A network approach to analysis of the performance of milk traders, producers and BDS providers in Tanzania and Uganda

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Abstract

Network analysis is applied to an investigation of the effectiveness of pro-poor interventions in the dairy industry of Tanzania and Uganda. A sample of milk producers and traders, and of suppliers of Business Development Services, is constructed by a snowball method to preserve market and other linkages amongst the actors.

Geometric analysis of the resulting networks is used for simple network diagnostics which are then applied to market structure analogues. Statistical and econometric analysis is then applied to examining actors' characteristics and performance by way of conventional actor-specific variables and by using information about the links between actors within networks. Indications of the success of the Business Development Services support programme are derived from network characteristics.

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Problem statement

Dairy production in East Africa provides income to a large number of producers and service providers, and offers a cheap source of high quality protein to the population. Dairy-generated income is available daily, and the prevailing market systems offer cash payment. Hence dairy offers significant benefits to the region's poor consumers and producers, and has been the target of development expenditures by both public and private sectors. Despite significant efforts toward developing co-operative-based formal large scale dairy processing, treatment and packaging, small scale producers and informal raw milk markets continue to dominate the dairy sectors in these countries (Omore *et al.*, 2004a, b; Ahmed *et al.*, 2004).

The East African dairy sector has undergone substantial development in the last two decades. Milk production has increased by 65% in Kenya to 4.1 million tonnes, and Uganda by 270% to 1.2 million tonnes in this time (FAOSTAT, 2012). Research, development and commercial interest has been focused not only at production level, but at the response of the whole value chain to increasing demand, populations and pace of urbanization. Enhancing hygiene and other quality issues, boosting production to achieve a marketable surplus, and training and certification for milk handlers and traders have seen successful applications. Such efforts directed at the small scale and informal dairy sector in Kenya have shown significant returns throughout the value chain (Kaitibie *et al.*, 2008), and are being rolled out to other countries in the region (ASARECA, 2007). A variety of interventions have been used, including mobilization of trained value chain service and input providers to hand on training key inputs, generally known as Business Development Services (BDS) (ILRI, 2006).

Analyses of the dairy value chain for the design of new interventions or the evaluation of past ones have favored a description of the actors along the value chain and estimation of costs, prices and margins (e.g. Sevo, 2008). Analysis of incentives for positive and pro-poor change such as income increase and reduced risk to public health have tended to focus on value chain actors' responses to price and cost. This approach has two main weaknesses: first that the interactions amongst traders, amongst producers, and between producers and traders are multifaceted and extend beyond payment and delivery (Coppock *et al.*, 2011); second that quality-based price changes in such circumstances are not commonly observed and in any case represent a small part of available benefits from change. Further, the costs, institutions and resources widely cited as related barriers to market entry by developing country smallholders (Barrett, 2008; Muriuku and Thorpe, 2001) are influenced by the nature of networks within which such market actors operate (Trienekens *et al.*, 2003; Wilson, 1998).

The current paper provides an analytical model based on networks - arrays of producers and traders supported by BDS providers – rather than the characteristics of samples of value chain actors in isolation from those of their peers, trading partners and service providers (Kranton and Meinhart, 2001). The model employs the nature of the network's arcs and edges (the forms of connection between network nodes) to quantify inter-actor variables usually generalized into opaque forces such as "trust". The model is then used preliminarily to assess market structure and the network-related impact of the BDS support programme.

Objectives

The overall objectives of the study are to enhance the effectiveness of dairy development interventions by increasing the understanding of producer-trader networks and identifying the relationship between network form and function on the one hand, and the ways change occurs and can be accelerated, on the other.

Procedures

A theory of change for small scale dairy producers and traders was established by discussion with expert informants, and in structured focus group discussions with producers, traders and BDS providers in Tanzania and Uganda. These, along with past work on developing country and agricultural markets and networks, were used to generate hypotheses about the causes and effects of change in performance variables such as production, costs, profits, investments and behavior regarding public health. Cross-sectional analysis of key conventional explanatory variables, and the extent and intensity of network linkages, were used to explain performance.

Existing information was used to establish sample frames for actors in selected regions, and a snowballing procedure was used to collect data on actors and those that trade with them. Questionnaires (of 3 types, corresponding to each actor) were implemented in Uganda and Tanzania. They included, among others, questions related to the respondents' characteristics, products marketing, linkages within the network and the duration and intensity of these linkages. Data analysis includes both geometric projection of network forms and statistical and econometric analysis[1] of the data referring both to actors and the linkages between them.

