Market quality gradients in smallholder dairy farming systems: How spatial factors affect smallholder production and marketing strategies in the East African highlands

Conceptual framework paper

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Abstract

Market integration of smallholder farmers is seen as an important pathway to secure food supply to growing urban markets in developing countries. However, it is still a question under which conditions such market integration can effectively emerge. Adequate configurations for input supply, output marketing, and service provision are required to foster market orientation, in which increased utilization of external inputs and services leads to intensification of production. This paper describes the conceptual basis and set-up of research that is currently being carried out in selected study areas in Ethiopia and Kenya. The conceptual framework considers spatial distribution of dairy farming systems and quality of in- and output markets as factors determining the market orientation of dairy farming. The proposed analytical framework looks at smallholder dairy farming systems, especially farmers' production and marketing strategies, as being influenced by spatial factors in farm assets, in- and output markets, end markets, and context. The research setup uses double market quality gradients that denote proximity to urban centres and proximity to service centres.

Keywords: smallholder dairy, farm typology, market quality, sustainable intensification, proximity, East Africa

1. Introduction

Market integration of smallholder farmers is seen as an important pathway to secure food supply to growing urban markets in developing countries (Reardon et al., 2014). With increasing pressure on land area following population growth it is essential to focus on improving productivity per unit of land (Akinlade et al., 2016). Relatively intensive modes of production and stronger market participation may provide alternative pathways to better livelihoods for smallholder farmers, especially in agricultural areas close to urban centres (Akinlade et al., 2016; Duncan et al., 2013). Intensification of dairy production goes hand in hand with increased utilization of external inputs and services, with the aim of growth in marketable surplus (Barrett et al., 2012). This commercialization of production results in a growing proportion of produce being sold and usually leads to farm specialization; it requires increasing market orientation, market participation and farmer business skills (Akinlade et al., 2016; Udo et al., 2011).

Duncan et al. (2013) showed that market orientation of dairy farming systems depends on market quality. They used the term 'market quality' as shorthand for the reliability and attractiveness of systems for milk procurement and for the delivery of inputs such as improved feed, veterinary care, improved breeding services and credit. They further noted that in many cases market quality refers not just to physical infrastructure but also to the institutional arrangements around milk procurement and input supply.

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Various authors indicate that in smallholder farming systems, factors that influence greater market participation are not only found on production level, but also on the levels of access to markets and of consumer demand (e.g. Omiti et al., 2006; Poulton et al., 2010; Somda et al., 2005). This complex of factors affect farmers' decisions on production strategies concerning breeding, feeding, husbandry and external input levels, as well as on marketing strategies regarding products, volumes and market channels (Barrett, 2008; Barrett et al., 2012; Duncan et al., 2013; Gebremedhin & Jaleta, 2010; Udo et al., 2011). Coupled with the diversity in farmer decision making stemming from diverse attitudes, behaviour, and orientation, understanding of locality and particularity is important to understand the diversity in how farmers deal with the risks associated with commercialization (Poole et al., 2013).

Literature about commercialization and intensification of mixed smallholder dairy farming systems uses various methodologies to compare dairy farming systems (van de Steeg et al., 2010) and to explore the relative importance of the multitude of socio-economic and biophysical factors that influence smallholder production and marketing strategies (e.g. Gebremedhin & Jaleta, 2010). Statistical and econometric methods used include factor analysis, cluster analysis, and principal component analysis, sometimes augmented by classification tree methods and expert-based classification rules (van de Steeg et al., 2010). Modelling of farming systems and market orientation levels is confounded by the large number of factors that determine the variety in production and marketing strategies involved (Groot et al., 2012).

