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DOI: <https://doi.org/10.22434/IFAMR2017.0122>



Godfrey, S.S., Ramsay, G.C., Behrendt, K., Wynn, P.C., Nordblom, T.L. and Aslam, N. 2018. Analysis of agribusiness value chains servicing small-holder dairy farming communities in Punjab, Pakistan: three case studies. *International Food and Agribusiness Management Review*

24 October 2018

OPEN ACCESS



International Food and Agribusiness Management Review

Please cite this article as 'in press'; DOI: 10.22434/IFAMR2017.0122

Received: 12 December 2017 / Accepted: 15 June 2018

Analysis of agribusiness value chains servicing small-holder dairy farming communities in Punjab, Pakistan: three case studies

RESEARCH ARTICLE

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Abstract

The agriculture sector in Pakistan, as in most developing countries, is dominated by smallholder producers. Pakistan has the world's third largest dairy industry, and milk is efficiently collected and distributed chiefly by informal value chains that market the raw product with minimal cool chain infrastructure. Formal processors have a small market share of 5%. Interview data from farmers, milk collectors and consumers from three rural-urban case study value chains were analysed to study opportunities and challenges faced by the dairy industry. Compositional analysis of milk samples (n=84) collected along these chains identified the fact that in Pakistan informal milk chains provide a cheaper source of calories for the final consumer than industrialised milk chains (USD 0.12 compared USD 0.15 per 100 calories). These three chains created an estimated 4,872 jobs from farm to market and provided access to interest-free credit for the farmers. The existing government price setting mechanism at the retail end and collusion by large processors to set farm gate prices provided significant limitations to the profitability of small-holder farms providing the product. The absence of quality and quantity standards, amid the exchange of huge numbers of small volumes of milk along these chains, are major impediments to industry growth.

Keywords: value chain, milk, nutrition, price, pro-poor policy

JEL code: Q13

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1. Introduction

Efficient value chains compete against each other to attain a larger share of the final consumers' expenditure on food. The competition or rivalry therefore, focuses on the structure and efficiency of value chains rather than the corporate entities operating within the industry (Boehlje, 1999). Value chains in developing countries, however, typically represent small scale production and marketing systems, and understanding their mechanism of operation can identify significant opportunities for poor producers and marketers: thus they have a pro-poor value chain focus (Echeverría *et al.*, 2011).

For developing countries, the challenge is to strengthen value chains that incorporate an ever growing workforce (Altenburg, 2006a). Globally, there are more than 570 million farms and nine out of ten of these are run by families. These farms occupy 70 to 80% of the world's agricultural land and produce 80% of the world's food. In the low income countries, more than 95% of all farms are smaller than 5 hectares (Food and Agriculture Organization, 2014).

The value chain concept is framed by the perspective of the final consumer looking back to the chain that produced and delivered the product (Collins, 2006). The consumers ultimately determine where value lies in the product (Fearne, 2009) and specify attributes that contribute most to product quality (Collins, 2009).

The value chain approach looks at the complex range of activities implemented by various chain actors or organisations. The chain starts from the production system of the raw materials and links with other enterprises engaged in trading, assembling, processing and marketing (Purcell *et al.*, 2008). The chains have different patterns of organisation and it is important to recognise these differences to identify the inherent risks and opportunities arising from these patterns, especially for poor people. This is required to form policies that optimise social inclusiveness without sacrificing long-term competitiveness (Altenburg, 2006b). Most value chains in developing countries serve domestic consumers. These chains need to be studied to better meet the nutritional needs of consumers and the livelihood of producers including an assurance of fair prices (Food and Agriculture Organization, 2013b, 2014). This applies to chains, which are run by local firms as well as those dominated by multinationals as they seek a market share. Pakistan as a developing country is no exception.

How different forms of industrial organisation impact on the availability, quality and price of products is a development issue, especially if the goods concerned comprise a substantial share of the poor households' consumption basket (Altenburg, 2006c). This research focuses on the farmer as the primary milk producer and source of the product through to the final consumer purchasing the product from a retail shop. The value chain analysis framework forming the basis of this study is defined as follows:

Food value chains are defined as systems driven by the interaction of their technical (production, processing, transport, etc.), economic (profitability), information-related (communication) and governance (human relationships) systems (Collins, 2009).

Boehlje (1999), makes a case for the structural realignments in agricultural industries that relate to transactions between various tiers of firms, 'requiring an understanding of relationships and information flows as well as physical and financial flows, best described by taking a value chain approach'. He thus advocates using value chain approach as an industry-wide tool.

In Pakistan, 60% of the country's population survive below the income poverty measure of USD 2 a day (World Bank, 2013): an average household spends 45% of the total household budget on food. Milk has a major share in the food consumption of a household, which spends 11% of its total budget on unpackaged fresh milk (Government of Pakistan, 2013a).

Milk (unpackaged fresh, packaged and powdered) provides 10.6% of the 1,700 calories and 18.7% of the 45 grams of protein consumed per capita per day (Government of Pakistan, 2013a, Wynn *et al.*, 2006).

Milk comprises a high protein element in the country's diet, which is ranked high for its consumption trend, among other developing countries (Government of Pakistan, 2011; Hemme and Otte, 2010). The significant volumes of fresh milk consumed also highlight a general consumer preference for fresh milk (Anjum, 1978; Government of Pakistan, 2013a) despite the common knowledge of product dilution with water (Burki *et al.*, 2004).

