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Mapping Linkages between Actors in Cattle Marketing Innovation System of Northeastern Nigeria

Abstract. The focus of this study was to analyze and map linkages among actors in the innovation system of cattle marketing in northeastern Nigeria. Specifically, linkages/interactions between actors and those of the innovation system network were determined. A structured questionnaire was used to collect data from 48 respondents and a Focus Group Discussion (FGD) session involving sixteen (16) participants each was conducted in three out of the four Adamawa Agricultural Development Project (AADP) zones of Adamawa State. Analytical tools used were descriptive statistics such as means, tables, and charts while the inferential statistical tool used was the Social Network Analysis (SNA). The results of the FGD interaction sessions revealed that the sixteen (16) actors had ninety-nine (99) ties in the network; these were classified into nine (9) key and seven (7) non-key actors with each group performing specific roles in the system. Furthermore, the result of the social network analysis revealed a network density of 0.83, indicating that 83% of all direct linkages were present. However, the network cohesion was 0.40, showing that only 40.0% of the connections were reciprocated, which implied that about 40% of the actors are not well connected. The result further revealed that both extension agents/Village Based Agents and the cattle dealers association had the highest degree and closeness centrality (73% and 6 links each), implying that they are the actors with more connections, closest to others and thus directly able to influence the decisions of other actors in the network; they can also be considered as the most important channels/agents for the diffusion of innovations in the system. The result of the network diagram revealed that there were strong, weak, unidirectional and reciprocal links among actors in the system. A strong link signifies high/dense interaction while a weak link signifies low/loose interaction among actors. Furthermore, unidirectional links indicate a one-way interaction/communication process while a reciprocal link signifies a feedback communication process. The study concluded that there is a great potential for increasing the interconnectedness, interaction, and collaboration between actors in the network. It was recommended that actors in public and private sectors should link, collaborate and interact more to produce a denser network for faster and more effective diffusion of technologies. Furthermore, the use of social media is strongly advocated to further strengthen linkage and networking among/between actors in the innovation system.

Key words: linkages, mapping, innovation system, Northeastern Nigeria

JEL Classification: D85, O31

Introduction

All over the world, the concept of innovation and innovation systems is fast gaining ground, particularly for agricultural systems. Innovation is the process by which social actors create value from knowledge. It does not as a rule result from research and development activities as has often been thought. Rather, farmers, artisans, and small scale food processors can create/develop innovations about their processes and products based upon several and diverse sources of knowledge and information often streaming from everyday activities. On the one hand, Innovation systems are complex, open and dynamic activity systems where actors (individuals, groups, and organizations) apply their minds, energies and resources to

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innovations in particular areas of human activity such as agriculture, climate change, desertification and food security, so as to improve its performance (Klerkx et al., 2009).

On the other hand, an Innovation system is a system comprising the organizations, enterprises, and individuals that demand and supply knowledge and technologies, and the policies, rules, and mechanisms which affect the way different agents interact to share, access, exchange, and use knowledge (World Bank, 2006).

Daane (2009) stressed that just as with other human activity systems, innovation systems do not exist 'out there' as objective entities or realities; they only exist 'in the minds of those who define them', i.e. a social construct, or as a heuristic device for analytical purposes. This definition implies that innovation systems are defined concerning a particular domain of human activity. Thus, one can, for example, define a system for innovation of a specific commodity, value chain or business cluster, or specific (agro) eco- or farming systems. With ineffective innovation networks, different actors need to bring resources and capabilities that are valuable to the rest and that contribute to the common goal (Hall, 2004). While networks of actors are important in climate change innovation systems, the qualities of the actors' interactions and linkages, and, in particular, of the social learning processes that occur during the innovation process, are most essential (Woodhill, 2005).

