

Analysis of camel milk value chain in the pastoral areas of eastern Ethiopia

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Abstract

This study was conducted to analyze camel milk value chain with the aim of characterizing the chain actors and their roles, pinpoint value chain constraints and opportunities and finally suggest interventions required for improving the performance of camel milk subsector in the pastoral areas of eastern Ethiopia. A total of three hundred fifteen key informants were interviewed using a structured questionnaire. Moreover, concerned organizations and institutions were accessed and available relevant documents have been searched to gather supplementary secondary information. The value chain analysis revealed that the major value chain actors are input suppliers, pastoral producers, rural and urban assemblers, wholesalers, milk market cooperative, privet processor, retailers and consumers. In spite of the existence of a substantial potential, the camel milk subsector do not make a considerable contribution to the livelihood of the pastoral communities due to production and marketing constraints. Furthermore, inefficient marketing systems coupled with poor linkages among the concerned stakeholders conspire to limit growth of subsector. Meanwhile, high demand and expanding exports directly to the relatively wealthy Middle East markets are major opportunities. It is, therefore, very important that all the constraints identified in this study need to be carefully considered and addressed. The study further suggests that, coordination and intervention strategies should be designed and applied across the entire value chain in order to develop the subsector.

Keywords: Camel milk value chain, chain actors, constraints, Ethiopia, opportunities

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Introduction

Camels can provide a useful addition to the economy and food security in terms of milk, meat and other products to the pastoral communities. In the context of advancing urbanization, camel milk is increasingly commercialized and consumed in urban areas. Indication from previous research has proved that camel milk production and marketing makes a considerable contribution to local and national economies as well as to individual livelihoods in the pastoral areas of Ethiopia (Kebede *et al.*, 2015; Galma, 2015) and also good potential for market oriented camel dairy developments (Faye *et al.*, 2014). Camel milk industry has a lot of potential for growth to improve the livelihoods and economic status of pastoral communities (CARE Kenya, 2009).

On the other side, the strong seasonality that characterizes pastoral environments has a specific impact on the functioning of the camel milk subsector. While camel physiology allows for milk production even during the dry and drought season, overall milk supply is lower. At the same time during long dry seasons herders are forced to trek long distance in search of feed and water (Land O'Lakes, 2010), thus further from communication and transport networks. Likewise, far distances, harsher climatic conditions, lack of cooling and storage facilities at milk vending sites, inappropriate handling of milk and storage vessels were some of the constraints that affect consistent and sustainable good quality supply (Farah *et al.*, 2007; Noor *et al.*, 2013). Indeed, the reduction in milk supply combined with other factors affects the whole chain.

Though, such information provides useful insights towards the designing and

implementation of strategies to alleviate the constraints of camel milk subsector. Yet, such type of information is currently unavailable or inadequate at best in the pastoral areas of eastern Ethiopia. This, therefore, demanded the need for employing comprehensive system assessment tools like value chain framework to diagnose the whole segments of the chain and propose holistic intervention strategies (Kaplinsky and Morris, 2001). Besides, it is now widely accepted that technological interventions are integrated with other complementary innervations that when trickled down in a piecemeal manner.

Furthermore, to date there is lack of information concerning how the camel milk value chain works coupled with lack of systematically documented knowledge in the pastoral areas of eastern Ethiopia in particular, and the country at large. The lack of relevant and up-to-date information on the camel milk value chain in the study areas and the country means it has received little attention from both government and researchers. The lack of research and policy attention is part of the reason for the lack of investment in measures to address the problems of subsector. Thus, investigation of the camel milk value chain in the pastoral areas of eastern Ethiopia will help to identify possible entry points for intervention and designing appropriate policies that would enhancing to the development of the subsector. This study was, therefore, aimed at mapping camel milk value chain by identifying value chain actors, their roles and linkages. It was further endeavored to assess the constraints that embedded in the chains and to be able to suggest realistic value chain improvement strategies and opportunities.

Method

Description of the study areas

Somali Region is the second-largest region in Ethiopia and covers 350,000 km². The region has 9 administrative zones, 68 *woredas* (districts), and 786 *kebeles* (wards) (BoFED, 2014). The study covers Fafan and Siti Zones, with a population of 800,000, of which 70 percent live in rural households, manage livestock herds, and can be considered as pastoralists. Fafan and Siti zones are characterized by unreliable and erratic rainfall with a precipitation ranging from 400 to 800 mm per annum, high ambient temperature (>30°C), sparsely distributed vegetation dominated by *Cactus*, *Acacia* species and bushy woodlands (Bekele, 2001).

