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Research Application Summary

# Social networks and influence of actor centrality positions in Conservation Agriculture knowledge systems in Kenya

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## Abstract

Conservation Agriculture (CA) knowledge systems are shaped by the power relationships among actors in the social systems and this influences how innovations maybe accepted or not by farmers. Using the Social Network Analysis (SNA), three scales of measurement, distance, centrality, and in and out degrees were used to determine actor centrality positions in the CA agricultural network. The objective was to determine which actor had the most power and if their positioning within the network could influence the CA knowledge diffusion process and therefore acceptance of the CA technology. The open source software, Social Network Visualizer (SocNetV) version 19, was used for the social network analysis. The study sample was purposively selected and a household survey conducted for 150 CA farmers, key informant interviews for eleven policy makers and four Information Communication Technology (ICT) service providers in the three wards of Tigithi, Ngobit and Umande in Laikipia County, Kenya. Key findings suggest that the emergence of power and influence in a network are closely related to the positioning of an actor. In this study, the farmers occupied the position of prominence and influence for both the Information and Power centrality. Also noted was that even in loosely knit networks, there is a pattern of relationships that shapes the dynamics of how knowledge networks function. In this network 84 possible relationships were observed, however for optimal functioning of the network, there were 462 possible relationships. Findings also indicate that farmers rely heavily on fellow farmers for acceptance and validation of innovations. The implication is that although a network may function with a few essential links, for the successful diffusion of an innovation, all possible links have to be utilized. By their position of power and influence in the network, farmers have to be engaged in all knowledge processes for the acceptance of the CA technology.

For policy, this implies that multi- stakeholder involvement is critical in the CA policy making process.

Key words: Conservation agriculture, information, innovations, Kenya, knowledge systems, Laikipia County, social networks, Sub- Saharan Africa

**Résumé**

Les systèmes de connaissances de l'agriculture de conservation (AC) sont façonnés par les relations de pouvoir entre les acteurs des systèmes sociaux et cela influence la façon dont les innovations peuvent être acceptées ou non par les agriculteurs. En utilisant de l'analyse des réseaux sociaux (ARS), trois échelles de mesure – la distance, la centralité, et 'dans et hors degrés' – ont été utilisées pour déterminer les positions de centralité de l'acteur dans le réseau agricole AC. L'objectif était de déterminer quel acteur avait le plus de pouvoir et si leur positionnement au sein du réseau pourrait influencer le processus de diffusion des connaissances d'AC et donc l'acceptation de la technologie de l'AC. Le logiciel libre accès, 'Social Network Visualizer (SocNetV)' Version 19, a été utilisé pour l'analyse des réseaux sociaux. L'échantillon de l'étude a été objectivement sélectionné et une enquête auprès des ménages réalisée pour 150 agriculteurs pratiquant l'AC, des entrevues avec des informateurs clés menées pour onze décideurs et quatre fournisseurs de services des technologies d'information de la communication (TIC) dans les trois quartiers de Tigithi, Ngobit et Umande dans le comté de Laikipia, au Kenya. Les principales conclusions suggèrent que l'émergence de la puissance et de l'influence dans un réseau sont étroitement liés au positionnement d'un acteur. Dans cette étude, les agriculteurs ont occupé la position d'importance et d'influence concernant à la fois la centralité l'information et du pouvoir. On a également noté que, même dans des réseaux peu structurés, il existe un modèle de relations qui façonne la dynamique de fonctionnement des réseaux de connaissances. Dans ce réseau 84 relations possibles ont été observées, mais pour un fonctionnement optimal du réseau, il y avait 462 relations possibles. Les résultats indiquent également que les agriculteurs comptent beaucoup sur les autres agriculteurs pour l'acceptation et la validation des innovations. L'implication est que, même si un réseau peut fonctionner avec quelques liens essentiels, pour que la diffusion d'une innovation réussisse, tous les liens possibles doivent être utilisés. Par leur position de pouvoir et d'influence dans le réseau, les agriculteurs doivent être engagés dans des processus de connaissance pour l'acceptation de la technologie d'AC. Pour les politiques, cela implique que la participation de multiples parties prenantes est essentielle dans le processus d'élaboration des politiques de l'AC.