In the case of Uganda the total number of respondents was 195 and in Tanzania 173. Details of type, location and number of participants are summarized in Table 1. Data collection in Uganda took place in 4 small and contiguous districts near the city of Kampala: Kampala, Masaka, Mbarara, and Rushere. In the case of Tanzania the surveys were implemented in 2 spatially separated and non-contiguous regions: Arusha located in the northern part of country and, and Mwanza located in the northwest on the shores of Lake Victoria.

Table 1. Participants' distribution

Country	Region	Producers	Traders	BDS providers
Uganda	Kampala	34	33	4
	Masaka	26	16	2
	Mbarara	22	16	2
	Rushere	22	16	2
	Total	104	81	10
Tanzania	Arusha	28	33	32
	Mwanza	38	40	42
	Total	66	73	74

[1] The Pajek® and STATA® software packages were used, respectively.

Results

Summary statistics

Across the networks analyzed, the majority of respondents are male: female participation is more important at the production level, especially in Tanzania (Table 2). Smallholder producers' age exceeds that of other value chain participants in both countries, with average around 50 years. BDS providers in Tanzania are on average older, and less educated, than their peers in Uganda. In both countries, traders are less educated than BDS providers, and Tanzanian traders are on average more experienced than Ugandan traders. Producers in the two countries have on average more than 17 years of experience. The majority of the interviewed actors are owners of their business.

Table 2. Participants' characteristics

Characteristic	Variables	Uganda			Tanzania		
		Producers	Traders	BDS Prov.	Producers	Traders	BDS Prov.
Gender (%)	male	77%	88%	100%	67%	77%	88%
	female	23%	12%	0%	33%	23%	12%
Age (years)	mean	47.9	35.1	32.8	49.8	38.8	44.4
	min/max/median	17/84/46	19/62/33	24/44/31	23/88/48	18/72/39	21/59/46
Years of schooling	mean	---	8.9	16.3	---	7.25	13.7
	min/max/median	---	0/20/8.5	13/21/15.5	---	0/17/7	7/21/14
Years of experience	mean	17.5	5.6	---	17.6	9.7	---
	min/max/median	2/50/15	0/20/4	---	2/54/16	0/28/7	---
Business status (%)	proprietor	---	78%	100%	---	97%	71%
	employee	---	14%	0%	---	1%	23%
	family member	---	4%	0%	---	1%	0%
	Other	---	4%	0%	---	1%	6%

Network configurations

Networks' mapping for milk producers and traders in Uganda (figure 1) and Tanzania (Mwanza and Arusha respectively figures 2 and 3) show that the majority of traders (62%; 58% and 53% respectively for Mwanza, Uganda, and Arusha) are linked to just one or two producers. Milk traders in Uganda handle generally larger volumes of milk compared to their colleagues in Tanzania (Mwanza). Average daily milk purchases by Ugandan and Tanzanian (both Mwanza and Arusha) traders which are respectively 133.7, 22.9 and 18.9 litres in the wet season, and 89.1, 19.4 and 10.7 litres in the dry season.

Gender differences

Male milk traders' supply networks appear to be more developed and dense in comparison to those of female traders. In the case of Arusha, on average each male trader has around 3.26 connections with producers. In the case of women the average is much lower at 1.92. The

situation is almost the same in the case of Mwanza where male traders' average number of connections is 3.40 and for females 2.25. In the case of Uganda, there is no apparent difference between genders of trader (female average is 2.40 and males' 2.38).