Sampling strategy and procedures

A three stage sampling procedure was used to collect primary data from camel milk producers. In the first stage, out of nine administration zones of Somali Regional State, Fafan and Siti zone were purposively selected for this study due to their high potential in camel milk production as well as marketing of camel milk. In addition, camel milk from two zones passes distant marketing channels up to the central Ethiopia and neighboring countries. In the second stage, based on the presence of sufficient camel herds, accessibility of the rural Kebele and necessity to obtain consent of the herd owners in accessing their herds to collaborate in the study, five districts out of 13 i.e., Gursum, Jijiga and Kebribeyah districts from Fafan zone and Shinile and Errer district from Siti zone were selected randomly. In the third stage, 100 households were selected from 11 rural kebele (RKs) in the Fafan site and 60

households were selected from 7 RKs in the Siti site. In addition to pastoral producers, sample respondents were also selected from the other value chain actors on the basis of their size and availability and interviewed based on their respective functions in the chain. By preparing checklist, 18 rural and urban assemblers, 4 wholesalers, 55 retailers and 113 consumers were selected using random sampling techniques. Furthermore, one private camel milk processor, one exporter and 4 milk market cooperatives were also included in the study.

Types and methods of data collection

Two cross-sectional surveys (key-informant survey) were carried from October 2015 to September 2016 using a single-visit multiple-response survey method (ILCA, 1990) in order to understand and describe the camel milk value chain and the various actors involved in the value chain. Separate semi-structured questionnaires were developed and administered to the different actors. In addition to the primary data generated through survey, secondary data was collected from reports published about the study areas and through consultation of concerned individuals in public institutions. The questionnaire mainly included open-ended questions on number of camel, amount of camel milk produced, amount of camel milk consumed and sold, milk collection; transportation and storage; milk marketing and market outlets for milk; input supply; service provision; constraints to milk production and marketing; and opportunities for camel milk development.

Statistical analysis

The survey responses were summarized into groups and given codes before entering into computer. Descriptive statistics was used to analyze the data using SPSS software version 20.0. In addition, value chain analysis approach was used to describe actors' activities and their roles.

Results and Discussion

Household and socioeconomic characteristics of pastoral producers

The average family size pooled across the two sites was 9.5 ± 3.76 . The family size obtained in the present study is within the range of what has been reported by Baars (2000) in the pastoral areas of eastern Ethiopia. The average age was 45 and 79 percent had no education at all. The low level of education in the study areas might impede technology transfer and access to vital production services. Therefore, government and pastoral area development partners must create awareness about the importance of education and efforts must be made to strengthen formal and pastoralists based education.

Camel ownership

Average number of camel, female camels, male camels and lactating camels per household are indicated in Table 1. Female camels are the core of the herd in the study areas since the main livelihood of the Somali pastoralists mainly depending on camel milk production. The dominance of camel herd by high percentage of female camels in this study is similar to the result reported in studies conducted by (Eyassu, 2009; Yosef *et al.*, 2014).

Lactation performance of camel

The estimated milk yield performance during wet and dry season and lactation length of camels are indicated in Table 2. The milk yield obtained from this study indicates that camel milk is an important source of protein and its value to the pastoral communities. The quantity of milk produced by camels is well suited to meet the milk requirements of pastoral and supply to the market, if managed bred, veterinary services, fed and water properly (Dereje and Ud'en, 2005; Megersa *et al.*, 2008; Eyasu, 2009; Faye *et al.*, 2014).

Table 1. Average number of camel, female camels, male camels and lactating camels in Fafan and Siti zone eastern Ethiopia

Variables	Fafan (N=100)	Siti (N=60)	Overall (N=160)
Number of camels	$32.15 \pm (1.69)$	$24.7 \pm (0.98)$	$29.36 \pm (1.16)$
Female camels	$23.57 \pm (1.29)$	$19.18 \pm (0.90)$	$21.93 \pm (0.89)$
Male camels	$8.58 \pm (0.50)$	$5.52 \pm (0.18)$	$7.43 \pm (0.34)$
Lactating camels	$5.74 \pm (0.22)$	$4.20 \pm (0.28)$	$5.16 \pm (0.18)$

N=sample size, Figures in parenthesis indicate standard error. Source: Survey result, 2015/16

Table 2. Milk yield performance during wet and dry season and lactation length of camels in Fafan and Siti zone eastern Ethiopia

Variables	Fafan (N=100)	Siti (N=60)	Over all (N=160)
Milk yield wet season (Li)	5.85± (0.21)	3.33± (0.14)	4.90± (0.17)
Milk yield dry season (Li)	4.13± (0.18)	2.78± (0.13)	3.62± (0.13)
Lactation length (month)	14.31±(0.46)	12.65±(0.35)	13.69±(0.32)

