Journal of Agricultural Extension and Rural Development

Volume 9 Number 11 November 2017

ISSN 2141-2170

Academic Journals

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Journal of Agricultural Extension and Rural Development

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academicJournals

Vol.9(11), pp. 247-254, November 2017
DOI: 10.5897/JAERD2017.0885
Articles Number: C4AA18266403
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Review

Understanding actor innovation behavior: The application of network governance theory in agricultural innovation platforms

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Received 12 May, 2017; Accepted 3 August, 2017

Innovation platforms are increasingly being used as a means of operationalizing innovation systems thinking. Agricultural innovation platforms are intended to bring together a number of stakeholders to promote an identified agricultural innovation. This is done through exchange of knowledge and other valuable resources to solve common problems. However, given the relatively new nature of innovation platforms, there is still limited conceptual knowledge on the mechanism within the platforms that leads to the implementation of innovations by different stakeholders who often have conflicting interests. This conceptual paper intended to review and unearth the intermediate processes that influence the actor innovation behavior by using the network governance theory. The review shows that the generation and implementation of ideas in an innovation platform is a process that involves structural, relational and social mechanisms. This review provides a foundation for future empirical studies in innovation platforms and particularly how they influence actor innovation behavior.

Key words: Innovation platform, innovation behavior, network governance, agricultural innovation platforms.

INTRODUCTION

Innovation platforms are considered to be a new and dynamic mechanism that brings together farmers and diverse service providers for knowledge generation, sharing and diffusion for purposes of social learning (Cullen et al., 2014). They are generally viewed as a component of wider participatory approaches that were promoted since the mid-1980s to integrate farmers' indigenous knowledge within the knowledge provided by agricultural extension workers (Swaans et al., 2013). Whereas some innovation platforms emerge through spontaneous processes, others may emerge through facilitation and direction by external forces (Consoli and Patrucco, 2011). Innovation platforms have been defined differently by different scholars. However, all definitions allude to the fact that innovation platforms bring together different stakeholders to identify solutions to common problems or to achieve common goals, joint conflict resolution, negotiation, social learning and collective

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decision making towards concerted action (Cadilhon, 2013). In the context of agriculture, Homann-Kee et al. (2013) define an innovation platform as a forum for learning and action involving a group of actors with different backgrounds and interests such as farmers, agricultural input suppliers, traders, food processors, researchers, government officials, etc., who come together to identify common challenges and develop common ways to mitigate them through social learning.

In the agricultural rural systems, innovation platforms are a means of addressing complex biophysical, technological, socio-cultural, economic and institutional challenges thereby contributing to structural and long-term engagement among different actors (Sumberg et al., 2013). The engagement of various stakeholders in exploring innovations to address these complex agricultural problems is essential for establishing whether the type of innovations are acceptable and feasible (Schut et al., 2014) and establishing the need for interdependency in overcoming challenges (Leeuwis and Aart, 2011; Messely et al., 2013). In addition to connecting and managing interfaces between multiple actors, innovation platforms perform a multiplicity of functions such as demand articulation, institutional support, network brokering, capacity building, innovation process management, and knowledge brokering (Kilelu et al., 2011). Innovation platforms are also referred to as multi-stakeholder platforms, innovation networks or learning alliances that offer a potential approach for implementing the agricultural innovation systems (Cullen et al., 2014). It is indeed argued that innovation platforms increase collaboration, exchange of knowledge and influence mediation among multiple actors such as farmers, researchers and policy makers thereby enhancing their capacity to innovate and scale up the innovations (Hermans et al., 2017).

Although innovation platforms are seen as a potential tool for addressing coordination and communication between stakeholders, power dynamics within the network can potentially influence platform processes. Power dynamics in platforms affect the innovation behavior of actors especially the marginalized groups such as farmers who quite often perform dormant roles in policy arena (Nederlof and Wongtschowski, 2011). Innovation behavior is a multi-dimensional concept that refers to the sum of all work activities carried out by individuals during an innovation process (De Jong and Den Hartog, 2010). It is a knowledge management process that involves recognizing a problem, creating solutions for the problem and creating support for the solutions (Subramaniam and Youndt, 2005).

Faysse (2006) argues that even when an innovation platform is widely considered to be a forum of inclusive participation and innovation, it often provides an imperfect negotiation process due to challenges such as power imbalance and information asymmetries between actors which may hinder platforms from realizing the envisaged innovations (Swaans et al., 2013). Extant literature has cited network governance as a critical component for dealing with the challenges of opportunistic behavior, inadequate adaptation and coordination among the actors in a network (Jones et al., 1997; Edmunds and Wollenberg, 2002; Nederlof and Pyburn, 2012). Therefore, studies in the antecedents of innovation behavior require a framework that integrates network governance theories. Network governance involves a select, persistent, and structured set of autonomous actors engaged in creating products or services based on implicit and open-ended contracts to adapt to environmental contingencies and to coordinate and safeguard exchanges (Jones et al., 1997). The theory is a synthesis of transaction cost (Williamson, 1975) and social network theories.

NETWORK GOVERNANCE THEORY

Literature has cited two main forms of governance; the bureaucratic and network forms (Kooiman, 1993; Lynn et al., 2001). These different types of governance are often a result of socio-economic and political process under which various social actors interact to achieve their set goals (Kim, 2006) and the effectiveness of each of the different types of governance (Rhodes, 1997). The bureaucratic governance also known as the central-rule model posits that there is a central steering agent (CSA) amongst numerous actors and assumes that the CSA has all information about all problems, preferences and solutions to problems facing the network. The model has its foundations in the conventional bureaucratic management approach that neglects the values and interests of the individual actors in the network and hence fails to utilize their intellectual capacities in management (Hanf and Toonen, 2012). It therefore postulates a top-down approach in the management and governance of innovation platforms. In terms of organizational structure, an innovation platform governed under this model is mechanical, formalized and specialized. Under the central-rule model, the level and variety of participation in strategic decisions, accountability and monitoring and evaluation is done by a small number of people usually at the higher levels of the hierarchy (Tsai, 2002). Critical knowledge and information sharing is also a preserve of this small number of individuals (Gigone and Hastie, 1997). The central-rule model has been criticized for limiting participation of the majority in decision making which reduces communication, commitment and involvement in tasks among members (Damanpour, 1991; Rogers, 2003; Sivadas and Dwyer, 2000). Bureaucratic governance is a traditional mode of governance that follows the rules and procedures and relies on supervision of stakeholders in the network (Considine and Lewis, 2003). The formal rules and procedures are imposed by higher authorities and this as

argued by some scholars enables bureaucratic governance to achieve a high degree of coordination and cooperation among the very many actors (Peters and Pierre, 1998). This however, is achieved at the expense of institutional flexibility and innovation (Lowndes and Skelcher, 1998). Because of this centralized and unified command of decision making structure, bureaucratic governance is also referred to as vertical or hierarchical governance form (Kim, 2006).

Network governance on the other hand has gained much attention in the last two decades with numerous scholars advancing theories and definitions of network as the starting point. Dubini and Aldrich (1991) and Kreiner and Schultz (1993) have described a network as a collaboration among individuals and organizations. Networks emphasize long-term exchanges that are based on trust and mutual interests of the actors (Larson, 1992; Liebeskind et al., 1996). According to Borgatti and Everett (1997), network governance refers to the coordination that is characterized by organic or informal social systems as opposed to the hierarchical and formal contractual relationships between the actors. This definition is however, criticized on the grounds that it assumes that there are no interactions between actors under the hierarchical form of governance. Provan and Kenis (2008) view all networks as having interactions but the focus on governance enables the critical analysis of rules, sanctions and structures of authority that are used to allocate resources, coordinate and control decisions in the entire network. Although, the concept of network governance is defined differently by different authors, all definitions allude to the fact that it is a pattern of interaction in exchange and relationships and flows of resources between independent units (Powell, 1990; Gerlach, 1992; Larson, 1992). Thus, network governance is composed of autonomous individuals and organizations that operate like a single entity in their tasks which require joint activity. To maintain networks, the network form of governance employs social control measures such as collective sanctions rather than relying on legal authorities (Jones and Hesterly, 1993). It is argued that an actor's decision to join a network is determined by among other factors the actors involved, contents of the network, efficiency and effectiveness of the network (Hay and Richards, 2000). The network governance theory is a synthesis of transaction cost theory and social network theory provided by Jones et al. (1997). The integration of transaction cost theory in social network helps to identify the conditions that facilitate the emergence of network governance (Jones et al., 1997).

According to the transaction cost theory, there are four conditions for the network form of governance to emerge-environmental uncertainty, asset specificity, task complexity and frequency. These conditions are also referred to as exchange conditions and that without them, there would be no need for the network form of governance (Williamson, 1991; Jones et al., 1997).

