An analysis of raw milk transportation and possible strategies to maintain milk quality in Matabeleland region, Zimbabwe.

A Research Project Submitted to
Larenstein University of Applied Sciences
In Partial Fulfilment of the Requirements of Degree of Master in
Agricultural production Chain Management,
Specialization Livestock Production Chains

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September 2011

Wageningen
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Acknowledgement

I would like to gratefully thank the Netherlands Organisation for International Cooperation in Higher Education (NUFFIC) for the study opportunity and financial support during my research study and the entire master programme.

I also thank the staff members at Dairy Services Bulawayo region for the support during data collection for the research study. Many thanks to dairy farmers in Matabeleland region for sparing time from their ever busy farming schedule to answer my questions during interviews. Special thanks go to my supervisor Jan Hoekstra and course coordinator Marco Verschuur for the assistance and guidance from research proposal until completion of the study. Glory to God for making everything possible.

Dedication

I dedicate this work to my wife Janet, daughters Tatenda, Tendai and son Tadiwanashe for enduring my long absence from home during the studies.

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Abbreviations and Terms

AGRITEX	Agriculture Technical and Extension Services
BMC	Bulk Milk Collection
CFU	Commercial Farmers Union
CIP	Cleaning In Process
DLP&D	Department of Livestock Production and Development
DR&SS	Department of Research and Specialist Services
DZL	Dairibord Zimbabwe Limited
MBC	Milk Bulking Centre
MCC	Milk Collection Centre
NADF	National Association of Dairy Farmers
NDC	National Dairy Cooperative
SCC	Somatic Cell Count
SHODFAZ	Smallholder Dairy Farmers Association of Zimbabwe
TBC	Total Bacterial Count
TNTC	Too Numerous To Count
VET SVS	Veterinary Services
ZDIT	Zimbabwe Dairy Industry Trust
ZDPA	Zimbabwe Dairy Processors Association
ZFU	Zimbabwe Farmers Union

Producer	- dairy farmer
Transportation	- In this research context, collection of milk from farms including milk storage facilities to processors including handling facilities at milk intake bay.

Abstract

Zimbabwe has an agro based economy. The agricultural sector, like many others in the country has been faced with many challenges for over a decade. There is a huge decline in raw milk production volumes from the dairy producers. This has been as a result of a decline in the national dairy herd. There are several smallholder dairy producers who are still faced with challenges of acclimatising to the challenges posed by the capital intensive industry. The study analysed raw milk transportation and the effect on quality in Matabeleland region of Zimbabwe. The major aim of the study was to come up with strategies and recommendations for improvement of raw milk transportation from the farms to the milk processing plants. Dairy sub sector stakeholders' opinions and views were mostly used in finding the state of affairs in transportation of raw milk from producers to processors. The stakeholders included mostly dairy producers, quality managers of milk processing plants, managers for bulk milk transporters.

A survey was conducted with 32 dairy farmers using questionnaires. Clustering of farmers was according to whether the farmer is on bulk milk collection or can milk delivery. 16 farmers on bulk milk collection were randomly selected. Another 16 producers on can milk delivery were also randomly selected. For the bulk milk collection producers, sub clustering on bulk collection by National dairy cooperative and bulk collection by processor was used. Interviews were done with key informants from milk processing plants and transporters. Information gathered for study included milk volumes supplied, collection intervals, transportation time from farm to processor, milk temperature, condition of vehicles, containers and milk handling facilities. Hygienic factors like detergents for cleaning equipment and storage of milk handling equipment was studied. Data collected was both quantitatively and qualitatively analysed. SPSS was used for statistical analysis.

The study established that the vehicles and containers used for raw milk transportation in Matabeleland region are too old and in bad state. Volumes produced by farmers are low in comparison to capacity of bulk milk trucks. Milk is staying for long time at dairy farms after milking before being transported to processing plants. There is need for smaller milk collection trucks and bulking or collection centres for milk before being delivered to processing plants. Sufficient staffing for Dairy services unit is important for efficient execution of duties like training of bulk milk tank drivers.

CHAPTER 1: INTRODUCTION

1.1 Background

The dairy sub sector in Zimbabwe has been facing big challenges for the past decade. A large number of dairy producers have left dairy farming especially from the Large Scale Commercial Producers. This has also seen a huge decline in the national dairy herd. As a result, national milk volumes have drastically reduced. Zimbabwe has been experiencing consecutive droughts from the year 2000 to 2010.The agriculture sector has been underperforming as most cropping is done using natural rainfall. The underperformance of crops has led to scarcity of raw materials for manufacturing of stock feeds. The raw materials which include maize grain, sorghum, soya bean and cotton seed have been in short supply to the stock feed manufacturers. Food consumption for humans has also resulted in raw materials for stock feed being channelled to human foodstuffs. The agricultural challenges faced by the nation have led to a sharp decline in milk volumes produced. As a result, most framers have moved from Bulk Milk Collection to can deliveries. This has resulted in several types of containers not conforming to dairy regulations being used for transportation of milk to processing plants. Milk rejections have increased at processing plant intake and milk processed products have become few in small shops and supermarkets. Milk producer price has been constant for some time whilst prices for stock feed have been regularly reviewed. The cost for transporting milk from the farm to processing plants has been increasing mostly because of the low volumes of milk compared to the distance from the farm to the processor.