Pakistan's population of 208 million people is growing at 2% per annum and is projected to reach 275 million by 2050, making it the fifth most populous nation (Government of Pakistan, 2017; United Nations, 2012; World Bank, 2014). Poverty is closely linked with undernourishment assessed by energy intake (Food and Agriculture Organization, 2013b). Pakistan's annual development plan 2013-14, disclosed that 33% of the country's children under five years of age and 18% of mothers are underweight (Government of Pakistan, 2013b). These facts highlight the issue of undernutrition in Pakistan and the need to study the diets of average Pakistanis.

Milk is supplied to the consumers by two main types of chains that can be defined as informal and formal chains. The main differences between the two are the provision of cool chain infrastructure and logistics, hygiene and handling practices and packaging in the latter (Zia *et al.*, 2011). Quality remains a concern in the informal chains. Milk adulteration is associated with dilution by up to 60% with poor quality water as well as the use of penicillin, formalin, hydrogen peroxide, milk productivity hormones and many other potentially harmful preservatives and residues (Staal *et al.*, 2008). Informal milk value chains operate with minimal technology and infrastructure but remain a dominant link between millions of urban consumers and predominantly smallholder dairy producers. The function of milk collection, transport, and distribution is performed by different tiers of small, medium and large vendors, colloquially known as '*Dhodhis*'. The milk is sold by specialised retail milk shops to final consumers (Figure 1) (Burki and Khan, 2007; Burki *et al.*, 2004).

Although the country's formal processing industry segment has negligible (5%) market share, there has been strong overall industry growth (Staal *et al.*, 2008). Processed dairy products comprise 5% of the total production whereas the rest of the milk is sold to the consumers as fresh, unpackaged product through value chains that operate with minimal cool chain technology (Burki *et al.*, 2004; Zia *et al.*, 2011): yet little was known about these chains and the industry that they service.

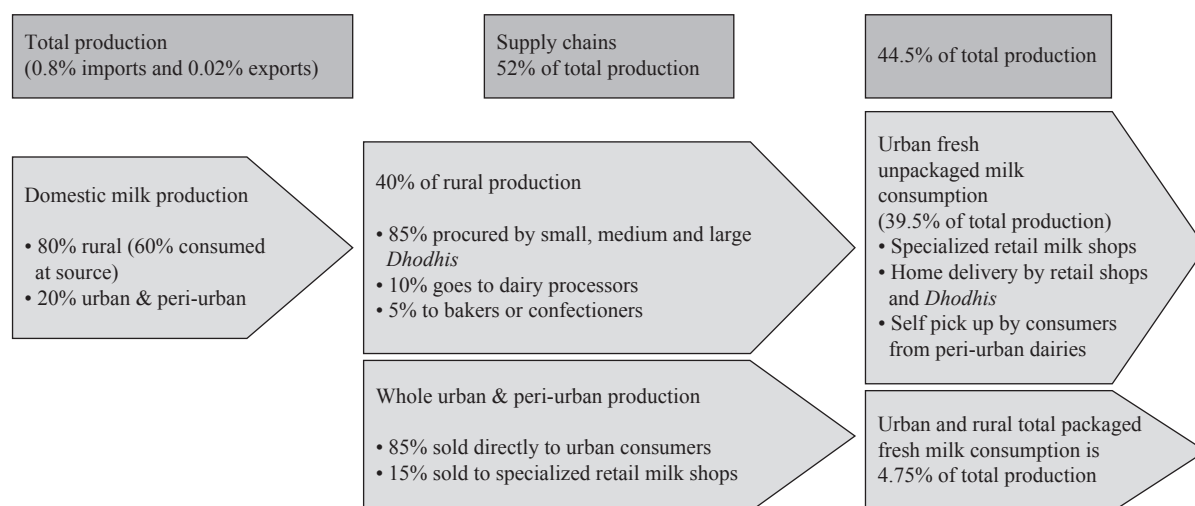


Figure 1. Fresh raw milk flows from rural and peri-urban producers to urban consumers.

The livestock sector has long been identified by the government as being of crucial importance to support pro-poor growth (Amjad, 2010). Cattle and buffalo milk is important to Pakistan's economy (Afzal, 2010). The livestock sector is dominated by small scale farmers with 89% of the households having access to less than 12.5 acres or 5 hectares (1 Acre=0.4047 hectares) of land and owning only 48% of the country's arable land. Approximately 80% of milk is produced in rural areas and 91% of households own less than 10 animals (Amjad, 2010; Government of Pakistan, 2010; Government of the Punjab, 2012; Zia *et al.*, 2011).

The livestock sector in Pakistan contributes 11% to the gross domestic product and milk is the major output from buffaloes and cows (Government of Pakistan, 2017). The value of milk produced by these large ruminants is USD 13 billion: this far exceeds the economic value of all other crops (Food and Agriculture Organization, 2013a). Milk production, however, is based on large numbers of livestock with low productivity per animal at 1,452 kg/year (Fakhar and Walker, 2006; Wynn *et al.*, 2006).

This paper provides an analysis of specific milk value chains supporting small-holder farming communities in Pakistan's Punjab. The research was carried out to understand how the domestic milk value chains operate and what, if anything, can be done to improve the livelihood of farmers. The study however led to identification of challenges not only faced by the farmers but also the chain's middlemen colloquially known as *Dhodhis*, and the final consumers. The analysis provided an insight into the opportunities that the existing informal fresh milk chains present and the impediments to the growth of the wider dairy industry. The three chains examined in this paper are located in irrigated Punjab, and connect rural producers from three different rural districts of Kasur, Okara and Pakpattan to urban consumers in metropolitan Lahore city.