Environmental uncertainty is a result of the unstable and unpredictable environment within which individuals and organizations work (Williamson, 1991). This may be a result of unpredictable supply and demand which necessitates individuals to integrate with a number of other actors in production processes (Helfat and Teece, 1987). The main sources of demand uncertainty are generated by unknown and rapid shifts in consumer tastes and preferences, seasonality, rapid changes in knowledge and technology and lack of information about past, current and future states in the environment (Jones et al., 1997). Uncertainty further arises from the inability to identify actors in a network who are likely to behave opportunistically (Williamson, 1994). Asset specificity refers to the extent to which an asset can be redeployed to alternative uses and by alternative users without a substantial sacrifice of its productive value (Williamson, 1989). Asset specific also known as customized exchanges involve unique equipment, processes, or knowledge developed by participants to complete exchanges and may take various forms including site specificity, physical asset specificity, human asset specificity, dedicated assets, brand name capital and temporal specificity (Williamson, 1989). Customized or asset-specific exchanges create dependency between different stakeholders thus increasing the need for coordination and raising concerns about how to safeguard these exchanges. Indeed, customization combined with uncertainty requires intensification of coordination between members within a given social setting to safeguard exchanges by reducing behavioral uncertainty (Hesterly and Zenger, 1993).

Task complexity refers to the number of different specialized inputs together with human resources needed to complete a product or service (Jones et al., 1997). Task complexity creates behavioral interdependence and heightens the need for coordinating activities (Pfeffer and Salancik, 1978). The different tasks and inputs are a result of increased scope of activities, number of products created, or number of differing markets served and the need to reduce costs in a rapidly changing environment which increases time pressures (Killing, 1988). Task complexity in conjunction with time pressures leads to team coordination where diversely skilled members work simultaneously to produce a good or service (Faulkner and Anderson, 1987). On the other hand, frequency concerns how often specific parties exchange with one other (Jones et al., 1997). It transforms the orientation that actors have toward an exchange because repeated personal contacts across organizational boundaries support some minimum level of courtesy and consideration between the actors and the amount of informal controls that can be exerted over exchanges (Granovetter, 1992). Frequency is important because it facilitates transfer of implicit knowledge and establishes the conditions for relational and structural embeddedness which provide the foundation for engaging social

mechanisms to adapt, coordinate, and safeguard exchanges effectively (Williamson, 1985). As the frequency of interactions increases, the need for the network form of governance becomes increasingly important. The degree of frequency may range from occasional to recurrent interactions (Williamson, 1985).

In addition to exchange conditions, Hay and Richards (2000) have provided resource dependency as another important reason for the emergence of networks. They stipulate that for networks to emerge there must be the recognition of potential mutual advantage for enhancing strategic capacities through pooling strategic resources together. This emerges from the fact that no single actor possesses all the necessary resources such as information, skills and inputs needed for enhancing production. This argument comes from resource dependency theory which presupposes that by engaging in a network, it is possible for actors to obtain the resources they need and be more effective than working individually (Hay and Richards, 2000). Although the unit of analysis associated with resource dependence theory has traditionally been the organization, its theoretical arguments can be applied to the analysis of the individual level social behavior (Johnson, 1998). It is argued that in order to manage interdependence with either sources of inputs or markets for output and diversify operations, individual actors no longer work alone in a closed environment but rather seek external resources through network formation which allows adaptation to external environment (Donaldson, 1995). A fundamental presumption of resource dependence theory is that in a network, dependence on other actors influences the actions and decisions pursued by a single firm (Nienhüser, 2008). The main thrust of exchange conditions and the need to pool resources together is that they drive actors toward embedding their transactions both structurally and relationally (Jones et al., 1997).

SOCIAL EMBEDDEDNESS

The exchange conditions discussed earlier constitute a fundamental foundation for social embeddedness which further determines the behavior of actors in a network (Nahapiet and Ghoshal, 1998; Rutten and Boekema, 2007). The concept of emebeddedness refers to the extent to which the economic behavior of individuals is determined by social relations between actors in ways that mainstream economic theories and price mechanism is assumed to have minimal effect (Granovetter, 1985; Uzzi, 1996). The concept of social embeddedness explains how the overall structure of relationships between actors affects economic action and outcomes in a network (Granovetter, 1973). Embeddedness is essential for easy communication and access to inputs due to social networks (Coleman, 1990; 1988). According to Nahapet and Ghosal (1998), social embeddedness has been divided into three major dimensions: structural, relational and cognitive; although, literature in management often merges cognitive embeddedness into structural since both are concerned with qualitative dimensions of network relationships.

Structural embeddedness has been defined by Simsek et al. (2003) in terms of the overall architecture of ties in the network. Other scholars such as Gulati (1998) and Burt (1992) have gone beyond just the layout of a network in terms of ties between actors to include the analysis of the structural position of each of the actors in the network. This is because the structural position measures the actor's involvement in decision making processes and consequently the flow of resources and innovation (Burt, 1992). According to Burt (1992), structural embeddedness can be described by described by density, centrality, betweenness and centralization. Density is the actual number of ties that an actor has, expressed as a proportion of the maximum possible number of ties in the network. However, the use of density to measure structural embeddedness is limited by the fact that it is sensible to the number of network nodes; therefore, it cannot be used for comparisons across networks that have different number of members (Scott and Bruce, 1994). Centrality is the number of ties that a node has with other nodes. Accordingly, a node with many ties is considered to be more central than other ties. There are two types of centrality: local centrality and global centrality. Local centrality looks at only direct ties, that is, the ties directly connected to a certain node as expressed in terms of the total number of ties in the network whereas global looks at indirect ties, that is, those that are not directly connected to that node as expressed in terms of the distances among the various nodes. Like density, centrality depends on the size of the network and therefore may not be used to compare networks that differ in size. Betweenness on the other hand is the extent to which a particular node lies "between" the various other nodes in the network. This is because some nodes play important roles because they act as a link between other nodes in the network. Although, it is a meaningful measure of structural embeddedness, it is the most complex of the measures of centrality (Burt, 1992). Centralization is the extent to which the entire network is centralized. It is measured by looking at the differences between centrality scores of the most central node and those of all other nodes. Structural dimension of embeddedness is rooted in Granovetter's (1973) work on the strength of social network ties.

On the other hand, relational embeddedness shows personal relationships developed through history of interactions, while cognitive embeddedness relates to the shared representations and intellectual capital that result from the network. In innovation networks, Nooteboom and Gilsing (2004) have provided scope, duration, frequency and trust as dimensions for measuring relational embeddedness. They introduced scope to be

able to establish a wide range of activities that exist between the actors in a network. They further argue that the frequency and duration of interaction between actors are an important ingredient for mutual understanding and trust which result into innovation performance. Relational embeddedness has also been looked at in terms of tie strength, stability and quality (Li et al., 2013). They argue that networks with higher levels of trust (tie strength) and longer periods of interaction (tie stability) lead to improved network performance. It has also been argued before that the strong and long lasting ties between actors enable the development of strong social rules which in turn leads to the creation of routine, common languages and a common culture that are essential for innovation performance (Coleman, 1990; 1988; Nelson and Winter, 1982). This is because such networks are effective in information transfer and finding joint problem solutions (Uzzi, 1996). Nevertheless, as noted by Uzzi (1997), too much embeddedness can be disadvantageous in a network. He argues that it reduces the flow of new information since actors with strong ties tend to isolate other actors from network information. There is therefore a need for optimal level of embeddedness where actors are neither too tightly connected nor too loosely connected for effective information flow (Jones et al., 1997). In general, social embeddedness leads to network performance through vertical and horizontal linkages between the actors (Granovetter, 1985). According to Giedraitis et al. (2009) vertical links result from specialization of actors along the supply chain while horizontal links lead to competition and rivalry among the actors.

SOCIAL MECHANISMS

Social embeddedness as discussed earlier enables the use of social mechanisms for coordinating and safeguarding exchanges (Jones et al., 1997). Social mechanisms are the institutional mechanisms such as restricted access to exchange, collective sanctions, macro-cultures and reputation that help to control the behavior of the social system and its components (Jones et al., 1997; Coleman, 1990; 1988; Nelson and Winter, 1992). Restricted access to exchanges refers to a reduction in the number of actors who can freely enter the network (Jones et al., 1997). It reduces coordination costs by eliminating some actors which eases interaction for knowledge sharing (Faulkner and Anderson, 1987). It also facilitates identification among the actors which helps create strong ties among them (Granovetter, 1973). Collective sanctions on the other hand help to punish members of the network who violate norms, values or goals of the network. This may involve ostracism or exclusion from the network for either short periods or indefinitely (Jones et al., 1997). Collective sanctions define acceptable behavior by demonstrating the consequences of non-compliance to the rules in the network.

Macro-culture on the other hand refers to shared values and norms that are specific to a network (Jones et al., 1997). The value and norms are shared by all members of the network and they specify the roles, role-relationship and the generally accepted approaches for solving complex problems in the network (Granovetter, 1992). Due to behaviors that are accepted by all actors, macro-culture allows efficient coordination and information flow among actors in the network (Faulkner and Anderson, 1987). Reputation on the other hand refers to the actor's attributes in terms of character, ability and trust that are important to safeguard exchange conditions. These attributes are particularly important because actors often have imperfect information about the behaviors of other actors (Fombrun and Shanley, 1990). Thus, the presence of these attributes and intermediate processes help to deter deceptive behavior, which enhances cooperation, adaptation and safeguard of exchanges which are key issues in assessing the effectiveness of social mechanisms (Figure 1) (Jones et al., 1997; Kilduff and Krackhardt, 1994).

