Pre-print:

Making decisions without reliable information: the struggle of local traders in the pastoral meat supply chain

Highlights:

- Lack of accurate and timely information blurs the decision making of producers and local traders, hence contributing to losses.
- Unpredictable price fluctuations in sheep and goat spot markets make market information rapidly irrelevant.
- Relations that structure information exchange must shift for pastoralists and local traders to have a better position within the pastoral meat value chain.

Abstract:

In Sub-Saharan Africa, arid and semi-arid rangelands are mainly used by pastoral communities for livestock production. In northern Kenya, these communities predominantly sell sheep and goats to local traders who connect them to different markets. This pastoral livestock supply chain is characterized by inadequate market information, without which it is difficult to improve the coordination of seller - buyer activities. This paper examines the information needs and constraints of producers and different categories of traders. Semi-structured and narrative interviews were conducted with 15 producers and 26 traders. Results revealed the particular information needs of traders; such as the range of prices in different markets, the extent of competition, grades of animals in high demand and further specifications. However, market information tended to change within a short time-span. Analysis of weekly prices for different grades revealed high price variability such

that they were only known on the market day. This unpredictability made it difficult for traders to improve prices offered to pastoral producers. We recommend strengthening relations of local traders to processors and wholesalers that structure information exchange so that they can make better decisions to improve their margins.

Keywords: Pastoralists, Traders, Market Information, Value Chain, Goats, Northern Kenya

1. Introduction

In Africa, 43 % of the land is arid and semi-arid, used for livestock production (Koohafkan and Stewart, 2008). In Sub-Saharan Africa, an estimated 50 million pastoralists rely on this land for their livelihoods (IIRR, 2014; Rass, 2006). Assessment of pastoralism's contribution to national economies revealed that it contributes over 35% of the agricultural GDP in Kenya, Sudan and Ethiopia (COMESA, 2009). Despite this significant contribution, pastoral livestock marketing has not been accorded priority in policy (Hatfield and Davies, 2007), budgetary allocations (Alushula, 2016) and institutional support (Otieno, 2008).

In Kenya, the long-term absence of a comprehensive livestock marketing policy has set the stage for minimal investments in marketing infrastructure and limited coordination among investments. The first statutes relevant to livestock marketing in the post-independence era were the Meat Control Act of 1977 (cap 356), the Animal Diseases Act of 1984 (cap 364) and the Crop and Livestock Production Act of 1977 (cap 321), revised in 2012. Although aspects of marketing were incorporated into the National Livestock Policy; sessional paper no. 2 of 2008, it does not specifically detail i) ways to streamline livestock marketing investments, and ii) integration of livestock producers in value chains. Only in 2016, did parliament pass the Livestock and Livestock Product Marketing Bill which established the Kenya Livestock and Livestock Products Development and Marketing Board tasked with spearheading market research and development for the sector. The approach outlined in the *"Agricultural Sector Development Strategy (ASDS), 2010-2020"* places emphasis on improving market access by supporting livestock marketing groups, building markets and strengthening associated

infrastructure such as market information systems (Republic of Kenya, 2010, p. 42). Moreover, many counties within arid and semi-arid areas of Kenya have been investing in infrastructure to target high-value livestock export markets, mostly to the Middle East. A recent example of such an investment is the construction of an abattoir in Marsabit County (worth 3.8 million USD) commissioned jointly by national and county governments in 2014 (Otieno, 2014). Promoting livestock trade is a core aim of the Kenya Meat Commission (KMC), although the scale of its activities has gradually declined over the last decade, attributed, in large part, to mismanagement (Ringa, 2013).

Despite these interventions, pastoralists still face the problem of low prices; suppressed by unfavourable terms of trade, droughts (Little et al., 2014), distance from main markets (Nunow, 2000), and relatively few traders. The problem is not that pastoralists are unwilling to sell their livestock, but rather that market conditions are often not to their advantage. Pastoral producers' weak position in the supply chain is attributed to lack of access to market information (Bailey et al., 1999). This information is required to make timely decisions for organizing livestock sales (Pavanello, 2010, p. 27). Therefore, unequal information exchange leaves producers relatively disadvantaged compared to traders (Stuth et al., 2006, p. 204). However, traders face high risks related to inadequate terminal market information (Bailey et al., 1999; Stuth et al., 2006). A further problem is livestock price volatility caused by informational disparities (Barrett and Luseno, 2004), climatic conditions, and changes in demand and supply (Barrett et al., 2003).

To improve producer prices, livestock market information systems were promoted by government and international donors. An early example of a project in northern Kenya is the ´Livestock Information Network and Knowledge System (LINKS)´ funded under USAID's Global Livestock Collaborative Research Support Program (GL-CRSP) (Stuth et al., 2006, p. 203). In this project, prices and information on livestock volume, forage condition, security and water supply were transmitted on a regular basis for selected markets in East Africa. Another example is a project conducted by the German development cooperation agency, GTZ (now GIZ), that supported the collection of price

information from four markets in Marsabit County to be broadcast across the region in Rendille and Borana languages (Bailey et al., 1999). However, these projects failed to influence producers' and traders' marketing decisions because of i) limited access to communication infrastructure in remote areas (Stuth et al., 2006), ii) coordination challenges for collecting and organizing information and punctually transmitting it to users (Komen, 2010). Decisions regarding which animals to sell, where and when to sell and at what price remain a challenge, resulting in higher transaction costs for producers and traders.

