



Structural Analysis of Social Networks Revealed by Small Holder Banana Farmers in Muranga County, Kenya

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Rec date: March 28, 2018; Acc date: April 18, 2018; Pub date: April 29, 2018

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Abstract

Inequitable access to appropriate and sufficient information has been recognized as a major impediment to small holder agricultural commercialization in most parts of sub-Saharan Africa. Theoretical and empirical studies in economics and sociology argue that social networks are the most persuasive source of information about new products and resources, but governments in developing countries continue to rely on extension officers to communicate with farmers about new technologies. Social network analysis (SNA) methodology has been used to depict the structure of social interactions among small holder banana farmers in Murang'a. These are decisions such as where to get hybrid planting materials, best field management practices, when to harvest, where to sell and at what price to sell the output. The key assumption is that networks formed via social interactions have quantifiable benefits to the participating household and lead directly or indirectly to a higher level of wellbeing. Social networks are major forms of social capital given that it is a resource found in personal relationships maintained by households in the net that can influence production decisions and economic outcomes. The results of the study revealed that very few (11.43%) farmers obtained information about tissue-culture banana planting materials, or about the market, directly from agricultural extension officers. The study revealed that there are those actors in the network who are very crucial in the diffusion of information and resources. This is indicated by various degrees of centrality in the network. The prevalence of these social networks has a sustainable impact in supplementing the extension services in rural areas, therefore, improving the productivity as well as the welfare of the households and the overall society.

Keywords: Social network analysis; Extension officers; Social capital

Introduction

Social network, an informal institutional arrangement, is one of the interactive forms that have an impact on agricultural commercialization. The social networks are important platforms within which actors or individuals have connections of some kind to some or all of the other members of the set [1,2]. Owing to these connections, Sharp and Smith argues that social networks ease transmission of information or the flow of new ideas and other resources hence can be a desirable avenue by which farmers can commercialize their production [3]. Several studies regard social network as a major form of social capital given that it is a resource found in personal relationships maintained by households that can influence production decisions and economic outcomes [4-7].

Actors within social networks can be connected based on similarity (same locality, affiliations, or other similar attributes), social relations (kinship, affective or cognitive relations), interactions and/or resource/information flows as such one farmer in a network affects other farmers' choices directly or indirectly without the intermediation of the market. Consequently, this farmers' level study conceptualized households as often seeking and participating in strategies to improve their capacity through engagement in social networks [8,9]. A pilot project study by Wambugu et al. found that tissue culture banana has additional advantages over traditional banana. This is accrued from the superiority of the planting materials in terms of; early maturity (12-16 months compared to 18-24 months for the traditional banana), bigger bunch weights (at least 20 kg compared to 10-15 kg for traditional

banana), high annual yield per unit of land (up to 50 tons per hectare compared to 30 tons for traditional banana), resistance to pests and diseases and coordination for market due to uniformity in maturity [10].

Since introduction of tissue culture technology in Kenya more than ten years ago, banana has turned from a backyard crop to a commercial crop in the country [11]. However, how this technology is transmitted to farmers is characterized by inadequacy from agricultural extension officers. Although the ratio of extension officers to farmers in Kenya is relatively convincing compared to other East African countries, the situation is still not promising. Statistics show that the ratios of extension officers to farmers are: Kenya; 1:1000, Tanzania; 1:1145 and Uganda; 1:2400. Due to this low ratio, farmers do rely on social interactions among themselves to get crucial information on new varieties of planting materials and market information of their produces [12].

Methodology

Study area and sampling technique

Murang'a County is one of the counties of Kenya's former Central Province. The County covers 0.4% of the total land mass in Kenya, over an area of 2,558.82 km² in the central part of Kenya. It is bordered by the Counties of Nyeri to the north, Nyandarua to the west, Kiambu to the south, Machakos to the south east, Embu to the east, and Kirinyaga to the north east. Having a total of 942,581 people living there, it is a host to 2.4% of the total population in Kenya. The county lies on coordinates: 0°45'S 37°7'E and has a density of 3.7 people per

household. The County has seven sub-counties namely, Kigumo, Kiharu, Kangema, Maragua, Kandara, Gatanga, and Mathiyoia. Banana production is practiced in the county due to rainfall reliability and distribution throughout the year [13,14].