This research aims to reduce the gap in systematic research on the comparative analysis of dairy farming systems from a market quality perspective, as identified by Duncan et al. (2013). To combine analysis of spatial distribution of dairy farming systems, quality of put- and output markets, and market orientation, the present paper analyses how spatial factors influence the interaction between dairy farming and marketing systems, particularly in i) the configuration of service support systems and ii) farmer decisions on utilization of the same in their production and marketing strategies. Increased understanding of these relationships is essential for design of in- and output marketing systems that can adequately support smallholders at different distances from urban centres (i.e. access to important end markets) and at different distances from main roads (i.e. access to input and service supply centres). What makes this research unique is its connection between farm typology and in- and output marketing as well as its distinction of proximity to in- and output market linkages of farming systems in two categories: 'Travel time from service centre in a dairy farming location to urban centre'; and 'travel time from dairy farm to service centre'.

This paper describes the conceptual basis for a spatial framework for analysis of the influence of market quality on dairy farming systems, as well as the set-up for field research to test that framework using purposive sampling. This field research currently is being carried out in selected study areas in Ethiopia and Kenya.

2. Conceptual framework

This section describes key concepts to do with spatial distribution of dairy farming systems: market orientation of dairy farms, proximity to in- and output markets, and quality and configuration of input- and service provision. It concludes with a presentation of the analytical framework for this research.

Production and marketing strategies in farming systems

Dairy farming system types are the consequence of agro-ecology and degree of market orientation (Pingali & Rosegrant, 1995; van de Steeg et al., 2010), both of which have strong spatial aspects. For farming systems we follow the definition of (van de Steeg et al., 2010), "a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate". Rather than looking at these as static and 'given', we recognize agency of farmers in actively pursuing production and marketing strategies that develop their farming system in a certain direction (van der Ploeg, 2008). A farmer's choices cumulatively result in that farmer's production and marketing strategies and the latter are influenced by the farmer's objectives, farm household assets, market opportunities and context variables (Poulton et al., 2010; Udo et al., 2011).

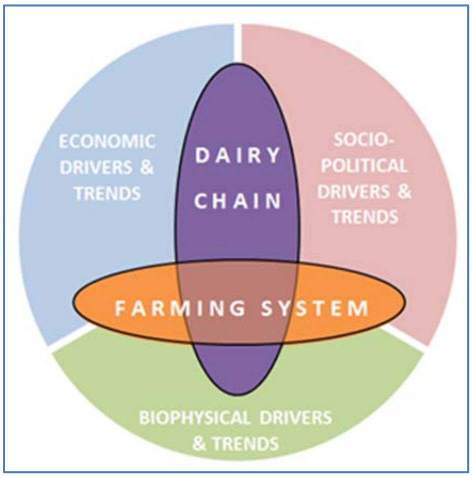

Figure 1. Five lenses for analysis of dairy farming systems (van der Lee et al., 2014)

To understand the production and marketing strategies within smallholder dairy farms and the reasons behind them, it thus is important to look at the farming system in relationship to the dairy value chain (primarily the connections to input, output and end markets relevant to dairy) and to economic, socio-political and biophysical context drivers and trends (Moll et al., 2007; van der Lee et al., 2014), as illustrated in Figure 1.

Proximity of farms to in- and output markets

Effects of distance to urban centres on farmer production and marketing strategies have been described by various authors and literature dates back to von Thunen (1875). Milk as fresh liquid product requires proximity to output markets, which explains peri-urban market-oriented dairy farming at close proximity to cities. On the other hand, milk production requires ample space for production of fodder and feeds, which may be scarce in peri-urban areas. In remote areas where this space is available, marketing of milk to the urban centre is a challenge. As milk cannot be transported across large distances without cooled transport, remote farmers more often produce and sell butter and cheese (Gebremedhin et al., 2014; Voors & D'Haese, 2010). Moreover, effective market linkages are needed to escape an autarkic market situation (Barrett, 2008). Shifts in technology, such as the introduction of ultra-high temperature (UHT) milk treatment in the 1990s, allowed expansion of milk production at huge distances from urban centres where it was not possible earlier (Novo et al., 2013). Farmers who are physically close to urban markets may have the choice between direct marketing of raw milk and delivery to industrial processors. For farmers in remote areas the opportunity for direct marketing usually is much more limited and depends largely on the geographic density of dairy cows as compared to density of rural consumers. For example, in Nyandarua County, Kenya, local marketing options are very limited as nearly all farm households keep one or more dairy cows to satisfy at least own household consumption needs.

