



Assessing the positions of actors in alternative food networks using connectedness and proximity: Kenyan organic vegetables

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General Note



Article is recommended to print as color version in recycled paper. *Save Trees, Save Nature.*

ABSTRACT

The novelty of the emerging concept “alternative food network” provides a great potential to boost the organic sector in Kenya. A census of all stakeholders in Nairobi’s organic fresh produce value chain was done using semi-structured questionnaires with Ucinet Version 6 used to analyze connections. The results revealed varying connectedness with a high degree (67%) and low Eigenvector (28%) centralities. Proximity varied with low Betweenness (4%) and high nearness (76%) centralities. Most produce was marketed using short supply chains (47% direct to customers and 16% through wholesalers). Spatial proximity, high social embeddedness, and trust were observed with production concentrated in urban and peri-urban areas. Structural holes were evident and characterized by farmers' exploitation, unequal distribution of benefits, and mismatch between supply and demand. Governmental organizations and produce-led sector support institutions have the potential to influence activities, relationships, and performance if utilized, they have unique access to non-redundant information. Emphasis on sharing critical information on demand and supply is vital if the sector is to achieve its optimal potential.

Keywords: Alternative food network; social network analysis; organic fresh produce; value chain analysis

1. INTRODUCTION

Commercial vegetable production and consumption have been on exponential growth in Kenya's major urban and peri-urban towns with kale (*Brassica oleracea*) being the most common leafy vegetables (Owuoret al., 2017). Urban consumers demand good looking vegetables; color, size, and shape attribute that has encouraged excessive use of chemical pesticides and fertilizers (Kutto et al., 2011). To address food safety risks, and unsustainable production and consumption behavior, there has been a global gradual shift to alternative food networks (Cerrada-Serra et al., 2018). Common features of alternative food networks include the existence of short supply chains, sustainable consumption, social embeddedness, farmers' markets, and baskets schemes (Blumberg, 2018; Cerrada-Serra et al., 2018; Renting et al., 2003; Sage, 2003; Tregear, 2011).

The organic sector has incorporated the novelty of alternative food networks with emphasis on connections and relationships driving the network organization (Blumberg, 2018; Freidberg and Goldstein, 2011; Gichure et al., 2014; Renting et al., 2003). Networks are complementary nodes and links composed of actors or stakeholders who exchange resources, ideas, and information and also conduct activities as a group where individual independence is intact (Brasset al., 2004; Kapucu, 2005; Provanet al., 2007). In a network, relationships are interdependent in such a way that what happens in one relationship affects other actors.

Recent reviews indicate influential nodes can be identified using centrality in weighted networks (Fei and Deng, 2017; Hu and Mei, 2018; Weiet al., 2013). There exists no optimal network structure as strong ties may encourage information transfer or contribute to the exploitation of weaker actors and reduces innovation, whereas weak ties are important to new knowledge creation or exploration although they hinder trust and traceability (Gichure et al., 2017; Gronumet al., 2012). To optimize organizational structure in the organic fresh produce value chain, the dynamic within, and the implications of smallholder participation have evaluated as done in other value chains (Orr and Donovan, 2018).

The current status of actors' positions in the Kenyan organic fresh produce value chain is poorly understood. Existing research into this sector has been conducted on information flow, transaction costs, and access to network resources (Gichure et al., 2017; Murimiet al., 2017) but aspects of mismatch between demand and supply has not been adequately addressed. The objective of this research is to bring out the network organization using positional centrality scores and analyzing these using the alternative food network approach. Such knowledge can be used by value chain actors to optimize their roles and by policymakers in laying strategies in developing the sector.