Livestock innovation systems are institutions (rules, norms and regulations), linkages and flows that connect actors. It goes beyond the creation of knowledge to demand for livestock and use of knowledge in production and marketing of livestock in useful ways (Madukwe, 2011). This process contributes to agriculture (livestock production, performance and marketing) through value chain and collaboration between pastoralists, livestock farmers, marketers, extension providers and facilitators to improve livestock production and marketing (Slingenberg et al., 2002; Federal Department of Livestock and Pest Control (FDLPC), 2002).

Despite the importance of Adamawa State in cattle production and marketing in Nigeria where actors interact through links/networks, there are very few studies on mapping of innovation networks and linkages between actors in the area. Therefore, it is paramount to conduct a baseline study since linkages/interactions and diagrams of the innovation system are not well ascertained, hence the need for this study.

Methodology

Study area

Adamawa State is located in northeastern Nigeria. It lies between latitudes 7° – 11°N of the equator and between longitudes 11° – 14°E of the Greenwich meridian (Adebayo, 2004). The State is segmented into twenty-one Local Government Areas (LGAs) which are further divided into four agricultural development project (ADP) zones: Zones 1, 2, 3 and 4. The State shares a common boundary with Borno State in the North, Gombe State in the Northwest and Taraba State in the South and West. It also has an International boundary with Cameroon Republic along its eastern borders (Adebayo et al., 2012; Adamawa State Diary, 2009; Adebayo, 1999).

The State covers a land area of about 39,741 km^2 and had an estimated total population of 4,154,000 persons in 2016 at 3.4% annual growth rate (NPC, 2006). Annual rainfall ranges between 900 to 1600 mm while maximum temperature range is between 39°C and 45°C.

Adamawa State is one of the leading cattle markets in Nigeria. Major cattle markets in the state include: Mubi, Gerei and Ganye international cattle markets; others are: Song, Ngurore and Toungo cattle markets. Major animals reared include cattle (with 3.2 million (21.7%) population out of the 14, 747, 267 million total population of cattle in Nigeria), sheep, goats, pigs and poultry (Babale, et al., 2012; Tibi and Aphunu, 2010; Haruna and Murtala, 2005). Available infrastructure includes road networks, electricity, hospitals, schools and research institutions.

Data Collection and Sampling Procedure

A purposive and multistage random sampling procedure was used to collect data for the study. In Stage 1, Adamawa state was purposively selected from the three cattle producing states of northeastern Nigeria – this was due to the Boko Haram insurgency. In Stage 2, three Local Government Areas (LGAs) were purposively selected (based on size of cattle market). These LGAs make up the largest cattle markets in the state. The selected LGAs were Mubi north, Song and Ganye (Mubi and Ganye share boarders with the Cameroon Republic, thus are involved in trans-border trades). One major cattle market was selected from each of the LGAs. Stage 3 involved the random selection of sixteen (16) actors, (one individual representing an organization/institution, Table 1) from each of the LGAs to participate in the Focus Group Discussion (FGD). The FGD was conducted twice in each of the selected LGAs with 16 participants in each meeting. This finally brought the total number to 96 respondents sampled for the study.

Table 1. Focus Group Discussion (FGD) Sample Frame

S/N	Key Actors	Number of participating institutions
1	Research Institutions	1
2	Adamawa agricultural development programme (AADP)	1
3	Veterinary Services	1
4	Extension Services	1
5	Cattle Marketers associations	1
6	Cattle Fatteners/Producers	1
7	Livestock feed millers associations	1
8	Livestock drug vendors associations	1
9	Transporters associations	1
10	NGOs/CSOs	1
11	Butchers associations	1
12	Village based agents (VBAs)	1
13	Hide/skin dealers association	1
14	Government feed mills (AADIL)	1
15	Ministry of agriculture (MOA)	1
16	Cattle dealers association	1
	Total	16

Source: Author's own study. The FGD was conducted in all the three major cattle markets.