N=sample size, Li=liters, Figures in parenthesis indicate standard error. Source: Survey result, 2015/16

Pastoral producers access to institutional support services

Access to extension service

Across Somali Region, information on animal production has been delivered to pastoralists through the extension service of the Bureau of Agriculture (BoA) through 548 animal health posts, 32 animal clinics, and 1,040 health technicians and animal health assistants (BoFED, 2014). However, only 29 % from Fafan and 15 % from Siti respondents report receiving camel extension service. Furthermore, respondent producers reported to receive inadequate preventive as well as control measures against camel diseases and parasites. In all study areas, vaccination against major diseases such as trypanosomiasis, anthrax, camel respiratory syndrome, brucellosis, camel pox, internal and external parasite infestation, mastitis, and neck wry are reportedly practiced by only less than 44 percent of the respondents. To overcome the disease problem, there is an urgent need to improve animal health services, through recruitment of qualified personnel and establishment of veterinary diagnostic facilities and strengthen the use of community-based animal health workers (CAHWs).

Access to credit facilities

Almost all pastoral producers interviewed indicated that credit service was not available, but their financial requirement was met from informal money lenders and relatives with and without interest. Furthermore, participants in FGD disclosed that there was no available commercial bank near to their villages, however, few rural micro finances were started to give loan but they are less willing of deal with poor without collateral. Thus, increasing the dimension of access to credit and forming well functioning formal rural financial systems that are responsive to the needs of pastoral producers need immediate attention. Pastoralists who get credit from different sources can improve financial capacity to purchase inputs, thereby increasing camel milk production and milk market participation.

Access to market information

Regarding to access to market information about 61% and 12% of pastoral producers from Fafan and Siti zone, respectively, indicated that they had access to local market information. The sources of information were mostly informal, from other fellow pastoralists (68.2%), traders (16.5%), personal observation (10.6%), and government extension agents (4.7%). Access to market information has a significant

positive effect on market participation and the quantity of milk supplied. Desta *et al.* (2006) find that assistance in basic education, information, and market relationships, increases pastoralists' livestock sales for export.

Milk production, consumption and sale

Regarding the total quantities of milk produced, consumed and sold per week/household (Table 3). A relatively large proportion of camel milk produced in Siti is consumed at home. This can be associated with the low entrepreneurial character of the pastoral producers in Siti. This situation can also be linked to the fact that the larger proportion of households at Siti was engaged in pastoral ways of life and none of them considered income derived from camel milk as a sole source of livelihood. Other likely reasons can be the poor road infrastructure and poor marketing infrastructure, which hindered the inclination of selling camel milk.

Analyses of the marketing characteristics of camel milk from Fafan area revealed that in the wet season a litre of fresh raw camel milk was sold at about six birr (equivalent to US\$0.3) and in the dry season a litre of fresh raw camel milk was increases up to ten birr (equivalent to US\$0.5). This was about eight times lower than the price of processed milk sold at 50 birr (equivalent to US\$2.5) in Jijiga, Harar and Dire Dawa urban markets. In Jijiga, Harar and Dire Dawa, processed camel milk is usually sold at up-market outlets to consumers who value hygienic quality and are also ready to pay more for the better quality. The bulk of the camel milk leaving from Fafan area to Jijiga urban markets was fresh raw milk. Neither the producers nor the milk market cooperative was value adding. Appropriate value addition to camel milk would potentially enhance pastoral incomes, reduce postharvest losses, remove market barriers related to quality and safety standards and expand market access (Faye1 et al., 2014).

Table 3. Total quantity of milk produced, consumed and sold per week per household (hh) in Fafan and Siti zones of eastern Ethiopia

Raw milk	Fafan zone		Siti zone		Overall mean	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
Quantity produced (Litre/week/hh)	236.25	167.1	98.7	78.75	184.66	133.98
Quantity home consumed (Litre/week /hh)	44.37	56.75	57.35	43.69	50.86	50.22
Quantity home consumed (Litre/week /capita)	0.042	0.053	0.13	0.097	0.039	0.033
Quantity sold (Litre/week/hh)	191.88	110.54	41.39	35.1	116.64	72.82
Proportions						
Proportion of milk consumed (%)	18.78	33.96	58.1	55.48	38.44	44.72
Proportion of milk sold (%)	81.22	66.15	41.93	44.52	61.58	55.34

Profile of other value chain actors

The survey result indicates that the sampled traders were on average 35 years old. Family size differs across the marketing agents and the average family members were 8.5. Traders had 8 years of experience on the average. About, 97.5% of the sample traders were female while 2.5% of them are male. Concerning the educational level, 88% of the sample traders did not go through formal education while only 10% and 2% of the respondents attained primary and secondary education, respectively.