2. MATERIALS AND METHODS

2.1. Study design and concept

The study was conducted in urban and peri-urban Nairobi where the majority of the organic consumers are located (Okello et al., 2012). A two-step social network analysis approach was used as recommended (Christensen and O'Sullivan, 2015). The first step involved mapping the formal network structure while the second step focused on analyzing the relationships between the identified network entities. The "net chain" concept used to link network perspectives to the supply chain was based on (Lazzarini et al., 2008). Data was collected using semi-structured questionnaires that were administered to all the stakeholders in the organic fresh produce network. The questionnaire provided a guide to the interview to unearth connections and strength of relationships among input providers, supply chain actors, institutional and individual customers, sector support groups, certification bodies, and governmental and non-governmental organizations.

To following, techniques were used to map the stakeholders, a review of secondary data from Kenya Organic Agricultural Network (KOAN), which is the national organic agriculture movement in Kenya, organic certification bodies in Kenya, Kenya Institute of Organic Agriculture (KIOF), the main certified organic farmer groups, and projects reports/ publications on Nairobi's organic produce networks were evaluated. Since the identified actors were less than 100, all were interviewed. Snowballing was done to identify more actors. To define the connections and strength of relationships, a matrix was used where each actor scored the connections in terms of strength, frequency of interactions, and direction.

2.2. Data analysis

Centrality was used to score actors' positions and network organizations. Four centrality measures were used, namely; Freeman degree centrality, node betweenness measure, closeness centrality, and Eigenvector centrality. Degree centrality measured the total number of nodes in direct contact with an individual. Betweenness centrality measured the existence of a link between any two

nodes through a focal node. Closeness centrality calculated the distance between one node relative to all others in the network. Eigenvector centrality measured the influence a particular node had on the network with respect to his linkages (Borgatti and Li, 2009; Brass et al., 2004; Faust, 1997).

The analysis assumed that ties between stakeholders were asymmetrical and some relationships considered unidirectional. The ties were dichotomized where a relationship was presented with a positive one (+1) while lack of relationship was zero (0). Ucinet® 6 for windows (version 6.408) was used to generate centrality measures. Ucinet® is social network analysis software (SNA software) that facilitates quantitative or qualitative analysis of social networks through a description of key network properties, both numerically and using visual representation.

Table 1: The overall degree, eigenvector, betweenness and closeness centrality measures of organic fresh produce supply chain actors in Nairobi, n= 97 actors

	Actors' Connectedness		Actors' proximity	
	Freeman's degree centrality	Eigenvector centrality	Betweenness centrality	Nearness
Mean centrality (±SD)	67.3 ± 14.5%	27.7 ± 5.5%	3.9 ± 2.7%	76.3 ± 8.2%
Maximum centrality	87.5%	35.4	10.3	88.9%
Minimum centrality	29.2%	12.6	0.1	58.5%
Overall network centralization	42.3%	17.08%	2.41%	26.87%