ACTOR INNOVATION BEHAVIOR

The social mechanisms that result from social embeddedness improve the network performance. For example, restricted access to exchanges in the network leads to a reduction in the number of exchange partners within the social network (Jones et al., 1997). This reduces coordination costs through fewer partners who interact more often and allows actors to learn about each other and to establish routines for working together to adapt and safeguard exchanges (Faulkner and Anderson, 1987; Jones et al., 1997). The end result of these interactions is improved network performance as measured by actor innovativeness. Innovative behavior is an act of generating and implementing new ideas for purposes of improving performance (Scott and Bruce, 1994; Woodman et al., 1993). The idea generation stage constitutes of idea exploration and generation (Mumford, 2000; Janssen 2000). At exploration level, individuals begin to look for ways of improving production processes and try to solve problems by themselves (Kleysen and Street, 2001). In agricultural innovation systems, this stage involves the recognition that current agricultural practices such as traditional crops that take long to mature and low yielding are a hindrance to agricultural progress. In this stage, questions relating to whether individuals pay attention to new and improved crop, look for opportunities to improve their farming systems, consider innovative opportunities and explore new crop varieties are essential (Messmann and Mulder, 2011). Idea exploration and generation constitute what has been termed as creative stage of innovation.

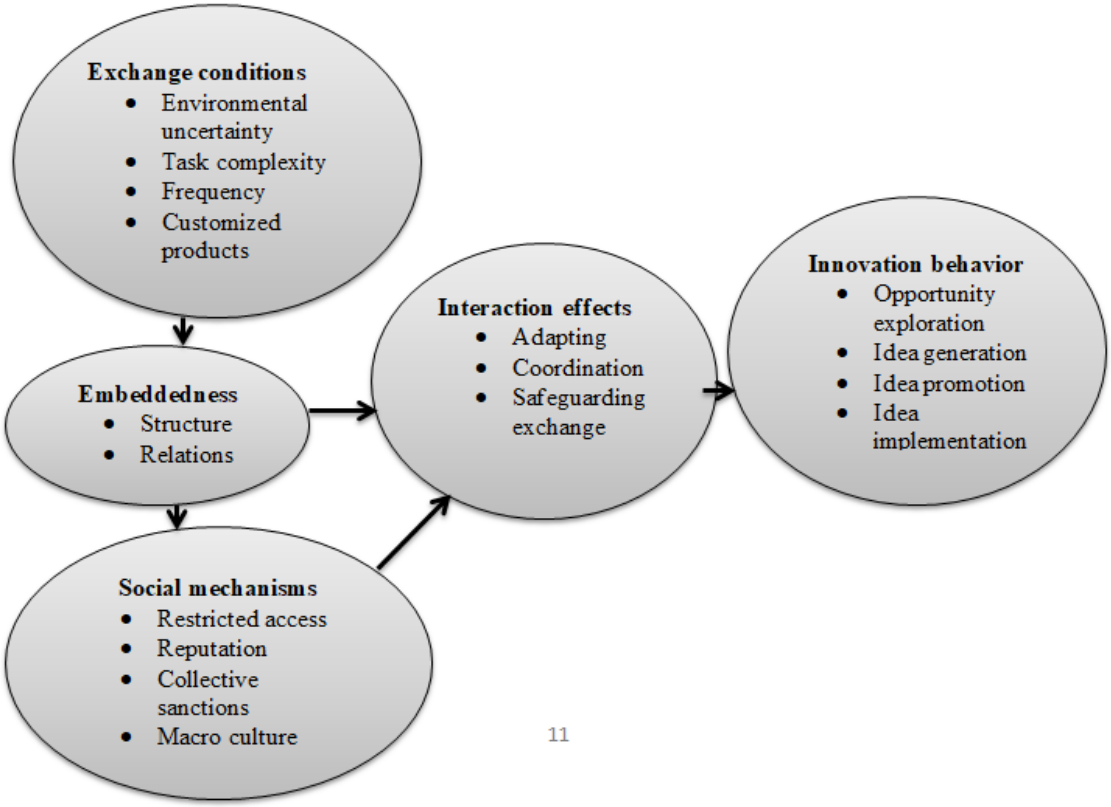

Figure 1. The conceptual process leading to innovation behavior. Source: Adopted from Jones et al.(1997) with modification.

In the implementation stage, innovative ideas are realized and put into practice. Like the generation stage, this stage is reconstructed into two distinctive stages; Idea promotion and Idea implementation. Idea promotion involves mobilizing support for new ideas, acquiring approval for new ideas, making important platform members enthusiastic for ideas and attempting to convince people to support them (Messmann and Mulder, 2011). This may be done by mobilizing resources, influencing and negotiating with a number of stakeholders in an innovation. Under innovation platform arrangement, this stage encompasses championing the ideas by convincing the social environment of the envisioned innovation, and building a coalition of allies that take over responsibility and provide necessary information, resources, and support among the actors. This owes to the fact that the success of an innovation depends on the ability to persuade powerful and influential people of the value of the innovations, and on the ability to access and utilize the actor networks (Dougherty and Hardy, 1996). The implementation stage on the other hand involves experimenting with the ideas and planning strategic integration of new ideas into practice. In this stage, new products, services and work processes are developed, tested and modified (De Jong, 2007). The new ideas such as new crops and farming practices become a regular part of the production processes (Kleysen and Street, 2001). In agricultural innovation platforms, the implementation stage transforms new varieties into useful applications, systematically introduces new varieties into farming systems and puts effort in the development and sustainability of the new crop verities and agricultural practices (Messmann and Mulder, 2011). The stage process of innovation behavior is consistent with the definition of innovation and helps to construct the process of innovation development from the emergence of an idea to its transformation into a practically relevant outcome (Janssen, 2000; Scott and Bruce, 1994).

CONCLUSION

The main objective of this review was to make a theoretical process that explains the innovation behavior of actors within a platform. The paper has made use of network governance theory to explain the reasons for the emergence of networks and how these social networks influence actor innovation behavior. In summary, the exchange conditions of asset specificity, demand uncertainty, task complexity, and frequency drive actors

towards social embeddedness. When actors are both structurally and relationally embeddeded with each other, enforcement of social mechanisms for adapting, coordinating and safeguarding exchanges becomes a reality. As Jones et al. (1997) argues structural embeddedness is a conduit for diffusing values and norms which enhance coordination and diffusion of valuable information among the independent actors. This also facilitates the development and institutionalization of values, norms, and beliefs shared across actors through shared perceptions and understandings (DiMaggio and Powell, 1983). The free flow of information allows the possibility of collective sanctions for non-compliance to norms and values (Jones et al., 1997; Gulati, 1998).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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academicJournals

Vol.9(11), pp. 255-261, November 2017
DOI: 10.5897/JAERD2017.0905
Articles Number: D620D5666415
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Harmonization of extension messages on climate smart agriculture in Malawi: Do we speak with one voice, and to whom?

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Received 8 August, 2017; Accepted 6 October, 2017

Poor access to extension services has been one of the major challenges that smallholder farmers in Malawi face. Dissemination of agricultural technologies is mainly done through field level extension workers and lead farmers; however, such workers are few in number. In addition to this, there is lack of harmonization of messages, approaches and methods in extension delivery at field level. Using baseline cross-sectional data, this study aims at contributing towards harmonization of extension messages and coordination of extension service providers in the implementation of climate smart agriculture technologies in Malawi. Existing information channels for disseminating climate smart agriculture and the capacity of extension workers and lead farmers were analyzed. Key study findings include poor coordination among stakeholders in the delivery, message package and incentive schemes; nonexistence of government approved climate smart agriculture specific training manuals among stakeholders; lack of knowledge and skills among field level extension workers in disseminating climate smart agriculture technologies; and limited access to knowledge and information by female farmers. The study recommends a harmonized and gender sensitive approach in extension delivery, coordination in the implementation of climate smart agriculture activities, and strengthening of District Agriculture Extension Committees for improved facilitation in extension delivery.

Key words: Extension, climate smart agriculture, smallholder farmers, Malawi.

INTRODUCTION

Agricultural support services such as access to extension, farm credit facilities and participation in functional markets, farmer associations, clubs and cooperatives have globally been touted to contribute towards improved farm level production and development of the agricultural sector (Maonga et al., 2017).

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These services tend to be very crucial especially in the successful development of smallholder agricultural sub-sector. In this sub-sector, smallholder farmers are generally characterized as a group possessing small landholdings for farming and with limited access to high productivity farm inputs such as fertilizer, hybrid seed varieties and improved breeds of livestock.