Strengthening information exchange is associated with: higher producer prices (Coronado et al., 2010), increased negotiating power (Shepherd and Schalke, 1995) and improved marketing decisions of both producers and traders (Magesa et al., 2014). Understanding of information exchange requires analysis of: i) "micro-level factors that influence individual actors to transmit information", and ii) "macro-level factors that determine the structure of channels directing the flow of information" (Frenzen and Nakamoto, 1993, p. 360). Analysing these relations can be grounded by social exchange theory (Emerson, 1976), complimented by investigation of activities and interdependencies between actors (Dubois et al., 2004) and further, by evaluating why supply chain actors engage in information sharing, what information they share, with whom and how (Kembro et al., 2014).

Only a few studies briefly touched on market information exchange in pastoral livestock markets (Bailey et al., 1999; Pavanello, 2010). This includes Stuth et al.´s (2006) research on the challenges and priorities for developing livestock information network and knowledge systems in northern Kenya and southern Ethiopia; and Jama et al.'s (2006) analysis of the strengths and limitations of livestock market information services to inform the design of better systems in Ethiopia's highland regions. However, these studies do not adequately consider the information requirements and constraints of different actors along the livestock supply chain.

To fill this gap, this paper aims to: i) identify specific information needs of pastoral producers and traders in sheep and goat supply chains in northern Kenya, ii) assess information gaps and constraints

that hamper information flow and access within the chain, and iii) identify options traders use to bridge information gaps. These aims are accomplished primarily through qualitative techniques described in the methods section. In the sheep and goat value chain, producers and traders transact in spot markets through direct negotiations, hence price information varies due to many factors and it is assumed that traders cannot anticipate prices based on past prices. We therefore test the hypothesis that current prices for four grades of goats in Nairobi are influenced by previous prices through time-series correlation of current and previous prices. This price analysis gives further perspective to contextualize the information needs and constraints shared by traders and pastoralists.

2. Theoretical framework

To understand information flow within exchange relationships that are not based on explicit agreements and contracts, we used a theoretical framework that emphasizes actors' relational interdependence and social networks. Social exchange theory reveals dynamics of exchange among mutually dependent actors interacting in a context where power is unequally distributed (Emerson, 1976, p. 351) and embedded within networks (Molm, 2003).

Although social exchange can be applied to many different kinds of relations, business exchange is a specific form of exchange that entails assessment of three complementary flows - product (material), finance (money) and knowledge (information) (Kaipia, 2009; Le Heron et al., 2001). The relational perspective in business, which includes socially embedded exchange processes, can include studies such as how supply chain actors engage in information seeking and what information is shared with whom (Kembro et al., 2014). Transmission of market information between actors requires analyses of both the "micro-level" factors that shape how individual actors convey information and the "macro-level" factors that explain the structures connecting the actors that define information flow (Frenzen and Nakamoto, 1993, p. 360).

In supply chains, actors share information to perform purposeful activities (Zott and Amit, 2010). Fulfilling the activities of an actor in the chain is partly contingent upon the degree of connection to other actors with varying levels of interdependence. This perspective draws attention to the importance of activity links in supply networks that relate the activities of disparate upstream and downstream actors (Håkansson and Snehota, 1995). Additionally, it is essential to understand the constraints in information sharing in supply chain (Kumar and Pugazhendhi 2012, 2148) to show how they influence the overall functioning of the system. For example, "the dynamics of how the delays, amplifications, and oscillations" affect supply chain processes, particularly in relation to transmission of demand related information (Sahin and Robinson 2002, p. 506).

In our study, we use social exchange theory to show how different sheep and goat supply chain actors seek to fulfil different information needs for making business decisions. Likewise, the limits of information exchange in this context reveal aspects of power inequalities within the chain.

3. Methods

3.1. Study area

This study was conducted in the southern part of Marsabit County in northern Kenya (fig. 1). The area is rural, with sparsely populated arid lands and represents an important livestock production area. It is home to pastoralists who mainly rely on livestock production for their livelihoods, mostly from the Rendille ethnic group but also, along the border to Samburu County, from the Ariaal ethnic group.

Insert Fig. 1: The study area

In the study area, sheep and goats are sold to acquire income for regular household needs at primary markets, in Illaut and Korr, and at a secondary market, in Merille. The Illaut market is held every two weeks. Occasionally cattle and camels are offered. Meanwhile, only sheep and goats are traded at the Korr market which takes place every Saturday. Primary markets are collection points for traders

trekking livestock to the secondary market which is a 2-3 day walk, and for those transporting animals to the terminal market at Kariobangi in Nairobi, lorries are used for a distance of over 600 km. Traders transporting animals to Nairobi typically need a minimum of 150 sheep and goats to fill a truck, that usually take 5-14 days to amass. The tarmacked road connecting Marsabit, Isiolo and Nairobi eases mobility in the region. However, other rural roads are not paved and many become impassable during wet seasons (County Government of Marsabit, 2013). Steadily growing mobile phone coverage offers better connectivity, especially in towns along the highway.