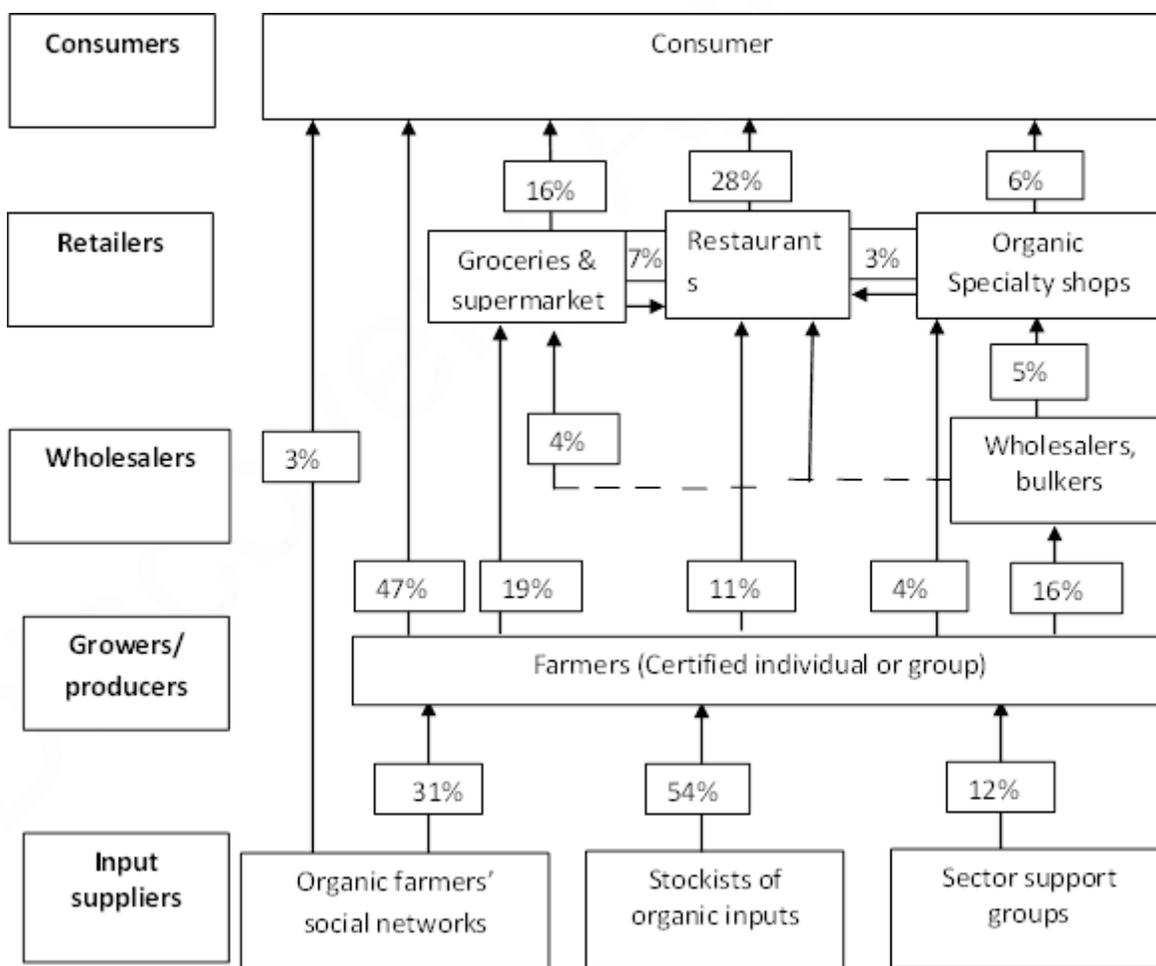


Figure 1: Organic fresh kale supply chain in Nairobi and its peri-urban (% represent the proportion of kales quantities passing through, and does not factor proportion of wastage/ postharvest losses)

3. RESULTS

3.1. Overall Network centrality and supply chain

The actors in the organic fresh produce value chain network were collapsed into 10 nodes to represent input providers, farmers, farmer groups, traders, certification bodies, agricultural training institutions, sector supporting groups, and consumers. The mean and standard deviations of the overall degree, eigenvector, betweenness, and closeness centrality measures of organic fresh produce supply chain actors are summarized in Table 1. Figure 1 brings out the organic fresh kales supply chain in Nairobi.

3.2 Connectedness of Organic Fresh produce value chain actors

3.2.1 Connectedness based on degree centrality

The Freeman's degree centrality values have been expressed as percentages of the number of actors in the network minus one (ego). Based on Freeman's degree centrality measures, the actors were fairly linked together with a degree centrality of 67.3 ± 14.5 percent and a network centralization of 42.3 percent (Table 1). The farmers (88%), national organic agriculture movements (83%), and government officers (mainly government extension) (75%) ranked highest and were most central based on the degree centrality. On the other hand, organic agriculture training institutions (55%), certification bodies (58%), and restaurants certified as organic (60%) ranked lowest and were considered to be at network periphery. Figure 2 brings out Freeman's degree centrality scores.