Mots clés: L'agriculture de conservation, l'information, les innovations, le Kenya, les systèmes de connaissances, le compte de Laikipia, les réseaux sociaux, l'Afrique sub-saharienne

## Background

Agriculture productivity in Africa has undergone fundamental changes particularly because it faces threats in the form of drastic climatic changes, volatile food prices and most challenging is the reactions from agricultural producers when exposed to new innovations. Many farming

systems are struggling to replenish soil fertility but lack investment capacity and secure land tenure (NEPAD, 2013). Although Agricultural production has increased steadily, its value almost tripled, there has been little improvement in the factors of production like labour and land. The unprecedented high population growth in the last thirty years has called for more land being put to agricultural production (Gajigo and Lukoma, 2011). Boosting agricultural productivity therefore calls for sustainable agricultural intensification. This means fostering access to inputs and encouraging the adoption of innovations like Conservation Agriculture (CA)

Conservation agriculture was practiced on 155 million hectares worldwide on both large and small farms by 2013. FAO (2011) statistics indicate that in East Africa the total area under CA was at 33,100 ha in Kenya, 25,000 ha in Tanzania, and 10,000 ha in Sudan by 2008. The rate of adoption however varies according to farm size, with large commercial farms comprising most of the area under CA globally and in parts of Africa. In Kenya, CA adoption has been growing among large-scale operators, with minimal growth among smallholders (Milder *et al*. 2011). The CA knowledge in Africa is disseminated through on- station and on-farm trials, to enable farmers adapt CA technologies to their own environment. At the institutional level, collaboration between stakeholders promoting CA has been limited with few formal and informal collaborations existing between institutions. Although minimum attempts have been made to create formal CA networks, no further action has been taken beyond meetings.

For the up-scaling of the Conservation agriculture practice, it is important to understand the social relations among the actors and the knowledge diffusion process. In this study, actors denoted as "nodes" refer to the different institutions promoting conservation agriculture. The social networks refer to the series of direct ties from one actor to a collection of other actors, where ties are the relationship between the actors. We used different shapes and colour codes to illustrate the actor categories and their roles. Each relationship refers to a particular type of resource exchange. Haythornthwaite (1996) suggests that patterns of relationships will show who exchanges information with whom. Borgatti and Foster (2003) suggest that individuals need to have certain kinds of relationships in order to utilize each other's knowledge. These relationships influence how new knowledge and innovation spread.

**Conceptual framework.** The study contributes to the social network theory by examining how social networks of actors in conservation agriculture knowledge systems influence the knowledge resource sharing patterns. Barnes (1954), as cited in Lucas and Mayne (2013) is often credited with the first practical application of social network analysis. This theory views social relationships in terms of nodes and ties. Conceptually the existence of networks within the CA knowledge system implies that relationships exists between the actors during the process of knowledge exchange. This study focuses on knowledge sharing relationships among CA actors in conservation agriculture systems in Laikipia County. The findings are based on the social networks of eight main categories of actors; Farmers, Government, NGOs, Private sector, Research, Financial institutions, Policy and the Media. The research question for this study was "How have social settings influenced and supported CA knowledge processes?" The study was held two assumptions; (i) density of CA social networks is

positively related to actor relationships; and (ii) centrality in CA social network is positively related to Influence and Power. The study was thus intended to examine how the positioning of actors in conservation agriculture knowledge systems may influence the acceptance of conservation agriculture farming practice.

## Study description

The study was conducted in Laikipia County, within the three wards of Tigithi, Ngobit and Umande. Laikipia County is a semi-arid area, average rainfall of 650 mm annually in space and time. Located on the leeward western slopes of Mt Kenya, both its culture and topography are diverse. Farmers keep livestock and grow a variety of crops such as maize, beans, potato, wheat, cabbages, tomatoes and snow peas (Laikipia CIDP, 2013).