Analytical Techniques

The Social Network Analysis (SNA) technique was used to map the linkages and interactions among actors in the innovation system – this tool is very useful in investigating social structures (Scott, 2000). It is important in understanding and mapping innovation systems because of its analytical focus on relationships and interactions between people and groups. SNA gives an understanding of how actors interact, how information/ resources move among/between actors and how actors' roles and relationships are structured. It captures knowledge flows and other attributes contained within such interactions (Spielman et al., 2009; Scott 2000; Asres et al. 2012). In SNA, the nodes of concern are people, groups and organizations; the links may be social contacts, exchange of information, political influence, money, joint membership in organizations, joint participation in specific events, etc. (Davis et al., 2006). The SNA determinants used for this study include density, centrality and cohesion, and the measures of centrality used were degree and closeness centrality.

Density

Density was computed within a group or between two groups – it considered how closely connected the actors were to each other. It was obtained using the model specified as follows.

$$D = \frac{\lambda}{N(N-\lambda)/2} \quad \text{.....(i)}$$

Where λ = total number of ties present and N = number of nodes in the network. Ties are the links and nodes are the actors in the network.

Degree centrality is the number of people attached to each person in a group. A person with 4 reciprocal relationships for example, has a degree of 4. It was given by:

$$Cd(n_i) = \lambda_i(n_i)/(n-1) \quad \text{.....(ii)}$$

Where ni = $_i$th node in the network, λ_i (n_i) = number of ties to n_i and n – 1 = size of network less the node of interest.

Closeness centrality is simply number of links a person/group must go through so as to reach everyone else in the network. The person with the highest closeness centrality score is the person who goes through the fewest number of ties to reach everyone else in the network. It was given by:

$$Cc(n_i)^{-1} = \sum_{i=1}^{N} d(n_i, n_j) \quad \text{.....(iii)}$$

Where d(ni, nj) = number of ties in the geodesic paths (shortest distance) linking n_i and n_j.

Cohesion is the average number of ties that it takes for a person in the group to reach another person within the same group. The average distance for the group gives an indication of the group's cohesion (Ehlrich and Carboni, 2005).

The choice of this research method was based on the title of the study, where linkage connotes social interaction in agricultural extension, hence the need for the SNA tool in this study. Interaction between actors in a system does contribute to generation of innovation. This is because diverse information/ideas shared by actors brings up new and better ideas, hence the innovation.

Results and discussion

Linkage and interactions among actors in the innovation system

Three different Focus Group Discussion interaction sessions were conducted, one in each of the sampled LGAs. Results of the FGD interaction revealed diverse actors in the innovation system comprised of public and private organizations. A total of sixteen (16) actors were identified, comprised of nine (9) key actors and seven (7) non-key/minor actors (lesser key actors) with a network/web of ninety nine (99) ties (links) taking part in the innovation system. The identified actors include: research institutes, extension agents, government agencies (AADP and MOA), cattle marketers, veterinary officers, cattle dealers association, cattle producers/fatteners, transporters and NGOs/CSOs. Others include drug dealers, feed millers, Adamawa agricultural development and investment limited (AADIL, a government-based feed mill), butchers association, village-based agents (VBA) and hide/skin dealers association. The first nine were key actors while the remaining seven were minor actors based on the degree of importance of their roles and network connection in the system as found in this study. It is assumed that key actors most often have strong connections within and between them, but that it is not so with non-key actors. This was observed during the FGD interaction session.

The result from the Focus Group Discussion (FGD) revealed that linkages/interactions exist between actors in the innovation system, implying that actors transfer and exchange relevant information which can enhance marketing performance between them from time to time. Though some of the actors, particularly cattle marketers, were unaware of this – as was unanimously agreed by the participants during the FGD session. This, they said, may be because most of the services or information shared among them is free, which implies that actors perform certain roles in the innovation system without knowing it. A consensus from the actors during the session revealed that some services that were not free include: veterinary inspection services, aid in difficult delivery, diagnosis and treatment of livestock diseases etc. Payment for such services sometimes prevents producers/fatteners and other marketers from patronizing the services. Instead, they go to local drug dealers for assistance. This assistance, according to them, is beneficial and profitable in the short run but may be harmful to consumers' health in the long run. For example, injecting cattle with shakapashe (liquid disinfectant/detol mixed with ampicloxacilin or tetracycline powder) can treat diarrhea and skin infection, but at the same time fattens up the animal for a space of 3-4 days for a better market value.