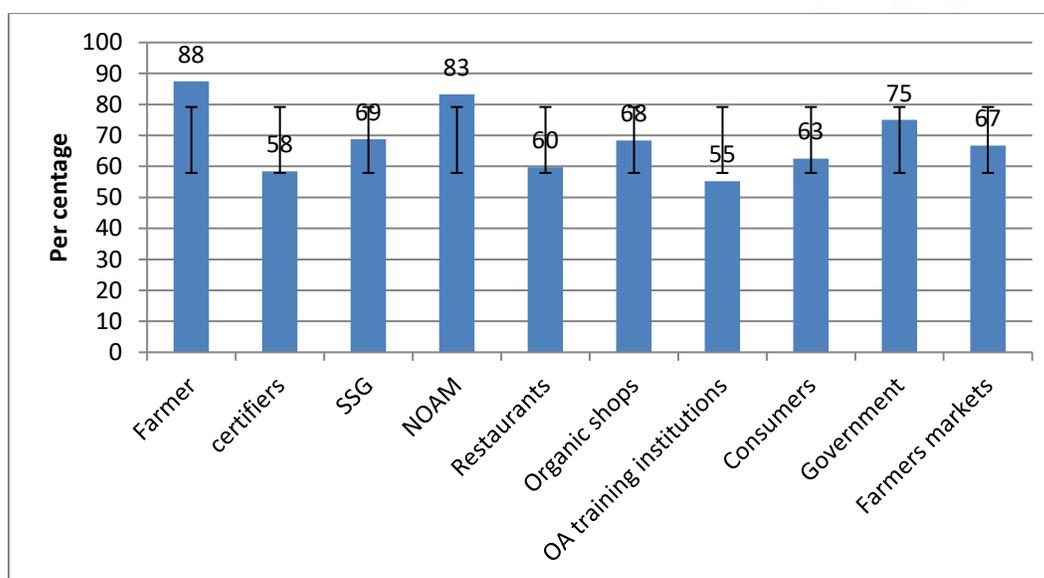


Figure 2: Freeman's degree centrality of stakeholders in the organic fresh produce value chain in Nairobi. SSG represent sector support group, NOAM represent Kenya Organic Agriculture Network

3.2.2 Connectedness Based on Eigenvector Centrality

The overall variations in distances accounted for by direct linkages were about 28% as shown in Table 2. From this, factors 2, 3, and 4 show the levels of indirect linkages, that is, the number of actors "between" any two actors. The overall connectedness based on Eigenvector centrality was 17.08 percent. There was relatively little variability in Eigenvector centralities (standard deviation 5.5) around the mean (27.7) (Table 1). This shows that there were not great inequalities in actor centrality based on the connections through other actors. Farmers (35%), KOAN (34%), sector support groups (29%), and organic specialty shops (29%) were most central based on the pattern of distances among the actors. On the other hand, certification bodies (23%), organic agriculture training institutions (23%) and restaurants (25%) were considered to be at the periphery and required more indirect linkages (Figure 3).

Table 2: Eigenvector factor value of organic fresh produce supply chain networks in Nairobi

Factor	Value	Percent	Cum%	Ratio
1	15.371	28.1	28.1	4.164
2	3.692	6.7	34.8	1.164
3	3.171	5.8	40.6	1.561
4	2.031	3.7	44.3	1.452