Camel milk value chain mapping

A generic schematic diagram representing camel milk value chain in the pastoral areas of eastern Ethiopia is presented in Figure 1. Except one private processor at Fafan site, the main value chain segments identified were input supply, production, marketing (distribution), processing and consumption. The key actors along the chain include input suppliers, service providers, pastoral and Agro-pastoral camel milk producers, village collectors, milk market cooperatives, private processing industry, wholesalers, retailers, exporter and consumers.

Under the input supply segment, inputs like veterinary drugs, mineral salts and milking equipments were supplied to camel milk value chain actors. The main supporters of the camel milk value chain in the study areas are Bureau of Livestock and Pastoralist Development (BoLPD), Bureau of Agriculture and Natural Resource Development (BoANRD), Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI), Jijiga University, Haramaya University, Oxfam, Mercy Corps, Aged Children Pastoralist Association (ACPA)

marketing and cooperative development, Bureau of Trade and Industry, Micro finance and banks. On the other hand, service provision by private actors was rather limited in scope and space across the study areas.

Pastoral and Agro-pastoral producers were the first link actors of the chain, who carry out production and supply their milk to collectors on business transaction or kinship base. On top of that, some pastoralists and Agro-pastoralists also sold their camel milk directly to consumers in near by district town or on the highway and on the roadsides. As far as the share is concerned, producers sold 29.86 % to the milk market cooperative, 25.65 % to collectors, 15.19% to wholesalers, 15.07% to retailers, 5.35 % to exporter, and 8.88% to consumers. Nevertheless, pastoral and Agro-pastoral producers lack the required technological, organizational as well as institutional capacity and they were poorly organized and distant from market outlets. They also lack economies of scale and institutional setups for risk management and face higher transaction costs.

The next stage of camel milk value chain was the bulking stage. Two groups of bulking normally operate in this stage. These include rural and urban assemblers and milk market cooperatives. Functions along the value chain for these groups comprise bulking of camel milk and transporting the camel milk to the next market chain. Moreover, camel milk market cooperatives were involved in the milk chain in two ways. First, they produced small quantities of milk. Second, they collected milk from neighboring producers and then delivered it to 53.39%, 12.18% and 34.43% private camel milk processing industry, exporter and retailers, respectively.