3.2. Data collection

Fieldwork included multiple phases from March 2014 until November 2016. Data presented in this paper is from two phases in 2015: 1) July-August, and 2) September-November. Feedback seminars where research results were shared back to the traders for further confirmation were conducted in November 2015 and September 2016.

From July to August, 2015, fieldwork included six focus groups with traders and twelve focus groups with livestock producers. Analysis of the focus group findings led to attention on market information for further exploration. The first author did field observations on 32 market days at the primary, secondary and terminal markets to identify interviewees and build rapport. Overall, about 30 traders were identified who were active during the study period. Of these, interviews were done with all 14 long-distance traders, 7 itinerant traders (out of 9 total) and 5 inter-local market traders (out of 7 totals). At the markets, producers were also identified and purposively selected for interviews from different settlements (locations) within the study area. Subsequent interviewees were identified through the snowball technique and the interviews were conducted in Kiswahili and English, but frequently translated into the Rendille language, which is the native language spoken by the traders and pastoralists in the area. For traders who were confident speaking Kiswahili, translation was not always necessary.

Between September and November 2015, the first author conducted semi-structured interviews with producers and traders. Questions were structured on the basis of producers' and traders' supply

chain activities to identify: i) information required to do a specific activity, ii) sources of information, iii) constraints to sharing market information, and iv) ideas for improving information flow in the supply chain. These interviews were conducted with 15 producers and 25 traders (approximately 45 minutes each), including all 14 long-distance traders in Korr and Illaut and 11 other traders. These interviews were complemented by narrative interviews with 4 traders (3 of whom had already done semi-structured interviews and 1 new). In total, 26 traders were involved in this study. The narrative interview method was used to explore the trader´s perspectives through narration of their trading history including events they considered most relevant.

To further understand traders' information needs at the terminal market, a meeting was organized with 11 long-distance traders and an expert from the Neema slaughterhouse in Nairobi who had knowledge of the livestock and meat trade. The meeting was prepared using an expert interview structure through which the traders organized key topics they wanted to discuss based on questions they prepared including: specific requirements of different slaughterhouses, the typology of clients at the terminal market (including meat importing countries), types of animals required by different clients (and importing countries), and alternative markets for sheep and goats in Nairobi.

A major challenge that came across repeatedly was terminal market price fluctuation. To investigate this, Kariobangi market's weekly price data were acquired from the Kenya Livestock Marketing Council (KLMC). The weekly prices for different grades of goats sold from March, 2014 to January, 2015 were collected by the KLMC data collectors. In all, 15,400 livestock sales were recorded over 135 market days. To further contextualize the information needs and constraints given by the traders and pastoralists, longer term price analysis was produced from these data.

Individual interviews and selected traders' meetings were audio recorded. Notes were taken during all interviews and eight were fully transcribed. A thematic coding scheme was developed with four categories relating to our research: activities, information needs, information sources and gaps. Each category further contains sub-codes. This coding framework was applied to transcripts revealing

patterns in the data using RQDA® qualitative data analysis software that allows sorting by code and by attributes such as type of trader.

4. Results

4.1. Information needs in sheep and goat supply chains

We identified market information needs based on the activities of multiple actors including pastoral producers and different categories of traders. Local traders were divided into three categories with diverse supply chain activities: i) itinerant traders (IT), purchase from villages or water points to sell at primary markets, ii) inter-market traders (IMT), purchase from primary markets and sell at a secondary market, and iii) long-distance traders (LDT), buy from primary and secondary markets to sell at the terminal market in Nairobi. Table 1 shows the percentage of responses to different information needs as symbolized by different sizes of squares under each actor category. Generally, the information needs of the actors vary by activity, with more diverse information needs expressed for selling than for buying. The types and frequency of information collected varied by the individual actor's location and their access to different market options.

Insert Table 1: Information needed by producers and traders

Producers tended to have little flexibility regarding the market place because they mostly sold at nearby markets. As they usually sold in small "trade volumes", transaction costs to travel to far away markets were relatively high. However, producers still benefitted from information about different markets, because they used it to improve their bargaining position when negotiating with traders. For example, producers who were not in need of immediate cash, used information about low prices to postpone sales. For producers who were in a position to sell many animals, better livestock marketing information helped them optimize sales when prices were highest.

For traders, familiarity with the market influenced the depth and frequency of information they collected. For example, at markets close-to-home, traders operate within a circle of regular sellers

and clients; hence, they purposefully collected information less regularly and not as intensively. As stated by an inter-market trader:

> *"I collect detailed information only when I start going to a new market but as soon as I become a regular trader there, I mostly go without asking much. I mean this information is only very necessary when you are new to a market and I do this to study the operation of the market and then I never ask unless I am worried" (SSI_IMT20).*

However, when the market occurred at farther distances, like in Nairobi, more details were sought because of the high investment required; an average of 4,000 - 5,000 Euros to buy and transport a truck-load of animals. Once in Nairobi, the animals needed to be sold quickly, even if at a loss, because there was no possibility of returning them and the longer they remained unsold the more their condition declined. Thus, long-distance traders had less influence over their sales and more risk than other types of local traders. Due to these differences, our results will cite more examples from long-distance traders. The different types of information required are elaborated in Table 1.