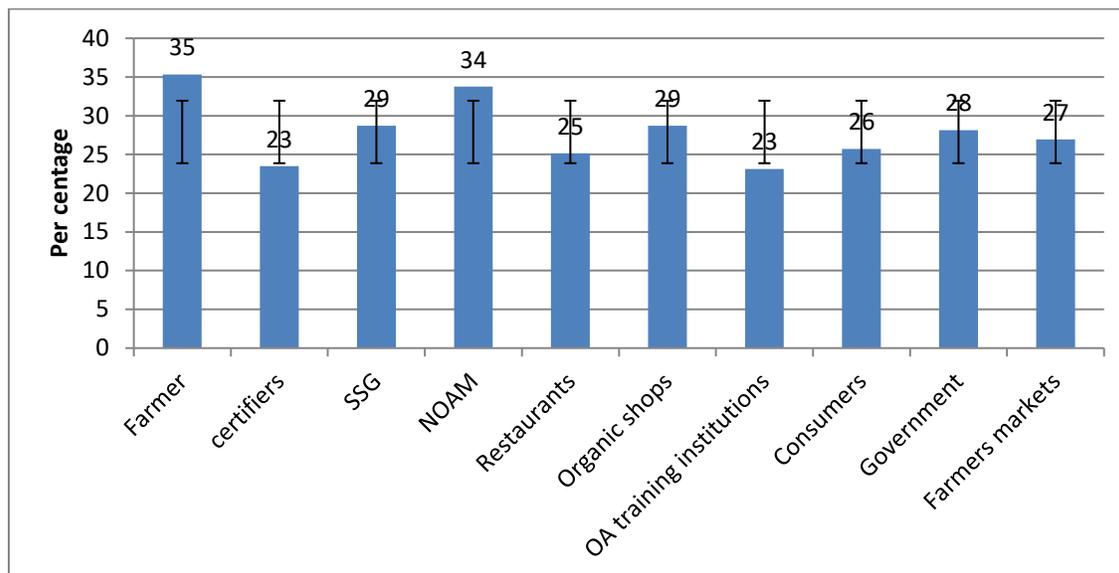


Figure 3: Eigenvector centrality measure of organic fresh produce supply chain networks in Nairobi. SSG represent sector support group, NOAM represent Kenya Organic Agriculture Network

3.3 Proximity of Organic fresh produce value chain actors

3.3.1 Proximity based on Node betweenness measure:

The actors had a lot of variations in positions relative to the positions of other actors with the betweenness range of 0.1 to 10.3. The betweenness variation was large with a standard deviation of 2.7 relative to a mean of 3.9. The overall network centralization was relatively low with an index of 2.41% which shows that most connections in the network must be through an intermediary, and this confirms the low betweenness scores (Table 1). Governmental organizations, farmers, and KOAN were considered to be most "proximate" while organic agriculture training institutions, restaurants, sector support groups, organic shops, and consumers were considered to be at network periphery (Figure 4).

3.3.2 Proximity based on closeness centrality scores

Actors within the network were relatively "far" from each other with an average closeness measure of 76 percent with a centralization score of 27 percent (Table 1). The nearness scores ranked farmer, KOAN, and governmental institutions as most proximate in the network while organic agriculture training institutions, organic restaurants, and certification bodies were on the periphery (Figure 5).