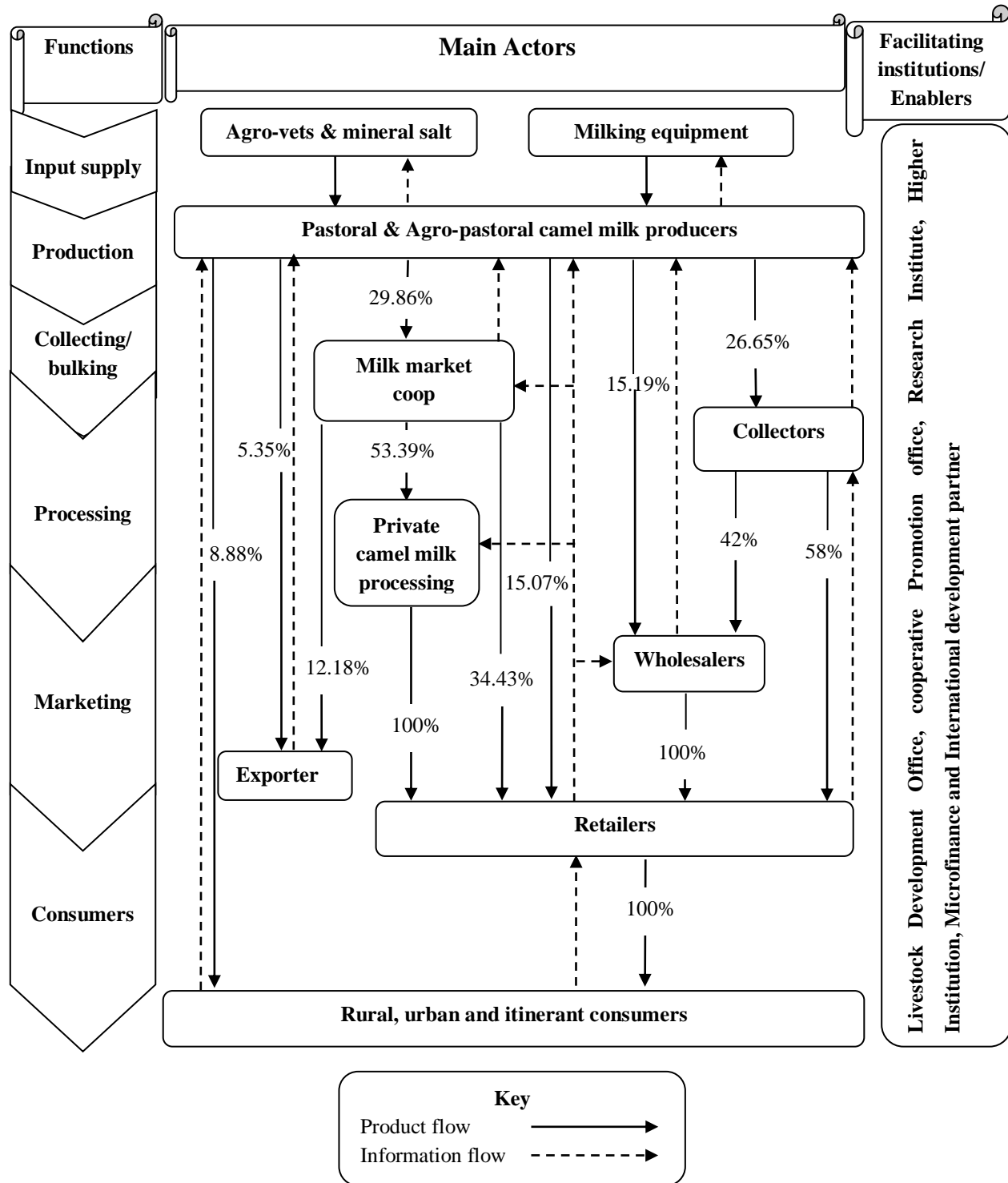


Figure 1. Camel milk value chain in pastoral areas of Easter Ethiopia
 Source: By authors based on information gathered from the field study

Similarly, collectors sold 42% of the milk to wholesalers and the remaining 58% to retailers. The most common mode of transportation under this category was donkey, camel, human labor and to urban market by vehicles.

Private camel milk processors (*Berwaqo*) is the only company which is selling processed camel milk. The plant is funded by USAID PRIME and supported by Mercy Corps. The overall the processing capacity is 15000 litres; however, at this stage, they are processing maximum around 2500 litres only with a high variability. In dry season, the production reduces to 300 litres per day. After the processing, the milk is mainly sold in 0.5 litre bottles in to retailers in Jijiga but also to distributors in Dire Dawa, Harar and Bole Michael in Addis Ababa (where large number of Somali live). Besides these local markets it has targeted *Hargessa*; Somali land and Djebuti.

Wholesalers are also the main actors in camel milk value chain and they are involved in buying raw milk from collectors (42%) and pastoral producers (15.20%) for further dispatching of the product to retailers. Though the product is highly perishable, wholesalers do not have proper storage and transport facilities.

On the other hand, retailers on different selling sites sell milk directly to consumers in small volumes, having bought larger volumes from pastoral producers (15.07%), milk market cooperative (34.43%), wholesalers (100%), collectors (58%) and private camel milk processing industry (100%). Some of the retailers sell milk open containers with poor sanitation, and most of the time they expose the milk to high temperature, which leads to rapid quality loss of the milk.

Consumers were mostly individual households, city and town dwellers, restaurants, cafeterias, universities, refugee camps and drivers on the highway.

Exporter: who reside in jigjiga and export camel milk to *wachale* legally. They have one retailer/distributor in Somali-land and send the milk to *Hargaisa*. They collect and transport the milk by their own Isuzu truck. They collect (5.35%) from pastoral producers and (12.18%) from milk market cooperative and export to *wochale*.

Beyond the evident informal linkages between pastoral producers and traders, the overall institutional linkage was weak and non-hierarchical (Faye *et al.*, 2014). Further, coalition between various policy and support actors was not strong and their efforts were not well aligned. Generally, this resulting in poor complementarily and inefficient use of available development resources in camel milk subsector.