**Data collection and processing.** The total survey population was 165 *(Tigithi (N-55); Ngobit (N-55); Umande(N-40); County headquarters ( N-15)* with a household survey targeting a purposively selected sample of 150 farmers practicing conservation agriculture. Key informant interviews were conducted with eleven policy makers and four ICT service providers. Data collected from the household survey was validated through key informant interviews. The questions on socio- economic characteristics were on age, gender, education, total land size, land under agricultural production and land under CA. Other sections are on the sources of CA knowledge, the different actors in the CA knowledge network and their positioning in the network.

To examine and visualize the centrality and power relationships among the actors, Social Network visualizer (SocNetV) version 2.0, an open-source software was used for the Social Network Analysis (SNA). Actors were represented as nodes in the network and the relationships represented as ties. The network size was generated to demonstrate the network density and illustrate the knowledge sharing pattern in the CA network. To analyze the positions of power and centrality, measures of geodesic distance, in-degree, out-degree, information and power centrality are used. The key elements of the SNA used in this study are described in Table 1.

## Results and discussion

**Socio- demographic characteristics.** The mean age of the survey population was 53.6 years with 58.7 per cent of the respondents' female and 41.3 per cent male. The mean education in years was nine. Kenya follows the 8-4-4 system of education with eight years in primary school, four years in secondary school and four years for either vocational or university education. In this study, the majority of the farmers had completed the primary education. The main occupation of the respondents was farming at 78.6 per cent. Farmers practising conservation agriculture accounted for 50 per cent. The total land size owned by the respondents was an average of 5.6 acres (approx. 2.6 ha), with land under agricultural production at an average of 3.1 acres (1.4 ha) and land under CA at an average of 2 acres (Table 2). The main conservation agriculture knowledge sources were Government, fellow

**Table 1. The key elements of The Social Network Analysis (SNA) used in the study**

| Element | Definition |
|---|---|
| Node | Represents the actors in a network |
| Line/Edge | Represents the tie or relationships between actors in a network |
| Socio- gram/Network | Graph consisting of nodes to represent actors and lines to represent ties or relations. It may represent a single relationship or multiple relations. |
| Network size | The size of the network is determined by (k*k-1) where k is the number of actors. |
| Network density | Density is defined as the sum of ties divided by the number of possible ties. The maximum number of connections that any individual actor could have in a network is k-1. |
| Geodesic distance | Geodesic distance is the number of links in the shortest possible path between two actors in a network. |
| Degree centrality | A measure that quantifies how many ties a node has to other nodes in the network. This index is often considered a measure of actor activity |
| In Degree | In- degree analyses the actors who are receivers of information within a network. |
| Out degree | Out-degree, is the measure of how influential an actor is in the network. |
| Centrality | Measure of the number of ties that a node has relative to the total number of ties existing in the network as a whole |
| Information centrality | Measure of the proportion of total information flow that is controlled by each actor. The IC metric uses all paths between actors weighted by strength of tie and distance. The IC' score is the standardized IC (IC divided by the sum IC). |
| Power centrality | The Power centrality (PC) index of a node u is the sum of the sizes of all Nth-order neighbourhoods with weight 1/n. PC' is the standardized index. The PC score is divided by the total number of nodes in the same component minus 1. |

Source: Borgatti and Foster (2003); Hanneman and Riddle (2005)

**Table 2. Socio- demographic characteristics for the study area**

| Household characteristics | Totals (n-150) |
|---|---|
| Gender of respondent | |
| Female(%) | 58.7 |
| Male (%) | 41.3 |
| Age (mean) | 53.6 |
| Education in years (mean) | 9.29 |
| Main occupation respondent (%) | |
| Farming | 78.6 |
| Agro-pastoralist | 15.9 |
| Government employee | 2.1 |
| Self- employed | 2.8 |
| Agriculture practice (%) | |
| Conservation agriculture | 50 |
| Conventional | 36.2 |
| Organic | 13.4 |
| Dairy farming | 0.3 |
| Land in acres | |
| Total land size (mean) | 5.6 |
| Land hired (mean) | 3.4 |
| Land bought (mean) | 4.7 |
| Land donated (mean) | 1.6 |
| Land inherited (mean) | 5.7 |
| Land settlement scheme (mean) | 6.0 |
| Land under agriculture production (mean) | 3.1 |
| Land under CA (mean) | 2.0 |

Source: Survey data, Laikipia county 2015

farmers and NGOs. The main dissemination approaches were field days, SMS and farmer field schools (Fig. 1).