All actors agreed that such and other negative practices have a harmful and multiplier effect on consumers in the long run, implying that actors may benefit by obtaining higher market values via such practices but consumers (which may include household members/relatives or even the actors themselves) will be eating unhealthy cattle products, thus leading to ill health or loss of lives.

Innovation system network and linkage

Linkage, degree and closeness centrality of the innovation system were determined through Social Network Analysis (SNA) of the data collected from the FGD interaction. The

density, an indicator for the level of connectedness of a network, was found to be 0.83 as indicated in Table 2 (density in this study also refers to strength of communication), indicating that 83% of all possible direct linkages in the network were present. Furthermore, cohesion of the network (Table 2) was 0.40. Implying that only 40% of the connections were reciprocated – this might indicate that some of the actors were not well connected. It might also suggest that there were weak and unidirectional links in the network. This thus revealed that there is a potential for increasing the interconnectedness between actors in the network, which could contribute to improving collaboration in cattle marketing innovation systems of the area. This outcome agrees with the findings of Asres et al. (2012), who observed 70% density and 32% cohesion in their study on small holder dairy farmers' innovation system in Ethiopia. The implication of the result is that there is a need for increasing the interconnectedness between the actors in the cattle marketing innovation system of the area.

Table 2. Distribution of density, cohesion, degree and closeness centrality of the innovation system

Actors	Degree centrality $\lambda_i n_i$	Closeness centrality $d(n_i n_j)$	Density	Cohesion
Government agencies (ADP/MOA)	0.63	6	0.83	0.40
Research institutes	0.33	3		
Extension agents/Village Based Agents	0.73	6		
Drug vendors	0.53	4		
Fatteners / producers	0.43	2		
Cattle dealers associations	0.73	6		
Feed millers	0.40	1		
AADIL	0.13	2		
Veterinary personnel	0.60	5		
Cattle marketers	0.53	4		
Butchers	0.27	4		
NGOs/CSOs	0.40	2		
Hide/skin dealer	0.27	2		

Source: Author's own Field survey, 2016.

Table 2 further revealed that both extension agents/VBA and cattle dealers association had the highest degree and closeness centrality (73% and 6 links each). This implies that they are the actors with more connections, closest to others, and hence might directly influence the decisions of other actors in the network. These are closely followed by government agencies and drug dealers with 60% and (4-6) links respectively. Others with high degree/closeness centrality include cattle marketers and veterinary agents; these were followed by transporters and fatteners/producers with 47% and 2 links each. All other actors in the network had low degree centrality (of 40% and below) as indicated in Table 2. High degree/closeness centrality makes the actors more accessible to other actors in the innovation

