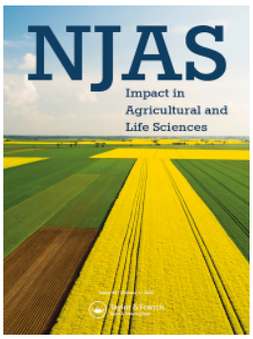

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The role of power relationships, trust and social networks in shaping milk quality in Kenya

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ABSTRACT

The objective of this study was to examine social networks in dairy value chains (DVCs) in Kenya and understand how DVC actors' power relationships and trust influence their behaviour regarding milk quality. We conducted a stakeholder analysis using the Net-Map tool in Laikipia, Nakuru and Nyandarua counties in Kenya. VisuaLyzer software was used to analyse the social networks. Thematic content analysis of the discussions, recorded during the mapping exercise, was undertaken using ATLAS.ti. Formal DVC had more actors and dense social networks characterised by vertical and horizontal integration, high levels of power asymmetries between actors, limited trust and short-term contractual arrangements. Informal DVC was characterised by fewer actors and less dense social networks, low levels of power asymmetries between actors and a high level of trust due to the existence of reciprocal personal relationships. Milk was perceived to be of higher quality in the formal value chain reflecting top-down enforcement of milk standards, bottom-up collective action, power asymmetries and contractual relationships. Poor milk quality management in the informal DVC underscores the need for powerful actors, e.g. regulatory agencies, and buyers such as processors, to influence other DVC actors' behavioural change. Understanding and leveraging DVC social networks and actors' power and

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addressing power asymmetries and enhancing trust between actors will increase compliance with milk quality standards. There is an urgent imperative to design policies and interventions which empower DVC actors, by providing economic incentives, enhancing their skills and knowledge and their access to infrastructure which facilitates milk quality improvement.

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KEYWORD Dairy value chains; food safety; trust; collective action; quality management; power (a) symmetry

1. Introduction

Demand for milk and milk products in low- and middle-income countries (LMICs) is growing, driven by population growth, economic development and changing dietary patterns (Lemma et al., 2018). At the same time, dairy sector growth in LMICs is constrained by poor milk quality due to weak food safety management systems (Alonso et al., 2018). The majority of milk traded in these countries is produced by smallholder farmers and commercialised through formal and informal dairy value chains (DVCs) (Alonso et al., 2018; Bebe et al., 2018). The formal DVC comprises licenced actors selling industrially processed-and-packaged milk and milk products. The informal DVC trades traditionally pasteurised milk and milk products that have not been industrially processed (Alonso et al., 2018; Blackmore et al., 2022). DVC actors perform value-addition activities such as bulking, transportation and processing (Stein & Barron, 2017). These actors operate in an institutional environment that includes regulations, social norms and customs, civil-society organisations, local and national politics, trade agreements and supporting industries such as transport and finance (Trienekens, 2011).

Understanding social networks in DVCs is key to improving milk quality in LMICs (Gorton et al., 2015). DVC actors are embedded within social networks, and their behaviour is shaped by the relationships within these networks. Relationships can be formal, i.e. contractual arrangements, or informal, i.e. reciprocal personal relationships (Konchak & Prasad, 2012). Vertical relationships exist between actors situated at different levels of a DVC, i.e. production, bulking, transporting, processing and distribution. Horizontal relationships exist between actors at the same level of a DVC, e.g. among farmers in a producer organisation (Bijman et al., 2016). The degree of vertical and horizontal relationships that exist between individuals and between groups influences their behaviour regarding the management of milk quality (Vermeulen, 2005).

Social networks differ in their composition, size and density (Borgatti & Li, 2009). Density is a measure of the closeness of relationships and a measure of

access to social capital in a network (Borgatti & Li, 2009). In a social network, core DVC actors have extensive relationships with other stakeholders, whereas peripheral actors have few relationships despite, in some cases, playing an integral part in the network (Borgatti, 2006). Social capital refers to the actual and potential resources that are embedded within social networks; it is derived from the social norms and reciprocal behaviour among actors (Fafchamps, 2006). Through feedback loops, social capital facilitates the strengthening of social networks and influences information flow and collective action, all of which are critical to the functioning of DVCs (Gorton et al., 2015).

Contingent on their positions within networks and access to resources, value chain actors have differing levels of power. Power constitutes a competitive advantage and can be defined as the ability to determine one's actions and influence the behaviour of others in a network (Belaya & Hanf, 2012). Powerful DVC actors exert their power in cooperation with other powerful actors and/or without the consent of the less powerful actors (Vermeulen, 2005). Power can be a tool for coordinating value chain activities and for enforcing compliance with norms (Belaya & Hanf, 2012, 2016). However, unbalanced or asymmetric power relationships, i.e. when some actors are more powerful than others, affect actors' levels of social relationships and willingness to cooperate and coordinate activities (Belaya & Hanf, 2012; Carbone, 2017). Formal value chains are characterised by a high degree of power asymmetry compared to informal value chains (Gereffi & Lee, 2009). In DVCs, less powerful actors are vulnerable to exploitation by powerful opportunistic and/or monopolistic actors which can lead to conflict and disaffection (Gorton et al., 2015).

The organisation and overall performance of the dairy sector is determined by levels of trust and cooperation among stakeholders (Dries et al., 2009; Msaddak et al., 2021). Trust can be defined as the expectation that another individual or firm will not act opportunistically (Martino, 2010). Social networks where actors are in regular contact can be regarded as characterised by high levels of trust (Fisher, 2013). Building trust reduces the transaction costs involved in establishing and implementing contractual arrangements and provides opportunities for cooperation and the building of social capital between DVC actors (Fisher, 2013; Martino, 2010). Trust and cooperation can emerge even in the absence of supporting incentive mechanisms and can thus be important mechanisms for managing milk quality in DVCs (Cabon-Dhersin & Ramani, 2007). Trust and non-contractual long-term relationships can serve to ensure coordination in the DVC where there is an absence or lack of strict vertical coordination and integration in value chains.

DVC actors' behaviour impacts milk quality (Nyokabi et al., 2018). Long-term purchase commitments and collaboration between DVC actors facilitate the creation of trust which can underpin milk quality improvements

(Indrawan et al., 2018). Social networks provide access to information, financial capital, human capital and other resources required to realise quality improvements in value chains (Bijman & Bitzer, 2016). Moreover, social networks foster business relationships which provide an imperative to improve milk quality and serve to reduce the risks associated with investments in milk quality improvements (Gorton et al., 2015; Trienekens, 2011). Realising high milk quality entails additional compliance costs, and thus the milk price should be high or an additional premium can be paid to farmers if the milk handling behaviour is improved and maintained (Rademaker et al., 2016; Saenger et al., 2013).

Milk is a perishable product which requires hygienic handling to guarantee its quality during production, bulking, transport and cooling (Ledo et al., 2019). Milk quality refers to the chemical, physical, technological, bacteriological, aesthetic and safety characteristics of milk (Ndambi et al., 2018). Milk quality can be regulated through top-down and bottom-up approaches. A top-down approach involves direct regulation by government agencies through rules, procedures and inspection to force value chain actors to comply with food safety standards (Luning & Marcelis, 2007). In contrast, a bottom-up approach reflects regulation through private agreements among DVC actors (Rao et al., 2016).