Information required for making a profit

Range of prices at the markets

In addition to the marketing costs, the trader's profit is influenced by the buying and selling prices of the animal. Therefore, all traders regularly enquired about the lowest and highest prices for every livestock grade at the primary, secondary and terminal markets, regardless of whether they planned to sell specific grade. Although most long-distance traders bought at the primary markets and seldom bought at the secondary market where prices were higher and competition stiffer, this information helped other traders to compare prices in different areas and to decide where to buy. All long-distance traders called the brokers at the terminal market in Nairobi before they started buying animals. The quote below reflects how they probed for price information:

> *"When I sell, I ask the broker about the prices of animals. I ask the prices from grade 1 to the last grade sold at Kariobangi… both the average price and the unit price" (SSI_LD31).*

By inquiring about prices for all grades, traders were able to: i) establish the threshold for buying prices, ii) identify the grade of animals to buy, and iii) evaluate the possible profit they might make from a trip.

The grades of animals in high demand

Long-distance traders regularly collected information on market demand, because the demand for sheep and goat at the Nairobi market strongly vacillated between grades. Although there are no formal grades for live sheep and goats, table 2 shows the description of the main grades that are commonly used in communication within the live sheep and goat chains.

Insert Table 2: Information about goats communicated between chain actors with informal grades

Traders enquired about the grades using market parlance about which goats were `released´, a term used to designate animals that sold quickly and at good prices.

> *"We ask which goats have been released today… sometimes you are told big goats or small and medium goats have been released…" (SSI_LD30).*

The Nairobi market ordinarily had two trading sessions each day; the early morning session was from 5-10 am, after which animals were grazed until trading resumed in the afternoon from 4-6pm. Traders enquired about the first trading session which was usually more vibrant and offered better prices.

Further livestock specifications

Breed[1] was an aspect of quality that affected the price and ultimately the profit margins of traders. Information about the breeds on offer was used by traders to assess potential sales and discern the type of animals to trade. As explained by an inter-local market trader, goats from neighbouring Samburu County made competition stiffer when they were sold at the secondary market:

[1] In this paper, we define breed as a specific group of livestock with definable external characteristics that enable its separation by visual appraisal from other similarly defined groups within the same species (FAO, 2000).

> *"I ask whether the goats from the Rift Valley are in the market, because they have bigger body sizes than our goats… They reduce the likelihood of our goats selling at better prices" (IMT_19).*

Within the producer region, this trader's quote shows that their goats were not the most preferred within southern Marsabit. However, at the terminal market, goats from all of Marsabit were highly preferred. This is emphasised by a long-distance trader, who explained the importance of knowing where other goats in the terminal market originate:

> *"We ask about different things, including which goats are in the market… The Galla goats are different from ours. So, if I am told a goat is selling at a specific price, I must ascertain its breed and origin" (NI_LD32).*

Galla goats, commonly reared by the Gabra and Borana pastoral communities, tended to fetch higher prices than the shorter Rendille goats because of their heavier weight and the market preference for their long and tall body.

Traders also enquired about livestock health[2] at primary markets or from the area of origin. A sick or weak animal was hard to sell and sometimes died in transit. As this contributed to losses incurred by traders, animal health became another factor in decision-making, as explained by a trader:

> *"I started buying from far away markets and many animals became Sirgo [heartwater disease] and died. So, for fear of buying from distant areas, I decided to buy from my home area since I know the owner and if I discover the animal is sick, I can return them to the owner" (NI_IMT19).*

Supply of animals at primary and secondary markets

To estimate the time it would take to buy a truck-load of animals, traders sought information on sheep and goat supply. Long-distance traders needed a minimum of 150 animals to fill a truck, which

[2] In this paper, by health we refer to the state of the animals expressed by body condition and in terms of being free from diseases

typically took from five days to two weeks. Additionally, low supply translated into higher buying prices. As explained by a trader:

> *"I enquire about the number of animals coming to the market, just to know how long it might take us to do the buying. If animals are few in the market, we can't meet our numbers to go to Nairobi and this is expensive" (SSI_LD33).*

Long-distance traders enquired about the supply information from the local broker or from the itinerant traders. For example:

> *"There is no other information we get apart from the itinerant traders who come from outside Korr. We ask if they have goats. But when we are not in a hurry to fill a truck, we just go directly to the market" (SSI_LD30).*

However, the actual number and grades of animals on sale at the primary markets could only be ascertained on the particular market day.

Competition

Generally, the number of traders at primary markets determined the extent of competition. Buying prices rose when traders were many, reducing their profit margins and the overall number of livestock a trader could buy. As stated by a long-distance trader:

> *"When we (traders) are many, the buying prices are bad and some days we buy at higher prices than what we are offered in Nairobi" (SSI_LD33).*

There was competition between traders who bought similar grades of animal. Producers sought information about traders who offered higher prices or bought a specific grade. The absence or presence of these traders was used as an indication of the level of competition and ultimately the buying prices of animals. As explained by a producer:

> *"We know all traders; we know those… who offer better prices. We ask which traders were present in the last market…. also some traders mainly buy big male goats while others buy mixed sizes…" (FN_P12).*

Prices at primary markets were also influenced by differences in traders' working capital and experience. For instance, when traders from outside the region competed with local traders, the livestock buying prices increased. These external traders were known to have relatively higher purchasing power than the local traders and often had more trading experience.