In Malawi, field experience has shown that extension is probably the commonest agricultural support service available and readily accessible by smallholder farmers. Access to agricultural extension by smallholder farmers in Malawi has been increasing gradually. National Statistical Office estimated that in 2005 only 13% of Malawi's agricultural households were able to access extension services (Agunga and Manda, 2014). In 2010, a countrywide study on adoption of metallic grain silos covering 10 districts across Malawi found that 47.4% of the sampled households had access to agricultural extension services (Maonga et al., 2013). In another country level study conducted in 11 districts on biofuel status in Malawi, 39% of the sampled smallholder farm households had access to extension, about 35% claimed affiliation with farmers' clubs, and only 4.6% had an opportunity to get farm credit facilities from formal lending institutions (Maonga et al., 2015; 2017).

Notable regional and global studies such as Ngomane (2006), Anderson (2007) and Zwane (2012) revealed that extension contributes to increased food production, through improved information dissemination, awareness of new agricultural technologies and technology adoption by farmers. Increased access to relevant agricultural extension messages is deemed to have positive influence on adoption of new farm technologies by farmers (Maonga et al., 2013; 2015). Agricultural extension also helps to liberate farmers from poverty; it serves as a catalyst for development in rural agricultural communities and collaborates farmers with researchers in agricultural development (David and Samuel, 2014).

Furthermore, shaped by the national agricultural development goals, the role of agriculture extension generally includes achieving national food security, improving rural livelihoods, and empowering natural resource management (Swanson and Rajalahti, 2010). On the environmental front, extension has been commended to play a pivotal role in addressing climate change issues by significantly contributing towards increased farmer awareness of the negative implications of the changing climatic conditions on farm productivity, and therefore the need for farmers to change farm management practices and adapt to climate change (Nhemachena and Hassan, 2007); farmers who are equipped with information about climate change are likely to have increased resilience to climate change shocks.

In Malawi, agricultural extension plays a facilitating role in the government efforts to achieve rural-based national development through increased farm productivity, improved food security and household income; extension also encourages farmers to take farming as business and thus, enabling them to participate in profitable agricultural enterprises leading to improved livelihoods (Malawi Government, 2012).

In order to widen access to extension services by farmers, the Government of Malawi introduced a pluralistic extension approach in 2002. However, the new approach brought mixed outcomes in the implementation of programs and projects in the agricultural communities. More farmers were and continue getting reached, but with poorly harmonized messages, approaches and methods. This has increased the workload on extension workers and lead farmers. It has further contributed to an information overload on smallholder farmers. Complicating the situation is the fact that female extension workers and lead farmers are few compared to their male counterparts in Malawi. This translates to limited access to new knowledge and information by women smallholder farmers. This is against the background that women in Malawi perform between 50 and 70% of all agricultural tasks, accounting for 70% of the country's labour force and the produced household food requirements, respectively. Such biases weaken capabilities of women to deal with socioeconomic problems and natural catastrophes such as climate change shocks whose impacts tend to be directly linked to gender differentiated vulnerabilities, coping and adaptation capacities and strategies (Women Environment and Development Organization (WEDO), 2010; Goh, 2012; Kakota et al., 2011; IPCC, 2014). Thus, women need to be empowered to enable them gain control over their destiny at personal life, community and society levels (Mare, 2017).

Constituting about 70% of the world's farmers and households living below the poverty line and also directly dependent on natural resources for their livelihood, women are more vulnerable to impacts of climate change and variability (WEDO, 2007; Goh, 2012; Agrawal et al., 2014). Therefore, unless gender inequalities are identified among climate-resilient interventions and gender needs addressed, development efforts will have marginal effects on livelihood improvement and solving food insecurity challenges. The 2013 to 2016 Malawi National Climate Change Programme advocated for gender responsive climate change policies and plans in order to build communities that are climate resilient. However, the gender gaps still exist in agricultural production; women continue to have poor access to and control over the means of agricultural production such as farm inputs, improved technologies, extension services, credit facilities and land (Kakota et al., 2011; World Bank, 2014). These factors reduce productive capacity of women and exacerbate their vulnerability to climate change shocks. Evidence shows that in Malawi, male-managed plots produce on average 25% more per hectare than female managed plots (World Bank, 2014). This is due to inadequate capacity among women, which

results from low access to extension services, education, information, and limited participation to local institutions.

The ability of women smallholder farmers to reap benefits from climate smart agricultural (CSA) practices will require institutional policy environment that is geared towards enabling women to have greater access to and control over appropriate agricultural technologies, information and financial support. Otherwise, poorly coordinated and lack of gender sensitive extension approaches will in the long-run reduce adaptive capacity and resilience of smallholder farmers to climate change and variability. This will likely contribute to environmental degradation, increased vulnerability and food insecurity.

The purpose of this study is therefore, to contribute to harmonization of extension messages and coordinate extension service providers in the implementation of CSA technologies in Malawi. The study pays particular attention to the analysis of existing information channels for disseminating CSA technologies as well as the capacity of extension workers and lead farmers in the dissemination of CSA technologies in Malawi through the case studies of selected three districts. The study is written with reference to the Malawi implementation plan for the National Agricultural Policy 2016, which particularly emphasizes coordination among all extension service providers and harmonizing extension messages on agricultural technologies amongst various extension service providers.

METHODOLOGY

Sources of data

This study is based on a baseline cross-sectional study. Data were collected from smallholder farmers and key agricultural stakeholders in three districts of Dowa, Nkhotakota and Phalombe between June and November 2015. The baseline study was the initial phase of the implementation of Capacity Building for Climate Change in Malawi (CABMACC) funded project titled “Framework for Enhancing Adaptive Capacity of Female Farmers to Climate Change” – Project Number CABMAC/001/01/2013.

Nkhotakota and Phalombe districts were identified from the six CABMACC priority areas. The two districts were selected because of their involvement in the previous studies on vulnerability to climate change such as the Climate Adaptation for Rural Livelihoods and Agriculture (CARLA). Dowa was identified from the districts where a collaborator to the CABMACC/001/01/2013 project, Development Fund of Norway, was implementing sustainable agriculture project using the lead farmer model. The choice of the districts was also based on the cultural and marriage beliefs that may have an influence in the access of resources, decision-making processes and adoption of CSA technologies. Geographically, all the three qualified as the right sites for implementation of CSA technologies.

Phalombe District is highly vulnerable to climate change effects especially floods owing to its hilly landscape with flood plains and undulating plateaus. The study was conducted in two Extension Planning Areas (EPAs) namely, Naminjiwa and Kasongo. The communities follow the matrilineal type of marriages where women are given preferences in the ownership of assets such as land because they remain in the villages while men migrate to other places to marry. In their culture, a woman has control over children and in the case of divorce the children stay with the mother. This type of marriage system tends to influence the uptake of technologies and other interventions that can enhance adaptive capacity by female farmers or otherwise.

Nkhotakota District is generally flat but also vulnerable to climate change effects such as dry spells and strong winds. Being along Lake Malawi lakeshore, communities in Nkhotakota depend on fishing besides agriculture for their livelihood. The study was conducted in Linga EPA where CABMACC projects are being implemented. Unlike Phalombe, communities in Nkhotakota follow a patrilineal system of marriage where men are given preferences over ownership and control over productive resources such as land. Polygamy is also common in Nkhotakota especially among the Muslim communities in the district and the study area in particular. These cultural and marriage beliefs have also an influence over adoption of CSA technologies.

Dowa District is geographically hilly. Communities in Dowa District generally practice patrilineal system of marriage just like Nkhotakota. Chibvala EPA, where the Development Fund of Norway has been implementing activities, attracts increased number of projects and trials on sustainable agriculture. The EPA is accessible by most of the non-governmental organization because of its proximity to Lilongwe, the capital city of Malawi. It was therefore, better placed for sharing experiences and lessons on CSA technologies.

Data were collected through desk study and field survey. Desk study involved a thorough review of existing training documents on CSA and extension delivery in Malawi and the international community in order to identify gaps in literature. Using checklists, key informant interviews were conducted with Ministry of Agriculture, Irrigation and Water Development through the Department of Agricultural Extension Services, and the Department of Land Resources Conservation; and also from non-governmental organizations, such as Self Help Africa, Farmers Union of Malawi, National Smallholder Farmers Association of Malawi, Evangelical Lutheran Church of Malawi and the Development Fund of Norway. Through plenary sessions, a knowledge gap analysis was conducted with selected participants drawn from extension offices in Nkhotakota, Dowa and Phalombe districts in order to capture training needs of the field level extension workers and lead farmers.

In a field survey approach, the study used a semi-structured questionnaire to collect primary data at smallholder farm household level through a series of oral interviews between trained enumerators and household head and/or spouse. Smallholder farmers were targeted because they are in a majority in Malawi’s agricultural sector; and also because a farm household is considered as a decision-making unit (Maonga et al., 2015).