1.2 Research problem

There is an increase in deterioration of raw milk quality during transportation and several milk consignments are being rejected at milk processing plants intake. This is resulting in low milk volumes for processors and poor dairy product quality in Matabeleland region. Raw milk is no longer reaching milk processing plants in good quality as it is taking long and sometimes not in good milk handling facilities.

1.3 Justification of study

Milk transportation is of paramount importance as deterioration in milk quality or milk spoilage will mean a complete loss to the entire milk consignment meant for processing. In the dairy value chain, it is important for every actor to maintain quality of the commodity as required by the chain actors. Quality is meeting or exceeding customer and consumer expectations (Luning and Marcelis, 2009). Zimbabwe is currently facing shortages in raw milk volumes resulting in processing plants operating far below capacity and eventually few milk processed products in retail shops. In 2010, Matabeleland region lost 20% of its annual milk intake at processor level due to milk rejections (Dairy Services 2011). Therefore it will be disastrous to incur further raw milk losses during transportation. Dairy Services as a government unit in Department of Livestock Production and Development are the authority responsible for monitoring the dairy sub sector. There is need to analyse raw milk transportation and recommend ways for further improvements in raw milk transportation.

1.4 Research Objective

To analyse raw milk transportation from farmers to processors in Matabeleland region and find out how raw milk transportation can be improved to maintain milk quality and reduce rejections related to raw milk transportation.

1.5 Research Questions

Main Question 1.

What are the factors to be considered for maintaining quality during raw milk transportation from farms to processing plants?

Sub questions

a) What volumes and at what intervals is milk transported to milk processing plant?
b) What facilities and equipment are being used to carry raw milk to processing plants?
c) What are the causes of raw milk spoilage during transportation from farms to processing plants?
d) What are the costs incurred in transporting raw milk to processing plants?

Main Question 2.

What are the quality aspects of raw milk being considered by milk processing plants to accept raw milk?

Sub questions

e) What are the quality standards for raw milk?
f) What kind of tests are done for raw milk at farm and processing plants to assure milk quality?
g) What are the contributions of milk processors in maintaining raw milk quality?
h) What regulations are in place for raw milk transportation?

1.6 Geography of Zimbabwe

Zimbabwe is located in south central Africa and has a total area of approximately 39 million hectares. The country is landlocked between the Zambezi and Limpopo rivers. Zimbabwe lies almost entirely over 1 000 feet (300metres) above sea level. It is bordered by South Africa south, Botswana to the south west, Zambia to the north-west and Mozambique to the east. The climate is tropical. The rainy season lasts from November to March followed by 8-9 months of warm and dry weather. Natural hazards in Zimbabwe include recurring droughts and unpredictable rainfall, though severe storms are rare.11 million hectares is commercial farming land. Only the central plateau and regions with altitudes above 1000metres are suitable for dairy production. The country is divided into five natural ecological regions as shown below.

Table 1.6 Natural Ecological regions of Zimbabwe

Ecological region	Rainfall	Dairy production system
Region 1	>1 000 mm	Varies from intensive zero grazing, through irrigation pastures to dairy ranching with low feed inputs.
Region II	750 –1000 mm	
Region III	650 – 750 mm	Most feeding is out of the bag, with some home mixing where irrigation is available.
Region IV	450 – 650 mm	Irrigation providing for pastures and crops for home mixing where irrigation is available and the balance of feed is bought in.
Region V	< 450 mm	Extensive Livestock farming

1.7 Description of Matabeleland Milk Chain

80% of the milk which goes to milk processing plants in Matabeleland region is produced by large scale commercial farmers. The remaining 20% is supplied by small holder producers. Milk from large scale commercial producers is of better quality compared to the one supplied by smallholder farmers. This is due to poor milk handling facilities compared to the ones used by large scale commercial farmers. The economic hardships and land reform programme has resulted in disturbances in the dairy sector in the region as well. Milk processing plants require milk of good quality from producers as well as consumers who are comparing local products with imported milk products.

Although Bulawayo is the second largest city in the country and major city for Matabeleland region, there has been little progress in terms of developing the city and region as compared to the capital city Harare. This has seen the region faced with several business challenges ranging from economic and semi arid environmental conditions.

CHAPTER 2: LITERATURE REVIEW

2.1 Dairy sub sector in Zimbabwe

Dairy sub sector in Zimbabwe is composed mainly of the large scale commercial dairy producers and small holder producers. The economic challenges faced by the country have impacted heavily on the dairy sub sector. Production cost has become high while producer price vary amongst milk processors but constant for a long period of time. As a result the dairy herd has drastically declined with the consequence of very low milk volumes produced for actors playing the processing function. Most farmers from the commercial large scale sector have either quit reduced dairy herds or ventured into other agricultural enterprises. The large scale sector is the one which supplies milk to milk processing plants in urban centres whilst the smallholder farmers are supplying Milk Collection Centres doted around shopping centres in small towns and district shopping centres. A number of national and international support is channelled towards the dairy sub sector. This includes Dairy Development Programme, Stabex project by the European commission. Milk processing plants include Dairibord Zimbabwe Private Limited, Nestle, Kershelmar Dairies, Kefalos Dairy, Dorking Dairies, Denluce, Sedgemoor, Crofthead among other several small processors who are cropping up due to deregulation of the sub sector.