Remoteness and proximity are relative terms that are influenced by quality of infrastructure like roads, electricity and telecom connectivity (Hoddinott et al., 2014; Kyeyamwa et al., 2008; Mutambara et al., 2013) and by agro-ecological factors like mountain areas and aridity (Reardon et al., 2014). We prefer 'travel time to market' as indicator for proximity over 'distance', as it denotes transaction costs in terms of time and transportation. Travel time can be influenced by road improvement , new means of transport and collective action for bulking milk along roads, and by availing milk cooling technologies (Gebremedhin et al., 2014).

At the local level, the need for daily transport of milk to milk collection centres (MCC) makes year-round access to all-weather roads (distance, travel time, mode of transport) and travel time to MCCs (density of milk collection grid, road conditions) important parameters for farmers when considering supply to liquid milk markets, be it to the 'industrial chain' for pasteurized and extended shelf life dairy products or to the 'traders chain' for raw milk (Muriuki & Thorpe, 2006; Voors & D'Haese, 2010). The suggested distinction by Gebremedhin et al. (2014) between farming 'near consumption centres', 'along the all-weather road', and 'remote' is particularly helpful as basis for a typology of farming systems based on proximity, but so far has not been validated with field studies.

Next to output marketing, proximity also affects marketing of external inputs and services to farmers, which is associated with differences in external input use between hinterland and non-hinterland areas (Reardon et al., 2014). According to Voors & D'Haese (2010) remote farmers face high transaction costs to reach input markets. Due to the small volumes, "last mile delivery" of inputs and services to the farm gate relatively is the most expensive part of the distribution chain, particularly in remote areas. Travel time to input market is one of the factors that increase transaction costs, next to asset specificity and uncertainty surrounding the transaction; proximity reduces not only transport costs but also other transaction costs: information gathering may be easier, negotiation more frequent, and monitoring less costly (Shiferaw et al., 2006; Voors & D'Haese, 2010).

Market quality and support system configuration for input- and service provision

Various studies have shown how limitations in market access negatively affect farmers' market participation and market orientation (Akinlade et al., 2016; Barrett et al., 2012; Gebremedhin & Jaleta, 2010; Omiti et al., 2006). Smallholder decisions on intensifying dairy production that require investments in e.g. better feeds and higher-yielding animals are depending on the proximity of such services (Duncan et al., 2013), which is associated with quality, price, and reliability of supply. On the other hand, supply of inputs and services is dependent on farmer demand and a gradual development of demand and supply can be expected (Jaleta et al., 2013). Remoteness results in reduction of both demand and supply of production inputs and services (Mutambara et al., 2013). As illustration, Table 1 portrays the resulting ranges of input and service options available to smallholders depending on proximity.

Table 1 - Inputs and services options available to smallholder dairy farmers for extremes in market access

Input/service	**(Peri-)urban**	**Remote**
Breeding	AI	Bull service
Animal health	Veterinary services, industrial drugs	Community-based animal health workers, use of traditional medicines
Feed supplements	Commercial feeds, by-products, silage	Crop residues
Equipment	Industrial	Artisanal
Fertilizers & pesticides	Chemical	Organic
Financial services	Financial institutions	Community, traders
Farm advice	Public and private service	Community-based
Milk marketing	Processing plant collection, direct marketing	Local milk sales, home-processed products

Effective and cost-efficient supply of inputs and services to farmers requires proper coordination mechanisms for cost-effective and adequate delivery. Such mechanisms may include geographic clustering of input supply and service provision, packaging of services, or connection of input and service provision to output marketing through vertical integration (Jaleta et al., 2013; Poulton et al., 2010).