The sample unit for this study consisted of smallholder banana farmers drawn from Kahuro division in Murang'a. First, Murang'a County was purposively selected because of the large number of small-scale banana farming. Within the County, Kahuro Sub-County was also purposively selected because this is where intensive banana farming is done in the area. Households were randomly selected within the sub-locations of Kahuro sub-county to give a total sample of 171 farmers.

Methods of data analysis

Social network analysis (SNA) technique has been used to identify the characteristics of social networks maintained by smallholder banana farmers in Murang'a County. Social network variables fall into three main categories – structural, composition and affiliation. The research was interested in social networks and network relationships as the basis for access to resources contained within the network, and ultimately what this means for smallholder farmer outcomes.

Structural variables-these describe the structure of the network. They relate to the shape or pattern of links in the network and describe the ties between the actors. Measures include: size of network, network density, measures of centrality and power and influence of the networks. Affiliation variables- specific type of network involving relations between a set of actors and a set of 'events' that the actors 'belong' to, such as participation in a particular organization and can extend to informal social occasions. Affiliation variables give the subset of actors that belong to each 'event'.

Composition/attribute variables-Composition or attribute variables refer to the data on individual actors' attitudes, opinions and behavior. They encompass characteristics such as age, sex, income, education etc. that are measured as values of variables. Thus, the positions of actors within a network and the strength of ties between them become critically important. Social positions were then evaluated by finding the centrality of a node identified through several connections among network members. Such measures have been used to characterize degrees of influence, prominence and importance of certain members. Tie strength principally involves closeness of bond.

UCINET 6.0 computer software has been used in the analysis to generate network characteristics portrayed by the farmers.

Results and Discussion

Demographic and socioeconomic characteristics of household heads

Table 1 presents the demographic and socioeconomic characteristics of 175 sampled respondents. These features were found to be of great help in terms of clearly depicting the diverse background of the respondents and how these characteristics influence their social life. The table shows that the ratio of male to female-headed households, in the sample, was almost one.

Male headed households	56
Female headed households	44
Age	
Household heads above 45 years	61.14
Household heads below 45 years	38.86
Education level	
Household heads without formal education	10.86
Household heads with primary education	42.29
Household heads with secondary education	37.14
Household heads with college education	8
Household heads with university education	1.7

Table 1: Household characteristics.

The Table shows that the majority (about 60%) of banana growers in the study area were over 45 years of age. This may be attributed to the fact that young people always try to avoid farming and go for other "lucrative" businesses in urban areas. Also, the proximity of the study area to the country's capital city might also be a push factor to the young populace in the area. On average, a typical household head attended about nine years of formal education.

Majority of the farmers were (about 90%) were literate, indicating that most of the household heads could, read and write. This was taken as an important factor for commercialization of banana farming. All the farmers in the sample had had secure titles to land, with a mean holding of 2 ha.

Network structure among banana farmers

This section assumed that sourcing of tissue-culture banana planting materials as well as market search involved complex interactions of individuals as they exchanged information. Analysis of the interactions was based on data collected from the sampled farmers, with the individual farmer as the unit of analysis. The networks presented here are, therefore egocentric networks; they depict the informational ties of the respondent. The section views the network at two levels: first, at the individual farmer's level, and secondly, at the level of the entire network.

Network size

The results from the study revealed that very few farmers (11.43%) obtained information about tissue-culture banana planting materials, or about the market, directly from agricultural extension officers. As shown in Figure 1, fellow farmers were the most important contact source. This clearly depicts the context of low extension agents to farmer ratio that characterize the country.