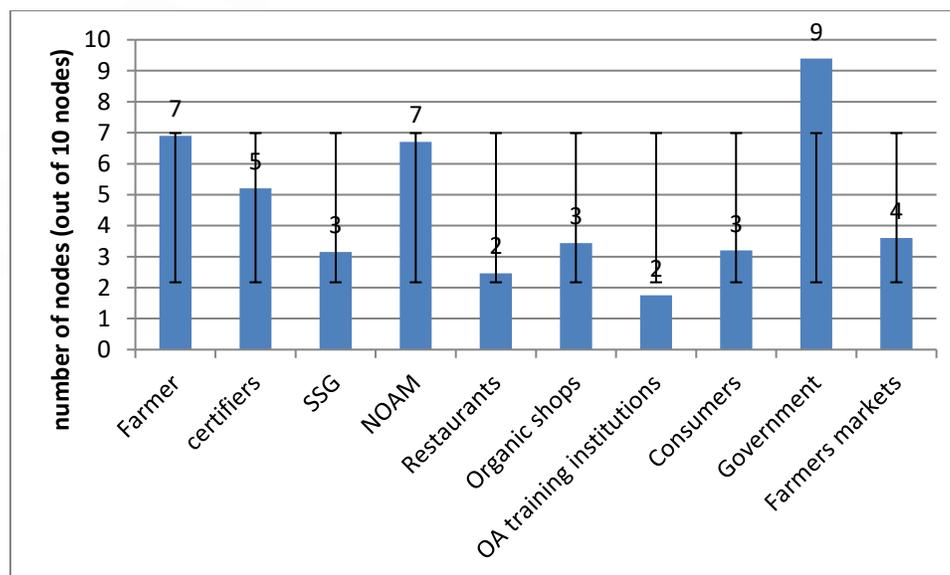


Figure 4: Node betweenness values of organic Fresh produce supply chain networks in Nairobi. SSG represent sector support group, NOAM represent Kenya Organic Agriculture Network

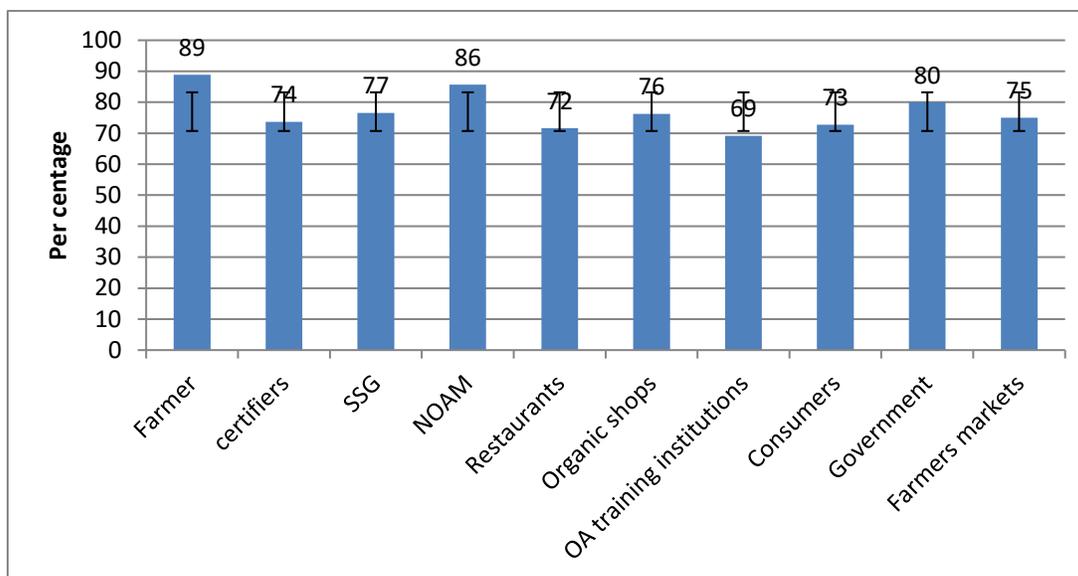


Figure 5: Closeness centrality based on nearness values of organic fresh produce supply chain networks in Nairobi. SSG represent sector support group, NOAM represent Kenya Organic Agriculture Network

4. DISCUSSION

4.1 Existence of alternative food networks in the supply chain

From the organic fresh kales supply chain, more than 47% was sold directly to consumers through the alternative food networks such as farmers market, basket schemes, home deliveries, or as farm-gate sales. Unlike conventional food networks, only 16% of the produce was through wholesalers and bulking agents. There was minimal value addition along the value chain, with excess production being sold through retailers (specialty outlets 6%, groceries, and supermarket 16% and restaurants 28%). This confirms reviews on emerging alternative food networks characterized by short supply chains (Forsell and Lankoski, 2015; Freidberg and Goldstein, 2011; Tregear, 2011).