The baseline study covered a sample of 138 smallholder farm households drawn from the three districts (37 from Dowa, 51 from Nkhota kota and 50 from Phalombe) through multi-stage sampling procedures. From the sample, 105 were male-headed households while 33 were female-headed households. However, 90 respondents were females while 48 were males because gender project female respondents were selected from both male-headed and female-headed households. The sample size was calculated using the formula presented in Equation 1.

$$n = [\{z^2 (1 - p)p\}/e^2] \quad (1)$$

In equation (1), n is sample size, p is estimate of the percentage population, e is acceptable sampling error, and z is the desired level of confidence (1.96 at 95%). The study was considered as sub-national, therefore, the desired allowable sampling error was within 0±10% which translated to (0.1) in the equation; an estimate of 50% or 0.5 was used because there were no previous estimates of the population proportion in the three districts on related studies.

The sample size was different in each district but the total

number per district exceeded 30, which is a recommended minimum sample size that allows drawing of basic inferential statistics whenever necessary. Smaller samples of this nature were appropriate for this study because the research was mainly qualitative in nature with a strong focus on an in-depth inquiry. With the indicated measurements (*e, p, z*), the formula would generate a sample size of 96 households.

However, the sample was increased to 138 in order to take care of non-responses and field errors and also to increase representativeness in the selected Extension Planning Areas drawn from the three districts.

The first three stages involved selection of districts, extension planning areas, traditional authorities and villages. Finally, using random tables obtained from district agriculture offices, households for interviews were selected from a list of villages through simple random and proportional probability sampling techniques in order to have proportionate representation of sub-samples across villages. In a form of triangulation, primary data were also collected through focus group discussions conducted with groups of smallholder farmers ranging between 8 and 15 members per group drawn from the sampled households. Focus group discussions were intended to capture in-depth qualitative data which would otherwise not be possible to collect through questionnaire administered survey; it also served the purpose of triangulating the questionnaire generated quantitative data.

Data analysis

In line with the objectives of this study data were analyzed using Statistical Package for Social Scientists version 20 and reported through descriptive statistics (percentages, means and frequencies). Therefore, the findings presented in this study are based on analysis of existing information channels for disseminating CSA technologies and capacity of extension workers and lead farmers in the dissemination of CSA technologies.

RESULTS AND DISCUSSION

The study generated two key findings based on the objectives of the study, and raised four critical issues that policy makers ought to pay attention to in the implementation of CSA technologies and practices in Malawi.

Existing information channels for disseminating CSA technologies

The common channels for disseminating CSA were extension workers (Government and NGOs), lead farmers, radios, village meetings, field days and demonstration plots. Government extension workers and lead farmers combined were found to be the main channel of communication for disseminating information of CSA technologies and practices.

However, it was noted that there were few extension workers against the number of farmers, and some sections had no extension workers at all. As a result, farmers relied on lead farmers because they were available almost in every village. In general, the results show that women in female-headed households had low access to the common channels of communication such as radio and cellphone. Only 33% of the respondents in female-headed households owned a cellphone as compared to 59% of the respondent in male-headed households.

Similarly, more male-headed households (70%) than female-headed households (24%) owned a radio. This implied that very few women in female-headed households accessed messages sent through cellphones and radio. When disaggregated by districts, the results showed that 64% of the respondents in Phalombe owned a radio followed by 63% in Nkhotakota while in Dowa 49% owned at least a radio. It was also noted that more respondents in Nkhotakota (58%) owned a cellphone followed by Dowa (57%) and the least was Phalombe with (46%).

Although, cellphones were used to communicate messages, it was observed that none of the messages received was related to CSA technologies. Most of the messages (52%) were related to social issues while only 7% of the messages received on radio were related to agriculture. The results also showed that 65% of the respondents in male-headed households could read and write as compared to only 36% of the respondents in female-headed households. As such, if the information were presented in a written form, very few female farmers would be able to read.

Phalombe had a highest percentage of respondents who could read and write the local language, Chichewa (70%) followed by Dowa (68%) and the least was Nkhotakota (41%). These findings provided an indicator of the channels that could be used to disseminate CSA technologies in each of the districts. It is also important to note that through focus group discussions the study revealed that “all the lead farmers could read and write and had a cellphone and a radio in possession,” which they used to bridge the communication gap.

Capacity of extension workers and lead farmers in disseminating CSA technologies

Qualitative findings from extension workers revealed that generally, they had little knowledge on the new agricultural practices such as CSA technologies because their formal training did not cover such technologies. It was noted that there were opportunities to attend trainings on new agriculture practices but only a few extension workers were selected to attend a particular training. Extension workers gave each other turns to attend the training; this implies that that one extension worker might not have acquired the required knowledge and skills of all the new practices.

The study also revealed that sometimes extension workers got mixed information on a particular technology from different trainers especially government versus non-governmental organization (NGOs). As such they got confused on the appropriate knowledge and skills to

disseminate to lead farmers and follower farmers. The extension workers also complained of the short duration of the training against the volume of work that was covered. Time was inadequate to learn a technology and put it into practice. It was reported that on average, training took two days including field visit and demonstrations. There was a suggestion of extending the duration of training to at least five days.

The discussions also revealed that there were no resources at the EPA level for conducting activities that will promote sharing of information and experiences after the action points developed during trainings. It was also noted that there was a training manual for training extension workers that was developed by the Department of Extension Services through the Ministry of Agriculture, Irrigation and Water Management; however, the information on Climate Smart Agriculture was very scanty in the manual. There was need to update the manual and include the detailed information on CSA technologies and other new practices that enhance farmers' adaptive capacity to climate change.

On the other hand, the discussions with lead farmers highlighted the challenges that they faced in providing extension services to farmers. Most of them had never attended any training apart from a one-day meeting that they sometimes attended at the EPA. There were no reference materials that they used as lead farmers, and that whatever they shared with farmers, came from their heads out of experience. There was also a problem of transportation to reach out to farmers owing to the fact that most of the lead farmers did not own even a bicycle though some of the follower farmers stayed far. It was observed that lead farmers were doing most of the work in providing extension services because of the shortage of extension workers especially in rural areas. For example, Chisoti Section under Linga EPA had no government extension worker and as such, farmers relied on the lead farmer for extension services. However, it was clear from the lead farmers that they had very little knowledge on the CSA technologies. Therefore, their capacity to train farmers was very low. Discussion with smallholder farmers also revealed that sometimes farmers did not trust the lead farmers because the latter tended to have lower knowledge on technologies and limited skill in demonstration plots.

Critical issues from the key findings

From the two key findings of the study, this paper further discusses four critical issues whose implications would potentially improve or hinder successful implementation and delivery of agricultural extension in general and adoption of CSA technologies in Malawi. Addressing these critical findings successfully would in principle lead to enhanced resilience to climate change shocks and improved food security and livelihoods among smallholder farm households in Malawi.

Lack of a common understanding of Climate Smart Agriculture

Focus group discussions with extension workers from Dowa, Phalombe and Nkhotakota districts revealed a lack of common understanding of CSA. There was a misconception of the difference between CSA and Conservation Agriculture. Another critical finding in this aspect was the poor coordination among stakeholders promoting and implementing CSA technologies. The stakeholders implementing CSA used different methodologies and training manuals with different messages on the same technologies. There was also inadequate harmonization of activities between NGOs and government, which led to dissemination of conflicting messages to farmers. It was further found that the NGO community introduced different incentives to government extension workers, lead farmers and farmers. This unfortunately led to abandonment of own work in favor of project activities, as well as deliberate duplication of interventions within the same impact areas with minimal progress on the ground. Furthermore, such an incentive scheme tended to create dependency, which eventually stood as a challenge for long-term sustainability of agricultural production and extension service delivery.

Non-existence of government approved CSA specific training manuals among stakeholders

The organizations that have been promoting CSA technologies in Malawi used generic agricultural training manuals to train extension workers and lead farmers. These manuals mainly contained parts of CSA technology messages, thereby making it difficult for extension workers and lead farmers to understand the process of implementing them. This affected quality and relevance of messages in addressing CSA technologies. In addition, there were no reference materials to guide lead farmers in disseminating CSA technologies. As such, most of what the lead farmers shared with their follower farmers came from their own memory and experiences.

Limited knowledge and skills among field level extension staff about CSA technologies

There were training gaps in CSA technologies in content, delivery and context leading to inadequate knowledge and skills among extension workers and lead farmers. There was no continuity in the participation of extension staff in training programs organized by projects, as extension workers gave each other turns to attend

training sessions. In this manner, extension workers failed to acquire a full package of knowledge and skills as designed by the training program. In this case, extension workers might not have gained the expected appropriate knowledge and skills to disseminate CSA technologies to lead farmers and follower farmers. Related to this, the EPA level had inadequate resources for conducting activities to promote sharing of information and experiences. These problems combined have serious negative consequences on the efforts to promote CSA technologies.