Given the enormous scale of the Pakistani dairy industry, which ranks the second and eleventh largest country for whole fresh buffalo and cow milk production, respectively (Food and Agriculture Organization, 2013a) and third largest milk producer in the world (Hemme, 2010) this study is a very small sample. The large scale of industry also means the value chains are quite diverse, regarding the number of participants involved in a chain and the milk exchange and transaction methods adopted by them. This study has been carried out with the anticipation that information shared by the chain actors was factual.

2. Materials and methods

The study originated from the irrigated Okara and arid Bhakkar districts of Punjab (Figure 2(A) and (B)). The choice of the districts studied was based on the availability of farm economic analysis data from a two-year longitudinal survey (Wynn, n.d.) for these two districts.

The study involved two stages. The first stage involved a scoping study which used a purposive sampling method (Patton, 2002) to identify and sample fresh, unpackaged milk and informal and formal chains in both districts. Twenty-seven producers, eleven small, eight medium and five large *Dhodhis*¹, twenty-two retailers, two formal processors and eleven consumers were interviewed personally by the first author², using four different questionnaires. In total twenty-five, informal chains and two formal processor chains were studied. The questionnaires were developed using a simple value chain analysis framework to identify key functions being performed along the chain. The initial rural participants were identified with the help of the Australian Centre for International Agricultural Research (ACIAR) project team (Wynn, 2010) and their buyers were then tracked and subsequently interviewed. Some *Dhodhis* and retailers were also randomly surveyed to provide greater cross-sectional perspectives. During this research the Okara-Lahore chain, Case study 2 (Table 1) model stood out because of its complexity; therefore, the first author conducted some preliminary analysis of the chain. Similarly, a more effective cool supply chain model³ from Pakpattan to

¹ Local middlemen milk buyers and sellers who are colloquially known as *dhodhis*.

² A Pakistani national of Punjabi origin who spoke the local language and understood the local culture context very well.

³ Partially refrigerated as it had a chiller installed at central milk collection point in rural district and at shops in urban areas. Unrefrigerated stages were found in the rural collection network i.e. small *dhodhi* milk collectors (bicycles and motor cycles) and its truck delivering milk from Pakpattan rural district central collection point to urban metropolitan Lahore.

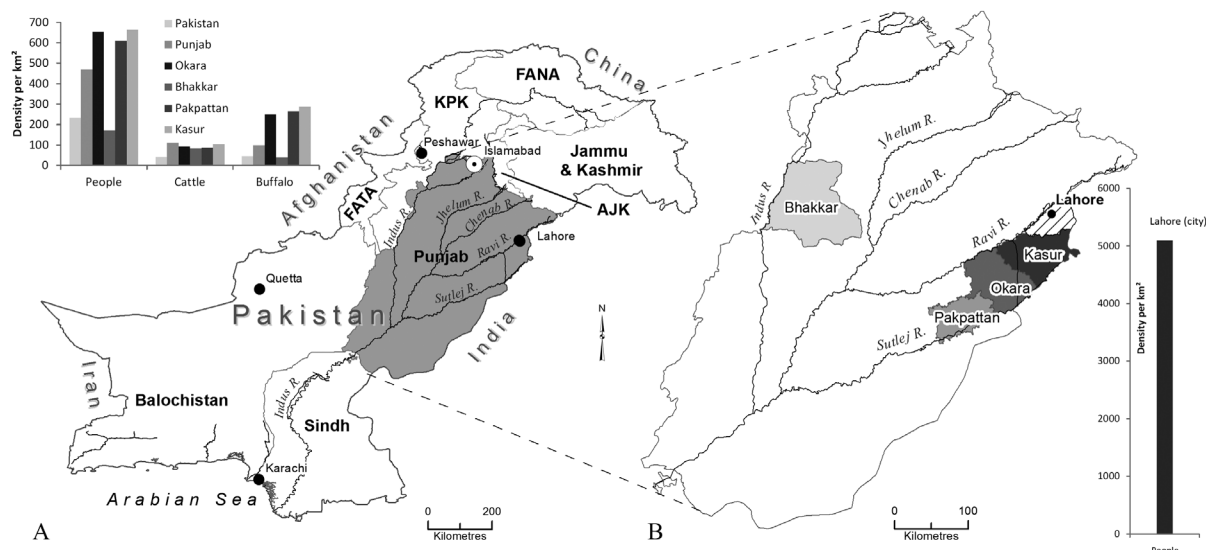


Figure 2. A = Map of Pakistan highlighting the Punjab province; B = Map of Punjab showing Kasur district and Lahore city.

Lahore (Case study 3 in Table 1) was also identified to be of interest and was investigated further. Quantity and quality assessment, price-setting mechanisms and financing emerged as important wider industry issues for further exploration.

In the second stage, four milk value chains including the two identified in the 1st scoping phase plus case studies 1 and 4 in Table 1; handling fresh, unpackaged product in Kasur, Okara and Pakpattan districts of irrigated Punjab (Figure 2B) supplying milk to metropolitan Lahore city were studied. Although a number of chain models existed, the choice of rural-urban chains was based on the outcome of the scoping study and the need to review individual cases more thoroughly at the rural-urban fringe where there are burgeoning urban populations of milk consumers. The chains identified for further study were complex with more operators carrying higher product volumes from farm to the consumer.

The selection of specific villages and districts was based on the author's close association with and support from the ongoing ACIAR dairy project (Wynn, 2010) being conducted in these areas, with staff having developed a working relationship with smallholder producers, serving as entry point for this study.