Social economic attributes	Proportion of respondents (%)
Gender	

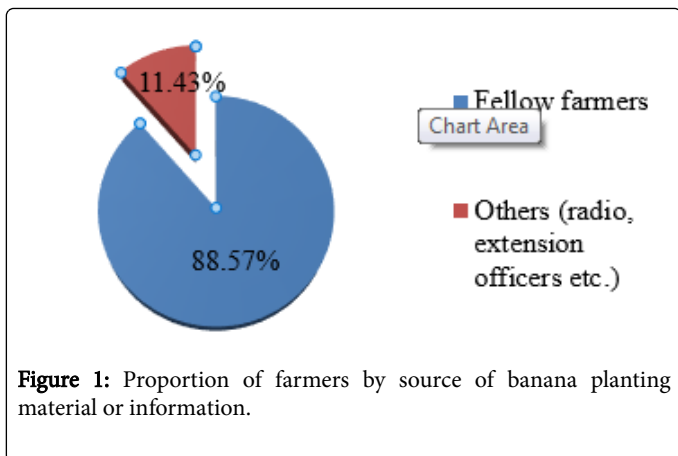


Figure 1: Proportion of farmers by source of banana planting material or information.

Majority (70%) of the farmers that indicated fellow farmers as their major sources of information had a direct network of 2 to 3 alters (see Table 1), while about 18% had 4 to 5 alters. In determining an individual farmer's direct network, the study placed weight on the first, second, and third contacts respectively, in the order in which the farmers mentioned them. This assumed that, when a farmer is prompted to specify who his or her information sources are, the most valuable sources will come to mind first.

In SNA, the size of the ego's direct network is an important indicator of the ego's network value. According to Scales et al., network size gives an indication of the likelihood of the ego being connected to an alter who possesses a resource that an ego need. The larger the ego's direct network, the higher the likelihood of it containing alters with valuable information. This means that, with respect to a given ego, the probability of networking with an alter who has what the ego needs increases with network size [15].

Number of alters	Proportion of egos in %
Egos with zero alter	8
Egos with one alter	3.43
Egos with two alters	31.43
Egos with three alters	38.86
Egos with four alters	15.43
Egos with five alters	2.86
Egos' attributes	
Alter as ego's friend	40
Alter as ego's neighbor	8.57
Alter and the ego in the same group/ organization	18.29
Alter as a trader in banana market	21.71
Others	11.43

Table 2: Distribution of sample households by network size.

Table 2 also shows that farmers viewed their information contacts as falling into four major categories. Friends weighed heavily (40.00%), traders (21.71%), followed by fellow members in organized groups

(18.29%), and the least was from other sources (11.43%). This means that there is diversity of information in the network in the sense that; for example, traders may be well acquainted with market information for the produces while the rest may have information on production management.

Betweenness centrality

Figure 2 presents a network map of betweenness centrality drawn using net draw in the Ucinet visualization. Pedants (egos with only one contact) and isolates (egos without any contact) were excluded. The logic behind this is that farmers without any partner or even one contact don't qualify for networking. For the sake of anonymity and confidentiality, the network participants were coded in two distinct ways. Numerical codes represent the egos, while numerical plus alphabetical codes represent alters that were identified by the egos as sources of information during the production and marketing process.

Betweenness centrality gives an indication of the degree of control exerted by individual participants [16]. It is the shortest path between any pair of nodes. Betweenness centrality is represented by the size of the nodes. The larger a node is, the higher the level of betweenness centrality and vice versa.

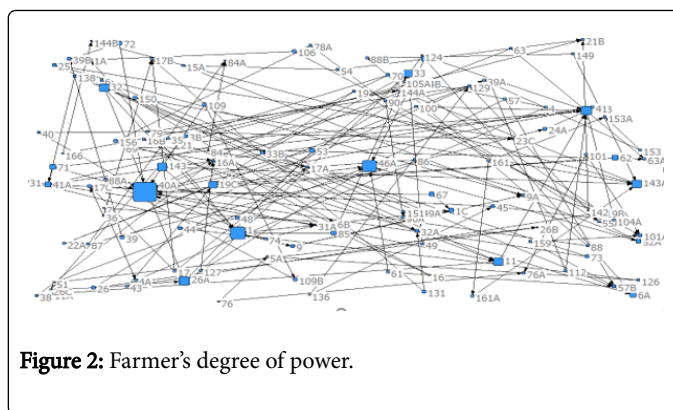


Figure 2: Farmer's degree of power.