This study uses Kenya as a case study, in examining the social networks in formal and informal DVCs, for a number of reasons. Firstly, the country is a major milk producer in sub-Saharan Africa and has a well-established dairy sector (Ajwang & Munyua, 2016). Secondly, the dairy sector contributes significantly to Gross Domestic Product (GDP) and plays an important role in food and nutrition security (Alonso et al., 2018). Thirdly, sector growth is currently constrained by poor quality milk due to unhygienic milk handling, low DVC integration, weak institutions and a lack of economic incentives for milk quality improvement (Ndambi et al., 2018; Nyokabi et al., 2018). Finally, DVC mapping has been undertaken in Kenya to identify actors, product flows and milk quality to capture value chain governance structures (Kiambi et al., 2018; Muloi et al., 2018). The influence of social networks and social network relationships, e.g. power asymmetries and trust, on DVC actors' behaviour regarding milk quality, however, has not been assessed.

The objective of this study was to examine social networks in the formal and informal DVCs in Kenya and understand how the social network structure, as well as DVC actors' power relationships, trusts and influences their behaviour regarding milk quality.

2. Conceptual framework

The conceptual framework employed in this study draws on several strands of literature including Social Network Analysis (SNA) (Borgatti & Li, 2009; Hauck &

Schiffer, 2012; Hauck et al., 2015; Scheiterle et al., 2018), Value Chain Analysis (VCA) (Kaplinsky, 2000; Rich et al., 2011), and Actor-Network Theory (ANT) (D'haese et al., 2007; Hauke & Cadilhon, 2018). Moreover, this conceptual framework is influenced by aspects of game theory, namely, related to the importance of trust and cooperation between actors to solve social dilemmas such as how to improve milk quality (K. C. Green, 2002; Kollock, 1998). Business relationships in the DVC face the potential risk of opportunism, i.e. non-respect of business or contractual commitments (Cabon-Dhersin & Ramani, 2007; Kollock, 1998). Opportunism is a distinctive feature of individual motivation that can lead to uncooperative behaviour between actors (K. C. Green, 2002; Kollock, 1998; Martino, 2010). Cabon-Dhersin and Ramani (2007) have developed theories on trust using two classic paradigms: the prisoner's dilemma and the game of chicken. In the context of the prisoner's dilemma, trust is contingent on the probability of having a cooperative non-opportunist partner. In the game of chicken, trust is purely dependent on outcomes (Cabon-Dhersin & Ramani, 2007). To address the dilemma of poor milk quality, it is important to build trust and strong business relationships between the DVC actors (Mehta et al., 2011). Trust and interpersonal relationships are more important than price in business-related decision-making (Mehta et al., 2011). The conceptual framework presented in Figure 1 outlines how the social network structure of a DVC, power relationships and trust influence actors' behaviour regarding milk quality.

Social network structure includes both vertical and horizontal integration among the DVC actors. Vertical integration reflects the alignment or coordination of DVC activities and decisions at different stages of the value chain; there is a continuum from weak alignment to very strict alignment (Trienekens et al., 2003). Vertical integration involves a lead actor coordinating other actors' behaviour to control milk supply or distribution, to increase their power in the marketplace, reduce costs and earn a high income (Trienekens, 2011). Horizontal integration reflects collective action in undertaking DVCs activities, e.g. joint milk sales and joint input procurement, as a mechanism to overcome market-related challenges relating to small-scale production and heterogeneous product quality (Bijman et al., 2016). Farmers are often horizontally integrated through producer organisations (POs), e.g. farmer groups and cooperatives. Collective action, however, can create social dilemmas, i.e. free-rider problems which occur when individuals want to enjoy the benefits of improved milk quality without contributing to the collective action of maintaining or improving milk quality. Free-rider problems, if not addressed, reduce social capital and trust among DVC actors (Gorton et al., 2015).

The density of a social network structure is the number of connections between actors (the level of DVC integration and coordination) and is a proxy for the number of horizontal and vertical links (Borgatti & Li,

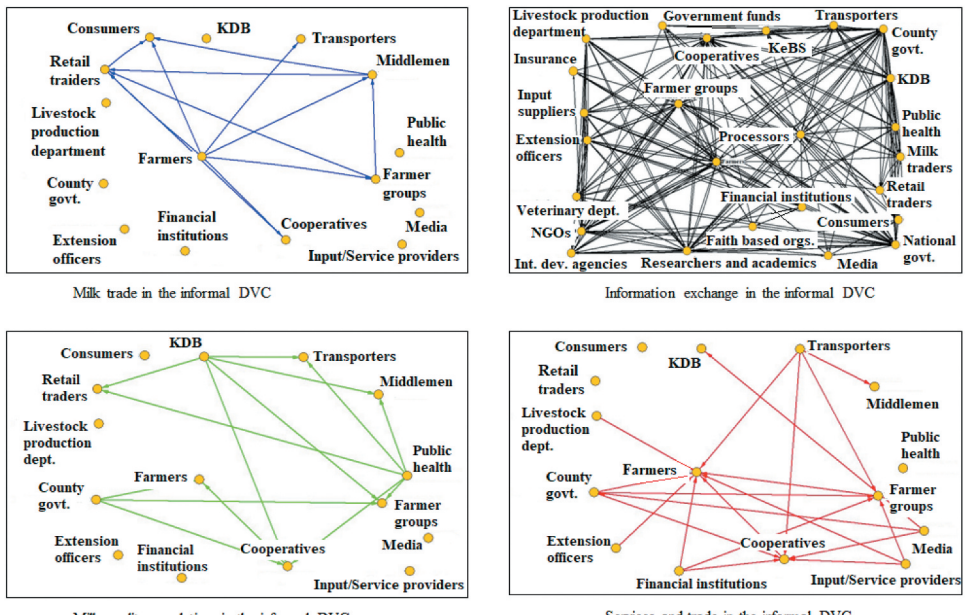

Figure 1. Conceptual framework (Source: author's conceptualisation).

2009). A highly dense network develops when trust exists between DVC actors (Morgan & McVay, 2012). Actors' relative importance in a social network structure is determined based on their degree of centrality, i.e. "in-degree" (incoming) and "out-degree" (outgoing) linkages to others. Actors who are linked to many nodes are considered more powerful and have higher visibility within a social network structure. Closeness centrality refers to how close an actor is to all other actors in a social network, i.e. lower values indicate more central actors. Betweenness centrality reflects the ability of an actor to serve as an intermediary. Intermediaries connect actors and have the power to control the flow of material and non-material resources, i.e. capital, information, advice, and trust. The diameter of a network is the shortest distance between the two most distant nodes in a network (Borgatti & Li, 2009; Borgatti, 2005).

DVC actors have varying levels of power, reflecting their access to and control of resources including finances, expertise, information, services, market position and access to political decision-makers (Belaya & Hanf, 2016; Nyaga et al., 2013). Formal DVCs are characterised by a high degree of power asymmetry, while there is a low degree of power asymmetry between actors in informal DVCs (Gereffi & Lee, 2009). Power asymmetries can be used to positively influence the behaviour of less powerful actors and to achieve desired outcomes such as improved milk quality (Vermeulen, 2005). However, if power is used negatively to exploit other actors, it can be the antithesis of trust (Belaya & Hanf, 2016; Gorton et al., 2015).

The density of a social network structure and its power asymmetry determine the levels of trust between DVC actors (Monastyrnaya et al., 2017; Trienekens et al., 2003). Trust reflects an optimistic expectation or belief regarding others' behaviour (Fafchamps, 2006). The presence or absence of trust in a social network structure influences its density and can explain why some networks are characterized by integration, coordination, cooperation, solidarity and reciprocity, whereas others are characterised by corruption, discord and opportunistic behaviour (Gereffi & Lee, 2009). Based on trust, social network structure and power asymmetries, it is possible to explore the perceptions of DVCs actors regarding milk quality management behaviour and how these perceptions influence milk quality and food safety.