At the terminal market, the number of trucks delivering animals on the same day was used to assess a market as good or bad. Signalling a good market for traders, 3 - 5 truck-loads of goats delivered on a day to the terminal market was interpreted to mean that goat demand and prices were likely to be favourable because there was no oversupply. In contrast, 7 or more truck-loads were taken as an indication that the prices offered would not be as attractive.

If competition was high on arrival, it was uneconomical to wait for a better day, as additional days led to costs related to herding, watching over the animals, the trader's upkeep, and, as explained earlier, reduced prices.

4.2. Constraints to information flow in sheep and goat supply chains

Information flow in the supply chain was not considered by traders to be timely and accurate. In Table 3 we identify information gaps that hindered the flow of information along the chain.

Insert Table 3: Information gaps in sheep and goat supply chains

From the table we can distil that i) although traders repeatedly enquired about demand, supply and price information, the actual information could only be known on the market day, ii) there was a lack of information about the entire supply chain such that individual actors did not know the profit margins of other actors, and iii) traders missed opportunities without information on alternative markets. Constraints to information flow are described in the next section.

Information changes in a short time-span

The information about prices in sheep and goat markets oscillated quickly. To demonstrate this, we used an example of weekly price fluctuations for two grades of goats at the terminal market in Nairobi (Fig. 2). The price data shows that i) there was a large change in average prices with a 41%

and 73% and a for grade 1 and 4 respectively (coefficient of variation of 0.11 and 0.18); ii) there was no discernible pattern of high and low price periods corresponding to rainy and dry seasons in the production area, and iii) the direction of change was not parallel for the two grades e.g. in April when prices for grade 1 was fairly stable, the prices for grade 4 continued to fluctuate. So, when long-distance traders bought goats based on information about good prices the second week of August (7,000 Ksh) for grade 1 and were then ready to sell them in the terminal market in Nairobi the following week, prices had reduced to 5,300 Ksh. Further, autocorrelation coefficients were calculated to determine if there was a direct correlation between current prices and previous prices. The insignificant coefficients of the lags and the low slope parameter show that the lagged prices poorly predict current prices (See supplementary information, Table A.1). This example shows that traders were continuously subjected to fluctuating profits and even losses. This risk is captured by a quote from a trader.

> *"The first trip, when I sold 18 he-goats, I made a profit of 10,000 shillings but in the second trip I lost 20,000 shillings… So, three out of six last trips, I made losses and in the most recent trip, I got profit of 15,000 shillings. Some trips we just sell animals at our buying prices" (NI_LD34).*

This shows the risks faced by traders. On average, long-distance traders made a profit of 250-300 Ksh per animal and the price variation of up to 2,000 Ksh obviously translated into substantial losses.

Insert Figure 2: Weekly price variation at Kariobangi terminal market, Nairobi

There is high variability in goat prices between each week, 2013 - 2015 (See supplementary information, Figure A.1). The prices usually changed with the level of competition among buyers, the number of animals supplied, the breeds and body condition of the animals on offer.

The demand for different grades of goats at the terminal market was highly dynamic. Traders usually called brokers and responded to demand they specified. However, by the time they had accomplished the tasks required to gather the number of animals of each grade, the prior

information was outdated and instead other grades of goats were on demand. This challenge was underscored by a long-distance trader who stated that:

> *"We always talk to the broker in Nairobi, but it does not work… in our last trip to Nairobi, we found that old female goats were on demand, the ones we usually buy at less than 1,000 shilling were selling at 2,500. Unfortunately we had just four of them" (SSI_LD34).*

The above quote offers an illustration of the practical difficulty experienced by long-distance traders to capitalize on demand information.

The actual supply and demand is only known on transaction day

Long-distance traders had no contract with clients such as processors and meat wholesalers in Nairobi to guarantee the grades and prices of goats to be delivered. The supply and demand of animals in the terminal market, and hence the price, were only known when traders arrived at the market. In this chain, the main challenge is the distance from the terminal market together with the period of time needed to gather the required animals from remote areas. In such a situation, traders would continuously call brokers for updates and occasionally based their judgment on their most recent trip or on experiences shared by other traders. Sometimes long-distance traders would catch a vibrant market in which a specific grade of animal was 'sold faster' and at a higher price. They would then base their next purchase on this past favourable market to procure the grades that corresponded with that day. Such a strategy based on experience of a previous market was found to be costly, as described by a long-distance trader:

> *"Our business is stressful… I might buy big goats based on the last demand and when I go to the market, I realize that these goats are not needed. Instead, small ones are in high demand. Again, we all focus on the small goats with every trader delivering them to the market, making the prices low" (NI_LD36).*

Although traders committed considerable capital to get the 'required' goats, these were not in demand when they arrived at the terminal market. As the actual demand was unknown until the market day, traders experienced reduced margins and even losses.