Few female extension workers and lead farmers affect CSA uptake

It has been noted that gendered constraints are affecting Malawian women smallholder farmers' uptake of CSA technologies. Women smallholder farmers prefer to get CSA messages from female extension workers, and lead farmers. However, there are fewer female extension workers and lead farmers in rural areas than their male counterparts. It was observed that women smallholder farmers have less information about CSA technologies than the male farmers. Limited land use rights, access to inputs, extension services and knowledge on CSA technologies are major constraints for adoption among women smallholder farmers in Malawi. It would be unrealistic to claim improved adoption of CSA technologies without properly addressing these contestations. Therefore, it is necessary to rethink about doing something to improve agricultural extension that currently does not provide equal rights to extension services to men and women smallholder farmers. The agricultural extension system should design a program that particularly addresses female extension agents and lead farmers to reach rural women in both male-headed and female-headed households.

CONCLUSION AND POLICY RECOMMENDATIONS

From the study findings, this study concludes that poor coordination among stakeholders in the delivery, message packaging and incentive schemes in addition to lack of government approved CSA specific training manuals have led to conflicting messages on CSA technologies among stakeholders and poor adoption of technologies among farmers in Malawi.

CSA is a new concept among most field level extension staff and the content may not have been covered during the previous extension training. The study also observed that there are inadequate training sessions to equip field level extension workers with appropriate knowledge and skills. As a result, most of the field level extension staffs have gaps in knowledge and skills to disseminate CSA technologies to lead farmers and follower farmers. If not addressed, these findings have serious implications including poor adoption of CSA technologies, particularly among female smallholder farmers, and may contribute to low adaptive capacity and exacerbate household food insecurity in Malawi.

Based on the findings and conclusions, the study recommends that there should be a harmonized approach and coordination in the implementation of CSA activities amongst different stakeholders in the country. On this issue, emphasis should be placed on strengthening district agricultural extension committee, which actively serves as overseer of agricultural activities at district level. We would also like to recommend that government approved CSA specific training manuals should be developed and made available for use in all EPAs in the country. These should serve as blue prints to be used by all stakeholders with intention to promote CSA in Malawi. Few modifications must of course, be allowed to accommodate area specific geographic and climatic differences that exhibit variations in agricultural production across the country. The agricultural extension system should design a program that particularly addresses female extension agents and lead farmers to reach out to rural women smallholder farmers.

Furthermore, the study recommends re-tooling of extension workers on CSA as well as increased training of lead farmers to ensure that they acquire up-to-date knowledge and skills required in the implementation of CSA technologies. Last, but not least, we recommend that improved and updated reference materials on CSA should be developed and provided to lead farmers and follower farmers in local language(s) to guide their use when working with other smallholder farmers in the respective farming communities in the country.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors express their gratitude to the Governments of Malawi and Norway for the financial support through CABMACC funded project ("Framework for Enhancing Adaptive Capacity of Female Farmers to Climate Change" – Project Number CABMAC/001/01/2013). We also appreciate the technical and logistical support rendered to the project by the Lilongwe University of Agriculture and Natural Resources (LUANAR) through its Programs Coordination Office. We would like to thank the following organizations: Self Help Africa, Farmers Union of Malawi, National Smallholder Farmers Association of Malawi, Evangelical Lutheran Church of Malawi and the Development Fund of Norway for accepting to voluntarily participate in the study as key informants. The role played by District Agriculture Officers for Dowa, Nkhotakota and Phalombe districts in coordinating the fieldwork is also acknowledged.

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academicJournals

Vol.9(11), pp. 262-269, November 2017
DOI: 10.5897/JAERD2017.0913
Articles Number: 5D36BFB66419
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Access to dry season water and small ruminants market integration in the Nadowli District of Upper West Region of Ghana

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Received 29 August, 2017; Accepted 6 October, 2017

Against a background of disconnect between high demand for small ruminants and limited market integration of small ruminants in the interior savannah agro-ecological zone of Ghana, the objective of this study was to assess the effects of differential access to dry season water on small ruminant production and market integration in the Nadowli District of Ghana. The study obtained data from 389 small ruminant households in the Nadwoli District. The data were analyzed using chi-square test, t-test and logistic regression. The results of the study indicate that 67% of small ruminant keepers in high dry season water access communities adopted all animal husbandry practices compared to 33% of small ruminant keepers in low dry season water access communities. The findings also show that small ruminant market integration was relatively higher for both sheep (48%) and goats (35%) in high dry season water access communities compared to 12 and 9% for sheep and goats, respectively, in low dry season water access communities. Veterinary service access, water access, shelter and free grazing show statistically significant predicting factors of small ruminant market integration. The adoption of good husbandry practices and the resultant high market integration suggests that when communities have access to dry season water, they tend to do better in taking advantage of market opportunities to reduce poverty and enhance food security.

Key words: Adoption, husbandry practices, institutions, sheep, goats.

INTRODUCTION

Markets depend on institutions (Greif, 2005). Two of such institutions identified in the field of new institutional economics are the 'contract-enforcement' institutions that determine the range of transactions in which individual actors can commit to keep their contractual obligations and the 'coercion-constraining' institutions that determine

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whether individual actors will bring their goods (for example, small ruminants) to the market in the first place (Greif, 2005). According to Xinshen et al. (2007), sustainable market integration of goods will improve production, augment growth, and assuage poverty. It is therefore assumed that market-led production of small ruminants is one of the strategies for small ruminant households to enhance food security and alleviate poverty.

Market integration is the result of the action of traders and the operating environment determined by the infrastructure available for trading such as transportation, credit, communication, storage facilities and the policies affecting price transmission (Goletti et al., 1995). Market integration can therefore be expressed as a function of market infrastructure, policy volatility and production (Goletti et al., 1995; Pasquariello, 2014). Policy volatility such as price stabilization, trade restrictions and credit regulations can either have a positive or negative influence on small ruminant market integration. Small ruminant market integration is relevant and generates certain benefits including reduction in the cost of agricultural products and strengthening of the backward and forward linkages between farm and non-farm production systems (Greif, 2005). Backward linkages is defined as the linkages from the farm to the non-farm sector that provides inputs for example, agrochemicals for agricultural production, while forward linkages is defined as the part of the non-farm sector that uses agricultural output as an input.

Unlike financial markets which became more integrated globally in the last few decades due to the progressive reduction of trade barriers for example, capital controls or taxes on repatriation to foreign investment around the world (Carrieri et al., 2013), there is lack of market integration of small ruminants. The lack of market integration of small ruminants is blamed on information asymmetry, lack of credit access, high incidence of pests and diseases, lack of feed in terms of quality and quantity, inadequate veterinary services, and shortage of water especially during the dry season (Amankwah et al., 2012; Musimwa et al., 2008; Zuwarimwe and Mbaai, 2015).

Ortmann and King (2010) suggest that smallholder livestock farmers' involvement in small ruminant markets is immaterial owing to the perception that small ruminants are kept as a form of non-monetary assets. Also, small ruminant households do not participate in livestock markets because they have doubts about the prices offered for animals at the market outlet (Ortmann and King, 2010).

According to Peden et al. (2007), there is a direct relationship between access to dry season water and marketing of small ruminants. Water and other resources help animals to adapt to adverse weather conditions (Araujo et al., 2010). Yet, dry season water is not accessible in some communities for home and animal production (Araujo et al., 2010).

In Ghana, small ruminants are concentrated in the guinea savannah agro-ecological zone, which is characterized by guinea grass (*Panicum maxicum*) and elephant grass (*Pennisetum purpureum*). Small ruminant production is important because it contributes to farmers livelihoods, asset savings and employment provision (Adzitey, 2013). Small ruminant production is also important because it contributes to about 8% of Ghana's gross domestic product (Ghana Statistical Service, 2012).

Due to the potentials of small ruminants to the economy of Ghana, institutional support to increase small ruminant production has been a key component of agricultural development programmes since the 1990s. For instance, between 1996 and 2003, the Upper West Agricultural Development Project under the International Fund for Agricultural Development introduced the Sahelian sheep and goats aimed at improving the size of local breeds in the region. Also, the Livestock Development Project implemented between 2003 and 2010 was aimed at increasing the income of smallholder livestock and diary farmers, processors and traders in the region. As part of the projects, smallholder farmers were trained and equipped with basic animal health care and husbandry practices. Under the Livestock Development Project for example, farmers were trained to establish between 0.2 and 0.4 ha of *Stylosanthes* and *Cajanus* spp. pasture for their small ruminants.

Despite these interventions, Ghana is yet to experience sustained small ruminant market integration (Xinshen et al., 2007) as available data on livestock indicates that there is an annual deficit of over 95,000 tonnes of chevon and mutton (Adzitey, 2013). Ghana only produces 30% of her meat demand and the rest is supplemented through importation of live small ruminants from northern neighbouring countries such as Burkina Faso, Mali and Niger (Adzitey, 2013; Amankwah et al., 2012).

The high and growing demand for small ruminants in local and international markets, the competitive advantage in small ruminant markets, the potential natural resource base/vegetation cover in Northern Ghana, ample policies and programmes to support small ruminant smallholder households' market participation and the experience of farmers keeping small ruminants are practical opportunities to enhance the contribution of the agricultural sector. Unfortunately, poverty is still the highest (63%) and so is food insecurity in northern Ghana (e.g., 10% in Northern region, 18% in Upper West region and 28% in Upper East region) (World Food Programme, 2012).