In Kenya, the factors that were assumed to influence DVC actors' relationships within the structure of the social network and, therefore, their behaviour regarding milk quality, were information exchange, access to input and services, milk trade and regulation regarding milk quality (Mutura, 2015; Oloo, 2011). DVC actors' behaviour reflects their "lived" experiences of managing milk quality and those of their peers in social networks (Muange & Schwarze, 2014; Vishnu et al., 2019).

3. Materials and methods

3.1. Study area

This study was conducted between June and August 2017 in Laikipia, Nakuru and Nyandarua counties in Kenya. These counties are important centres of milk production and have agricultural policies at the county level to support the dairy sector (Abdulai & Birachi, 2009; Migose et al., 2018; Muia et al., 2011; Staal et al., 2003).

3.2. Selection of dairy sector stakeholders

With the help of county extension and livestock departments, we selected and invited actors in each county to participate in the Net-Map exercise, based on purposive sampling. The inclusion criteria for actors were: (1) resident in the county, (2) experienced and currently involved in the dairy sector, and (3) willing to participate in the Net-Map exercise. Actors selected included farmers, milk transporters, processors, input providers, extension officers, veterinary officers and representatives of farmer groups, co-operatives, county livestock development departments, public health departments, Kenya Bureau of Standards (KeBS), the Kenyan Dairy Board (KDB), and county and national governments. In total, 16 dairy sector stakeholders were selected in Laikipia, 18 stakeholders in Nakuru and 15 stakeholders in Nyandarua.

3.3. Data collection

The conceptual framework was operationalised in the three counties using the Net-Map tool which is a participatory tool for visual mapping (Haggblade & Theriault, 2012; Ilukor et al., 2015; Schiffer & Waale, 2008). Qualitative and quantitative data were collected using a participatory mapping technique outlined by the Net-Map tool, based on in-depth interviews and visualisation of social networks (Hauck & Schiffer, 2012; Hauck et al., 2015). The Net-Map tool was implemented as explained by Scheiterle et al. (2018) and Schiffer and Hauck (2010).

The Net-Map exercise meetings involved the following steps:

(1) The researcher pointed out the purpose of the research and explained that the goal of the meeting was to map, describe and understand the function and role of each actor in the dairy sector and the links, i.e. relationships, existing between actors. Before the start of the Net-Map exercise, informed consent was obtained from participants.
(2) A blank A2 size sheet of paper placed in the middle of the floor was used to draw the social network map. Net-Map exercise participants

were asked to identify all actors involved in the Kenyan dairy sector, in both the formal and informal DVC. Coloured sticky notes were used to depict the actors identified and to categorize them into different groups, e.g. private or public institutions, or international actors. These notes were fixed to the A2 sheet.

(3) Participants were asked to identify the relations between the different actors (milk trade, exchange of information and advice, procurement of services and inputs, and milk quality regulation). The relationships were drawn, and colour-coded (using markers) for the different types of relationships, taking into consideration the direction of the relationship. A legend was drawn beside the map to describe the relationships represented by the different coloured lines.

(4) After completing the social network map, participants were asked to review whether all institutions and actors in the dairy sector were included and whether there was a need to add any further relationships to the map.

(5) Participants were asked to rank the actors included in the map according to their perceived power to determine milk quality and power to influence milk quality in the DVCs. This study defined power to determine milk quality as the ability or authority of an actor to dictate what quality parameters the final product should meet. Power to influence milk quality was defined as the ability of an actor to change or improve milk quality parameters in the final product (during production, handling, transportation, storage, and packaging). Actors' power to determine milk quality and power to influence milk quality was scored on a scale from 0 to 10, (0 - no power to 10 - very powerful). Visualisation of ranking was undertaken using a tower of coins (corresponding to the assigned ranking score) placed beside each actor on a sheet of paper. The maximum possible height of this tower was 10 coins. The final scores were arrived at by a consensus of all participants at the meeting.

(6) The final step of the Net-Map exercise was a discussion with participants to follow up with questions about the roles of different actors and opportunities and bottlenecks in the sector.

In addition to mapping the complex value chain processes in which the formal and informal DVC actors engaged (Hauck & Schiffer, 2012; Raabe et al., 2010), the Net-Map exercise in each county facilitated the gathering of descriptions or "network narratives" which provided in-depth insight into actors' perception of formal and informal relationships and their impact on milk quality (Hauck & Schiffer, 2012; Hauck et al., 2015). Each iteration of the Net-Map process was audio-visually recorded for documentation purposes, with participants' consent, using a Dictaphone and camera.

3.4. Data analysis

The Net-Map data, relating to DVC actors, relationships, power to influence and determine milk quality, was entered into an Excel spreadsheet as described by Schiffer et al. (2010) and Scheiterle et al. (2018). The data was exported for analysis to VisuaLyzer 2.2 software (Medical Decision Logic Inc, 2014). Net-Map diagrams were developed and compared to the original drawings to ensure reliability. Similar DVC actors were grouped using colours. Actors' relationships were represented by arrows indicating the direction of the relationships which were also colour-coded. The Net-Maps developed in collaboration with stakeholders in the three counties were combined to develop social network maps for the formal and informal DVCs indicating the relationships which existed between actors.

The social network structure was assessed, using VisuaLyzer software, to determine network density and node degree, closeness and betweenness centralities (Freeman, 1978).

The recorded discussions were transcribed verbatim in Swahili and translated to English by a research assistant with a good command of both languages. The transcripts were compared against the original recordings and notes taken during the Net-Map exercise to ensure the accuracy of ideas was maintained during transcription and translation. Inductive content analysis was undertaken using ATLAS.ti software (ATLAS.ti Scientific Software Development GmbH, 2019). Inductive content analysis process was implemented as described by J. Green et al. (2007) and involved familiarisation with the data through reading and re-reading of the transcripts. Unique and recurring themes related to social networks and milk quality management in the Kenyan dairy sector were identified and grouped. Emerging themes were identified and added as appropriate, for example, the use of milk rejected in the formal DVC due to poor quality.

4. Results

4.1. DVC social networks maps

Social networks existing in the formal and informal DVCs in Kenya are presented in Figures 2 and 3. The dairy sector social networks existing at a county-level, i.e. Laikipia, Nakuru and Nyandarua counties, are presented in Figures 6, 7 and 8 (supplementary material). The properties of these county-level social networks, i.e. actors, their centrality measures, and the number and direction of relationships, are summarised in Tables 1 and 2 (supplementary material).

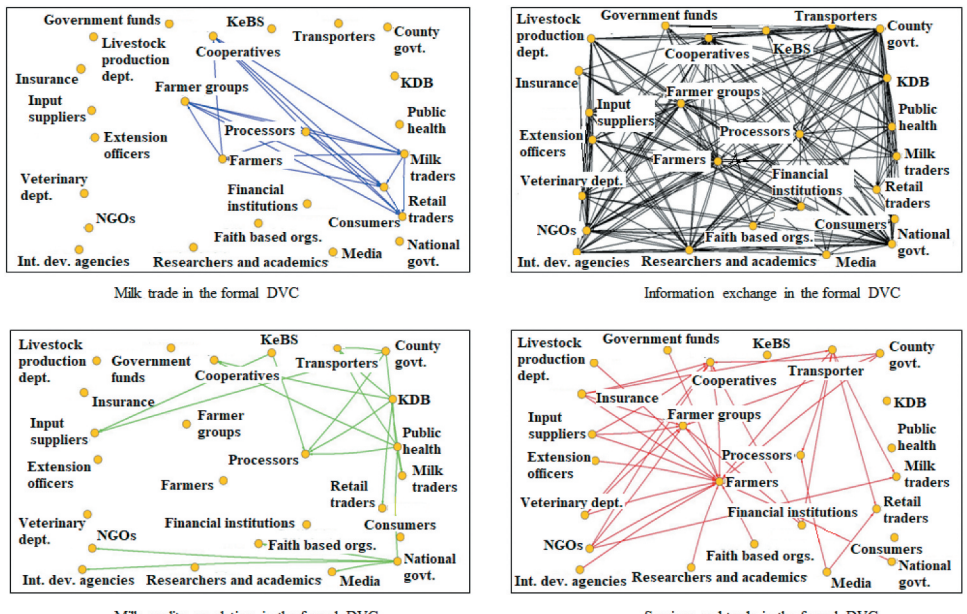

Figure 2. Social network map for the formal DVC.