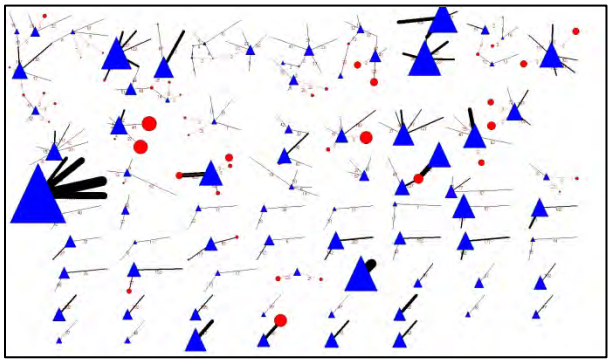

Figure 1. Milk supply network in Uganda

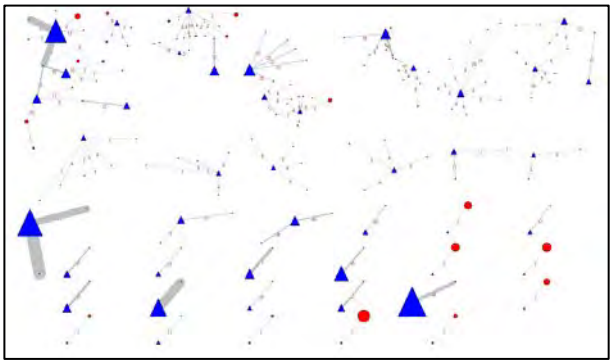

Figure 2. Milk supply network in Mwanza

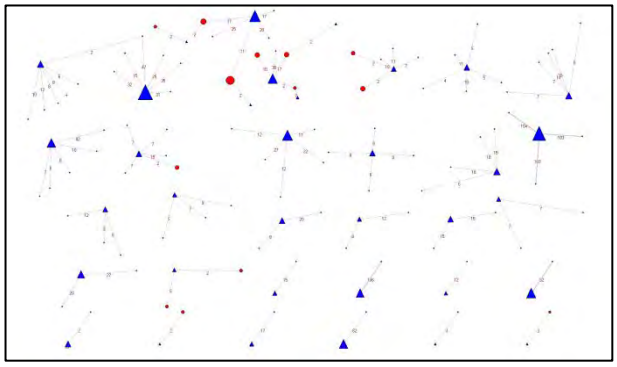

Figure 3. Milk supply network in Arusha

Blue triangle: Trader (size depicts sales volumes); Red circle: Producer (size depicts milk volume)

Thickness of line: Quantity of milk traded between producers and traders.

Marketing channels

In terms of milk sales, it is interesting to highlight the fact that the majority of milk traders are linked to only one type of retail outlet. In the case of Ugandan traders around two thirds (67%) are selling milk to only one type of retailers. This proportion is slightly lower in the case of traders from Mwanza and from Arusha with respectively 53% and 55%. Direct milk selling to consumers represents the most important retail outlet with 52% of Ugandan traders indicating consumers as one of their retail outlet. The same patterns are observed in the cases of traders from Mwanza and Arusha, reporting consumers as retail outlets at respectively 52% and 49%.

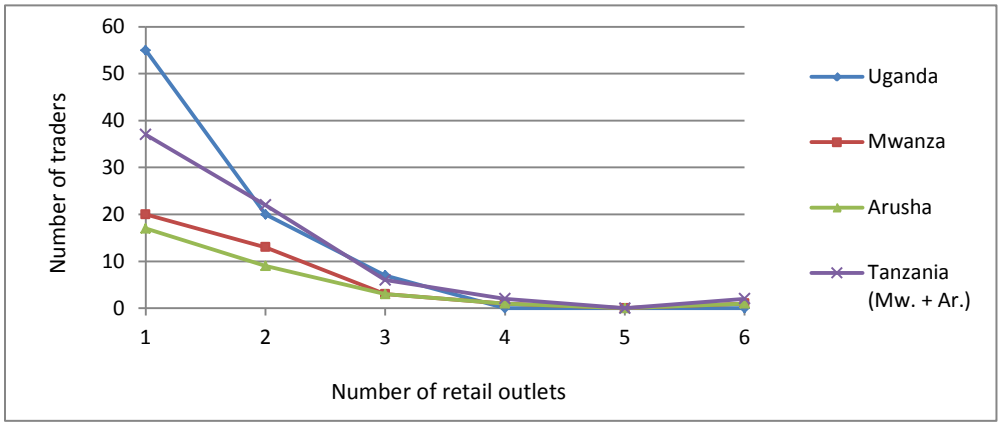

Figure 4. Number of connections between traders and retail outlets

For Ugandan milk traders, restaurants/hotels (18%) and other traders (17%) are the next most important milk sales channels. In the case of Mwanza and Arusah, restaurants/hotels represent the second most important channel with respectively 28% and 24% of traders indicating these outlets. In the case of Arusha, it is interesting to note that institutions such as schools and hospitals are listed as outlets by 9% of the milk traders.

Patterns of BDS provision

Figures 5, 6 and 7 show the relations between milk producers, milk traders and BDS providers. It is possible to distinguish (with different intensity and importance) 3 different relationships between the dairy actors:

1. BDS providers working exclusively with producers, and supplying them with inputs (animal feeds, drugs, vaccines, etc.) and services (training on milk hygiene, information and advisory services, etc.).
2. BDS providers working exclusively with traders, and supplying them with inputs and services.
3. BDS providers working with both producers and traders. This case is very rare for the three regions.