2.1.1 Large scale commercial producers

Large scale commercial producer is composed of both white and black farmers with the white farmers being majority and black farmers slightly lower. The large scale sector is dominated by exotic pure dairy breeds which include the Friesian, Holstein, Jersey, Red Dane, Ayrshire and some cross breeds. Milk production from these animals is high averaging 20-30 litres per animal per day and over 300 day lactation period. Milk volume from this sector is high and is transported by National Dairy Cooperative (NDC) bulk milk tankers. Of late, some of the large scale producers are now having milk transported by the processor. Processors like Dairibord Zimbabwe Limited and Kershelmar Dairy have decided to venture into milk procurement for the producers who are supplying their plants with milk.

2.1.2 Small holder producers

Small holder producers are composed of farmers in communal and resettled areas. These farmers own 10 animals with about 5 milking cows on average. Milk has been mostly for home consumption. Establishment of Milk Collection Centres (MCC) has been a drive to most smallholder producers to come into commercial dairying. Production for most smallholder producers is not market oriented. This has greatly influenced the prevailing poor milk quality standards both hygienically and compositionally. Research and development efforts need to look at present and potential market demand. A consumption to production approach is required from various stakeholders evaluating especially small holder dairy farming systems shaped by interactions of economics, policy and technology. (Thorpe and Miriuki 2000). The establishment of milk collection centres has also seen a number of increase in dairy cross breed herds in the communal communities and an increase in milk production levels. On average 4-5 litres per day and around 200 lactation days. Cross breeds include those of local breeds and pure exotic breeds. Local breeds include Mashona, Nkone and Tuli and are very common in the smallholder areas. Transportation of milk to Milk Collection Centres is done by the producers themselves in most cases. This is due to the small volumes produced and most producers in smallholder areas find it too expensive to be on Bulk Milk Collection. The major constraints faced by smallholder dairy farmers in the semiarid areas are shortage of feed and transport. Rangeland is the common source of feed for the dairy animals.

2.1.3 Milk processing plants

Milk processing involves large investments in plant and equipment. For milk processing plants to operate efficiently, the facilities need to be used to full capacity year round, every year. This is difficult to achieve when there are big variations in raw milk supplied from year to year within seasons (Kohls and Uhl 2002). Few locally processed dairy products have contributed to influx of several imported dairy products on local market. Milk processors are not happy with the current situation though raw milk production levels are low to increase operational capacity of processing plants. Trade issues in the dairy industry often raise strong emotional reactions with problems assuming a greater importance than their substantive importance justifies (Grant 1991).

There are several milk processing plants in Zimbabwe despite the low milk volumes currently produced by the dairy sub sector. Processing plants are found in most regions of the country although Mashonaland region has the highest number of milk processing plants. The processors vary from individual dairy producers who have vertically integrated into processing and big organisations with various share holders. DZL and Nestle are the biggest processing plants in Mashonaland region. There are also other processor like Kefalos, Dorking and Denluce dairy. Transportation of milk is done by NDC, NFB and by producers themselves using cans. Matabeleland region has Kershelmar, DZL and Umzingwane as organisations processing milk. Sedgemoor and Crofthead are individual dairy producers who have ventured into dairy processing from their raw milk. However poor raw milk transportation services offered by NDC have resulted in processors like Kershelmar and DZL (NFB) venturing into raw milk transportation.

2.2 Zimbabwe Dairy sector value chain map

The following actors, supporters and influencers are found in the Zimbabwe dairy sector value chain. Information flows which include milk volumes, prices and manufacturing and expiry dates are also indicated at different actor levels on the map. The role of market information network is to collect process and disseminate market data systematically and continuously and make it available to users for decision making purposes (Schubert, 2008). This is also evident in the Zimbabwean dairy chain map.