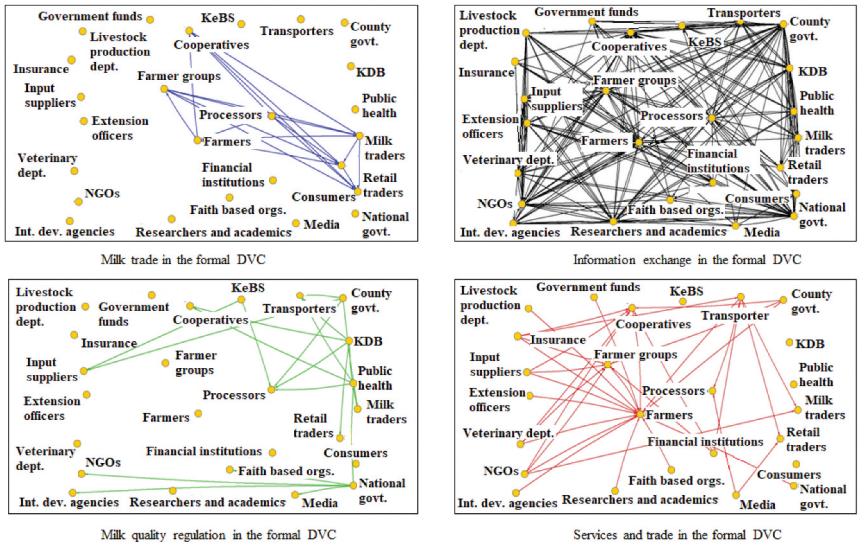

Figure 3. Social network structure of the informal DVC.

4.1.1. The social network structure of the formal DVC

The formal DVC encompassed a diverse set of actors and a large number of actors linked by extensive social networks (Figure 2). These actors dominated the pasteurised milk and processed dairy products markets and were connected by direct and indirect linkages: supply of inputs and services, information sharing, milk quality regulations, and milk trade activities such as producing, bulking and transporting. Information exchange and the supply of inputs and services created the majority of the linkages between formal DVC actors. Milk trade and milk quality regulation only created linkages between actors producing and handling milk.

In all three counties, the dairy sector stakeholders who participated in the Net-Map exercise reported that the majority of the formal DVC actors who handled milk were licenced by the KDB and traded milk that was destined for processing, pasteurisation, and packaging. Processed, packaged, and branded milk and dairy products sold by processing companies had the KeBS mark of quality indicating they met milk quality standards. Net-Map exercise participants reported that vertical integration and coordination of DVC activities by formal DVC actors were loose and changed seasonally. In rural locations, some supporting actors were reported as missing or absent, i.e. KeBS and KDB, while in urban locations, some supporting actors were reported as present but underfunded or/and understaffed to carry out their mandates, i.e. the public health department and KDB.

Table 1. Social network properties of DVCs in Laikipia, Nakuru, Nyandarua counties.

Network characteristics	Laikipia	Nakuru	Nyandarua
Links* (number of social networks)	58	62	55
Nodes* (number of actors)	19	19	21
Network diameter* (steps)	3	3	4
Number of links in the social networks in the dairy sector			
Milk trade	13	13	12
Exchange of information exchange	25	25	23
Procurement of inputs and extension services	8	12	14
Milk quality regulation	12	12	6
Actors in the DVCs			
Formal DVC	Farmers, Transporters, Farmer groups, Farmer cooperatives, Marketing cooperatives, Processors, Consumers, Retail traders, Government livestock and extension departments, Formal retail channels, National and county governments, Public health department, Kenya Dairy Board (KDB), Kenya Bureau of Standards (KeBS), Non-governmental organisations (NGOs), Local and foreign development agencies, Church-based organisations, Private input suppliers, Private extension providers, Academia, Insurance companies, and Media.		
Informal DVC	Farmers, Middlemen, Retail traders, Public health department, KDB, Transporters, Consumers		

Core actors	Laikipia	Nakuru	Nyandarua
Based on centrality measures	Farmers, Processors, Consumers	Farmers, Processors, Consumers, Transporter, Cooperatives	Farmers, Consumers, Processors, Transporters, Financial institutions

Note: *Links – relationships between actors, Nodes – DVC actors, Network diameter- maximum distance between any pair of actors in a network.

In urban areas, farmers sold milk directly to consumers. In rural locations, milk trade was based on short-term contracts, with long-term commitments avoided due to seasonal price volatility. Processors primarily purchased milk from farmers and POs. A small number of independent transporters, however, collected milk from farmers on behalf of POs and processors. It was difficult for POs and processors to contract these transporters as they were not organised. Moreover, it was difficult to engage and train them on milk handling practices.

In highly productive rural areas, POs served as a platform for DVC integration, pooling and selling milk at a negotiated price on behalf of their members. They supplied several processors at any given time on a contractual basis to prevent dependence on a single processor and to secure a good producer price. Moreover, POs acted as saving and credit cooperatives (SACCOs), encouraging farmers to save proceeds from their milk sales and allowing them to obtain loans for school fees, inputs and equipment purchases and to cover emergency costs. They used milk supplies as collateral for loans advanced. In addition, they acted as intermediaries and guarantors in

Table 2. Social network analysis measures (* La - Laikipia, Nak - Nakuru, Nya – Nyandarua.