The number of participants interviewed in the second stage for each chain are provided in Table 1, which also describes the number of tiers for each chain. Only the Okara-Lahore chain had a Medium *Dhodhi* operator. Of the four cases, the Large *Dhodhi* operator of one of the two Pakpattan-Lahore chains identified later refused to cooperate and therefore the case had to be deleted (Table 1). A senior official of a multinational formal processor was also interviewed.

Yin's (2009) case study method was used for this research. The use of the case study approach for an empirical inquiry allows the researcher to investigate a contemporary phenomenon that is the 'case' in depth and within its real-life context. Furthermore, the use of multiple cases (Figure 3) allows substantial analytical benefits as they provide more compelling evidence and the overall study is, therefore, more robust.

The research was underpinned by mixed methods of qualitative and quantitative techniques to collect and analyse data. The method combined the use of both quantitative and qualitative methodologies within the same study. The integration of these two approaches to collect data helped develop a more complete understanding of the research problems. These studies can later be integrated within a larger theoretical framework (Bergman, 2008; Creswell, 2010; Creswell and Plano Clark, 2011; Jupp, 2006).

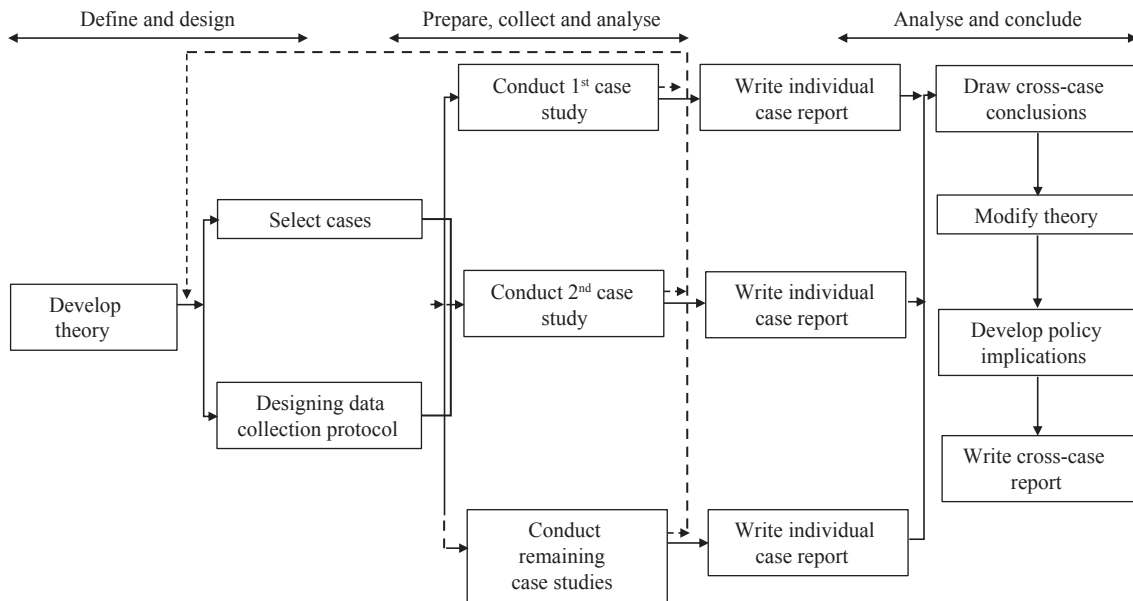


Figure 3. Outline of the multiple case study procedure (adapted from Yin, 2009).

The quantitative data collected for each value chain case study gave a clear picture of:

1. Physical flows including product quantity, quality and time to transfer product along the chain.
2. Financial flows represented by costs, margins, value creation and distribution.
3. Technology and infrastructure used in transport, storage, cooling and processing and its economic value.

The qualitative data collected for each value chain case study identified:

1. Value chain participants and their functions (who?), roles (what?) and the rules (how/why?) determining their activity.
2. Governance internal to the chain implicated in the formation of relationships, power dynamics, conflict and problem solving. External governance in terms of government and dominant market participants and their influence on price, quality and price information flows.
3. Information flows with a particular focus on price to understand the type, direction, timing, completeness, accuracy and distortion if any in these flows.
4. Consumers and their buying behaviour, preferences and unmet needs, attributes of milk they value while buying milk and their demographics.

For this research, field observations were made, and detailed face-to-face interviews were conducted with milk value chain participants using four questionnaires that included fixed-choice and open-ended questions. The questionnaires from the first stage were further refined to go deeper using the framework developed in the literature review to both collect and analyse the data. The purpose of the research was explained carefully to each respondent to gain the trust needed.

Patton (2002) and Yin (2009) point towards the use of interviews and personal observations as the key tools for data collection in qualitative case study research. Clarke (1999), described interviews as a conversation with a purpose. In a structured interview, questions are asked in a systematic and consistent order while semi-structured interviews follow a less rigid format and include open-ended questions.

For this research, structured questions were asked to quantify some aspects such as milk quality attributes of greatest importance in business dealings. Both the Likert scale and ranking scale were used to record the priorities of respondents, including consumer preferences. The semi-structured questions were used to understand how and why the chain participants do what they do. The semi-structured questions generated

more in-depth responses while often the structured questions also led to further discussions and insight. The USAID (2005) qualitative interview manual was also used as a guide for this research in a developing country setting. The first author tested the questions with a colleague with several years of fieldwork experience in the dairy sector of Pakistan. The sequence of questions was refined several times after each case study. Interviews with each respondent, took between fifteen minutes to an hour depending on the respondent's place in the chain. The difference in time taken depended on the level of complexity and number of questions asked: for example, the questionnaire for the consumer was brief compared to those used for farmers, middlemen and retailers in the chain. All questionnaires included an explanation of the purpose of the research to all respondents.