Coverage and quality of support services need to be improved; private provision of services needs to be developed and pluralistic service provision in camel milk value chain actors should be coordinated. Development of sustainable camel milk value chain equally depends on the existence of a vibrant private sector capable of providing the essential input and support services. This implies, in addition to the creation of enabling policies, laws and regulatory environment for private service delivery, public support for private service development is vital (Tesfaye *et al.*, 2010). This is because often market alone fails to allocate resources such as capital, skills and technological development to private sector and to ensure effective coordination within a sector (Kurokawa *et al.*, 2008). Thus, futile linkage was evident among supporting

institutions, which is the main feature of camel milk value chain in pastoral areas of eastern Ethiopia. Even the former linkage was mainly based on win-lose situation and, therefore, it also requires institutional reform for innovation. Further, key actors should be brought together and strategize the intervention to transform the camel milk subsector. It also requires forming a platform of actors that coordinates actors and leads the innovation processes for transformed and sustained camel subsector.

Constraints and opportunities along the camel milk value chain in the study areas

Among the constraints facing camel milk production in the study areas (Figure 2), disease and feed shortage were the major challenges reported by most of the camel producers. As indicated by Eyassu (2009) and Yosef *et al.* (2014), camel milk production is under pressure because of multiple changes in

the production environment. Increasing human population pressure on pastoral grazing areas and the economic implications resulting from diseases and lack of veterinary services are some of the factors that adversely affect camel milk production (Khan and Eqbal, 2001).

The major causes of feed shortage indicated by pastoral producers in the study areas were erratic rainfall (33.43%), shrinking grazing lands due to competition for land with crops (29.9%), encroachment by alien species (24.7%) and changing land use patterns that favor urbanization and settlement (11.97). Feeding of thorny cactus during the dry and drought season was a unique mitigation strategy. However, it caused mortality and poor production performances for the camels. Use of cultivated forages, supplementation with commercial feeds and feed conservation technologies were not available for pastoralist producers.

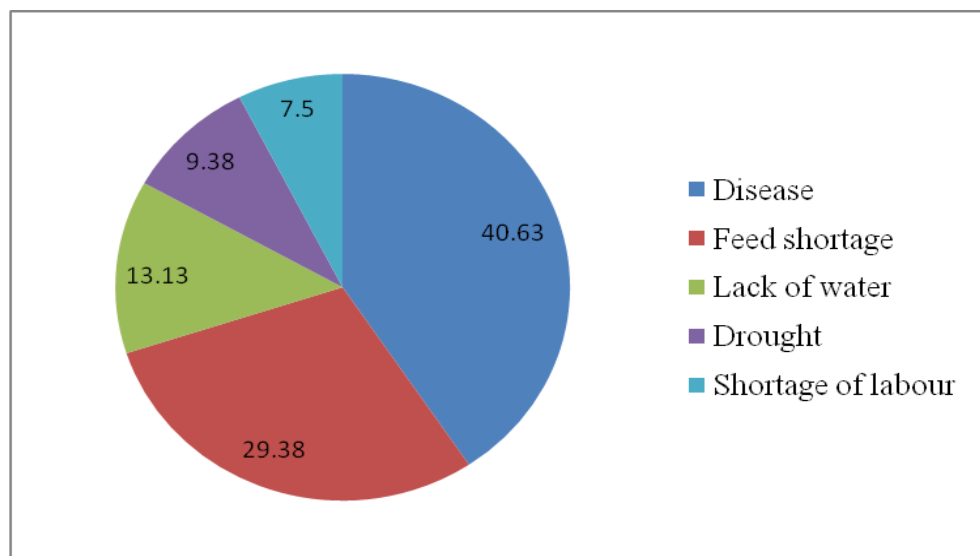


Figure 2. Major constraints associated with camel milk production in the pastoral areas of eastern Ethiopia

In order to mitigate the constraints of feed shortage in the study areas, organized community-based communal grazing area improvement programs, strengthen existing enclosures to restore indigenous vegetation and introduction of drought resistant, palatable and nutritious shrub species as feed for camels may help to solve the problem of feed shortage. To ease the unavailability of purchased feed resources establishing pastoral producers groups and organized cooperatives, to enable cost-effective purchase of required feed inputs and supplies to members. In this regard, the support of government and other development agencies will be imperative for initial take-off period. According to Tolera *et al.*, (2012) effective interventions that can address feed scarcity can lead to improved livestock production.

The mean (\pm SE) distance pastoral producers travel to sell milk was 4.67 ± 0.13 km, and ranges from 0.5 to 14 km. The long distance to market in the study areas decreases their participation in milk marketing. Producers close to the milk collection center or marketing point can easily supply their milk and earn market price as compared to the distant producers. On the other hand, producers from distant places may not be able to supply milk with desirable quality to the collection point or market places. This could be attributed to either poor handling practice after milk production or exposure of the milk to the ambient temperature during transportation to the market. Thus, the milk may occasionally be rejected due to poor quality at the market. Therefore, establishing additional milk collection points at reasonable distances apart and supplying cooling facilities at least at the collection centers may improve the volume of milk delivered, its quality and its shelf life.