	Degree Centrality n (%)			In- degree Centrality n (%)			Out- degree Centrality n (%)			Normalized closeness centrality (undirected graph) %			Normalized betweenness centrality (undirected graph) %		
Actor	La*	Nak*	Nya*	La*	Nak*	Nya*	La*	Nak*	Nya*	La*	Nak*	Nya*	La*	Nak*	Nya*
Input provider	5 (27.8)	2 (11.1)	4 (20.0)	3 (16.7)	2 (11.1)	2 (10.0)	2 (11.1)	0 (0.0)	2 (10.0)	52.9	42.9	50.0	1.7	0.6	9.1
Veterinary providers	2 (11.1)	2 (11.1)	1 (5.0)	1 (5.6)	1 (5.6)	0 (0.0)	1 (5.6)	1 (5.6)	1 (5.0)	48.6	48.6	44.4	0.0	0.0	0.0
Government extension department	2 (11.1)	2 (11.1)	4 (20.0)	1 (5.6)	1 (5.6)	2 (10.0)	1 (5.6)	1 (5.6)	2 (10.0)	46.2	45.0	46.5	0.0	0.0	4.7
Financial institutions	6 (33.3)	4 (22.2)	5 (25.0)	2 (11.4)	2 (11.1)	3 (15.0)	4 (22.2)	2 (11.1)	2 (10.0)	58.1	54.5	39.2	0.9	0.0	1.7
NGOs/development partners	3 (16.7)	3 (16.7)	3 (15.0)	0 (0.0)	0 (0.0)	1 (5.0)	3 (16.7)	3 (16.7)	2 (10.0)	50.0	48.6	46.5	0.0	0.0	4.7
Research and academia	3 (16.7)	3 (16.7)	4 (20.0)	1 (5.6)	1 (5.6)	2 (10.0)	2 (11.1)	2 (11.1)	2 (10.0)	47.4	46.2	33.3	0.0	0.0	0.3
Farmers	17 (94.4)	16 (88.9)	21 (105)	10 (55.6)	9 (50.0)	10 (50.0)	7 (38.9)	7 (38.9)	11 (55.0)	81.8	78.3	76.9	46.2	42.8	76.4
Transporters	7 (38.9)	6 (33.3)	4 (20.0)	5 (27.8)	4 (22.2)	2 (10.0)	2 (11.1)	2 (11.1)	2 (10.0)	60.0	56.3	54.1	3.9	2.98	13.4
Farmer groups & cooperatives	9 (50.0)	8 (44.4)	3 (15.0)	4 (22.2)	3 (16.7)	1 (5.0)	5 (27.8)	5 (27.8)	2 (10.0)	64.3	64.3	45.5	9.4	15.6	0.0
Sales & marketing cooperatives	2 (11.1)	2 (11.1)	3 (15.0)	1 (11.1)	1 (5.6)	1 (5.0)	1 (5.6)	1 (5.6)	2 (10.0)	43.9	43.9	51.3	0.0	0.0	4.0
Processors	13 (72.2)	13 (72.2)	5 (25.0)	7 (38.9)	7 (38.9)	5 (25.0)	6 (33.3)	6 (33.3)	0 (0.0)	69.2	69.2	43.5	20.3	22.9	6.6
Informal traders	4 (22.2)	4 (22.2)	2 (10.0)	3 (22.2)	3 (16.7)	1 (5.0)	1 (5.6)	1 (5.6)	1 (5.0)	54.5	54.5	45.5	2.4	2.6	0.0
Consumers	5 (27.8)	5 (27.8)	5 (25.0)	5 (27.8)	5 (27.8)	5 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	58.1	56.3	51.3	3.4	3.3	2.5
KDB	3 (16.7)	3(16.7)	2 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (16.7)	3 (16.7)	2 (10.0)	45.0	45.0	38.4	0.5	0.5	0.0
KeBS	5 (27.8)	5 (27.8)	2 (10.0)	2 (11.1)	2 (11.1)	0 (0.0)	3 (16.7)	3 (16.7)	2 (10.0)	48.6	48.6	39.2	0.7	2.4	1.0
Public health department	3 (16.7)	3 (16.7)	2 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (16.7)	3 (16.7)	2 (10.0)	48.6	48.9	39.2	0.16	0.4	1.1
National government	6 (33.3)	6 (33.3)	-	3 (16.7)	3 (16.7)	-	3 (16.7)	3 (16.7)	-	54.5	54.5	-	1.98	2.6	-
County government	8 (44.4)	8 (44.4)	-	4 (22.2)	4 (22.2)	-	4 (22.2)	4 (22.2)	-	60.0	60.0	-	5.8	6.7	-
Insurance	-	-	2 (10.0)	-	-	1 (5.0)	-	-	1 (5.0)	-	-	44.4	-	-	0.0
Livestock production department	3 (16.7)	3 (16.7)	2 (10.0)	1 (5.6)	1 (5.6)	1 (5.0)	2 (11.1)	2 (11.1)	1 (5.0)	48.6	47.4	44.4	0.0	0.0	0.0

(*Continued*)

Table 2. (Continued).

	Degree Centrality n (%)			In- degree Centrality n (%)			Out- degree Centrality n (%)			Normalized closeness centrality (undirected graph) %			Normalized betweenness centrality (undirected graph) %		
Actor	La*	Nak*	Nya*	La*	Nak*	Nya*	La*	Nak*	Nya*	La*	Nak*	Nya*	La*	Nak*	Nya*
Middlemen (bulkers)	-	-	4 (20.0)	-	-	2 (10.0)	-	-	2 (10.0)	-	-	48.8	-	-	6.6
Government funds (women & youth)	-	-	4 (20.0)	-	-	2 (10.0)	-	-	2 (10.0)	-	-	46.5	-	-	2.2
Average	5.6 (31.0)	5.2 (28.7)	4.0 (20.0)	2.8 (15.5)	2.6 (14.3)	2 (10.0)	2.8 (15.5)	2.6 (14.3)	2 (10.0)	54.8	53.3	46.4	5.1	5.4	6.4
Standard deviation	3.8 (21.4)	3.7 (20.7)	4.0 (19.8)	2.5 (14.1)	2.3 (13.0)	2.2 (11.2)	1.8 (9.8)	1.8 (10.2)	2.1 (10.6)	9.3	9.1	8.4	10.8	10.6	16.0
Min	2 (11.1)	2 (11.1)	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	43.9	42.9	33.3	0.0	0.0	0.0
Max	17 (94.4)	16 (88.9)	21 (105.0)	10 (55.6)	9 (50.0)	10 (50.0)	7 (38.9)	7 (38.9)	11 (55.0)	81.8	78.3	76.9	46.2	42.8	76.4

contractual relationships between farmers, financial institutions and inputs and extension providers. POs facilitated a check-off system whereby farmers received inputs and services on credit and paid at a later date from the proceeds from milk sales.

The Net-Map exercise participants reported, however, that POs were inefficient. They attributed this inefficiency to intra-group challenges such as bad leadership, poor meeting attendance, limited information exchange, particularly relating to milk prices and quality requirements, and lack of farmer training on milk quality handling and hygiene practices. PO leaders were reported as often attending government meetings for personal gain rather than to champion the interests of farmers.

4.1.2. The social network structure of the informal DVC

Figure 3 presents the social network structure of the informal DVC. The value chain was characterised by a high number of individual actors selling small quantities of milk. Informal DVC had less diversity of actors and a less-dense DVC social network. Linkages between DVC actors were formed through information-sharing, supply and procurement of services and inputs, milk trade and milk quality regulation. Similar to the formal DVC, milk trade and milk quality regulation created the most social networks between informal DVC actors.

Vertical and horizontal integration and coordination of activities were almost non-existent in the informal DVC. Formal contractual relationships were absent and, instead, business agreements were based on verbal and on-spot contracts, personal relationships and trust. Although Net-Map exercise participants reported that, in the wider dairy sector, informal DVC actors were perceived as periphery actors due to their low centrality measures, these actors dominated the milk trade in the three counties, selling raw milk and, in some cases, pasteurised milk.

Farmers in both urban and rural areas perceived the informal DVC as a lucrative market channel as it offered higher milk prices. In urban areas, farmers sold their milk directly to retailers, traders, middlemen and consumers. In rural areas, the majority of farmers were members of POs which bulked and marketed milk on their behalf. Other than farmers, the informal DVC actors involved in milk bulking and transporting activities were traders. These traders were unable to purchase milk in large volumes but offered farmers and POs comparatively higher milk prices than other actors and did not have strict milk quality demands.

Unlike formal DVC actors, informal DVC actors, e.g. farmers, retailers, traders and middlemen, were unable to collectively negotiate with or lobby the government agencies, such as KeBS, to influence the distribution of resources allocated to the dairy sector, e.g. milk cooling tanks which were considered key to improving milk quality. This was due to the absence of

collective organisations beyond farmer-level organisations, e.g. SACCOs or trade unions.