Considering that there is increasing water scarcity due to lack of functioning dams/dugouts in many communities in the Nadowli District and the expectant increasing demand for small ruminant products, the need to understand how small ruminant market integration can stimulate domestic and export markets growth is necessary.

The literature suggests that few studies have focused on correlation coefficients of spatial prices as a measurement of market integration and the use of time series methods to estimate cointegration between non-stationary prices at the expense of structural factors responsible for market integration (Pukthuanthong and Roll, 2009).

According to Ayantunde et al. (2008), in order to identify the potentials of small ruminant farming for poverty alleviation in the transitional zone through market integration, water access for animal production, farmers' agronomic practices and farmers' adoption of improved technology should first be sought.

The objective of this study was to assess how water access during the dry season at the community level affects market integration of small ruminant households in the Nadowli-Kaleo District of Northern Ghana. Specifically, the study sought to:

(1) Examine the difference in small ruminant production practices of small ruminant households between communities with low and high dry season water access.
(2) Investigate the predicting factors of small ruminant households' adoption of husbandry practices, (3) Identify the effects of differential access to dry season water on small ruminant market integration, and
(4) Investigate the predicting factors of small ruminant households' market integration.

Significance of the study

An understanding of the determining factors of market integration will help the Ghana Government to be more interested in policy interventions and strategies to improve the degree of integration of small ruminants. The knowledge of such factors will also help the Ministry of Food and Agriculture in Ghana, the International Fund for Agricultural Development, the District Assemblies and a number of organizations and private individuals to know the impact of their resources such as capacity building/training, technical and infrastructural intervention strategies on the livelihoods of rural people. Also, the understanding of such information will provide useful insights towards future programme/project design and implementation of strategies to alleviate dry season water challenges. Furthermore, the study will aid in the understanding of the underlying structural factors responsible for market integration because this current study departs from the use of time series approach in the estimation of market integration.

MATERIALS AND METHODS

Description of the study area

The study was carried out in the Nadowli-Kaleo District of the Upper West Region of Ghana. The district was chosen because of the role of small ruminants in the livelihoods of the people, the suitable vegetation, the district's proximity to the animal research institute and cross boarder markets. The Nadowli-Kaleo District lies between latitude 10.8° 28' and 9.8° 18' North and longitude 2.7° 10' and 1.9° 10' West (Figure 1). The district has a mean annual temperature of 32°C, and a mean monthly temperature ranging from 36°C in March to 27°C in August. Farming is the main occupation of majority of the people. Consequently, most rural development programmes and projects aimed at alleviating poverty in the district are largely related to crop and livestock farming. The district has several livestock markets with high participation of citizens from neighbouring countries such as Burkina Faso and Ivory Coast. The district has about eight hundred thousand small ruminants of which, 90% are owned by smallholder mixed crop-livestock farmers and 10% owned by pastoralists (Department of Agriculture, 2012).

Study design and sampling technique

The study design was a cross-sectional survey. A list of all communities were obtained from the Planning Department of the Nadowli-Kaleo District Assembly. The communities were grouped into two on the basis of availability of dams and/or dugouts. A purposive sampling technique was used to select Dakyia and Tabiasi communities because of the communities' access to dry season water, while Musama and Tangasie communities were selected because of their lack of access to dry season water. Dry season water is defined as the availability of dams and/or dugouts in communities for the purpose of agriculture. In each community, a list of small ruminant households was obtained from the Veterinary Service Directorate of the Department of Agriculture in the Nadowli-Kaleo District. For the selection of small ruminant households, a simple random sampling technique was used. Using Krejcie and Morgan (1970) sample size determination table, a population of 100,005 will require a sample size of 389 respondents.

Data collection and analyses

A questionnaire was used to collect data on the socio-demographic characteristics of household heads such as gender, age, education level, years of experience in small ruminants farming, income level, reasons for keeping small ruminants, and the number of small ruminants kept.

Data collection also covered husbandry practices such as feeding practices, watering, housing, veterinary services access and use, animal mortality, access to and use of animal vaccines and medicines. Finally, data were collected on marketing and transaction costs such as the price of sheep and goats, cost of transporting sheep and goats, major season in which animals are sold and types of market for sheep and goats sales (for example, auction, private, butcheries, abattoirs, etc).

Data were entered into the Statistical Package for Social Sciences (SPSS) version 20. Data analysis involved comparing results of high dry season water access communities with results from low dry season water access communities. The test for differences of categorical variables was carried out using Chi-square analysis and t-test.

Additionally, the logistic regression procedure applying the backward likeli-hood-ratio (LR) test was used to investigate the set of socio-demographic characterisitics and adoption of good animal husbandry practices on market integration of small ruminants.

Logistic regression allows the prediction of market integration from a set of categorical and/or continuous variables (x). The dependent variable is dichotomous and takes the value of 1 if households participate in commercial livestock markets or the value of 0 if otherwise. The logistic regression function was applied in this study because the relationship between the dependent variable and independent variables is a non-linear function.

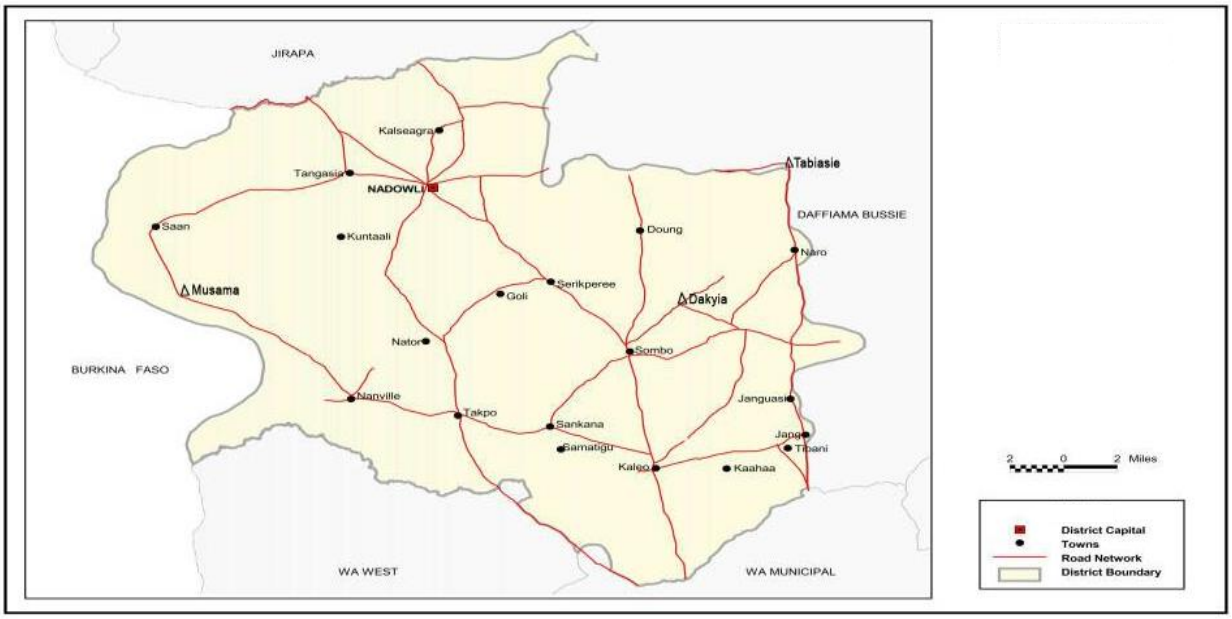

Figure 1. Map of the study area (Nadowli Kaleo).

$$\text{Logit } (y(x)) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_j x_j \quad (1)$$

where α = the constant of the equation and β = the coefficient of the independent variables.

The positive or negative sign of the coefficient indicates the direction of the relationship between a given independent variable (x) and the dependent variable (y), while the odds ratio gives the magnitude of the change in the odds of having the dependent variable event for a one unit change in the given independent variable.

RESULTS AND DISCUSSION

Socio-demographic characteristics of small ruminant households

Table 1 shows the socio-demographic characteristics of small ruminant keepers in the study area. The bivariate analysis of the study shows that there is no statistically significant difference in small ruminant keepers' age, education and experience in rearing small ruminants. However, the study results indicate a statistically significant difference ($p < 0.01$) in gender between low and high dry season water access communities. The findings show that there are more female small ruminant keepers in high dry season water access communities probably due to dry season water accessibility. The purpose of keeping small ruminants was found to be statistically significant ($p<0.01$) for cash income. The results indicate that 99% of farmers in low dry season water access communities keep small ruminants for cash.