The practices and understanding of two key aspects of milk quality and quantity varied for chain participants and across the milk value chains. Evidence related to these practices was gathered through direct observation of their participation and practices at various tiers along the chain. Apart from taking occasional field notes outside the formally designed questionnaires, pictures and voice recordings were extremely valuable tools for the analysis of data collected subsequently.

In this research, validity of data was addressed by collecting from multiple sources. This approach to validation is consistent with Patton (2002) and Yin (2009) who recommended the use of multiple sources of evidence in case studies.

Various government reports and local research publications on the dairy industry of Pakistan also helped make better sense of the local industry although these were somewhat generic and biased against the local milk chains.

Secondly, interviews with a Pakistani professor who had conducted research on the dairy sector of Pakistan, a senior bureaucrat from the Punjab Livestock Department as well as discussion with extension officers from the same department and ACIAR dairy project field staff all added to the first author's understanding of the local milk marketing context.

The most important advantage presented by using multiple sources of evidence is the development of converging lines of inquiry or triangulation, a technique that ensures that a comprehensive and well developed analysis is undertaken (Patton, 2002; Yin, 2009). The author relied on triangulation through matching and cross-examining the responses of chain participants about the same factor to check for consistency. Finally, the milk quality information collected by Aslam (2015) at each tier of the three milk value chains studied provided a key source of validation allowing a richer, more complete understanding of the dairy industry of Pakistan.

3. Results

At the retail end of the fresh milk value chains, 68% of the consumers (Figure 4) placed high fat content as their top priority attribute when purchasing milk while only 9% consumers ranked safety and health as their first priority⁴. A consumer (Kasur-Lahore Retailer1-Consumer4) interviewed at one retail shop stated, 'There should be cream on top of milk, no matter how many times it is boiled'. The preference for fat content was the key quality attribute sought through procurement of buffalo milk in all three chains studied.

An important discovery was that consumers were receiving 900 to 970 ml for the price paid for each litre. Additionally, the quality of milk supplied to consumers varied seasonally with a deterioration in summer (Figure 5) when the milk was in short supply and high temperatures invited greater use of cooling ice in milk. The quality improved in winter with increased production and lower temperatures allowed for less ice in milk. The price of calories obtained from milk and the levels of protein and fat (Table 2) obtained were

⁴ The sample may be biased towards fresh milk as the consumers were interviewed at the fresh unpackaged milk retail shops.

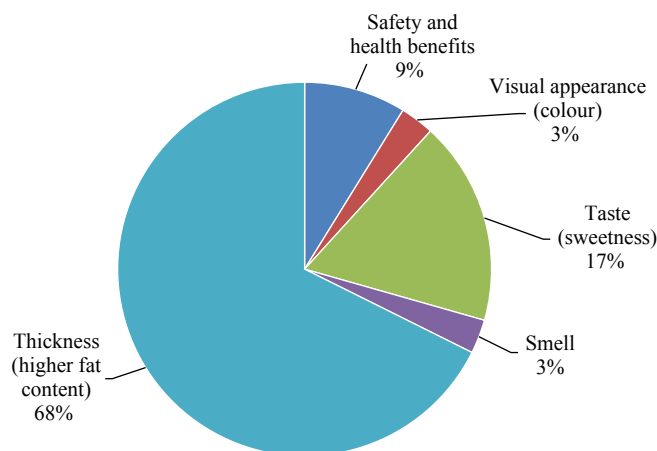


Figure 4. Milk attributes preferred by the consumers across 3 informal rural-urban milk value chains servicing the Lahore milk market (n=35).

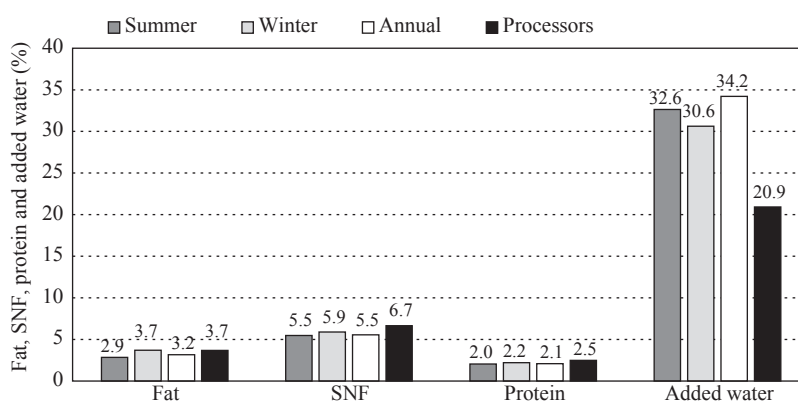


Figure 5. Milk composition in summer, winter and annually at the seven fresh retail shops and packaged milk sold by the formal processors. SNF = solids no fat; data recorded by Aslam (2015) and Aslam *et al.* (2016) (n=84).

Table 2. Average price and volume of sale from seven retail milk shops at the end of the three rural-urban milk value chains. Energy, calories, fat and protein are based on the data recorded by Aslam (2015) and Aslam *et al.* (2016).