Factors affecting the time needed to respond to positive market information

There are different reasons why long-distance traders could not react quickly to favourable market information. First, they needed time to buy enough sheep and goats to fill a truck to transport to the terminal market, especially when competition between traders was high at primary markets. Once traders set off on this journey, the initial information they had about the terminal market was usually no longer valid. This is explained by a long-distance trader:

> *"We speak to the broker in Nairobi but always it does not work because we can get information on the prices, the sizes on demand that day but by the time we are ready to travel, the initial information we got is not wholly the same as the current one… we ask about prices and demand but it's not fully useful, we just do it to avoid travelling blindly" (SSI_LD34).*

Secondly, to transport animals to the terminal market, traders needed to hire a truck. However, its availability depended on the truck owner's other business. Additionally, when transport fees were high, traders might also wait for a less expensive truck to become available. As explained by a long-distance trader:

> *"Some vehicle owners have a lot of commitment and they have choice to put their vehicle on another route. Sometimes when the owner doesn't want his car to come to Korr, he raises the fee to unreasonable amount…" (SSI_LD33).*

Thirdly, when the specific grades needed were not offered at primary markets, traders took more time to fill a truck. As a long-distance trader explained:

> *"Sometimes we get information about specific sizes of goats that can fetch better prices but - these sizes are mostly not sold by producers, hence buying them takes a longer time" (SSI_LD35).*

In such a situation, traders could only buy in small numbers, thus extending their response time. Meanwhile, during this time, they ran increased risk that the demand period would lapse, annulling the information that they were acting on.

4.3. Bridging information gaps

Traders bridge information gaps through different strategies specified below.

Regular information exchange with brokers

All long-distance traders confirmed that brokers played a central role in sharing terminal market information. As explained earlier, although it was highly probable that this information would not hold until they arrived, they maintained communication with brokers - before buying, when booking the truck, the day prior to traveling and during transit.

This continuous communication with the broker helped them get the best possible information under the circumstances. Nonetheless, this frequent exchange between traders and brokers did not guarantee that the same information would prevail when traders delivered animals to the market.

> *"It's hard. Recently, I was told by a colleague in the market that the smallest size is fast moving. I bought them in high number and travelled in a record three days, but on arrival I found that the demand condition had completely changed" (SSI_LD35).*

Delayed sales

Both producers and traders could, to some extent, postpone their sales when prices were low. Producers (mostly wealthy ones with less immediate demand for cash) temporarily delayed sales; for

example they might present an animal in the market and return it to the herd when prices were not favourable.

When information on demand, price or any other condition was reported as unfavourable by the broker, long-distance traders postponed embarking on the journey to the terminal market.

> *"Two things are extremely crucial, the prices and security at the market. When responses on the two are bad, we don't travel" (SSI_LD31).*

From the interviews, we established that this was a common strategy among long-distance traders because once they left the production area, the costs for postponing sales became unreasonable. Until a broker advised them of a good time to depart, they were inclined to stay in the production area.

Selling on the way

To improve their position in the face of information gaps, long-distance traders would sell sheep and goats along the highway at Karatina town and at the Embu-Nairobi highway junction (Makutano). However, few traders could fulfil this strategy because roadside sales were irregular and the first trucks to start the journey from Marsabit usually seized the opportunities. For this type of roadside transaction, traders with grade 1 goats or big rams had better chances. A long-distance trader shared insight on this market:

> *"There are many traders with butcheries in surrounding smaller towns. The majority… are buying mostly for slaughter. So they choose the animals they want in the truck" (SSI_LD33).*

Although the number of animals sold this way was usually low, traders preferred this market because prices were higher compared to the terminal market. They perceived it as reducing the risk of the overall trip, because some of their animals were already sold at a good price before reaching the terminal market.

Mixed delivery

All long-distance traders transported a combination of animal grades in an attempt to mitigate the risk of uncertain or contradictory information about terminal market demand. Delivering mixed grades was perceived as a way of balancing fortunes because of the demand unpredictability. As expressed by a long-distance trader, they chose this strategy to reduce their risk:

> *"Sometimes you are told big goats or small and medium goats have been released… you cannot be certain. I won't leave the Ilmole [small immature sizes], even though they might have lower prices" (SSI_LD30).*

Because of the smaller body size, many *Ilmole*[3] could be carried in a truck. While this was an important strategy to minimize risk and possible economic losses, it also limited the potential for profit because traders could not fully match their supply with what was demanded. The parallel price movement between grades (See ssupplementary information, Table A.2) shows insignificant interaction term between grade and time, hence confirms narrow price spread among the grades.

Multiple sources of information

To get diverse opinions, traders sought information from different sources other than just the brokers. This included personal visits to the market (primary and secondary markets), engaging relatives living closer to the market and contacting other traders. A trader gave the following example:

> *"I deal with two people based in Nairobi, my broker and my son in-law… I send my son in-law to get an alternative view on the market. I send him to the market to go see all grades sold on that day and brief me on their prices" (SSI_LD34).*

Additionally, some long-distance traders drew on reciprocity with other Marsabit County traders from Gabra, Borana, Turkana and Samburu ethnic groups. As stated by a trader:

[3] A common name given to 9-15 months old male or female goats

> *"Mobile phone has helped us so much… I even have the telephone numbers of traders in Nairobi… so if I find that Korr traders have not been to the market, I next call the trader in Merille and finally those in Kariobangi market. If I don't get information from one, I try the next" (SSI_IMT20).*

According to long-distance traders from southern Marsabit, such relations with other traders increased their chances of getting information from each other rather than relying only on brokers.