Fundamentally, betweenness centrality measures the extent to which a participant is a gate keeper in the network; that is, which participant must a pair of other participants pass through for them to connect. Betweenness centrality captures another aspect of importance in a network — the ability to act as a bridge between other nodes, the ability to connect otherwise unconnected others. Farmers 40A, 46A and 1 respectively shows the highest level of betweenness centrality. Farmer 40A is critical since he can direct the flow of information across this network because he has the power to either pass information on or not. A node with low betweenness, on the other hand, may be redundant because there are other paths by which one might cross from one side of a network to another.

Farmers 40A, 46A and 1 are very crucial in this network because of their attributes (Table 2). They are very critical in the flow of information throughout the network of 373 farmers. If the three farmers stopped participating, there will be less information flow in this network. Fundamentally, these farmers act like "village extension officers" and the result shows that their ratio to the other farmers is far much lower than the ratio of agricultural extension officers to farmers. This has an important implication for extension service. Identifying and empowering "village extension officers" with knowledge would facilitate information transmission to the wider society in a cost-effective way.

Degree centrality

Degree centrality is a measure of the number of direct ties that a net member has. From Figure 3, the degree of centrality is depicted by the size of the nodes. The larger a node is, the higher the degree of centrality and vice versa.

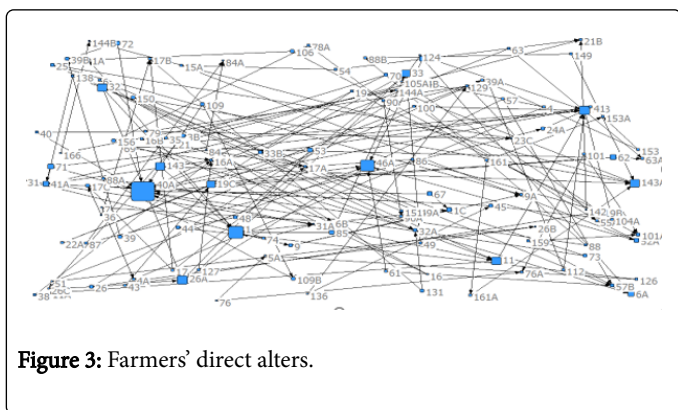


Figure 3: Farmers' direct alters.

Basically, participants with high degree centrality have the largest number of participants connected to them. In this case, the role they play in the network is not of prime interest but how many egos in the study mentioned them as sources of information. This measure of centrality captures the number of alters that an ego has. Within the context of this study, highly connected members have a high probability of receiving banana-information

In the network under study, farmers 40A, 41A and 46A respectively were the most central in the sense that they had the highest number of egos considering them as sources of information and planting materials. Based on betweenness centrality, farmer 1 was very critical in transmitting information. However, Figure 3 reveals that the farmer was not active in sourcing information from other farmers. It can therefore be concluded that he acquired his first-hand information, either from agricultural officers or maybe his experience in farming and therefore highly considered by most of the participants in the network.

Farmer 41A had several farmers connected to her but not very crucial in transmitting information; she is a kind of information “sink”. Thus, in her absence, information will still flow. Nonetheless, the farmer is a necessity but not a binding player in the network. Farmer 40A is very critical in the network, whichever the angle of approach. He is the core of the network among banana farmers.

Table 3 reveals that farmer 40A has the highest number of egos who consider him as a source of banana resources and information (in degree). The degree of a node is the number of ties connecting it to other nodes in the network.

ID	Degree	Betweenness	Closeness	Harmonic closeness	Eigenvector
40A	12	3609	3254	35.3	0.534
41A	9	1096	3396	29.69	0.051
46A	7	3777.5	3223	34.13	0.39
1	6	2543.5	3308	30.09	0.021

Table 3: Farmers' attributes.