Government extension was the main source of agricultural information, followed by fellow farmers and non- governmental organizations. The main dissemination approaches were field days and farmer field schools, which farmers said were very useful to them as it allowed them to see first -hand the different CA trials in farmers' fields and meet other stakeholders, other important approaches were the short messaging services (SMS) alerts on their mobile phones, which normally informed them of important meetings, events and trainings taking place or were sometimes invitations to field days and trainings. Trainings equipped the farmers with CA technical skills and it was also where they learnt about the different CA farming equipment and where to get them. Research centres although few and were located in distant places allowed them to take their soils for testing and gave them information on the right cover crops to plant. A very convenient source of CA information

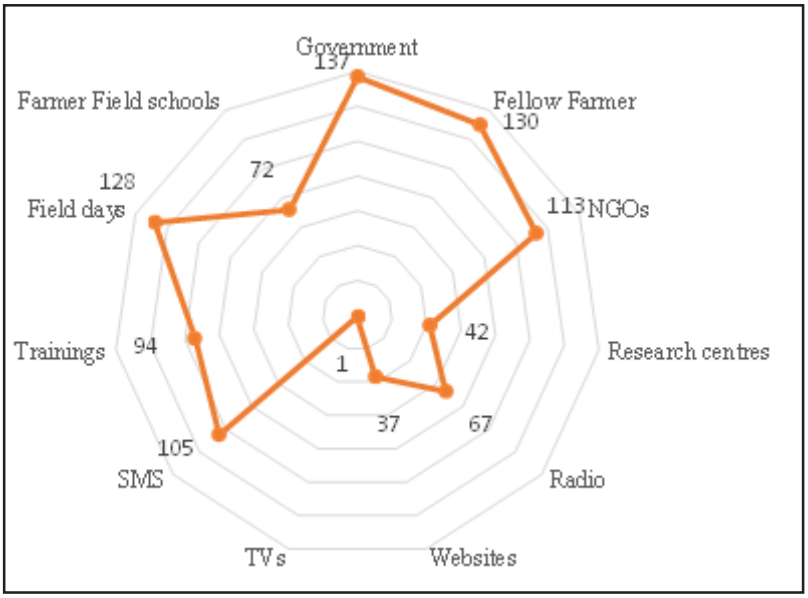


**Figure 1. Sources of Conservation Agriculture information**

Data source: Household survey, KII, Laikipia County 2015

was the Radio (*both on phone and handsets)* which usually had informative farmers' testimonies. Although respondents said the timing of these programs had to be reviewed as the farming programs were aired in the morning hours when they are engaged in field activities.

**Network size.** The network size consisted of twenty- two nodes with 84 observed relationships and a network density of 18 per cent, however 462, (22* 22-1) relationships were possible. In this network, the maximum number of possible connections any individual actor had was 21. Eight categories of actors exist in this network differentiated by colour codes and shapes to depict the different roles each actor plays in the network.

The low percentage of the network density indicates a low level of interaction among the actors, and a slow speed of knowledge diffusion. Most actors in this network even the ones in the position of prominence were using long pathways to interact and in the knowledge sharing process. Only fourteen of the twenty- two actors in this network had more than three possible short direct links through which they could exchange knowledge. These results demonstrate that when knowledge diffusion is handled by a few actors in a network, both the flow of resources in the network and the network growth is limited. The findings support the assumption that density of CA social networks is positively related to actor relationships.