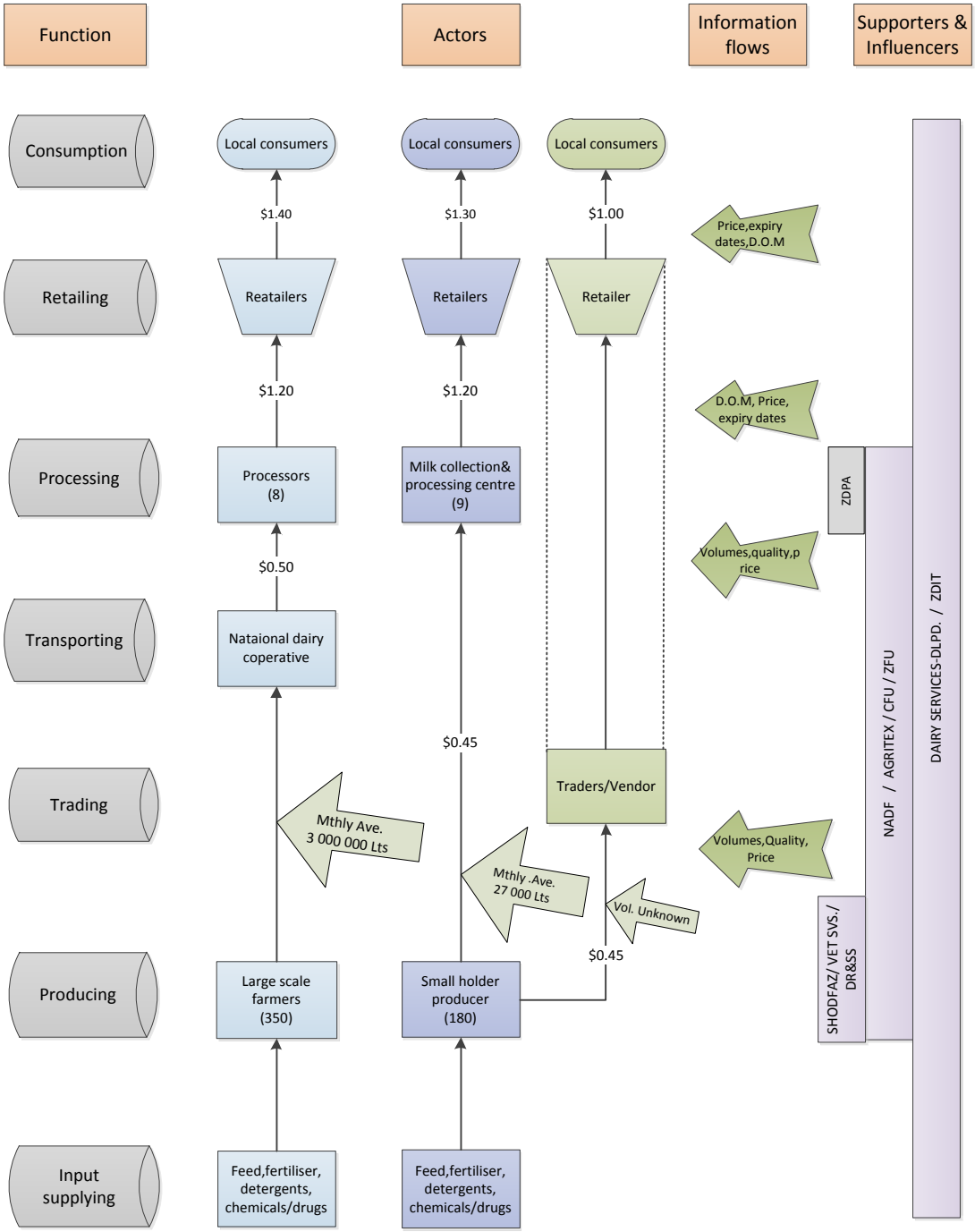

Figure 2.1 Zimbabwe dairy sector chain map

2.3 Steps in raw milk transportation from producer to processors

2.3.1 Steps followed in bulk milk collection

Milk is stored in a farm bulk milk tank. The farm bulk milk tank is made of stainless steel and vary in terms of capacity from 500litres to 9 000 litre tanks. Farm bulk tanks are fitted with an agitator. An agitator assists in having uniform milk temperature in the bulk tank. Farm bulk tanks also have thermostats for controlling bulk tank temperature. Temperature should be maintained at 4°C to avoid bacterial replication. Milk is supplied to processors within 72 hours after milking.

All bulk milk tanker drivers are trained by Dairy Services before being allowed to collect milk from the farms. On collection milk from farm, driver should run agitator first before taking a bulk tank sample. The driver does organoleptic test like smell, visualise the milk, check tank thermometer as well as feeling the tank temperature and taste the milk if necessary. A stainless steel dipper is used to take a sample from each individual tank at the farm. A sample for each farm bulk tank is identified with a sticker showing name of producer, collection time, tank capacity and collected volume. Samples are placed in a cooler box with ice packs to maintain temperature on transit to processing plants. Milk is pumped into truck bulk tanker if the driver is satisfied with the quality. The driver may reject the milk to avoid contaminating the entire bulk truck. The bulk tanker should have functional cooling system to maintain temperature during transit.

At processor intake bay, bulk tank truck arrival time is recorded. Laboratory technician carry out organoleptic and platform tests before milk is offloaded into plant milk silos. If bulk truck milk sample fails, milk is rejected and Dairy Services technician will conduct tests to approve quality of the milk. Individual producer samples are tested to identify problematic producers. All individual farm bulk tank samples are taken to Dairy Services laboratory. Samples are tested by dairy services laboratory technicians and the results are posted back to the individual producers as well as processors. Results of raw milk samples tested by Dairy Services are used for producer milk payment by milk processing plants. Dairy Services tests results are used for payment purposes as a neutral unit to avoid disputes between processor and producers.