While the degree for the above farmers in the network measures how many ties the farmer has, the eigenvector centrality of these farmers measures how many ties the farmers alters have. Farmer 46A has his alters more connected to other farmers than any of the rest. The combination of a high degree and a high eigenvector centrality score revealed by farmer 46A is very crucial. People who have contact with other participants who are in turn well connected may be influential because they know the right people, the popular people, and the people who can effectively get a message out. The efforts of such people of influence are likely to be efficient because the messages they deliver to each of their contacts would spread far. McPherson et al. argue that actors who have more ties with other participants in the network are in advantaged positions because they have alternative ways to satisfy their needs. Because they have many ties, they may have access to, and be able to call on more of the resources of the network as a whole [17]. Closeness centrality is the only measure of centrality that the smaller the number, the better. Farmer 46A has the lowest average path link and this means he is the closest link to other nodes in the net. Fundamentally, if this farmer has certain information or unique production traits, it takes only a few steps for this information to spread from this farmer to the rest in the network.

Network density

Network density is a ratio of the existing ties to the possible number of ties if all the actors were possibly connected to each other. As in Table 4, the network density for banana farmers in Kahuro division is given by 0.003 or 0.3% which indicates a sparse network. Denser network may mean greater likelihood of sharing very similar resources, whereas more open or sparse networks might mean better access to better or more varied resources or Information [15].

Density	No. of ties	Avg degree
0.003	375	1.011

Table 4: Network density.

The larger the network, the lower is the density. A simple formula for calculating network density is given by:

$$\text{Network density} = \frac{\text{No. Of existing ties}}{\text{Total possible no. of ties}}$$

Based on Scales et al. argument, the network depicted by banana farmers in Kahuro division is sparse implying that chances of diversity in input varieties and diversities in production and marketing information are very high. Therefore, if the farmers are clustered together, there is high chance that they will have a lot of similarities in their production and market information. This result to ‘inbreeding’ which is not healthy in the dynamic world of ideas [15].

Diversity in resource and composition

Diversity in this context refers to knowing mixture of people and hence enhancing the chances of the banana farmers having the right contact for a given purpose. Farmers in Kahuro had their contacts ranging from group members, traders, friends and neighbors. High diversity implies integration into several spheres of society or social circles/ contexts and this is advantageous for mobilizing resources and for instrumental actions like gathering information [18-20]. From Figure 4, the size of the node is proportional to the weight of the resource generator. FRIEND1 to FRIEND5 represents alter one to five

(maximum number of alters recorded). The same applies to the rest of the nodes.

About half of banana farmers in the division prefer getting resources from their friends while the other half of the farmers get information from neighbors, banana traders, and group members. This means that at any point in time there is diversity of production information, diversity in banana varieties and diversity in market information in this network.

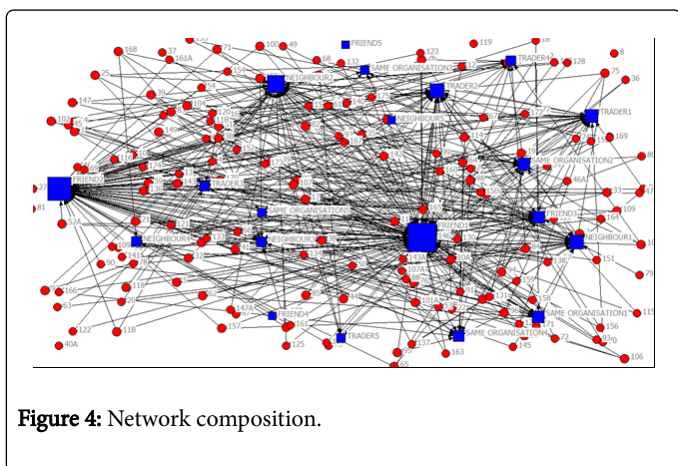


Figure 4: Network composition.