**Geodesic distance.** The matrix below illustrates the number of shortest paths that resources can flow between any two actors at any given time. In this matrix actor twelve- meteorological services and actor thirteen, extension services had the highest number (nine) of shortest

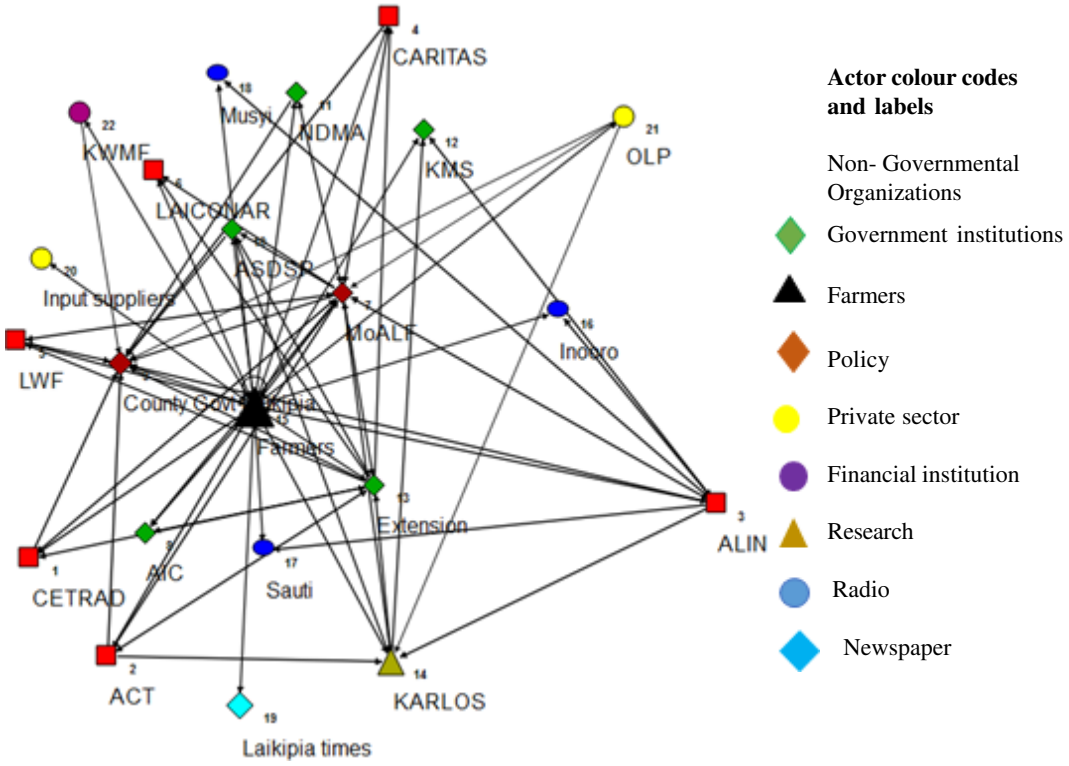


**Figure 2. Socio- gram of social network in Conservation Agriculture knowledge systems**

Data source: Household survey, KII, Laikipia County 2015

path they were using to exchange knowledge resources between them. Actor six (*Laikipia County Natural Resource network),* Actor nine (*the Laikipia county headquarters)* and Actors sixteen, seventeen, eighteen respectively (*Radio Inooro, Sauti ya Mwanachi, Musyi radio),* had the lowest number of pathways they were using, sometimes with no short pathway between them and other actors in the network.

These findings indicate that, among the actors, the high number of short possible pathways between the meteorological and extension services in the county reflects the high demand for climate information. The stimulus for climate information is triggered by the location of the county, in the leeward side of mountain Kenya and the channels used to disseminate the information, a very active sms based information service run through a collaboration between the County, the Arid lands Information Network (ALIN) and the Kenya Meteorological Services (KMS) ensures that farmers get up to date usable information. The media had minimal relationships with all actors in this network yet media has a prominent role in diffusion of information and in terms of reach, the radio is a powerful dissemination tool in rural Africa. These relationships within a network play an important role in the awareness creation of innovations, if not fully exploited slow down the uptake of technologies.

