	0.139	0.261	0.103	0.154	0.947	0.133	0.200
Research	0.918	0.083	0.222	0.283	0.077	0.154	0.842	0.133	0.333
Traders	0.036	0.139	0.056	0.008	0.077	0.051	0.000	0.000	0.067
Processors	0.044	0.167	0.056	0.018	0.077	0.051	0.000	0.000	0.000
Regulatory bodies	1.000	0.111	0.139	0.018	0.103	0.051	0.000	0.000	0.000
Banana COOP Union	0.000	0.000	0.000	0.653	0.077	0.205	0.000	0.000	0.000
Export Co.	0.000	0.028	0.000	0.000	0.026	0.000	0.000	0.000	0.000
Input supplier	0.000	0.028	0.028	0.000	0.051	0.051	0.000	0.067	0.067
Media	0.000	0.028	0.028	0.000	0.026	0.026	0.000	0.133	0.067
Financial providers	0.000	0.000	0.083	0.000	0.051	0.026	0.947	0.067	0.133
CBOs	0.000	0.056	0.083	0.087	0.051	0.077	0.000	0.067	0.067
Farmer groups	0.891	0.194	0.111	1.000	0.231	0.154	1.000	0.400	0.067
Export farmers	0.342	0.083	0.083	0.000	0.051	0.026	0.000	0.000	0.000

The high out degree result compared to that of other actors implies that farmer groups are better positioned to introduce technological innovations in Isingiro. Such results portray the prominence of farmer-to-farmer extension in a situation where extension is constrained to reach out to a number of actors. Because farmer to farmer extension is locally based, there is trust, reduced risk, easy access and compatibility of information and services among actors (Weyori et al. 2017) leading to the quicker embrace and ownership of technologies. The position of farmer groups in Isingiro could be attributed to the banana cooperative union which is spearheading the wide establishment of farmer groups as primary cooperatives and linking them to a number of service providers. However, KII results with Banana cooperative union management in Isingiro revealed that some actors were not responding to the call for collaboration with farmers as indicated in the narrative; "*Some actors such as traders do not respond to such calls for collaboration because they fear their profits are going to be reduced.*" Such results indicate that although the banana traders are strongly linked to the farmer groups, they are not at all linked to the Banana cooperative union. As is the case in Bunyangabu, the traders' preferred direct linkage with farmers could be a reflection of opportunistic behaviour which reduces farmers' profitability from banana harvests.

Magnan et al. (2015) noted that out- directed ties indicate the actors who may introduce improved technologies into the network. Therefore, the results showing that the banana cooperative union has the overall highest out degree of 0.205 suggest that it is the overall most influential in facilitating exchange of information and services among actors in Isingiro. This was further emphasized during KIIs with the cooperative leadership where one of them revealed that the cooperative played an active role in mobilising various actors to identify challenges and areas of collective intervention in the banana value chain as noted in the quotes: "As *banana cooperative union, we recommend some farmer groups and primary cooperatives to access financial services as a group; for example; we recently recommended*

Kikunyu Banana farmers' cooperative and Rugaga banana cooperative to access loans from Centenary Bank." Such facilitated linkages to funding opportunities help farmers access services leading to the adoption of technologies which require initial capital investments such as fertilizer use.

The results further show that research and extension, with relative betweenness of 0.283 and 0.261 respectively were among key bridges for information and services (Table 3). However, some actors criticized them for engaging farmers only and neglecting the rest of the actors in the value chain. This was revealed during KII with motorcycle banana traders in Isingiro, Kaberebere market as expressed in the narrative: *"These days NARO, like any other organisation is operating in this area but it is more concerned with farmers' increase in banana productivity but for us, the traders we are left out. They should for once think about us traders and train us in issues like business management, how to access quick loans not from money lenders and how to make profits."*

The results from KIIs with Public extension agents in the district affirm such a disconnection and suggested the need to engage entire value chain actors and wholesomely look at information and service delivery among them as a way to improve adoption of banana technologies. This was expressed in the following narrations: *"Most of our partners in extension and research promote on farm productivity of bananas so in this area, we have no problem with banana productivity. Farmers in this area produce a lot of bananas; we are instead faced with lack of banana markets."* The district commercial officer too had this to say: "*We have one extension worker per Sub County to promote productivity but information on value addition is scarce among these extension workers. They also need to be trained in such aspects like banana wine processing in order for them to regularly monitor such developments among banana farmers and processors in this area."* Extension agents' need for information across the banana value chain depicts a shift from one way information

dissemination approach to the innovation systems thinking where actors of a particular system equally contribute to the innovation processes. Extension and research in Isingiro need to take advantage of established farmer structures and the Banana cooperative Union to reach out to, but also receive feedback from a number of actors in order to improve farmer profitability and maintain high productivity level.