The assumption in this network is that the first to third network partners who are mentioned by the respondent are those who interact frequently, and, in this study, more weight is put on the first, second and third alters, their attributes and the alters relationship with the ego. From Figure 4, the problem of recall sets in when the respondent is probed to identify more than two network partners and only a few of the farmers identified five partners in the network. This is depicted by the decrease in the size of the nodes from one to five. Majority of the farmers had an average of two to three partners whom they considered as sources of information and planting materials. As the probe for more alters increased, the lesser the number of egos who were able to make an accurate recall.

Diversity in composition refers to the probability that, by chance alone, any given network should be a representative of both genders at an equivalent ratio. In Figure 5, male 1 and female 1 represents the gender of network partner one and the rest up to male5 and female5 which is the gender of network partner five mentioned by the ego. The maximum number of alters mentioned by the farmers during the interview were five.

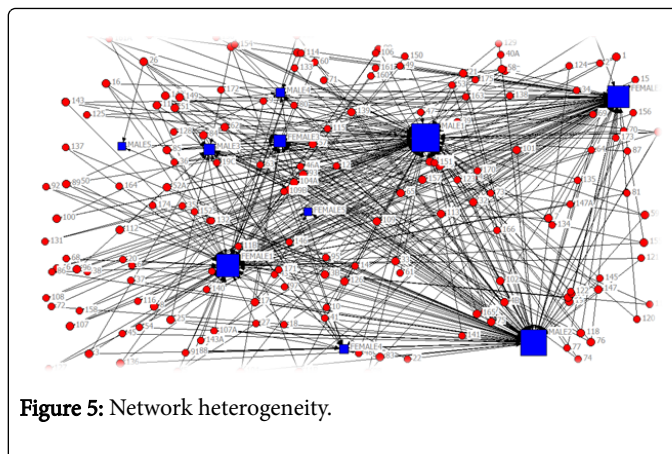


Figure 5: Network heterogeneity.

From Figure 5, both male and female seems to report the same size of the network partners. Respondent's networks may be highly heterogeneous in some respects, yet homogeneous in others, for example in the way they vary by for example age or sex. Farmers in Kahuro are heterogeneous in terms of gender of network partner. This diversity is very critical in terms of resource acquisition by an ego in that one gender, for example, might be good maybe in management practices during banana production while the other is a good avenue for gathering market information.

Conclusion

As the results indicate, farmers in Kahuro depicted heterogeneity of network where male and female farmers interacted in the sharing of materials and market information. This is clearly depicted by the fact that gender differences were not significant in the sharing of information but rather a catalyst in the diversity of information and resources. However, homogeneity in terms of age was observed where most of the farmers who were above 45 years seemed to form a network. This is attributed to the fact that the young populace tends to be 'pushed' by lucrative opportunities in the urban area and the tradition that farming is not meant for the young. As depicted, 11.43% of the farmers got information and planting materials from extension officers as opposed to 88.57% of whom got information from fellow farmers. This is a discouraging scenario and very vivid in developing countries. Nonetheless, a promising solution for this in the county was found where farmers in the network were found to be supplementing each other with information and planting materials not only in a sustainable way but also in a cost-effective way. This is clear in the sense that the study was able to identify 'village extension officers' whom the farmers in the area rely on for information and planting materials.

Farmers who were relying on fellow farmers for information were found to be highly involved in market participation. This is attributed to the fact that networking among the farmers is a form of human capital on its own and can minimize transaction costs involved in farming and marketing which has always been identified as a barrier to agricultural commercialization. Therefore, this research indicates that networking among smallholder farmers and traders has the potential to enhance banana commercialization in the area and take smallholder farmers out of poverty if constraining factors such as lack of capital, basic skills (farming and commercial), high transaction costs, lack of infrastructure, lack of information and lack of educations could be eliminated.

Recommendation

Government, in collaboration with NGOs and the private sector, should identify and locate the most central individuals ('village extension officers') in a given society and equip them with needed skills and resources and this can cost-effectively supplement the role of extension officers. This could enhance sustainability of new projects introduced in a given area.

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