| v | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 1 | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 3 | 1 | 2 | 3 | 3 | 3 | 1 | 3 | 1 | 4 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 5 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 11 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 12 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 | 1 | 2 | 6 | 7 | 7 | 7 | 6 | 6 | 6 | 6 |
| 14 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 20 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| 22 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure 3. Geodesic distance for CA knowledge Actors**

Data source: Household survey, KII, Laikipia County 2015

**Out degree centrality.** The maximum out degree of points in this study was node fifteen, the farmers (104.76%), indicating that they had the most influential position in the network (Table 3). The minimum degree of points was node six – Laikipia County Natural Resource Network (0%), Other actors with low influence in this network were actors nine, seventeen, eighteen and nineteen (*the Laikipia county headquarters*, *Radio Inooro, Sauti ya Mwanachi, Musyi radio ).*

Positions of influence in a network, determines who holds the power and therefore can influence choices in a community. In this networks, held the most influential position and as end users of the CA technology could influence the acceptance or rejection of the innovation. Other actors of influence were the county government, who have to authorize operations any kind of activity in the county. The media also emerged as a powerful actor. Media has the power to set the agenda and because of their agenda setting role, they have the ability to influence any salience topic on the public *agenda.* Mcombs (n.d), suggests that if a news item is covered frequently and prominently, the audience will regard the issue as more important and may be influenced to take it up.

**Table 3. Measures of centrality in the Conservation Agriculture knowledge network**

| Actors | Out-degree DC (%) | In-degree DP (%) | Information IC (%) | Power PC (%) |
|---|---|---|---|---|
| 1. CETRAD | 19.0 | 14.3 | 4.6 | 59.5 |
| 2. ACT | 23.8 | | 14.3 | 5.0 |
| 61.9 | | | | |
| 3. ALIN | 38.1 | 14.3 | 5.7 | 69.0 |
| 4. CARITAS | 9.5 | 14.3 | 4.6 | 48.4 |
| 5. LWF | 14.2 | 14.3 | 4.6 | 57.1 |
| 6. LAICONAR | 0 | 14.3 | 4.0 | 0 |
| 7. Mo ALF | 61.9 | 42.9 | 6.6 | 80.9 |
| 8. AIC | 4.7 | 14.3 | 4.0 | 52.3 |
| 9. County Government | 0 | 57.1 | 6.4 | 0 |
| 10. ASDP | 14.3 | 19.0 | 5.0 | 57.1 |
| 11. NDMA | 14.3 | 9.5 | 4.0 | 57.1 |
| 12. KMS | 4.7 | 14.2 | 4.0 | 42.0 |
| 13. Extension | 42.8 | 28.5 | 6.2 | 65.0 |
| 14. KARLO | 19.0 | 23.8 | 5.8 | 59.5 |
| 15. Farmers | 104.7 | 57.1 | 7.2 | 100 |
| 16. Inooro Radio | 0 | 9.5 | 3.2 | 0 |
| 17. Sauti ya Mwananchi | 0 | 9.5 | 3.2 | 0 |
| 18. Musyi Radio | 0 | 9.5 | 3.2 | 0 |
| 19. Laikipia County times | 0 | 4.8 | 2.0 | 0 |
| 20. Input suppliers | 4.7 | 4.8 | 2.0 | 52.3 |
| 21. OLP | 14.2 | 4.8 | 4.6 | 52.3 |
| 22. Kenya women microfinance | 9.5 | 4.8 | 3.2 | 54.7 |

Data source: Household survey, KII, Laikipia County 2015

**In degree centrality.** In the CA networks, node nine, Laikipia County Government (57.14%) and Node fifteen, farmers (57.14%) had the maximum in-degree of points. Node nineteen, the Laikipia Times newspaper (4.7%) had the minimum in-degree of points (Table 3). Other actors who were receiving more information than other actors are actors fourteen, (23%) seven (42%) and thirteen (28%) *(Kenya Agricultural research and livestock institute, the Ministry of agriculture and livestock and Extension services).* In this network, it was noted that actors who receive information from many sources were prestigious and powerful, but they could also suffer from information overload. The Laikipia county government and farmers are the highest receivers of CA information, and this was because of their positioning in the network as key and influential players in the network