4.3.3   Case 3: Nakaseke

The results show that farmer groups had the overall highest relative betweenness of 1 indicating that they are the major intermediaries for facilitating exchange of information and services among actors in Nakaseke banana value chain. Financial service providers and extension, with relative betweenness of 0.947 each and research with 0.842 were also potential intermediaries (Table 3). However, farmer groups' low out-degree of 0.067 indicates that they were less influential compared to research (0.333), extension (0.2) and financial service providers (0.133) (Table 3). Nakaseke's location enables farmers to access cheaper substitutes of bananas such as maize flour on the market (Bagamba 2007) therefore, there is less labour allocated to banana production in Nakaseke.

The position of financial providers in Isingiro indicates that farmers in Nakaseke are benefiting from financial institutions compared to other cases. Additionally, Nakaseke's proximity to a number of research institutions makes it well positioned as a place for farmer field trials for banana innovations. Therefore, this allows research to play a temporary role of extension agents in the area.

4.4   The actor information and service support needs

The results from KIIs with processors, traders and FGDs with farmers revealed the aspects of the value chain where each of them needed information and support services (Figure 4). The farmers, traders and processors revealed common support needs such as training in general

banana agronomy, banana pests and disease control and agro-processing (Figure 4). This reflects the desire for all the key actors to integrate from production to the final stages of the value chain. In such a situation, facilitated peer-peer learning groups could provide platforms for each of the actors to share experiences and learn from one another. Such groups also improve actor strengths and minimise vulnerabilities in light of the ties created. Therefore, service providers should aim at establishing lasting relationships and trust among actors as sources of valuable information over time.
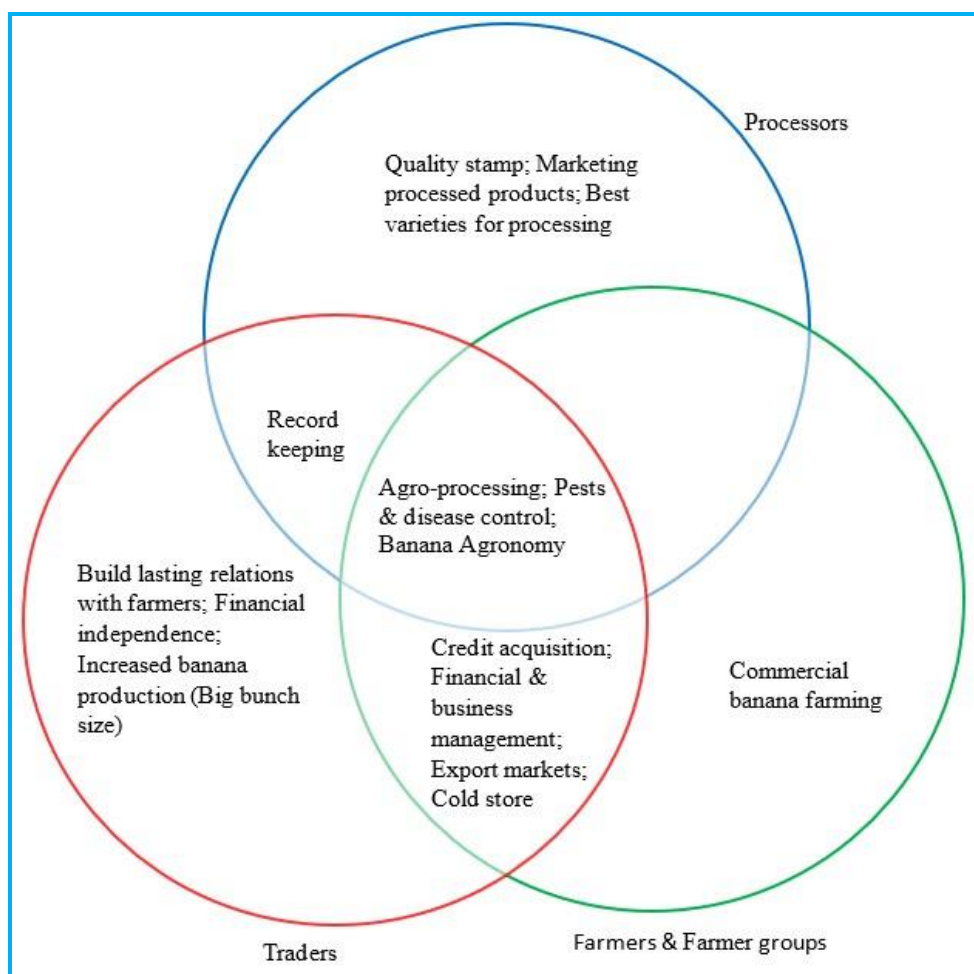

Figure 4: Information support needs by the processors, traders and farmers

Traders and processors showed a great desire to train in record keeping to enhance calculation of profits from their business investments while at the same time the traders and farmer groups together needed support in credit acquisition, financial and business

management, export markets and investments in cold storage (Figure 4). This reflects the actors' change in orientation from subsistence farming to commercial farming. Thus, interventions should aim at connecting the actors with service providers who can strengthen their business skills in order to sustainably benefit from production and investments in banana production. Such connections could result into credit acquisition, financial and business management, export markets and investments in cold storage. There is need to negotiate engagements with financial service providers at low interest rates.