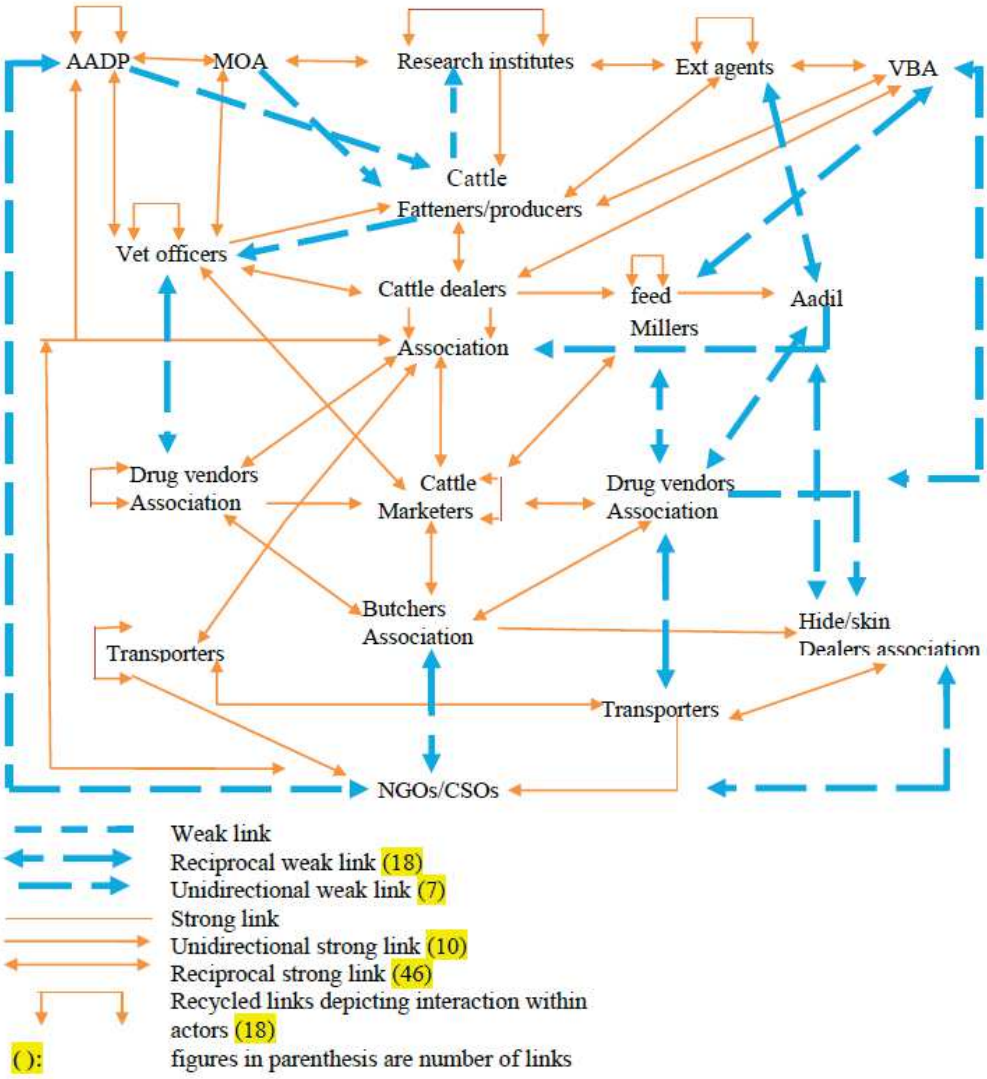
system, implying that they can be readily involved in an innovation process and that they can be considered as the most important channels/agents for diffusion of innovations in the system.

Mapping linkages and interactions in Cattle Marketing Innovation System

Figure 1 shows the diagram of the innovation system depicting linkages and degree of interaction between all actors. Actors were classified as key and non-key based on the importance of their roles and the strength/direction of their links, which shows how closely they interact in the innovation system. The diagram shows that there are strong, weak, unidirectional and reciprocal links among actors in the system. A strong link signifies high/dense interaction while a weak link signifies low/loose interaction among actors. Furthermore, unidirectional links indicate a one-way interaction/communication process while a reciprocal link signifies a feedback communication process.