4.2. DVC actors and their roles

Table 1 summarises the structure of the social networks in the formal and informal DVCs and highlights the core actors and supporting and regulatory actors. Based on their centrality measures, the core actors in both DVCs were identified as: farmers, processors, consumers and POs. These actors produced, transformed, and sold milk and dairy products to consumers. Supporting actors included input and service providers, extension service providers, NGOs and development agencies. Regulatory actors included the national and county governments and government agencies responsible for monitoring, certifying and enforcing milk quality standards and public health regulations.

Supporting actors provided services, information and, in some cases, inputs to help farmers improve dairy production and comply with milk quality standards and regulations. Farmers obtained inputs and extension from private and public service providers. In the three counties, the cost of public services was, in some instances, subsidised through national- or county-government initiatives, e.g. vaccination, disease control and farmer training. The national government provided financial assistance specifically to female and young farmers through women and youth funds, to invest in milk production inputs, quality breeds and farm equipment, while the national meteorological department provided weather information and forecasts to help all farmers in planning production.

The Net-Map exercise participants perceived public sector extension services as inefficient and of poor quality, and private sector extension service providers as profit-driven and, therefore, unaffordable. Supporting actors, e.g. NGOs and development agencies, were viewed as playing an important role in bridging the services delivery gap in the dairy sector, supporting farmers and other small-scale DVC actors, e.g. transporters and traders. However, their interventions were regarded as short-term in nature and as not guaranteeing sustained adoption of technologies and innovations.

4.3. Power (a)symmetries in DVCs

Figure 4 summarises the Net-Map exercise participants' perceptions of DVC actors' relative power to determine milk quality. Consumers were perceived as the actor most powerful in determining milk quality through their purchasing behaviour. Government regulatory agencies were also considered powerful as they enforced milk quality standards and public health regulations. Security agencies, i.e. police, enforced milk movement regulations and

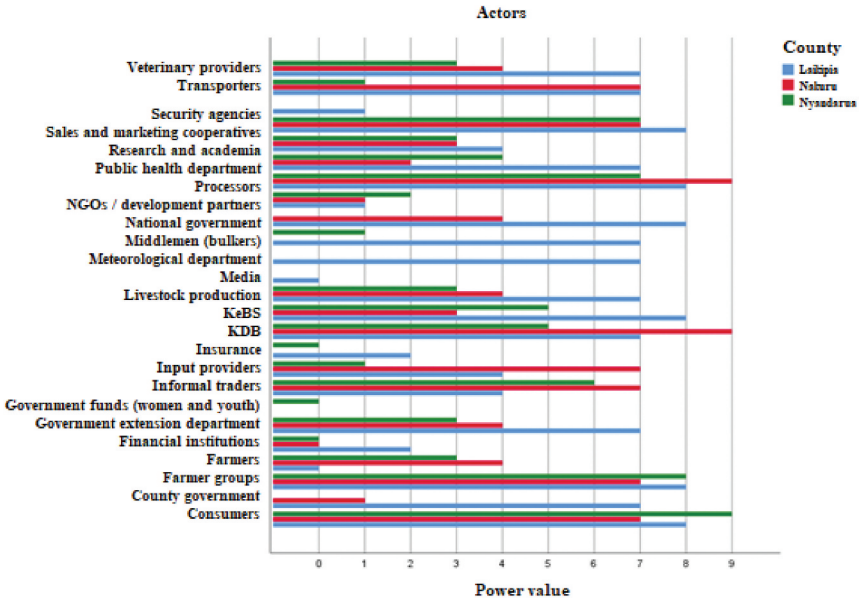

Figure 4. Perceptions of power to determine milk quality in Laikipia, Nakuru and Nyandarua counties (scored 0–10, 0 no power and 10 very powerful).

helped other agencies, i.e. KeBS and KDB, execute their mandates. Processors and POs were powerful actors as they only purchased milk which met quality standards based on milk density, organoleptic and alcohol tests. Supporting actors, i.e. NGOs and development agencies, were perceived as having limited power to determine milk quality.

Figure 5 summarises Net-Map participants' perceptions of DVC actors' power to influence milk quality. DVC actors who handled milk, such as farmers and transporters, were perceived as having the power to influence and improve milk quality. Farmers' adoption of good feeding strategies, improved milk handling and animal health practices were viewed as contributing to improved milk quality. Farmers' abilities to invest in milk quality improvements, however, were limited by delayed milk payments from milk buyers and low milk prices. Transporters, traders, and processors failed to buy all of the milk available during the rainy season, leading to economic losses and undermining the long-term collaboration and milk quality improvements.

Power asymmetries between DVC actors were perceived to influence the equitability of benefit sharing and value creation in the formal DVC. Farmgate milk prices were perceived as low (Ksh 20–35, approximately US $0.30) compared to prices in the informal DVC (Ksh 30–40 approximately US $0.35). Retail prices for pasteurised and unpasteurised milk in the informal

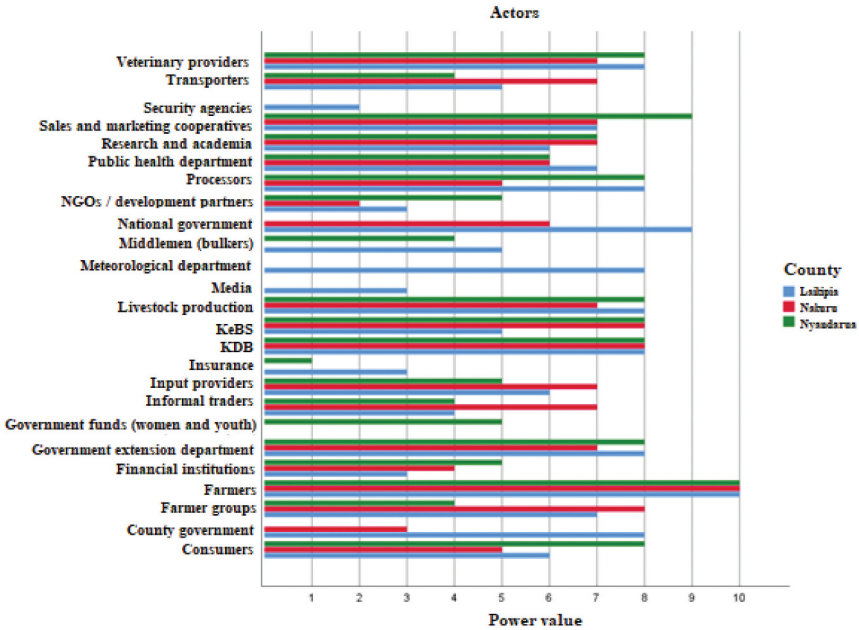

Figure 5. Perceptions of power to influence milk quality in Laikipia, Nakuru and Nyandarua counties (scored 0–10, 0 no power and 10 very powerful).

DVC were lower (Ksh. 60, approximately US $0.50) than pasteurised and packaged milk in the formal DVC (Ksh 110, approximately US $1.00). Processors reported that the farmgate milk price was low due to low demand for premium dairy products, e.g. cheese, high processing costs, marketing costs and taxes.

The majority of formal DVC actors viewed processors as not transparent regarding milk prices and as fixing milk prices without consulting or negotiating with farmers. Milk prices varied depending on the distance to markets and the quality of infrastructure, i.e. roads and cooling plants. Milk prices were also influenced by seasonality, with high prices offered in the dry season and low prices offered during the rainy season. The formal DVC had strict milk quality requirements. However, a milk quality–based payment system and/or economic incentives for milk quality improvement were lacking in both the formal and informal DVC.