	Fresh milk retail shops (N=7)	Formal processors: Nestlé, Engro and Haleeb
Unit volumes of sale for 1 litre standardised into ml	941 ¹	1000
Effective price per litre (USD ²)	0.59	0.96
ECM per litre ³ milk standardised to 4% fat and 3.3% protein	0.8	0.9
Energy (kcal per 100 ml)	56	63
Price per 100 calories (USD)	0.12	0.15

¹ The seven-fresh unpackaged milk retail shops were each selling 900 to 970 ml for the price of a litre of milk, which gave a mean value estimate of 941 ml. Milk was marketed as a litre, kilogram or by the colloquial term, *gadvi*.

² 1 USD = 94 PKR, official exchange rate from State Bank of Pakistan as an average of June and July 2012 (State Bank of Pakistan, 2013).

³ The formula from the IFCN (International Farm Comparison Network, 2017) has been used, which standardises milk to 4% fat and 3.3% protein using the energy corrected milk (ECM) equation: ECM milk = (milk production × (0.383 × % fat + 0.242 × % protein + 0.7832) / 3.1138).

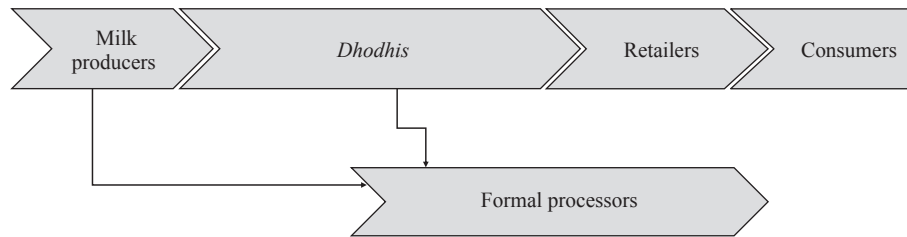


Figure 6. Formal and informal milk supply channels to the Pakistani consumer.

equivalent to the doubly priced Ultra Heat Treated (UHT) packaged milk sold by the large processors. These operators bought their bulk milk supplies from the informal local channels and supplemented their supplies by utilising and reconstituting cheap imported powdered milk when milk was in short supply (Figure 5 and 6).

The retail price of fresh unpackaged milk in urban markets was fixed on an annual basis by the city district government before the start of summer season. This price fixation policy did not apply to the packaged milk sold by formal processors. For 2012, a price of 57 Rs per litre (0.61 USD/litre) had been fixed. Retailer1 of Okara-Lahore chain said, "Price changes...after a year...the current price was fixed about two months ago...the rate will remain same in winter...the price will only change after a year". There was no logical rationale used to determine this benchmark government retail milk price for fresh milk. Some large *Dhodhis* cum retailers influenced the price setting mechanism, which meant they held substantial power in the urban markets. However, the fixed price was not strictly followed by the retailers and worked as a loose benchmark around which prices fluctuated. Depending on the nature of their business, some retailers acted independently to set their retail price based on the unit used while others relied on the large *Dhodhis*' business acumen in recommending a suitable price. The units for milk volume also varied widely across the chains and at various tiers of each chain.

The formal processors controlled the farm gate milk prices and thus were the key price brokers. The medium *Dhodhi* operating within the Okara-Lahore chain explained that price⁵ paid to farmers was dictated by the formal processors. In this case price setting was dictated by 'Adam Cheese, Chaudhry Dairies Limited, Nestlé', but it did vary slightly across the region according to the relative influence of each corporate entity.

These prices were associated with supply or production. The formal processor who said, 'Nestlé reviews farm gate milk prices paid on a weekly basis', verified this. He further stated,

the price is based on estimated domestic milk supply, competitors' demand and the international price of powdered milk. The average farm gate or contractor price range this year will vary from a minimum of Rs 37.5 (0.39 USD) to a maximum of Rs 50 (0.539 USD).

The large *Dhodhi* operating within the Pakpattan-Lahore chain stated that

The rate [price] can change any time in summer by fifty paisas to one rupee⁶...the prices go down from November to April [over the peak season for milk production]⁷...the prices are linked to the import of powdered milk by big milk factories as it is cheaper to them...the market slows with the import of powder...we give a price slightly higher than the company [processor].

⁵ Milk price information comes to a local bus stand located at a midpoint between a few villages, which is also a delivery and collection point for these informal milk chains.

⁶ Paisa and Rupee are Pakistani currency units. Paisa is similar to cents and one rupee is same as a one dollar (the dollar is much more powerful than rupee).

⁷ Peak production season due the lactation cycle of dairy animals and higher availability of green fodders.

The statement highlights the fact that the market is distorted by the importation of powdered milk and that there is competition between the formal and informal markets with the informal operators having to pay a higher price to procure milk.

The major farm gate price changes were therefore related to season, while minor price changes occurred on a regular basis and were either absorbed by the large *Dhodhis* or in some cases passed on to the small *Dhodhis*. The price offered by the chain to small *Dhodhis* was higher than that offered by the formal processors. The data gathered did not indicate that minor regular price changes were passed to the producers, but summer and winter season market price fluctuations were mentioned in almost all cases.

The large and medium *Dhodhis* operating in the Okara-Lahore chain appeared to strictly follow the formal processor prices. The same applied to the large *Dhodhi* operating in the Pakpattan-Lahore chain. This farm gate price determined by the formal processors worked as a benchmark, and the larger operators in these informal chains could not offer a price less than that to their small *Dhodhi* suppliers.

The large *Dhodhis* absorbed the fluctuation in rural milk prices to a large degree. Their small *Dhodhi* buyers informed the producers of prices, but these producers also consulted other *Dhodhis* and neighbours.