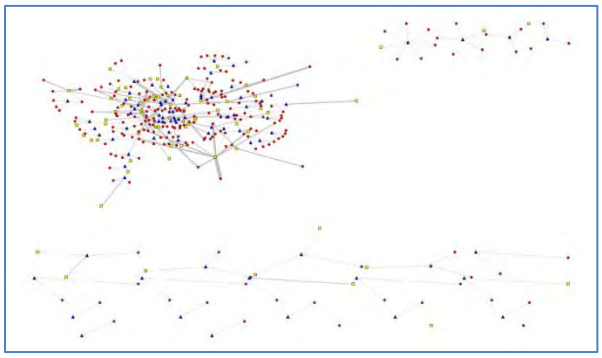

Figure 5. Milk supply and BDS network in Uganda

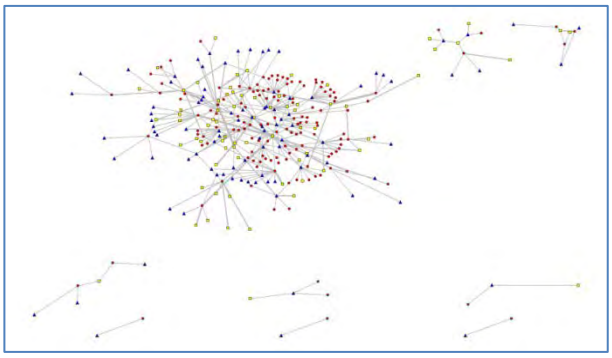

Figure 6. Milk supply and BDS network in Mwanza

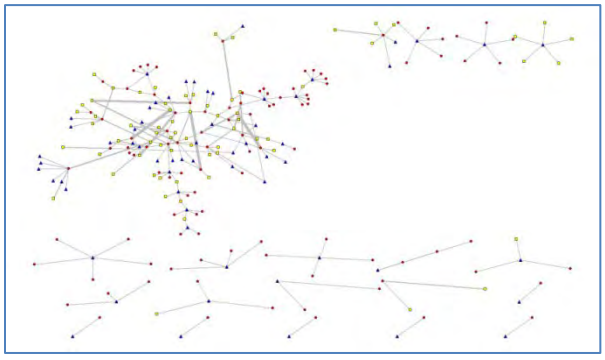

Figure 7. Milk supply and BDS network in Arusha

Blue triangle: Trader

Red circle: Producer

Yellow box: BDS provider

A notable result is that many BDS providers are working only with one trader or one producer. This could be due to the fact that the experience of BDS business is limited in both countries, and need time to develop their business activities and expand their client base. It is also notable that many BDS providers are only connected to traders: it is possible that in some cases traders are playing the role of intermediaries between BDS providers and producers, buying inputs from the former and selling them to the latter. This should be confirmed by further analysis.

Indications of the impact of BDS support programmes

The average number of connections for BDS providers with the value chain actors (producers and traders), has been calculated in order to assess the impacts of the training and accompanying programme that some BDS provides have received from the project. The results indicate that in the case of Mwanza, BDS providers who have participated in the programme present on average a higher number of connections (3.56) in comparison to those who did not participate (0.82). In the cases of Uganda and Arusha the difference is less clear: Ugandan BDS providers who participated to the programme have in average 6 connections with either traders or producers, whereas those who did not participate average 5.5 connections. In the case of Arusha, the average numbers of connections are respectively 1 for BDS taking part to the programme and 1.4 for those who did not participate. These results may indicate the relative importance of the BDS programme in terms of improving BDS providers' connections and value chains' interactions.

It is interesting to observe the difference between the two countries. In the case of Tanzania, and except the case of trained BDS providers in Mwanza, the rest of BDS providers have on average almost only one connection. In the case of Uganda average connections are around 6 for both groups of BDS providers. This could probably positively affect (and explain) the individual volumes of milk (which also implies the total volumes) produced and exchanged among the value chain. In a previous paragraph, milk sales data showed the big difference between average quantities traded in each country (almost 6 times higher in Uganda compared to both Tanzanian regions)

Conclusion

The paper presents an empirical network model of agricultural markets as proposed by Kranton and Meinhart (2001), which offers a number of advantages in terms of the analysis of prospective pro-poor development interventions. The informal markets for milk in Tanzania and Uganda are modeled in this way, and insight into market power, measures of individual actors' success, and predisposing factors for value chain upgrading are offered.

Geometric configuration and the distribution of arcs and edges in the networks are used to provide preliminary comments on market power. BDS providers' configuration of services is also described. The nature of the arcs and edges are examined to evaluate the distribution of service and input providers, and the degree of bundling in their provision: these factors affect smallholders' market access.

As further steps in these preliminary results, an econometric analysis is now underway to test hypotheses relating network configuration to actors' performance, and relating network structure to actors' behavior and uptake of change. Cluster analysis is also being used to explain actors'

performance, comparing socioeconomic and demographic variables with those related to the nature of actors' networks.

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