2.3.2 Steps followed in can milk delivery

Stainless steel cans are mostly used for can milk deliveries. Milk cans vary in size from 30 litres and majority being 50 litre cans. Aluminium cans used to be very common but of late, the cans are rarely used. Cans are fitted with a lid and usually a small chain permanently attaching the lid to the can to avoid complete separation of the two. Plastic milk containers are increasingly being used by dairy producers. The containers also vary in sizes from 5 litres, normally used by smallholder producers up to 100 litre plastic containers also used by some large scale producers.

Cans filled with milk are placed in an immersion cooler which is a pool of water used for maintaining low milk temperature at 4°C. Milk cans are also placed in the refrigerator set at 4°C to maintain milk temperature. Disadvantage of refrigerator is the limited capacity to accommodate a larger number of cans. Milk is supplied to processors within 72 hours after milking.

Milk is delivered to milk processing plants using a van or pick-up truck. Deliveries should be early in the morning to take advantage of low morning temperatures during transit. Deliveries are to be done within an hour of transit time especially when using transport without refrigeration facility. A vehicle should have a canopy or shed to protect milk cans from dust or sun shine.

Milk cans are checked and tested. If the cans are numerous, random sampling can be done to assess the milk quality. Milk can be rejected by the processor if not satisfied with the quality of milk. A dairy Services technician will be called to approve the status of the milk to avoid disputes between producer and processor on quality of the milk. Time of arrival, temperature, volume and name of producer are captured at the milk intake bay.

Table 2.3 National Dairy data

Year	Milk volumes	No. Registered Producers
2005	90 947 139.00	278
2006	81 336 620.00	279
2007	72 771 351.00	278
2008	42 777 234.00	271
2009	31 987 042.61	207
2010	26 282 472.00	385

Source: Dairy Services

Table 2.4 Milk processors volumes and plant location

Processor	Regional location	Monthly average of daily intake (litres)
DZL	Mashonaland, Manicaland Midlands & Matabeleland	700 300
Kershelmar dairy	Matabeleland	360 047
Mzingwane Dairy	Matabeleland	3 000
Nestle	Mashonaland	506 343
Kefalos	Mashonaland	634 188
Den Dairy	Mashonaland	600 630
Dorking	Mashonaland	6 500
Dunluce	Mashonaland	150 000
Sedgemoor Dairy	Matabeleland	35 000
Crofthead Enterprises	Matabeleland	25 000

Source: Dairy Services

2.4 Milk quality

Milk is a highly nutritious product and that makes it a good medium for bacterial growth. As a result, milk can be a good source for bacterial infections to humans if consumed in its raw state before pasteurisation. In environments where the consumers are of low class and unaware of risks pertaining public health and food quality, unscrupulous operators tend to bypass quality management principles thereby putting at risk both public health and the image of the sector (Gadaga, 2003).

Milk quality is mostly looked at from two folds. These are hygienic quality and compositional quality. Hygienic quality is concerned with the micro biological load for the milk whilst compositional quality is concerned with the chemical constituencies making up the milk. Microbial spoilage of raw milk can potentially occur from the metabolism of lactose, proteinaceous compounds, fatty acids (unsaturated), and the hydrolysis of tryglycerides.(Bibek 2001).Hygienic quality is measured in various ways which include Methylene blue reductive test, and the most commonly used being Total Bacterial Count.
For composition, fat content, protein, lactose, minerals and somatic cell counts will determine the milk quality.

Selling of raw milk for public consumption is illegal in most developing countries. This is due to the low hygienic standards of milk which poses a big threat to milk borne diseases like tuberculosis, measles, contagious abortion among others. In some developed countries raw milk can be sold for public consumption. This is enabled by high milk hygienic standards and food and dairy regulations which are highly adhered to.

Table2.5 Raw milk and milk products legal standards for Zimbabwe

Test	Product	Legal Requirement
Butterfat	Raw and pasteurized milk	3%
Solids non fat (SNF)	Raw milk	8.5%
Coliforms	Milk and milk products	Nil
Yeasts and Moulds	Milk and milk products	Nil
Phosphatase	Pasteurised milk	<10g of p –nitro phenol/ml
Total Bacterial Count (TBC)	Raw milk	<500 000/ml
	Pasteurised milk	<20 000/ml
Freezing Point Depression	Raw milk	At least 0.530° Hortvet (H)
Triphenol Tetrazolium Chloride	Raw milk	Negative

Source: Dairy Services

2.4.1 Effect of equipment/material on milk quality

Handling methods employed during transportation and storage affect milk quality to a great extend. Milk handling material type also affects milk quality. Spoilage and contamination of raw milk occur as a result of poor hygiene, extended time of transportation and lack of suitable storage facilities. Poor hygiene to a greater extend has been one of the most important reasons of spoilage of products (Bonfoh 2006). Most common materials used include stainless steel and plastic containers. Plastic containers have adhesive properties which make them difficult to clean. Costs and availability of appropriate and recommended materials are the limiting factors especially in developing countries. Within the dairy industry, cleaning and disinfection is carried out on a daily basis, sometimes several times a day. (Lelieveld, Mostert and Holah 2005). This is supposed to be the case with all dairy premises even in developing countries but the opposite may found to be true.