In summary, the key source of price information for all three chains in the urban market was the government price and in rural markets, it was the formal processors' prices. The large, medium and small *Dhodhis* operating within rural regions were well aware of the unwritten rural pricing rules.

The three-case study informal chains generated an estimated 4,872 employment opportunities from farm to market and conferred many advantages for the small producers, including:

- Interest free loans, initial cash advances to procure milk, a regular stream of income. Farmers used these advances to meet their household needs. The producers also borrowed money from their small *Dhodhi* buyer whenever a need arose. In all three chains, the small *Dhodhis* provided services such as the supply of fertilisers, feed supplements and even household groceries to the producer households.
- Rewards for higher butterfat content of milk: large *Dhodhis* offered an incentive to their supplier *Dhodhis* for higher fat content associated with buffalo milk which was passed on to the farmers.
- Acquisition of milk from the farm doorstep: farming is labour intensive and time-consuming. The small *Dhodhis* collect milk at the producers' doorstep, which saves them time and transportation costs.

Large *Dhodhis* in all three chains preferred collection of buffalo milk containing higher fat, and then diluted it with ice for the retail urban market in order to gain volume. This practice was also unavoidable given the absence of proper cool chain infrastructure. There was a lack of consistency between chains with each using different formulae to determine quality when buying milk. Keenly aware of this, larger buyers use a hydrometer to measure milk density to accurately gauge the level of dilution by addition of cooling ice/water.

Large *Dhodhis* operating in the Kasur-Lahore and Okara-Lahore chains used the same formula of 6% fat standard in milk to assess milk quality, as follows:

$$\text{Premium Paid} = \frac{\text{Milk in litre} \times \% \text{ actual fat}}{6\% \text{ base target fat content}} \times \text{Base Price per litre}$$

The Large *Dhodhi* operating in the Okara-Lahore chain was artificially inflating the fat content by 0.7% to account for the seasonal decrease in fat content for the milk collected over summer. This content was often less than the 6% standard at this time. This was confirmed by the first author's observation of the 5.7% fat average as the minimum standard used by the Kasur-Lahore chain's large *Dhodhi* for his total rural collection.

The larger operator in the Pakpattan-Lahore chain, however, had adopted the multinational milk processor Nestlé's standard of 13% total solids calculated as follows:

$$0.22 \times \text{Actual Fat} + 0.72 + \text{SNF} + \text{Actual Fat} = \frac{\text{TS per liter} \times \text{Gross volume}}{13\% \text{ TS}} = \text{Net volume}$$

where TS (Total solids) = Fat + SNF (Solid Not Fat)
and SNF (Solid Not Fat) = LR(lactometer reading) \times 0.25

The large *Dhodhis* of Kasur-Lahore and Okara-Lahore chains claimed to be supplying milk at around 4.8% and 4.5% fat respectively to the retail shops in the urban Lahore market. Similarly, the large *Dhodhi* operating in the Pakpattan-Lahore chain was selling milk at around 4.5 to 4.6% fat. He aimed to sell at 5% fat but was unable to do so given that Nestlé had lowered its minimum quality standard to 13% total solids from 14% at the farm gate (Table 3). This lowering of the standard by Nestlé meant small *Dhodhi* suppliers operating in the Pakpattan-Lahore chain gained volumes and had to be paid more for the milk procured. A worked example based on the formula above is as noted in Table 3).

The units of volumes to buy milk at the farm gate and sell at retail shops varied across and along the three chains (Supplementary Table S1). The unit alterations coupled with dilution of milk allowed the middlemen and retailers to generate profits amid tight margins.

4. Discussion

Fortunately the world does not face the prospect of large-scale famines, yet 842 million people cannot afford to eat an adequate balanced diet (Food and Agriculture Organization, 2014). Better nutrition therefore is of utmost importance to consumers in developing countries who spend half of their household budget on food (Asian Development Bank, 2011).

The application of this value chain framework approach to study the Pakistani dairy industry highlights the fact that the final consumers and markets drive the product standard and quality specifications (Kula *et al.*, 2006). Fat in milk is the attribute most valued by the Pakistani consumers with little concern for health and safety (Figure 4). Thus, the boiling of milk is practiced solely for the efficient recovery of fat to make ghee and not to render the product safe for consumption. Clearly there is a deficiency in the education process for consumers here. The consumers can also buy milk at a lower price if it is supplied by the informal chains. This milk is approximately half the price of packaged UHT long life milk, which has almost the same butterfat content (Table 2).

The current structure of the Pakistani dairy industry is similar to value chain in most countries that is large number of farmers and concentration as the product moves downstream to consumers. The large smallholder production base with 8.8 million milk producer households sell raw fresh milk as a homogenous commodity and individual farmers do not influence the prices they obtain (Bain, 1968; Kohls and Uhl, 2002; Seitz *et al.*, 2002). Formal processors (Zia *et al.*, 2011) represent an oligopoly model. These processors are mainly selling their own differentiated brands of UHT milk and exercise substantial power to set farm gate prices and charge a significantly inflated high price for the final product.

Table 3. Gain in milk volumes based on lowering the total solids per litre from 13 to 14.¹

Constant	Actual fat in milk	Constant	Measure LR that gives SNF	Actual fat	= TS per litre	Gross volume	TS %age	= Net volume
0.22	5.8	0.72	7.0	4.0	= 13.0	100.00	13	= 100.0
0.22	5.8	0.72	7.0	4.0	= 14.0	100.00	13	= 107.7

¹ LR = lactometer reading; SNF = solid not fat; TS = total solids.