Analytical framework

Based on the above we propose a spatial framework for analysis of influence of market quality on dairy farming systems. This analytical framework, as portrayed in Figure 2, looks at smallholder dairy farming systems as being influenced by factors from the input market, farm resources, output market and end market. It builds on Somda et al. (2005) and Reardon et al. (2015) who classify factors that influence greater market participation of smallholders.

In this analytical framework we focus on spatial factors and those factors that can be expected to be influenced by them. These were selected from the wide range of factors described for different crops and livestock products by various authors (Akinlade et al., 2016; Bahta & Malope, 2014; Barrett et al., 2012; Gebremedhin & Jaleta, 2010; Moll et al., 2007; Mugisha et al., 2014; Mutambara et al., 2013; Omiti et al., 2006; Reardon et al., 2014; Somda et al., 2005; Udo et al., 2011; van de Steeg et al., 2010; van Melle et al., 2013; Voors & D'Haese, 2010).

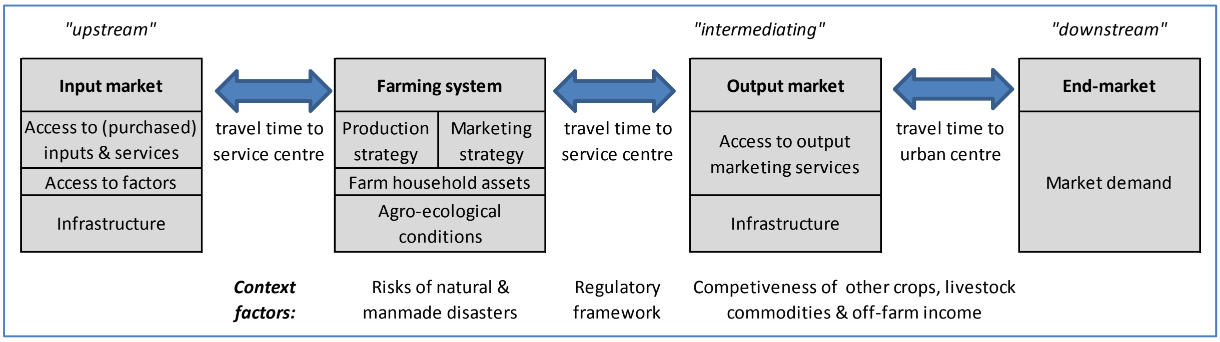

Figure 2. Spatial factors in market quality affecting production and marketing strategies of smallholders

Table 2 highlights the main spatial factors, for each step in the value chain, and the farming system elements that can be expected to be influenced by them. Their influence on market orientation of dairy farming will be analysed using descriptive statistics, and underlying mechanisms will be explored.

Table 2 – Framework for analysis of spatial factors influencing dairy farming systems

	Spatial factors:	*Influence on:*
Farming system		
Farm household assets [4]	land (farm size); water sources; real estate	herd size and composition; crop options; agro-biodiversity; income sources; animal disease prevalence; farming practices; farm technology; household consumption preferences; access to production factors land, labour and capital
Agro-ecological conditions [5]	altitude; rainfall; temperatures; soil types; biodiversity	
Input market quality		
Infrastructure	proximity farm to ISPs; proximity ISPs to urban centre; density of dairy farm distribution; road density and - conditions throughout year; utilities – electricity; piped water; ICT network connectivity	education level; means of transport; access to stock, artificial insemination services, animal health services, drugs and pesticides, feed, seeds, fertilizer, farm equipment and fuel, farm advice, information, financial services
Access to inputs and services	density of ISPs	
Access to factors	land, labour and capital markets	
Output market quality		
Infrastructure	milk collection grid; road network (density, quality, and distance to all-weather road)[6]; electricity and water grid; ICT network connectivity; public transport services	access to milk collection, transportation, processing, distribution and/or direct milk market outlets - availability, reliability, contacts and transaction costs
Access to output marketing services	proximity/travel time to service centre (MCC) and to urban centre	
End market quality		
Market demand	demographic dynamics; income dynamics; changes in consumer characteristics; distance and sourcing relationships	dynamics in the effective demand at farm level for milk and dairy products from both urban and rural consumers – prices, seasonality, reliability [7]
Context factors: Some context factors with spatial influence need to be considered, as these are expected to differ between countries and between locations within countries:		
Risks of natural & manmade disasters	droughts, livestock disease outbreaks, and political changes	agro-ecology; farm household assets; in- and output market demand; impact of regulations at farm level; likelihood that areas that at one time are suitable for dairy may lose out to other cash crops (like potatoes, coffee, tea, or sugarcane), livestock commodities (like stock, beef or eggs) or off-farm income
Regulatory framework	spatial effects of regulations relevant to dairy farmers and dairy chain actors , regarding milk marketing, labour, and land use; including development policies for remote areas	
Competiveness of dairy	dynamics in markets, policy or agro-ecology that render dairy less profitable	