2.5 Milk transportation in Zimbabwe

Originally, the Bulk Milk Collection Scheme was run by the Dairy Marketing Board now called Dairibord Zimbabwe Limited. After privatisation of most parastatals like Dairy Marketing Board, milk collection was taken over by the National Dairy Co-operative, and the system is run as a commercial enterprise. Members of National Dairy Co-operative are mostly the large scale commercial producers and processors in the sub sector value chain. Of late due to inefficiencies by National Dairy Cooperative, Dairibord Zimbabwe Limited, Kershelmar Dairies and other processors have ventured into acquiring of bulk milk transportation trucks. Frequent power cuts, high fuel and stock feed prices have also led to a reduction in milk volumes produced by farmers and this has seen quite a number producers opting to deliver milk in cans to processing plants. Much as it has resulted in cost saving on the producers' point of view, this has resulted in a chain of problems due to poor quality as a result of milk transportation to processing plants. This is not desirable for the entire performance of the dairy value chain. Large volumes are being rejected at milk processing plant intake and leading to limited dairy processed products. Milk transportation in Matabeleland is mostly done using three channels. National Dairy Cooperative (Bulk Milk Collection), Processors Collection (Bulk Milk Collection) and Can delivery by producers.

2.5.1 National Dairy Cooperative

Large scale commercial producers are mostly on bulk milk collection which is done by National Dairy Cooperative (NDC). The cooperative is owned by the producers and also offer services to non cooperative members.NDC owns a fleet of trucks which are used for milk collection around the farms to milk processing plants. Producer organisations strengthen smallholder's positions in markets, strengthen bargaining power, reduce transaction costs and raise the voice of smallholders in the policy process (World Development Report 2008). This is supposed to be the case with NDC but of late the producer organisation has resulted in loss of faith from the Matabeleland client base. The trucks have a capacity to carry over 30 000 litres and are divided into two compartments. Trailers are also used which have a capacity of about 10 000litres. It is rare to have a truck with a trailer going for milk collection because of the drop in milk volumes even from large scale commercial producers. Producers pay for transport cost after receiving payment from milk processing plant.

2.5.2 Milk collection by processors

Dairibord Zimbabwe Limited use its fleet of trucks to collect milk from producers which supply raw milk to its processing plant and other clients who may require its services. NFB logistics is owned by Dairibord Holdings Limited. NFB logistics is into transport logistics within Zimbabwe and in southern African region. NFB gives transport services to Dairibord subsidiaries or group companies, third parties and non group customers. NFB has a range of trucks as it is involved in various transportation logistics. For milk transportation, insulated bulk tank trailers are used to maintain ambient temperatures over long and short distances. Refrigerated trucks are used for processed products for maintenance of right temperatures. Flat decks are used to carry containers for other goods besides milk transportation.

Kershelmar Dairy is another processor in Matabeleland which has ventured into milk transportation. Currently has two trucks with 20 to 30 000 litres capacity. The bulk milk tankers are insulated and milk transportation is from producers who are supplying Kershelmar dairy only.

2.5.3 Can milk delivery by Producers

Can delivery was mostly practised by smallholder producers and a few commercial producers who were producing low volumes. It has become a common practise these days for both smallholder and large scale commercial producers to deliver milk to processing plants using cans. This can be attributed to the decline in milk volumes in the large scale commercial sector. The cost of transportation charged by the cooperative can be another influencing factor. The cans used are stainless steel cans though plastic containers have of late become familiar. Milk processing plants are also sourcing stainless steel can for the producers. In most cases the cans are offered by the processor and the producer is obliged to deliver to that particular processor. As most producers have lost faith in the milk transporter (NDC), this has resulted in insufficiency in the number of proper stainless steel cans for the producers. This has led to use of containers which are not appropriate and difficult to sterilise posing a threat to raw milk quality delivered to processing plants.

Most smallholder producers are supplying milk to Milk Collection Centres. Milk Collection Centres are processing raw milk into various products like yoghurt and pasteurised milk like processing plants does. Producers supplying milk collection centres use their own transport to ferry the milk to the centres. The European commission through NADF has promised to buy small trucks which will collect milk from their farms and homesteads. This will go a long way in cost reduction for the smallholder producers. European small holder dairy projects are being conducted in association with National Association of Dairy Farmers. (NADF)

2.6 Milk transportation in other countries

Raw milk will be around 37.2°C to 38.8°C when milked directly from the udder. Raw milk need to be chilled as fast as possible to around 4.4°C preferable within an hour to avoid

bacterial replication which doubles every 20 minutes at body temperature. Chilling the milk fast will prolong the shelf life, reduce off flavour. The cold chain should begin from the bulk tank at the farm. Milk should be stirred as it is rapidly cooling and to be kept cool during transportation and storage until use.