5 Conclusion and implication

The increased recognition of systemic approaches involving various actors from diverse disciplines into agricultural information and service delivery reflect the desire to increase timely information outreach to the relevant end users. In this paper, we analysed the concept of agricultural information exchange and service delivery among banana value chain actors across the three traditional banana growing areas in Uganda. We highlight the positions and influence of different actors in exchange of information and services in the banana value chain. Although this study mainly focuses on banana value chain, our results provide an example to any other agricultural value chain in the developing country context to identify the actors and linkages which can hinder or promote information exchange and service delivery among them. This highlights who among the actors to engage and how for maximum service delivery within the value chain. The overall results show the presence of diverse actors with potential contributions to information exchange and service delivery in the value chain. The results across the three case studies show that although research and extension were relatively central across the three networks, they had weak or missing connections with the key actors such as the processors, traders and farmer groups. our results conform with (Sanya et al. 2018) who also identified weak relationships between researches and farmers during development of banana hybrid varieties in Uganda. This loose connection depicts that

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research and extension are mainly focused on technology and information dissemination ignoring feedback for their own learning from other key actors. The likely outcome is generation and promotion of technologies which are not acceptable among end users. Thus, the position of key actors such as farmers, traders and processors should be improved by seeking feedback from them to inform agricultural technology development and promotion processes.

The strengths of network linkages across the three case studies are relatively weak as indicated by the low percentage of reciprocated ties. The low network densities also indicate that information exchange and service delivery in the networks is less cohesive (Filippini et al. 2020). This reflects a communication asymmetry where many actors do not receive feedback on the information disseminated or services delivered. Cohesive networks enhance feedback which creates awareness of relevant innovations leading to inclusive value chain development. This minimises farmers' risks associated with on-farm under or over production thus, increased returns to investments in banana production and increased chances of technology uptake.

SNA results show that regulatory bodies, namely local government in Bunyangabu and farmer groups in Isingiro and Nakaseke were well positioned compared to all other actors. This was indicated by their overall highest relative betweenness of 1. Their characteristic is that they are locally embedded thus, collaboration with them in technology promotion could help to overcome local barriers and ensures continued evaluation. This stresses the importance involving diverse actors for effective agricultural innovation (Horton et al. 2022).

Based on the results from this study, it can be implied that there are a number of value chain actors whose positions can hinder or facilitate exchange of information, technologies and services. They create favourable or unfavourable conditions for exchanging information and

services within the network. Therefore, extension agents should take advantage of such actors' knowledge and service networks as mechanisms to help expand and sustain their reach. Also, to note is that although farmers are usually highly connected, their position will only improve if they are in rightful position to negotiate and influence information, services and institutional arrangements they need to operate sustainably and profitably. This could be achieved through strengthening their organisational capacity to engage other actors and demanding relevant information and services from them. We recognize the level of network analysis as a limitation to this study. It involved aggregation of individual actors into groups such that network linkages focused on group level than individual level. Although this was useful to enable relative comparisons of actor connectivity across the study sites, it did not bring out individual contributions to the network. Further research should focus on network building at multiple levels that is within and between the groups. It should also assess actor commitments to the continued collaboration among actors in the value chain.

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Notes on contributors

Stella Kiconco is a PhD fellow in Agricultural Extension at University of Pretoria. She works with National Agricultural Research Organization (NARO) as a Research Officer-Socioeconomics. Her research interests include Agricultural Innovation Systems, Agricultural marketing, On-farm research and agricultural value chain development.

Joseph Benjamin Stevens is a Senior Lecturer at University of Pretoria. His research interests are in Group dynamics and leadership, adoption and behaviour, agricultural and rural development, extension approaches and principles. He holds PhD Agricultural Extension of University of Pretoria, South Africa.

Kenneth Akankwasa is a Senior Research Officer- Socioeconomics with NARO. His research interests include Agricultural Marketing, On farm research, Value chain development and Monitoring and evaluation. He holds a PhD in Agribusiness of the University of Kwa Zulu Natal, South Africa.

Jerome Kubiriba holds a PhD Plant Pathology of Greenwich University, UK. He is a Senior Research Scientist at NARO – with experience of working with farmers as last-mile users of the research outputs. His research interests include Farming systems research, value chain development and on farm research.

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