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4 *Hamilton-Peach & Townsley, 2004; Poole et al., 2013*

5 *van de Steeg et al., 2010*

6 *Roads can be classified as (milk collection trucks may use roads of types i) and ii)):*
  i. *all-weather roads that farmers can travel on with either private or public transport and that ISP vehicles can travel on to reach farms, year-round*
  ii. *feeder roads with secondary surfacing that can be used part of the year, and*
  iii. *farm roads that cannot be used regularly by vehicles at all or not without much difficulty.*

7 *At remote farm level this can, for example, translate into the possibility to sell to processors in the dry season when milk supply is low, but not in the rainy season, when processors can get plenty of milk nearby their plants.*

3. Research set-up

To test the analytical framework presented in the previous section, a field study is being carried out that combines analysis of spatial distribution of dairy farming systems, quality of in- and output markets, and market orientation of farmers. This research focuses on spatial factors along a double gradient from high to low market quality. It pursues more in-depth understanding by looking at two cases of market quality gradients for smallholder dairy farming in Ethiopia and Kenya.

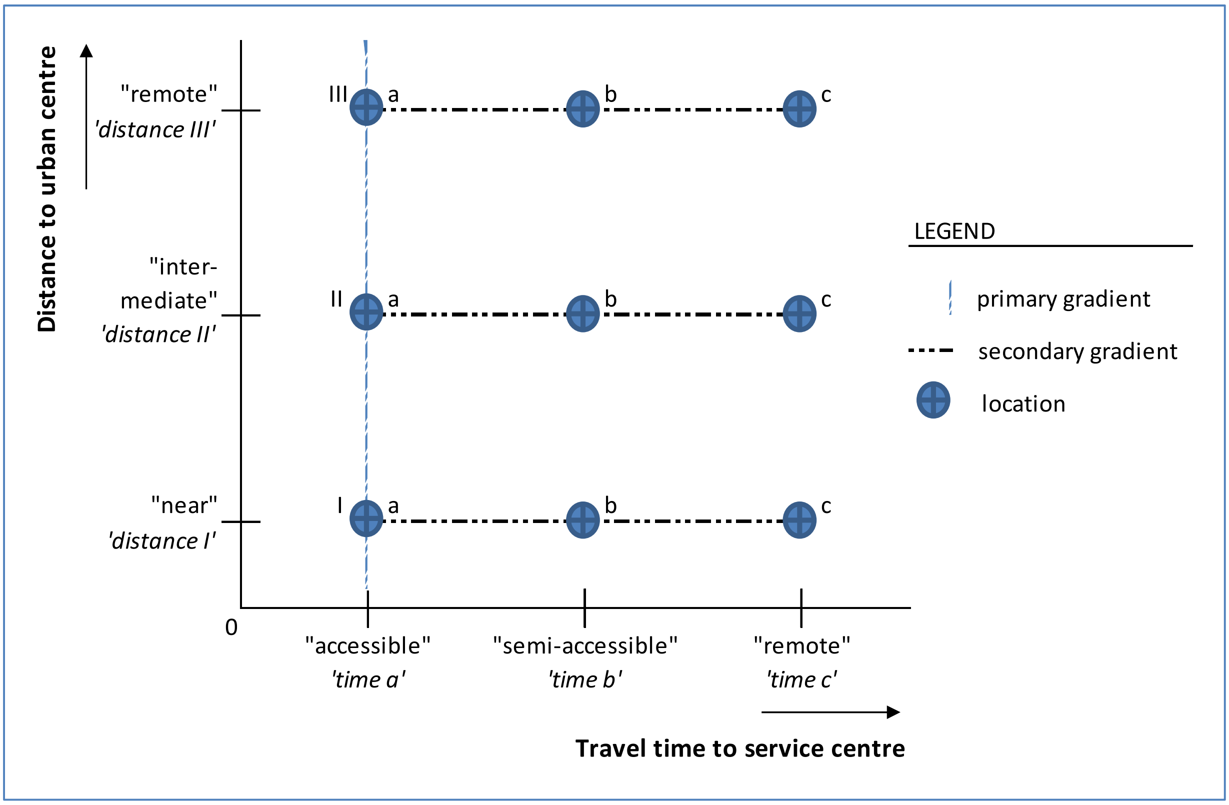

Figure 3. Primary and secondary gradients in research setup

In Kenya and Ethiopia two study areas were selected that are considered to be areas with good dairy potential for smallholders. After scoping of collection and service infrastructure, a gradient in terms of density of i) input supply services and ii) output marketing services was selected in each study area:

- *Primary gradient* – Three locations (I-III) with dairy potential for smallholders along a market quality gradient (at increasing travel time from urban market); areas with plantations and areas that due to low rainfall have low dairy potential were left aside. In East Shoa and Arsi zones, Ethiopia, three locations were selected along the axis from the urban centre Addis Abeba to remote parts of Arsi (Bek'oji and Sagure districts); in Nyandarua County, Kenya, three locations were selected along the axis of secondary town Nyahururu to remote parts of Kipipiri sub-county. Selection resulted in:
    - location (I) being a town centre of 50-100,000 people that is (relatively) close to a major urban centre with strong market pull, where multiple milk collection centres are available – Ol Kalao, Nyandarua, Kenya (close to Nyahururu, with good connections to urban markets) and Bishoftu, East Shoa, Ethiopia, close to Addis Abeba;
    - location (II) being a town service centre with moderate market pull, with input shops and one or few (preferably chilled) milk collection centres - Wanjohi in Kenya and Bek'oji in Ethiopia;
    - location (III) being a small rural centre that is considered remote by local standards, with some services at the main, gravel road (Geta in Kipipiri sub-county, Nyandarua county, Kenya; Danisa in Sagure district, Ethiopia).

Areas with plantations and areas where agro-ecology favours cash crops over dairy (due to lower altitude and rainfall) where not selected, explaining the relatively large distances between Bishoftu and Bek'oji and between Ol Kalao and Wanjohi.

- *Secondary gradient:* In each of the locations I-III, a secondary gradient was established with again three sub-locations (a-c), differing in travel time from all-weather roads and 'the market' (a service centre with IPSs and output market opportunities): a) accessible (close to service centre, close to type i) all-weather roads) , b) semi-accessible (1 hour walk from service centre, accessible by type ii) feeder roads) and c) remote (0.5-1 hour walk from feeder road, 1.5 -2 hours walk from service centre, located along type iii) farm roads) (see Figure 3). This gradient is in line with distinctions made by (Gebremedhin et al., 2014).
- In each of the nine sub-locations in each study area, ten farmers are randomly selected from all dairy farmers in the sub-location, as provided by the local livestock department office, so ninety dairy farms and their market linkages are investigated in each study area, using questionnaires and focus group discussions with dairy farmers and former dairy farmers, and interviews with ISPs and key resource persons.

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