India produces highest volumes of milk in the world. The country has the highest buffalo and cattle population in the world as well. The dairy community is characterised by marginalised and small farmers who have dairy animals mostly for home consumption. High milk volumes are marketed through a disorganised market sector. This is done through milk vendors, wholesalers, retailers and farmers themselves. The organised dairy sector is dominated by cooperatives which account for approximately 20% of total milk production. (Rajendran and Samarendu 2004).

In Michigan in the United States, there is a division of Food and dairy which is under Department of Agriculture and Rural Development. This Food and Dairy Division administers companies, milk trucks and hauler or sampler who pick up and deliver milk from the farms to processing plants within the state. The milk transportation company has to be licenced by state of Michigan. The person who collects raw milk samples and transport raw milk from the farm to the processing plant, receiving station or transfer station must have a licence or permit to carry out those duties. (Food and Dairy Division 2010).

2.6.1 Milk in cans

Milk that is transported in cans is usually carried by small vehicles to processing plants. For smallholder farmers, transportation could be by bicycles. The cans should be protected from the sun before and during transportation to the processing plant. Insulated or refrigerated trucks are recommended to transport cooled milk in cans over long distances especially under high ambient temperatures.

2.6.2 Milk in bulk

If milk is stored in a bulk cooler at the farm, it is advisable to have the milk transported in bulk as well to milk processing plant. It is a bad practice to transport milk in cans from a bulk cooler. There are high chances of contamination if milk is to be transferred from bulk cooler into numerous small cans. Temperature of milk in cans is difficult to control than in bulk. Besides contamination risk, filling and later on emptying and sanitising of cans requires more labour and is costly. Truck mounted road tankers or haulers are usually used for transportation of bulk milk. Tanks should be insulated and can also have a shield to protect milk from an increase in temperature. Shield is of importance in conditions of high sunshine.

2.6.3 Tank trucks/ haulers

Bulk milk collection is done by special trucks manufactured for this purpose. The tanks are fitted with a hose, milk pump, a filter, milk flow metre, sampling equipment and a refrigerated cabinet for sample bottles (Van den berg 1988).

2.6.4 Milk volumes and collection intervals

Frequency of collecting milk from farm depends on farm storage capacity and refrigeration temperatures which the farm can achieve. Less frequent milk transportation results in less costs but providing the processing plant with quality milk is very important. It is possible to store milk at farm for 7 days provided the initial milk quality is excellent. However, in practice milk collection is done every 3 days or every 3 days with daily collection being less common.
Milk can be supplied to the processing plants by farmers themselves or by the processing plant (processor). It is also possible to contract a third party who can be a professional transporter. In cases where dairy farmers are far away from processing plant and more common with small suppliers, it will be preferable to establish milk collection point where the milk will be picked and transported to the processing plant. This system may also have

advantages in areas even not too far away from the processing plant as it allows milk deliveries to the processing plant to be spread out over the day. The other advantage of a collection point is avoidance of congestion of individual suppliers at the plant. A collection point can be merely an open spot along the roadside or at a dairy farm with dairy and necessary equipment and laboratory and permanent or part time workers. In situations where milk will be transported over long distances, it is recommended to cool the milk on the farm or in collection centre before transportation as it will obviously take long time to reach the processing plant. Uncooled raw milk must be transported as quickly as possible to milk processing plant and this requires an efficient transport system and also leads to peak hours of operation for the transporter.

2.6.5 Milk transportation costs

Transporting milk efficiently and effectively has a cost bearing. This is particularly important for recommendations to be made for improvement of regional milk transportation system. Therefore there is need to know the components which makes up transport cost. Transport cost for raw milk consists of the following cost components.

Fixed costs- these include cost of the vehicle, insurance, road tax and overhead charges. These costs are independent of mileage.

Variable costs- this include labour (wages), fuel, vehicle tyres, repairs and maintenance. These costs are dependent on mileage and usage.

2.7 Business agreements between producers and processors

There are various business agreements between producers and producers in Zimbabwe. Contracts are mostly common between producers and processors. Producer will supply the processor a certain volume of milk and a bonus or premium is paid for supply up and above the stipulated volume for that particular month. Contracts are mostly on annual basis and are renewed after each year if both parties are still interested in the business relationship.

2.7.1 Legislation and policies

(McEachern and Mountjoy 1999) noted that policies on marketing of dairy products in developing countries have often relied on standards originating from developed countries where large-scale production systems, cold chain pathways, and milk pasteurization are key features. However, some of these standards may be inappropriate in developing countries, owing to climate, poor infrastructure, and large distances. This calls for a relook at dairy policies and legislation to create an enabling environment for the current actors to perform well, urging improvement of the entire chain. A value chain approach and awareness amongst all actors is essential to preserve the safety, nutritional value and other good qualities of one of the earth's most nutritious food.

A desirable situation will be for the actors in the chain to be self driven on quality issues. However government interventions can take various ways. Direct command and control (CAC) and information-based interventions that provide incentives for private market solutions (Latin and Nordhaus 1983).