The result, according to the participants at the FGD session, shows that government agencies (AADP, MOA) had a strong direct and reciprocal link with research institutes, extension agents and village-based agents (VBAs). They collaborate and share information about new/improved government policies, research findings and results, improved livestock management practices and technology transfer pathways. These agencies further had a strong and reciprocal interaction with veterinary officers and cattle dealers association. Veterinary officers had the same interaction with fatteners/producers but with a weak feedback, which implies that fatteners/producers interact less often with veterinary officers. Most of the key actors are strongly and reciprocally connected to cattle marketers, butchers association, drug dealers and feed millers. This is indicated in Figure 1 by the bold red and double directional arrows, signifying strong links and close interaction between them, as was observed during the FGD session. Cattle marketers, drug dealers, marketers association, transporters and hide/skin dealers association also had strong reciprocal links between them. Furthermore, strong but unidirectional links exist between cattle marketers association, hide/skin dealers association and NGOs/CSOs. This might be because their unions solicit for funds and other incentives for their members from the NGOs. It might also suggest that some NGO/CSO members form part of the transporters and hide/skin association members, as agreed by participants at the session.

On the other hand, AADIL (government feed mill and a subsidiary of AADP) had a weak connection with both cattle and drug dealers associations, which also had a weak interaction with hide/skin dealers association, as indicated by the blue dotted arrows in Figure 1. Furthermore, weak links exist between government agencies and NGOs/CSOs. Butchers, drug dealers and hide/skin dealers also had weak but reciprocal links with NGOS/CSOs, implying that there is a reciprocal but less often (low) interaction between them. Other connections with weak ties (linkages) exist between government agencies and cattle fatteners, (this may be because most of the fatteners, excluding producers, are not members of any cooperative union), and between veterinary officers and research institutes with cattle fatteners as indicated on the diagram in Figure 1.



AADP – Adamawa Agricultural Development Project
MOA – Ministry of Agriculture
VBA – Village Based Agents
AADIL – State Government Feed Mills, a Subsidiary of AADP.

Fig. 1. The Diagram of Cattle Marketing Innovation System

Source: Author's own Field survey, 2016.

Furthermore, as indicated in the diagram (Figure 1), interactions/linkages exist among (within) some key actors such as research institutes located around the state, veterinary officers, extension agents located in different local government areas, cattle dealers

associations located in the three major cattle markets, and transporters. Others include non-key actors such as drug dealers, feed millers, VBAs and hide/skin dealers. They collaborate, share and exchange relevant information among themselves as a single group of actors and also interact with other actors in the innovation system; this is indicated by the recycled arrows in the diagram. The diagram further reveals that there are crucial nodes (actors) and connections, implying that key actors are not only connected to themselves but to other lesser actors (non- key actors) in the innovation system. This implies that relevant information can also be obtained from lesser actors in an innovation system. This is consistent with the notion of "the strength of weak ties" described by Spielman et al. (2010). They noted in their study that weak actors had far-reaching ties that are more likely to bring new information and opportunities to innovation networks.

Key actors (AADP, MOA, Research institutes, Veterinary officers, Extension agents and Cattle marketers) must relate with lesser actors for a better performance of the innovation system. The lesser actors (Drug dealers, Feed millers and Butchers association, Transporters and NGOs/CSOs) helped to link key actors to themselves and with other lesser actors in the innovation system. This finding coincides with that of Cash (2001), who observed that country and area extension officers (key and lesser actors) have provided important links as boundary organizations between different levels of organizations in the U.S.A. Cash explained that they (both key and lesser actors) facilitate the transfer and use of information within and between the different boundary organizations.

Conclusion

The findings of this study revealed that the innovation network in Nigeria is densely interconnected with both strong and weak links. The result further showed that extension agents/VBA and cattle dealers associations had the highest degree and closeness centrality (73% and 6 links each.)

Actors are very important personalities in an innovation system. They perform the major marketing functions and without them there would be a geometric retrogression and eventual collapse of the innovation system. This would further lead to a multiplier effect on the entire agricultural innovation system in the region, resulting in negative repercussions for food security and livelihood. It was recommended that actors in public and private sectors should link, collaborate and interact more to produce a denser network for faster and more effective

diffusion of technologies. Furthermore, the use of social media is strongly advocated to further strengthen linkage and networking among/between actors.

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