Further, the problem of milk spoilage was one of the great concerns in the study areas. This problem occurs mainly due to inadequate clean water to enhance milking hygiene and milk handling was often lacking, yet plastic containers were commonly used for milk storage and transportation from production areas to markets. These types of containers were not easy to clean and therefore cause milk spoilage, even when washed with hot water. The problem of milk spoilage, which causes direct economic loss for producer, can be overcome, at least in part, by providing water sources, use of appropriate milk containers for storage and transportation of milk, and educating camel producers on clean milk production. Such interventions not only reduce post-handling losses but also provide safe and quality of camel milk to consumers. Similar challenges and constraints were indicated by other researchers (Farah *et al.*, 2007; Noor *et al.*, 2013) as potential limiting factors for the camel milk commercialization in the dry land areas of Africa.

Developing a market orientation requires the support of pastoral producers as well as the sufficient availability of market information to customer wants (Farah *et al.*, 2007; Farah and Younan, 2005; Faye and Konuspayeva, 2012). The adoption of market standards may further facilitate the transactions between pastoral producers and their potential buyers (Faye *et al.*, 2014). The formation of producer groups may also help pastoral producers to increase their level of market orientation and take advantage of market opportunities (Markelova and Mwangi, 2010; Anderson *et al.*, 2012). Collective marketing may enable pastoral producers to meet quality and safety standards and enable the supply of the required quantities by larger buyers. In addition, improving marketing skills may

increase the competitiveness of pastoral producers (Kyeyamwa *et al.*, 2008; Musinga *et al.*, 2008) and strengthen their position in the national and international camel milk marketing (Coppock *et al.*, 2005; Faye *et al.*, 2014). Added to this, pastoral producers' organizations should provide a forum where pastoralists can express their dissatisfaction over prices, timing, and increase the likelihood that an organization should recognize its social and environmental responsibilities.

Major constraints faced by camel milk marketing agents

Some of the problems encountered by camel milk marketing agents (Figure 3) were similar among marketing agents. However, some

problems were unique to that affected particular milk marketing agents due to their nature of operation. Milk handling practice at collection points, lack of immediate acceptor, poor infrastructure, unreliable transportation and lack or ineffective communication with other partner in the chain were constraints encounter by camel milk marketing agents (Herren, 1990; Musinga *et al.*, 2008; Nori, 2010; Anderson *et al.*, 2012). An example was the inadequate communication in the chain, *i.e.*, milk marketing cooperative claimed that sometimes they were waiting at the milk collection points, but the Processors/collector fail to come due to various problems without communicating with the milk market cooperative. Hence, milk market cooperative loss their time, milk or economic values.