**Information and power centrality.** The maximum information centrality position was node fifteen (farmers) controlling 7.2 per cent of the total information flow. Node nineteen-(the Laikipia Times newspaper) and node twenty (input suppliers) were the nodes with the lowest degrees, controlling only 2 per cent respectively of the CA information flow and therefore were the most vulnerable in the network. Nodes fourteen, thirteen, nine, seven and three (Kenya Agricultural research & livestock institute, the Ministry of agriculture

livestock and fisheries, Extension services, Laikipia County Government and Arid Land Information Network) also contributed significantly to the information flow.

The node with the maximum power centrality was node fifteen- Farmers (100%) and minimum power centrality position was occupied by node six -the Laikipia County Natural Resource Network (0%). Other actors in this network who were occupying prominent centrality positions were the NGOs represented by nodes one (Centre for Training Research and Dissemination-CETRAD 59.5%); node two (African Conservation Tillage Network-ACT 61.9%), node three (ALIN 57.1%) & node five (Lutheran World Federation-LWF 57.1%). Government institutions node eleven, National Drought Management Authority node thirteen and Ministry of agriculture, livestock and fisheries node seven; and Research node fourteen the Kenya Agricultural Research and livestock organization-KALRO were also occupying high power centrality positions (Table 3).

Information and Power centrality positions give actors access to a variety of resources from other actors in the network and these actors are well positioned to forward knowledge resources or prevent such resources from being forwarded. In this study both the Information and Power centrality positions were occupied by node 15- the farmers. Farmers in this network were the central actors, were perceived to be influential and were more likely to have greater access to CA knowledge and resources. Periphery actors in this CA network were, the Agricultural Information Centre and the radios stations at the county. Such actors in a network are weak but can prove to be important links in influencing technology acceptance and adoption and therefore should not ignored but harnessed for more active roles within the network.

The results of this study support the assumptions that network density and centrality positions of actors in a network influence knowledge diffusion in CA knowledge systems. Farmers and the County Government emerged as the most powerful and influential power brokers in the CA knowledge network in this study. NGO actors, CETRAD, ACT and ALIN also emerged as powerful NGO actors in the CA knowledge system alongside the Farmers and the county government because of their role in dissemination and skills training on CA. Research played an important role in the network with the Kenya agricultural research and livestock organization receiving most of the information flows especially on soil testing and cover crops. During this study, the maximum number of the shortest information flow path was between the meteorological and extension services because of the channel of communication to farmers, sms based information service which reaches large numbers within the shortest time possible. The National Drought Management Authority also occupied a position of prominence in the power centrality positions implying that climate information was one of important information needs in this network. The relationships and the different roles of the actors gives an indication of what likely information actor- Y, could be looking for from actor – X. Actors in such close knit networks. It is also likely that actors are aware of each other's knowledge needs as information diffuses quickly in small networks. Many of the actors even the ones in the position of prominence were using long pathways to interact. The relationship among the actors was therefore not being fully utilized to be able to maximize the resources within this CA network.

## Conclusion

We used the social network analysis to examine the CA social network and how the actor centrality positions influence knowledge diffusion in the conservation agriculture knowledge network. Findings indicate that the strength of ties between the actors influences how and what type of knowledge is exchanged. This paper suggests that in an agriculture knowledge network, all possible links should be fully utilized to allow maximum utilization of the knowledge and resources flowing between actors. The periphery actors in a network are sometimes the most important actors to facilitate knowledge diffusion and influence uptake of a technology. The Agriculture Information Centre (AIC) is a semi-autonomous government agency whose primary role is to provide agricultural information through media channels like radio, video and printed technical materials. Both the AIC and the radio stations were not fully engaged in this network yet these are the mass media channels critical in awareness creation and acceptance of innovations. In social networks, the direct actors involved in the dissemination of an innovation may not necessarily be the influencers to trigger acceptance, it is therefore important to recognize the influencers and power brokers, examine the role of each actor in the network for successful knowledge diffusion and acceptance of technologies.

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