Adoption of husbandry practices

Table 2 presents bivarate analysis which shows a statistically significant difference ($p < 0.041$) in adoption of good husbandry practices between high and low dry season water access communities. The results show that 67% of small ruminant keepers in high dry season water access communities, and 33% of small ruminant keepers in low dry season water access communities adopted all husbandry practices taught them during the implementation of the Upper West Agricultural Development Project and the Livestock Development Project. The adoption of good husbandry practices contributed to low animal mortality in high dry season water access communities. The findings indicate that 60% of small ruminant households in high dry season water access communities and 64% of small ruminant households in low dry season water access communities reported animal mortalities between 2010 and 2012 (Table 3). The average number of animal deaths in both low and high dry season water access communities was 5, which is lower than the national average of 7 animals. The causes of animal mortality were generally pest and diseases such as pneumonia, diarrhoea and worms. The respondents attributed the high mortality to unavailability of vaccines in the district to vaccinate animals against Peste des Petits Ruminants and Contagious Caprine Pleuro-Pneumonia.

Table 1. Socio-demographic characteristics of smallholder small ruminant households.

Characteristic	Dry season water access communities				District		χ^2 test	P value
	Low		High					
	Frequency	%	Frequency	%	Frequency	%		
Gender							7.781	P =0.005
Male	156	45.3	188	54.7	344	100.0		
Female	10	22.2	35	77.8	45	100.0		
Age							0.000	P =1.000
<35	44	42.7	59	57.3	103	100.0		
≥35	122	42.7	164	57.3	286	100.0		
Education							0.252	P =0.620
No formal	132	41.9	183	58.9	315	100.0		
Formal	34	45.9	40	54.1	74	100.0		
Years of experience							0.448	P =0.500
<10	61	36.8	81	36.3	135	34.7		
≥10	105	63.2	142	63.7	254	65.3		
Cash income							3.752	P =0.005
Yes	165	99.4	216	96.9	381	97.9		
No	1	0.6	7	3.1	8	2.1		

Table 2. Adoption of animal husbandry practices**.**

Adoption package	Dry season water access communities				District		χ^2 test	Sig.
	Low		High					
	Frequency	%	Frequency	%	Frequency	%		
Some	115	49.1	119	50.9	234	100.0	9.402	P =0.041
All	51	32.9	104	67.1	155	100.0		

Table 3. Mortality of animals between 2010 and 2012.

Mortality	Low dry season water access community			High dry season water access community			Statistics (t-test)
	N	Mean	Std dev.	N	Mean	Std dev.	
Sheep	166	5.902	0.178	223	2.087	0.081	***
Goats	166	5.890	0.126	223	3.281	0.094	***

***p < 0.001.

Predicting factors of adoption of good animal husbandry practices

Results from the logistic regression analysis are presented in Table 4. Overall, the model was able to correctly assign 60% of small ruminant households in high dry season water access communities. The results show that the model is good at 22% but not great. The results also indicate that 17% probability of small ruminant households adoption is explained by the logistic model. However, while it identified correctly 68% of high dry season water access communities, the classification of low dry season water access community was poor. The logistic regression confirms that the adoption of good animal husbandry practices is influenced by:

(1) Education level of household head (P<0.05)
(2) Herd size/number of animals kept (P<0.05)

Table 4. Logistic regression: Pedicting factors of adoption of good husbandry practices by smallholder small ruminant household heads.

Predictor	B (Coefficient)	SE of β	Wald's χ^2	df	P	e^{β} (Odds ratio)
Constant	-2.322	0.476	23.746	1	0.000	0.098
Gender	-0.132	0.367	0.129	1	0.719	0.876
Education	0.626	0.292	4.595	1	0.032	1.870
Dry season water access	0.601	0.238	6.352	1	0.012	1.824
Herd size	0.016	0.008	4.142	1	0.042	1.016
Income level	-0.210	0.241	0.759	1	0.384	0.811
Veterinary access	1.880	0.283	44.129	1	0.000	6.551
Test			χ^2	**df**	**P**	
Overall model evaluation (Model χ^2)			68.634	6	0.000	
Goodness-of-fit test (Hosmer and Lemeshow)			11.022	8	0.200	
-2 Log-Likelihood = 445.470						
Cox and Snell R^2 = 0.165						
Nagelkerke R^2 = 0.223						

(3) Households access to veterinary services (P<0.01); and
(4) Households access to dry season water (P<0.01).

The findings corroborate Legesse et al. (2013) and Sandeep et al. (2006) that farmers' adoption of improved animal husbandry practice vary by agro-ecological zones, and between farmers facing different markets and institutions in watershed and non-watershed villages. The coefficient of herd size was positive, which implies that the more the number of small ruminants kept by households, the higher the probability of accessing vertinary services for small ruminants. Furthermore, the findings show that education of household heads has a positive coefficient, which indicates that education has a direct influence on farmers' adoption of good husbandry practice. The findings imply that farmers with formal education are likely to be aware of more sources of information and then make informed decisions regarding their farming activities. This assertion confirms the findings of Moyo and Salawu (2016) that the education of farmers influence adoption of agricultural technology in Nigeria. Gender and income level of small ruminant household heads were also tested in the model but did not indicate a statistically significant effect on adoption of husbandry practices. This findings contradicts Legesse et al. (2013) that higher income farmers have greater access to resources and are able to assume risk than those with lower income level.

Predicting factors of small ruminant households market integration

As shown in Table 5, the models that explained best the likelihood of smallholder small ruminant household heads' market integration were marketing infrastructure, volatility of policy and production. The model had an overall accuracy of 77%. The results show that the model is good at 42% yet still not great. The results also indicate that 31% probability of small ruminant households market integration is explained by the logistic model.

Production shocks show a positive correlation effect on market integration of small ruminants suggesting that during production period of mild or low animal deaths due to pest and disease for instance, more animals are raised resulting in inflows across the markets leading to higher market integration. This finding agrees with Pukthuanthong and Roll (2009) that during crisis periods shocks facing an inverstor tend to be more positively correlated with market integration.

The findings also indicate that the price of animals sold has a negative correlational effect on market integration. This suggests that if the price of animals sold falls, the probability of households selling their animals will decrease, all other things being equal. Furthermore, the findings indicate that the coefficient of shelter/housing is negative suggesting that when households do not have shelter for their animals, the probability of market integration becomes high in other to avoid loss through accidents and theft. Free grazing and water access were found to be significant and would lead to improvement in market integration by small ruminant households.

In high dry season water access community, 48 and 35% of households participate in commercial livestock markets to sell sheep and goats, respectively, while 12 and 9% of small ruminant keepers sold sheep and goats, respectively in low dry season water access community. The high market participation of small ruminant keepers

Table 5. Logistic regression: Predicting factors of market integration of smallholder small ruminant households.

Predictor	B (Coefficient)	SE (β)	Wald's χ^2	Df	p	e^{β} (odds ratio)
Constant	-1.870	0.692	7.303	1	0.007	0.154
Shelter/Housing	-0.780	0.320	5.938	1	0.015	0.458
Free grazing	0.565	0.272	4.311	1	0.038	1.760
Price of animal	-1.276	0.279	20.942	1	0.000	0.279
Transportation	0.735	0.261	7.929	1	0.005	2.085
Market information	0.994	0.561	3.143	1	0.076	2.703
Number of animals in stock	3.482	0.606	32.972	1	0.000	32.530
Production shocks	0.755	0.319	5.591	1	0.018	2.127
Water access	1.489	0.320	21.671	1	0.000	4.432
Veterinary access	0.617	0.279	4.888	1	0.027	1.853
Test			χ^2	**df**	**p**	
Overall model evaluation (Model χ^2)			144.410	9	0.000	
Goodness-of-fit test (Hosmer and Lemeshow)			6.754	8	0.563	
-2 Log-Likelihood = 391.705						
Cox and Snell R^2 = 0.310						
Nagelkerke R^2 = 0.415						

in high dry season water access community suggests that when there is access to dry season water, farmers have a tendency to take advantage of the resource to raise more small ruminants.

In low dry season water access community, small ruminant keepers are unable to participate in livestock markets due to low multiplication of animals caused by poor access to drinking water and grasses. The lack of access to dry season water and grazing field in low dry season water access community has always been a precursor of conflict between pastoralist and farming communities in the Nadowli-Kaleo District. This finding concurs with Zuwarimwe and Mbaai (2015) in Namibia that the lack of quality grazing and water facilities adversely affects smallholder livestock farmers' market participation.

CONCLUSION AND RECOMMENDATIONS

This paper has investigated issues related to adoption of good husbandry practices and market integration of small ruminants. The logistic regression test shows that factors influencing the adoption of good husbandry practices are education level of small ruminant keepers, the herd size/number of animals kept, small ruminant keepers' access to veterinary services and access to dry season water.

The adoption of good husbandry practices have led to farmers having low animal mortality. The results of the study also show that market integration is positively affected by production shocks, number of animals in stock, veterinary access and water access, whereas it is negatively affected by price of animal and animal shelter. The study finding on water access suggests that water availability and accessibility will enhance small ruminant production because it would help farmers to water and feed animals better.

The adoption of good husbandry practices and the resultant high market integration of small ruminants suggest that when communities have access to dry season water, they tend to do better in taking advantage of market opportunities to reduce poverty and enhance food security. However, considering that not all farming communities in the district have access to dry season water (e.g., dams and dugouts), there is the need for a policy that would ensure that farming communities have access to dry season water in order for them to raise small rumiants for livelihood and poverty reduction.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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