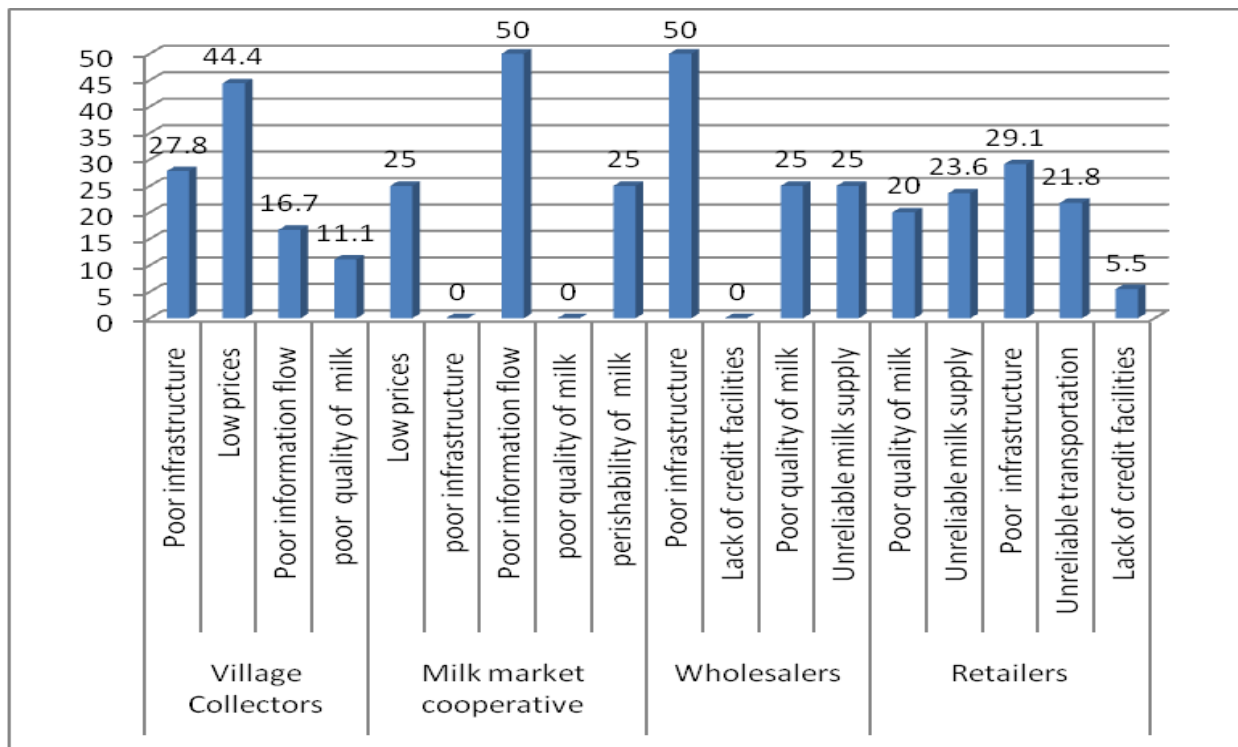


Figure 3. Major constraints for camel milk marketing identified by the marketing agents

The problems of equipment used, transportation mechanism, and lack of cooling systems at collection points and during transportation were a few examples of logistic problems observed in the study areas. These could be addressed through logistics function improvement across the camel milk value chain. To this end, the overall chain actors' commitments to make necessary investments at required stages are critical. Further, building the capacity of camel milk marketing agents by providing facilities may help to alleviate some of the problems that camel milk marketing agents face in study areas. Milk being perishable and demand being high for urban consumption, efficiency in collection and transportation of this bulk from collection centers, requires a well-defined method of preservation and distribution. This would impact on the amount that would be available for consumption through losses in quality (Ahmed *et al.*, 2004).

Processors face problems of inferior quality milk supply, in consistent cost variation on raw materials and expensive transportation cost and unfair competition from informal vendors. Further constraints mentioned by private processors, seasonality of milk supply, hard to reach the collection centers during rainy season and frequently power supply interruption. Seasonality of milk supply is posing great challenge on the viability of Private camel milk Processors in the study areas. Milk supply fluctuation is mostly a result of seasonal milk fluctuation due to lack of input at the production. However, other factors such as poor infrastructure also contribute to supply fluctuation (Holloway, 2000). Contracts established amongst the different actors take seasonality into account as a main parameter,

and cost and gain sharing are spread through the year, as different needs at different times are taken into account.

On the other hand, large camel population resources, existence of suitable agro-ecologies for camel milk production, increasing domestic and international demand for camel milk, strong social capital and high women involvement, better market opportunity, and proximity to international markets indicate the potential and opportunities for camel milk production and marketing development in the pastoral areas of eastern Ethiopia. Such an increase in the demand side will be the impetus for the pastoralists and agro-pastoralists, camel milk marketing cooperative, traders and private processing industries to increase their outputs. Besides, availability of actors in the camel milk value chain though not well structured, specific policy reforms such as privatization and commercialization, establishment of new regional livestock offices, cooperative promotion offices, conducive government policy for pastoral area and credit institutions, employment opportunities and diversification of family business are identified as major opportunities for improving the camel milk business in the pastoral areas of eastern Ethiopia.

Conclusions and policy implications

Camel milk value chain in the pastoral area of eastern Ethiopia was not well organized. The roles and functions of all actors in the value chain were not clear and there was weak linkage among stakeholders. There was no responsible body working for effective and efficient linkage between value chain actors. Therefore, redefining and integrating the existing concerns of the government, the private sector and public institutions in

promoting the development of camel milk subsector is required. Any efforts to improve camel milk production must consider concerning prevalence of disease and improved milk yield as a result of dry season feed supplementation. To address camel milk value chain constraints, it is important to adopt holistic interventions that include proper marketing development, general infrastructure development, and investing in technologies that reduce input cost and stabilize milk supply fluctuations. Developing modern camel milk processing technology should be given attention as this could benefit the pastoral producers for increasing the production and quality of the product. Given that pastoral producers are small-scale and unorganized in the study areas, this state of affairs clearly needs strong government intervention. Not only does it require providing input facilities, but also their dissemination to ensure optimal access. Efforts should also be made to strengthen pastoral groups and cooperatives and encourage collective action of pastoral to lower transaction costs to access inputs as well as to increase the price of the milk that encourage pastoralists to increase production.

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