4.2 Connectedness of Organic Fresh produce value chain actors

From the results, both the degree and eigenvector centralities scores for the actors revealed similar trends. High connectedness means an actor is more active in the network and acts as the main path for information flow (Borgatti and Li, 2009). Farmer, national organic agriculture movement (KOAN), sector support groups, and governmental organizations were relatively more connected; and were thereby considered as the dealmakers who made things happen. Low connectedness score for certification bodies, a section of traders (organic restaurants), and training institutions from the degree and eigenvector centrality scores indicate their weak positioning with little influence. Connectedness has been described as one of the key elements in alternative food markets (Venn et al., 2006). The spatial limitation which is a key factor in the peri-urban production system has been regarded as a recipe for connectedness (Labelle, 2008). The low eigenvector scores may point to the existence of structural holes in the network (Borgatti and Li, 2009). It is evident that actors with low eigenvector scores have used the power of weak ties (possession of non-redundant information) to their advantage (Burchard and Cornwell, 2018). On this, the traders and consumers were seen to exploit weak positions amongst smallholder farmers (Murimiet al., 2017).

Lower connectedness between producers and consumers may be a cause of the mismatch between supply and demand, a cause for the observed market failure in this supply chain as has been reported in similar research (Dodgson et al., 2011). On the positive, high degree centrality with low eigenvector scores has to be associated with successful group certification, trust, and traceability which are key in the implementation of food safety and quality management system in the chain (Gichure et al., 2017).

4.3 Proximity of Organic fresh produce value chain actors

Based on network betweenness centrality, the centralization was approximately 2.41 percent which confirms the low Eigen scores. Betweenness centrality shows an actor's importance as a connector between other actors in the network (Borgatti and Li, 2009; Freeman, 1978). The network centralization score based on closeness centrality measure was about 27 percent which confirms

betweenness proximity scores. This may encourage uniqueness, creativity, and reduce exploitation among members. Embeddedness is a key indicator of strong inter-personal ties and can be expressed through face-to-face transactions, spatial proximity, and certification/traceability (Gichure et al., 2017; Pinna, 2017; Sage, 2003). Low embeddedness may point out to a few information "gatekeepers" which is maybe good for alternative food markets (Borgatti and Li, 2009; Feeley, 2000). However, the role of highly embedded actors, namely governmental organizations, certification bodies, and KOAN needs to play a crucial role to address the mismatch between production and consumption. However, this may discourage innovations and creativity. On the flipside, sector support groups, traders (restaurants and specialty shops), organic agriculture training institutions, and consumers with low betweenness centrality scores still point out to looming market failure, and a potential impediment to information flow (Chiffolleau, 2009; Gichure et al., 2017; Vroegindeweyet al., 2018). Farmers had high closeness centrality value and have the potential to avoid being controlled by others as suggested in similar work (Borgatti and Li, 2009).

5. CONCLUSION

The study has explored the use of positions of value chain actors to analyze the organic fresh produce network organization. An alternative food network was evidenced by a high proportion of produce going through short supply chains. The centrality scores of individual actors varied rather considerably, and therefore the benefits of networking may be unequally distributed along with the network. The existence of trust, traceability, and social embeddedness was confirmed by the connectedness and proximity scores. Based on connectedness, high degree centrality with low eigenvector points to the existence of structural holes that traders and consumers were using to exploit smallholder farmers. Governmental organizations, sector support institutions, and national organic movement were most central with regards to connectedness and proximity which creates an opportunity for them to influence the sector as they could access information non-redundant information, mainly on supply and demand. A section of traders (organic restaurants), training institutions, and certification bodies present great potential in the network as they had the potential to utilize existing structural holes to bridge supply and demand mismatch. The role of social networks amongst farmers needs to be emphasized as it increased centrality amongst smallholders with regards to connectedness and proximity as revealed with successful group certification, trust, and traceability.

Authors' contributions

Josphat Njenga Gichure: conceptualized the research, conducted data collection, analyzed the data, and prepared the manuscript.

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Conflict of Interest: The authors declare that there are no conflicts of interests.

Peer-review: External peer-review was done through double-blind method.

Data and materials availability: All data associated with this study are present in the paper.

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