4.4. Trust between DVC actors

Dense social networks in the formal DVC facilitated trust creation between actors. Trust between formal DVC actors was based on formal

instruments such as contracts which specified product quality and legal recourse in case of breach and led to horizontal and vertical integration and coordination. Trust also reflected the social capital shared between a set of actors, i.e. trust between farmers led to horizontal integration of DVCs activities and the formation of POs. Trust, however, was limited in the formal DVC due to power asymmetry between actors and processing companies' preference for short-term contracts due to milk price volatility.

In the informal DVC, trust was based on social capital and personal relationships as there were no formal instruments to enforce milk quality requirements. Instead, milk quality reflected mutual trust developed between actors over a period of time.

There was distrust between formal and informal DVCs actors. Informal DVC actors perceived national and county governments and government agencies as biased and favouring formal DVC actors. Informal DVC actors were not involved in the policy development process at the county or national levels. Large processing companies had the ability to lobby the government and its agencies, which resulted in the introduction of laws that favoured formal DVC actors and undermined informal DVC actors. Net-Map exercise participants reported that mergers and acquisitions among processing companies had consolidated power into a few companies, created an oligopsony and reduced competition, to the detriment of farmers, consumers and less powerful actors such as traders in the informal DVC.

4.5. Influence of social network structure power structures and trust on milk quality management

Social networks, i.e. DVC integration and coordination, power structures and trust, affect DVC actors' behaviour related to milk quality. Government regulatory agencies, i.e. KDB, KeBS and the public health department, use their power vested by the law to enforce milk quality standards and food safety regulations stipulated by the Kenya Dairy Act. Milk quality monitoring, licencing, and certification by these agencies occurred regularly in the formal DVC and infrequently in the informal DVC. Regulatory agencies such as KDB, KeBS and the public health department were, however, underfunded and understaffed to properly carry out their mandates.

Milk quality was also regulated by processors and buyers who demanded POs and farmers meet strict milk quality standards. Milk quality tests, i.e. density and alcohol tests, were commonly conducted in the formal DVC but only occasionally in the informal DVC. The use of verbal, on-spot and short-term contracts made it difficult to specify quality requirements to be met by individual farmers.

Recent devolution of functions from the national government to county government units was viewed as having improved service provision at a grassroots level. However, it was not clear to Net-Map exercise participants which functions were the responsibility of the national and/or county governments. County-level institutions such as regulatory agencies and extension services were described as chronically underfunded and understaffed to fulfil their mandates and have an ageing workforce. Limited collaboration between the national and county governments and their agencies, and quality surveillance laboratories also constrained milk quality improvements.

Formal DVC actors had the public health certificates required to handle milk, i.e. milk transporters had milk movement certificates required to transport milk and milk retailers had public health and business certificates mandatory for running milk bars, vending machines (ATMs) and retail shops. Some actors in the informal DVC, however, operated without obtaining mandatory public health, milk movement and business certificates.

Net-Map exercise participants reported that poor quality milk rejected by processors and PO cooling plants was often traded in the informal DVC. As the enforcement of milk standards by regulatory agencies was low in informal DVC, government's and processors' power to determine milk quality was negated and circumvented which impeded milk quality improvement.

In both DVCs, poor quality road infrastructure increased the transaction costs associated with access to information, extension services, farm inputs, milk markets and hindered milk collection logistics, particularly during the rainy season. The majority of Net-Map exercise participants believed that the government should facilitate the purchase of aluminium containers, equipment to test milk and facilitate the purchase of motorcycles (*"boda boda"*) to transport milk in order to reduce post-harvest losses and poor milk quality caused by slow transportation due to poor road conditions.

5. Discussion

The objective of this study was to examine social networks in the formal and informal DVCs in Kenya and understand how DVC actors' power relationships and trust influence their behaviour regarding milk quality.

5.1. Social network structure of the formal and informal DVCs in Kenya

The results of this study indicate that the formal and informal DVCs in Kenya differ in their social network structure. The formal DVC encompasses a more diverse set of actors and has a dense social network structure. Formal DVC actors are dependent on contractual relationships which facilitate collaboration, and integration and coordination of DVC activities; they place little

emphasis on building and leveraging personal trust in undertaking activities. In contrast, the informal DVC comprises a less diverse set of actors, has a less dense social network structure and shows lower integration and coordination of activities. Informal DVC actors rely on short-term relationships that change from season to season and are highly dependent on personal trust.

In both DVCs, the absence of supporting actors such as KeBS and KDB, and understaffing or/and underfunding of regulatory institutions, such as the agricultural extension service and the public health department, result in institutional voids which undermine milk quality management. Missing horizontal and vertical linkages between DVCs actors constrain collaboration and coordination of DVC activities; in particular, vertical integration of activities such as logistics, cooling and bulking affects milk quality.

5.2. Influence of social network structure on DVC actors' behaviour relating to milk quality

The social network structure of the formal and informal DVCs in Kenya influences actors' behaviour regarding milk quality. The results of this study corroborate with Gorton et al. (2015), who reported that low emphasis by formal DVC actors on building and relying on personal trust in undertaking activities undermines their willingness to commit to long-term collaboration and adversely impacts milk quality management. Although formal DVC actors rely on contractual relationships, they solely dominate the pasteurised milk and processed dairy products market. In contrast, informal DVC actors dominate the milk trade in the three counties, selling raw milk and, in some cases, pasteurised milk. Current low adoption of contracts in the dairy sector in Kenya, notably in the informal DVC, could be addressed by increasing vertical linkages between actors and vertical integration of activities, and redressing the short-term orientation of business relationships, as suggested by the findings of Abdulai and Birachi (2009). Formal contracts could be used to increase compliance with milk quality standards as they explicitly specify the required milk quality. In Vietnam, the adoption of formal contracts has led to increased compliance with food safety regulations by DVC actors and has led to improved milk quality (Saenger et al., 2013).

The results of this study underline an urgent imperative for addressing the loose vertical integration of activities in both DVCs that results in value chain inefficiencies and high transaction costs, as also reported by Trienekens (2011). Lead actors, such as processors and supermarket chains, could provide technology, extension services and inputs to help farmers meet milk quality standards (Trienekens, 2011). Increased vertical integration could facilitate farmers' access to high-value, niche markets which offer lucrative prices but demand high-quality milk (Delgado, 1999). Farmers in Kenya are currently dependent on the informal DVC as the main market channel as they cannot

meet the quality and quantity demands of the formal DVC. Similar findings regarding smallholder farmers' inability to access the economic resources required to secure quality services and inputs and, thus, ensure high-quality milk in other emerging economies have been reported by (Trienekens, 2011).

Increased horizontal integration could equally enable farmers to derive greater socio-economic benefits from their participation in DVCs, by enhancing their access to credit facilities, inputs, and extension. POs facilitate the collective sale of milk and enable farmers to negotiate access to milk markets offering farm gate prices which can improve their livelihoods (Mwambi et al., 2020). The results of this study indicate that increased horizontal linkages between actors and integration of activities in the DVCs in Kenya could increase farmers' market participation and benefits derived from milk value addition. In addition to enhancing farmers' access to inputs, credit, information, extension and innovation support services, increased horizontal integration could reduce the transaction costs (Kilelu et al., 2017; Rao et al., 2016).

5.3. Influence of power and trust on DVC actors' behaviour relating to milk quality

The results of this study reveal actors' behaviour regarding milk quality is influenced by a high degree of power asymmetry in the formal DVC and a low degree of power asymmetry in the informal DVC. Power asymmetry, when abused by powerful DVC actors, can serve as a disincentive for smaller DVC actors' to invest in milk quality improvements (Rademaker et al., 2016). Farm-gate milk prices and profit margins are low in DVCs in Kenya due to high production costs (Mutura, 2015). In contrast, retail prices for milk and dairy products are high and inelastic, which can be attributed to weak coordination and integration in the DVCs activities and lack of competition between the limited number of processors operating in the Kenyan dairy sector (Birachi, 2006).