Establish relations with clients at the secondary market

Inter-market traders with more business experience established preferential contacts with regular clients who came from Nairobi, Isiolo and Meru to buy at the secondary market. They called these clients ahead of market days to know their demand preferences, provisional prices and also to compare offers from different clients. As expressed by an inter-market trader:

> *"For different sizes of animals I buy, I have someone to buy from me… that small one there, I have a ready customer waiting for it, including for the big ones. Now, I have even advanced, I have two customers for these small sizes and they know I will bring a specific number of goats to next market" (SSI_IMT20).*

The inter-market traders had an advantage over the long-distance traders because their clients came to them at the secondary market with the goal of leaving on the same day. Therefore, by virtue of being able to sell a higher number of animals, they had first priority from these clients. However, the actual prices could only be agreed on the market day.

5. Discussion and policy implications

5.1. Information needs and constraints

Our study explores information needs and constraints of producers and local traders and additionally provides insights on the price discovery process in pastoral sheep and goat supply chains. Currently, the terminal market is organized as a spot market with no pre-agreed arrangements. The absence of

formal contracts (Mahmoud, 2008, p. 573; Williams and Okike, 2007) specifying prices and spelling out the terms of agreement, meant that traders relied on existing social networks for price discovery. The traders' information needs to fulfil their role in the chain are extensive. They need information on prices, specifications of animals in high demand, information on supply (i.e. number and location of producers with different types of animals on offer), and competition (number and capacity of competing traders) as this influences buying and selling prices.

The results show that the process through which traders learn about prices follows the typical price discovery process. Price discovery "is the process of buyers and sellers arriving at a transaction price for a given quality and quantity of a product at a given time and place" (Ward and Schroeder 2002, p. 1). However, in this particular context, we demonstrate that getting relevant information to make this process less precarious is very challenging for local traders and pastoralists. For example, Ward, (1984) specifies that price discovery in the livestock market must first be informed by the supply and demand conditions to determine (implicitly or explicitly) the general level of expected prices, while considering the costs and expected profits to establish the range within which the transaction prices will likely fluctuate. However, local traders and pastoralists only have limited information at the time that they are negotiating. Further, Ward (1984) states that in livestock markets, buyers and sellers must further consider the value of the animal with regard to its size, grade and weight among other factors. However, as of 2017, there are no grades given for live sheep and goats by the Kenya Bureau of Standard or Kenya Meat Commission. Instead, the traders and producers apply *de facto* informal criteria in the market, similar to those used for beef (Alarcon et al., 2017, p. 152). The absence of formal grading system limits the ability of that local traders and livestock producers to take advantages inherent in different quality of animals to realize higher income.

Our analysis has also shown that the prices have high fluctuations by grade further confirming local traders' complaint that it is unpredictable. Long-distance traders connecting Marsabit County to Nairobi especially need relevant information on prices at the terminal market because each trip involves significant investment. Once delivered, the animals must be sold, even at a loss because

there is no possibility of returning them to the production area; hence long-distance traders have less negotiating power when selling. The influence of distance is significant for traders from Marsabit when compared, for example, with traders from Kajiado which is closer to Nairobi. Even in the late nineties, traders from this pastoral region were able to create preferential trading agreements and use refrigerated trucks (Zaal and Ton, 1999). Local traders from southern Marsabit are replaceable in their relationship to the Nairobi-based broker who can easily get goats from other parts of Kenya and even Tanzania.

Long-distance traders were particularly challenged by the fluctuating prices at the terminal market and the constant change in supply and demand that created high risks for them when they chose to act on information received from the terminal market. At first glance, this matches with findings from previous studies (Jama et al., 2006; Komen, 2010) which underlined the limited utility of market information caused by delays between when information was gathered, organized and transmitted and the time of sale. However, our findings establish that even when information was transmitted without delay; it rapidly became irrelevant because of the dynamic market.

Contrary to other research (Barrett et al., 2003; Barrett and Luseno, 2004), we did not find that price fluctuations were driven by seasonal variation. At the terminal market, sheep and goat prices vacillated between market days and were influenced by factors like the level of competition among buyers, supply of animals, breeds, and animals' body condition. As a result, we found that the 'real' prices were only known on the transaction day. This impaired the ability of traders to make well-informed buying and selling decisions (Jama et al., 2006) because, for example, the information that triggered animal purchases (e.g. high demand for a specific type of goats or high prices) was no longer relevant upon arrival. With the high price fluctuations at the terminal market, long-distance traders faced diminished profits and even risked losses. To deal with the demand uncertainty, traders used various strategies to cope with the information gaps such as purchasing different categories of animals. Although these strategies helped to reduce losses, they also limited potential profits. For

local traders with relatively low capital, the high uncertainty of the spot market made it difficult for many of them to sustain their small-scale businesses without additional buffer.