The milk collection and distribution function performed by middlemen from informal marketing channels makes them indispensable. These informal chains are not only the key link between producers and consumers but also supply milk to the formal processors. The formal sector struggles with the logistics of the collection of commercially significant quantities of milk from small-holder farmers each offering very small volumes with inferior road networks connecting milk producing areas to markets using their network of central collection chilling tanks. The operators in small informal chains prevail because of their lower cost structure and their ability to collect from vast areas while offering financial security for farmers and distributing key household goods and provision of other services. They are therefore deep-rooted in local communities.

Table 4 compares the key difference among the three informal chain cases studied. The three case studies demonstrated that the milk valued chains generated substantial farm to market job opportunities. The comparison provided in Table 4 highlights several areas for further exploration. Two areas in particular warrant further exploration, namely: the governance of the chains and the nature of both quality and quantity as the profits associated with the current practices of informal chains. The provision of interest free loans to farmers in a financial environment where credit availability is challenging (Ahmed and Gautam, 2013) appears to provide an incentive to farmers to participate in the chains as well as being an important part of the governance of the chains. These receipts of a regular cash flow to meet their household needs of farmers, is a key competitive advantage of the informal chains in comparison to the formal packaged milk chains.

The *Dhodhis* are also vertically integrating downstream at the retail end and represent the characteristics of monopolistic competition. These chains have established their own brand name (first author's observation based on field research not mentioned in the results) at their specialised milk retail outlets. This branding gives them product differentiation. They also understand what consumers really value, that is, high fat buffalo milk, and these chains have mechanisms in place to meet this consumer preference at a low price, again providing a key competitive advantage.

Table 4. Cross case table for the three case study chains.

Case study number ¹	Physical flows	Financial flows	Technology and infrastructure	Governance	Information flows
Case 1: value chain 1: rural Kasur- urban Lahore chain	Small volumes in total (1,400 litres)	Large <i>Dhodhi</i> extended cash advances to small <i>Dhodhis</i> who then extended loans to farmers	Poor cool chain facilities extensive use of ice to cool milk – refrigerator in retail store	Large <i>Dhodhi</i> less control at production level but significant control at retail level	No tracing system claim made
Case 2: value chain 2: rural Okara- urban Lahore chain	Moderate volumes (2,350 litres)	Large and medium <i>Dhodhis</i> extended cash advances to small <i>Dhodhis</i> who then extended loans to farmers	Poor cool chain facilities extensive use of ice to cool milk – refrigerator in retail store	Large <i>Dhodhi</i> control at production and retail levels	Claimed to trace quality issues back to small <i>Dhodhi</i>
Case 3: value chain 3: rural Pakpattan- urban Lahore chain	Large volumes (23,387 litres)	Large <i>Dhodhis</i> extended cash advances to small <i>Dhodhis</i> who then extended loans to farmers	Good cool chain with chillers installed by large <i>Dhodhi</i>	Large <i>Dhodhi</i> less control at production level but significant control at retail level	No tracing system

¹ One of the two Large *Dhodhi* operators of Pakpattan-Lahore chains identified earlier declined to cooperate, thus Case 4 Value chain 4: rural Pakpattan-urban Lahore chain has been dropped from further consideration in this study.

The key message for regulatory authorities from these studies relates to the need for competitive pricing market policies that ensure that small-holder farming communities receive a fair return over the cost of production for their milk. There is a need for pricing incentives for the production of a high-quality product recognised as such by urban consumers. Clearly education of all actors along marketing chains needs to be implemented to boost the health status of the vast milk consuming population of Pakistan.

5. Conclusions

This study demonstrates that the informal chains provide a fresh milk cheaper than packaged milk as a source of calories for urban consumers. These chains operate amid tight margins and appear to require other incentives for participants to be involved. At the rural end, the chains provide farmers with access to interest free credit and regular cash flows that encourage their participation and possibly play an important role in the maintenance of relationships in, and governance of, the various chains. The role of the large *Dhodhi* in the governance of the chain is an important area that requires additional exploration. In particular, the dynamics of power, coordination, control and the nature of relationships at different tiers of the chains in relation to the effective operation of the chains requires further research.

The biased urban government price fixation policies and collusion by large formal processors to fix farm gate prices adversely impact the industry amid a complete absence and implementation of product quality and quantity standards. Low margins along the chain could be a factor in the variable quality and quantity of the final product with consumers having to trade off quality for price. There is a lack of consistency in how product quality is maintained across the various chains with one chain being partially based on chillers while the other two worked with ice. Approaches to maintain product quality along the chain need to be researched further incorporating and examination of the relationship between quality, price and method used to refrigerate milk.

Policy intervention is obligatory on the part of the government in relation to this deficiency to facilitate a fair and balanced pricing mechanism across the industry. There is also clearly a need for raising awareness of consumers on the nutritional virtues of untainted milk with clear labelling from both formal and informal channels. The potential for the dairy industry in Pakistan to meet increasing domestic demand and become a major exporter of dairy products will depend on these key reforms to its *modus operandi*.

Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2017.0122>.

Table S1. Physical and financial flows (per day) along the three fresh, unpackaged milk value chains in Punjab.

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\$(protocol):/www.wageningenacademic.com/doi/pdf/10.22434/IFAMR2017.0122 - Sunday, November 18, 2018 7:59:22 AM - Harper Adams University College IP Address: 193.61.96.229