Powerful actors such as processors and POs are in a position to shape the behaviour of actors in their sphere of influence to conform to the stipulated standards and regulations (Chepkoech, 2010; Kilelu et al., 2017). However, the results of this study indicate that processors are more concerned about protecting their market share, as evidenced by their preference for short-term contracts and oligopolistic practices than leveraging their power to improve milk quality, which is in agreement with Rademaker et al. (2016).

5.4. Milk quality management in DVCs

The results of this study underscore that a top-down milk quality management approach has the potential to influence formal and informal DVC actors'

behaviour and compliance with milk quality regulations via rules, procedures and through inspections. This is in agreement with the findings of Chepkoech (2010) and Oloo (2011). However, the results of this study are also in agreement with previous research which suggested that, although a legal framework exists for formalising the informal DVC in Kenya, actors' low adoption of certification inhibits their behaviour in managing milk quality (Alonso et al., 2018; Blackmore et al., 2022). The current top-down approach to milk management in the dairy sector in Kenya is constrained by understaffing and underfunding of agencies mandated with enforcing milk quality regulations, e.g. public health department and KDB (Blackmore et al., 2022). The major constraint to operationalising a top-down approach to milk quality improvement in Kenya is that standards formulated in the context of developed economies have been adopted without concurrent investment in infrastructure, i.e. roads and cooling plants (Blackmore et al., 2022). This has made it difficult for DVC actors to comply with expected milk quality standards and food safety regulations (Jacxsens et al., 2015; Omiti et al., 2006).

The results of this study indicate a bottom-up approach, which relies on POs and the collective action of DVC actors, could be more effective in improving milk quality management than the current top-down approach adopted by stakeholders in the dairy sector in Kenya. Collective action by DVC actors is key to effecting behaviour change where formal institutions are absent or not functioning (Abdulai & Birachi, 2009). Research on dairy platforms in East Africa, i.e. dairy hubs, indicates that farmers' collective action can lead to improved milk quality. Regulation of milk quality by POs is important, as are PO coordination and organisation of bulking and/or chilling of milk, and PO initiatives aimed at increasing farmers' use of inputs and services and access to loans and training (Rao et al., 2016).

The results of this study reveal that social networks influence trust-building processes and shape DVC actors' perceptions and reciprocal expectations. Trust based on contractual instruments and high-power asymmetry enables powerful actors, through actions such as rejection of poor quality milk, to incentivise and initiate behavioural change regarding milk quality management among farmers, transporters, and bulking agents. Trust influences DVC actors' milk quality management practices and their willingness to have either binding contractual arrangements or spot market contracts (Mehta et al., 2011). However, long-term collaboration is undermined when powerful actors are perceived as abusing their power, for example, in setting milk prices. Farmers' current perception that there is a lack of transparency in price setting and that they receive too low milk prices undermines their willingness to improve milk quality. The results of this study indicate there is an imperative to address the short-term orientation of business relationships and the opportunistic behaviour of processors. This will facilitate

increased collaboration between DVC actors and integration of DVC activities crucial to sustained improvements in milk quality (Birachi, 2006).

It is crucial that regulatory and core actors in the dairy sector, such as the Kenyan government and cooperatives and processors leverage their influence on informal DVC actors to promote milk quality improvements as personal relationships and trust and low power asymmetry were not considered sufficient enough to enforce behavioural change. In order to improve milk quality in the Kenyan dairy sector, there is an urgent need in the informal DVC to eliminate the trade of poor quality milk rejected by actors in the formal DVC, as also reported by Chepkoech (2010).

6. Policy implications

Poor milk quality in DVCs and public health concerns have led consumers to demand improved milk quality in Kenya (Ndambi et al., 2018). There is a need to engage informal DVC actors in policy-making and milk quality improvement initiatives rather than regard them as periphery actors as they dominate milk trade in the Kenyan dairy sector (Rademaker et al., 2016; Roesel & Grace, 2015). Realising sustained milk quality improvements will require leveraging power, trust, bottom-up and top-down milk quality management approaches to improve DVC actors' behaviour regarding milk quality. There is scope to empower DVC actors with skills and the provision of infrastructure to enable milk quality improvement. Increasing transparency and participation in policy-making and implementation processes will create a conducive policy environment for sustained milk quality improvement.

In addressing the issue of milk quality through policies and behaviour change interventions, it is important to understand that DVC actors' perceptions of milk quality differ depending on their role in the value chain, i.e. producing, processing, trading and consuming milk and milk products (Bijman & Bitzer, 2016; Ndambi et al., 2018). For example, processors are concerned about milk composition, microbial and chemical contamination, and adulteration, whereas informal traders are primarily concerned about the microbial contamination of milk. DVC actors in Kenya currently perceive few economic incentives to improve milk quality due to the absence of quality-based payment systems, i.e. a bonus for producing or trading consistent high-quality milk and a price penalty for low-quality milk (Rademaker et al., 2016).

The strength of the conceptual framework used in this study stems from the synergies between the different component concepts and theories. Social network analysis provides a framework to study the roles of and relationships between DVC actors and allows for the identification of the visible and invisible ties in a social networks (Haggblade & Theriault, 2012; Trienekens, 2011). Participatory visual methods such as Netmap can be used to capture the activities and processes along formal and informal value chains, from

input supply to production, processing, handling, transportation, storage, packaging and marketing of the final product to consumers (Trienekens, 2011). Netmap allows for the investigation of the stakeholders' actual and perceived power between DVC actors (Birner et al., 2010; Schiffer et al., 2010). Data collected through participatory, collaborative and visual research is credible and acceptable to all stakeholders and can support the development of solutions specific to local contexts (Table 2). The research process ensures production of participant-directed data created away from the direct influence from the researcher (Birner et al., 2010; Schiffer et al., 2010).

The main limitation of the research approach is that, due to the number of interrelated concepts involved, it can be tedious and requires considerable planning and time management skills (Birner et al., 2010; Schiffer et al., 2010). There is a need for reflexivity on the part of the researcher to understand that factors such as class, age and gender can influence the data collection process, and it is thus important that all stakeholders, including the less powerful, are involved in the research process and empowered to tell their stories (Migliorini & Rania, 2017).

7. Conclusion

This research contributes to the empirical and theoretical literature on the role of social networks in DVCs in Kenya and similar LMICs. Our results show that understanding DVC social network structure, power (a)symmetry and trust, can contribute to the design of policies and interventions which have the capacity to increase DVC actors' compliance with milk quality standards and food safety regulations. Inclusive policy-making and implementation processes hinge on participatory research, co-generation of knowledge and social learning are key to improving DVC actors' adoption of policies and technologies and realising sustained behaviour change regarding milk quality.

The results of this study provide a platform for further research on milk quality and DVCs in LMICs. It is important to capture the views and opinions of all DVC actors, not just those actors which are powerful due to their position within the value chain and have the ability to influence policy-making through lobbying, but also those small and less powerful actors which, despite often being overlooked in policy-making and implementation processes, are important dairy sector stakeholders, e.g. informal DVC actors. Participatory and visual research approaches to data collection and the use of tools such as Net-Map are inclusive and easy-to-use and can capture the opinions of different actors in a sector, social network or value chain. Participatory approaches facilitate the development of context-aware interventions that are attuned to the social, cultural, and economic environments in which DVC actors are engaged in producing,

processing and trading milk and milk products. Policies and interventions are more likely to be accepted by the DVC actors targeted if these actors are given the opportunity to participate in and influence their design and implementation.

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