In our results, the quality and flow of information experienced by local traders was hampered by their lack of connection to clients with clearly defined demand specifications. For example, there was no link between the long-distance traders and buyers at the terminal market; instead, they relied on brokers who sold animals on their behalf (Roba et al., 2017). As expressed by (Pavanello, 2010, p. 18; Teklewold et al., 2008, p. 42), brokers are essential for facilitating information flow from the terminal market to traders at the primary markets. However, we observed that the dominant position of these brokers simultaneously excludes traders from accessing first-hand market information from buyers. This means that even when they continually seek information about the market, that they are not structurally in a position to have more control. This links to what Frenzen and Nakamoto (1993) said about how "macro-level" structures connecting actors influence information flow.

Lack of knowledge about buyers' preferences for animal qualities and the level of livestock supply and demand, as also indicated by (Williams and Okike, 2007) caused livestock producers and traders from our study region to miss opportunities for higher prices. Consequently, traders were unsure what prices they could attain, and whether they would make a profit or a loss. Hence, they were not in a position to offer higher prices to pastoral producers. This points to how the unequal distribution of power (Emerson, 1976) within the supply chain affects the livelihoods of those in pastoral regions.

5.2. Practical implications for policy and projects

Addressing the challenges identified in our study requires building new relations that fulfil the information needs of producers and local traders. We reviewed some options including information and communication technology (ICT), group marketing, product branding, and livestock auctions that potentially shift relations shaping information flow. Although this example is focused on Kenya, this process is relevant for policy that aims to support livelihoods in pastoral regions more generally.

ICT-based market information services have frequently been promoted as a solution for connecting smallholders with sellers and buyers. In Kenya, mobile phones have become widespread among even

remote rural communities, hence ICT technologies have become a realistic option (Wyche and Steinfield, 2016) For example, ICT connections have been used to connect input suppliers and smallholder farmers to ensure seed distribution (Ogutu et al., 2014). However, technology alone cannot solve the problem without social context. With lessons from rural Zambia, Milligan et al. (2011) demonstrate how new relations between farmers and urban buyers were built by establishing an interactive SMS platform to offer information on commodity characteristics, prices and buyer contacts. This has only recently become an option in Northern Kenya as mobile service, including internet, has only been available, for example in Korr in the study region, since mid-2015.

Group marketing that combines the efforts of multiple long-distance traders to aggregate a higher number of animals position them to attract buyers with whom they could pre-establish prices for a specific quantity and quality of goats. The incentive for meat processors, importers and wholesalers would be a guaranteed supply at a specified time; that could potentially reduce their overall procurement costs. These long-distance traders could ensure consistent supplies through arrangements with pastoral producer groups and possibly inter-local market traders. This would be a necessary step to diversify from the current spot market.

Product branding has the potential to enable a shift from an undifferentiated commodity market to a niche market. Establishing a process to ensure the traceability of sheep and goats from pastoral areas could benefit actors from Marsabit, because their goats are already preferred. Previous assessments of labelling and branding goat and sheep meat established the following producer advantages: i) comparatively more income than from the mass market (Mathias et al., 2010), ii) better decision-making conditions to optimize profits from preferred animals (Imami et al., 2011). However, this requires policy attention to establish reputable enforcement systems for traceability.

Lastly, livestock auctions could be a mechanism for drawing in new actors to pastoral regions. Evaluations of livestock auctions reveal a number of benefits for both buyers and sellers (Green et al.,

2006; Robinson and Christley, 2007; Williams, 1993). Three benefits have been consistently highlighted: i) higher prices resulting from competitive bidding, ii) improved information flow and price accuracy, and iii) increased number of potential buyers, including processors. In Kenya, auctions were previously organized by the government between 1946 and the early 1980s (Kerven, 1992). Although the numbers transacted were generally low because of the quota set by the Kenya Meat Commission (KMC), auction sales gave pastoralist producers an alternative option for price discovery in the absence of established primary markets. However, this was abolished when the livestock market was liberalized. This weakened coordination between buyers and sellers and also shifted structural relations between diverse actors belonging to different ethnicities and classes. This liberalization was associated with few actors having the power to connect to terminal market clients, the reverberations of which are still ongoing.

6. Conclusion

This study reveals the information needs of different actors in pastoral sheep and goat supply chains, in which livestock are mainly traded in spot markets. It shows that long-distance traders had the highest information needs because of decisions related to activities to reach the terminal market were beset with unpredictability. However the organization of structural relations that influenced information flow within the chain made obtaining accurate information practically impossible. As terminal market prices fluctuated with no recognizable pattern, classical market information systems were of limited use since they cannot reliably forecast market trends in such a situation. Thus, the profit margin of long-distance traders depended almost entirely on chance.

Based on these findings, it is necessary to recognize the central role of long-distance traders and support their business through respective policies. We recommend that future research and development efforts to focus on options for improving the structural relations between chain actors. Policy and programs that only connect pastoralists to the market without addressing how they are connected to the market will miss the mark. The aim is to strengthen relations that structure

information exchange to minimize information asymmetry. In doing so, the producers and traders can make marketing decisions to earn better prices and improve their margins. That requires trust building and improving relations that facilitate fulfilling information needs of producers and traders.

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