Direct interventions include CAC standards for performance, e.g. pathogen counts for products at some stage of the marketing channel (Hathaway, 1995).

2.7.2 Regulations for milk transportation

Zimbabwe dairy regulations stipulate that milk shall be transported by vehicles inspected and approved for the purpose of milk transportation. The requirement include that the bulk milk tank shall be used for milk transportation only. The tank truck shall be made of material conducive for milk transportation without compromising the milk quality. The manholes to be fitted with rubber seals to prevent dust and other foreign bodies from contaminating the milk. Bulk tank compartments to be fitted with spray balls, milk inlet, outlet valves. Vehicles to be regularly checked by dairy inspectors and swabbed for hygienic tests. Drivers to be trained and have a proficiency certificate before the driver could be allowed to drive and collect milk

from the dairy farms. Milk to be transported to the processing plant within 72 hours after milking. Stainless steel cans are recommended for milk supplied to processing plants in milk cans. Milk cans shall not be exposed to sun during transportation.

2.8 Controlling milk at milk reception/intake

Organoleptic are simple, initial and important tests based on smell, taste and appearance which enables rapid segregation of poor milk if a skilled person with good senses carries them out. These tests are universally applied, and are to be complemented by the other platform tests.

At milk processing plant intake or reception point, milk will undergo some platform tests before being pumped into plant silos. Firstly the volume of milk is measured. Quality will be checked and samples will be taken for laboratory analysis. For bulk milk collection, the driver takes a sample from farm bulk tank before pumping the milk into the truck tank. The driver checks acceptability of milk through organoleptic tests like smell and sight. Agitator must be switched on to mix the milk before taking a sample. Measures quantity of milk using a dip stick in the farm tank or flow metre mounted on the truck. Milk from different producers is mixed in truck tanks, received at collection centres or processing plants must then be measured and sampled regardless of milk supplied to one processing plant. This is important to track on problematic farmers in cases of bulk milk consignment turning bad and administration of processing plant and control of internal efficiency.

2.8.1 Adulteration of milk

Consumers require pure and unadulterated milk. This therefore calls for all actors in the milk supply chain to have the value chain perspective. In the course of evolution, through trial and error, man has learned to handle those foods that would cause adverse effects. Further, he has developed processing methods to eliminate or reduce toxicity in a number of cases (de Vries 1996) this must be taken advantage of for production and processing of good and healthy food for the people. Adulteration of milk is usually on purpose in order to defraud. Few occasions are by accidents during production and processing. Compounds intentionally added to improve food characteristics may result in special toxicological problems (Pussa 2008). Potential adulterants are:- extraneous water, detergents/sterilants, teat dips, udder salves, Neutralisers to mask developed acidity, skim-milk powder to elevate milk solids, salt or sugar to mask extraneous water or elevate total solids, preservatives like formalin, hydrogen peroxide, hypochlorite used to mask poor hygienic quality and Foreign fats.
Most common potential adulterant in milk is extraneous water. Producers may want to be awarded bonuses or premiums for milk consignments especially where processors use compositional content or hygienic levels for milk payment schemes. It is very critical to check the inside of the truck tank to see if there is no water remaining after the CIP.

2.9. Food quality

In most spheres the term quality is narrowed down to product quality only. The meaning of quality refers to all those features of a product or services which are required by the customer. Food borne disease takes a huge toll on human health and mortality (D'Mello 2003). This is important in milk value chain as there are various actors and different actor requirements which need to be satisfied to accomplish quality product or services. In trying to satisfy the next actor along the chain, different product transformations may be included but these must not compromise the health of the general public. Therefore, it is important for every actor in the chain to have a chain perspective in playing the role.
Food quality (FQ) and Quality management (QM) are two basic components of food quality management. It deals with the physical aspects of quality as well as managing the people who have to realise it (Luning and Marcelis, 2009). People are important as they are the ones who make decisions which have a bearing on the quality aspects of the commodity as well as having high potential to contaminate the product.

2.9.1 Quality control in the Zimbabwe dairy sector

The Dairy Act [Chapter 18:08] and dairy regulations RGN No. 886 of 1977 are the two instruments which are controlling how the dairy sector operates in Zimbabwe. The Dairy Act gives basic principles whilst the regulations are narrow and specific for each aspect of dairy activity to fulfil the principles of the Dairy Act.

Due to the informal sector which has become pronounced in Zimbabwe, monitoring of food safety and quality standards has become very difficult. There is quality control in the formal sector though economic challenges are posing a challenge. Milk processors encourage production of good quality milk by paying premiums for both hygienically and compositional good quality milk. Dairy Services monitors the entire dairy sector and does the testing for milk payment schemes. An influx of imported dairy products also poses challenges to public health. Standards for imported dairy products are not known. While foreign food regulatory systems need not be identical to all countries, they must employ equivalent sanitary measures that assure equal level of protection against food hazards as achieved locally (Kutz 2007).

CHAPTER 3: METHODOLOGY

3.1 Study area

The study was conducted in Matabeleland region of Zimbabwe. Matabeleland region is composed of three provinces which include Matabeleland north, south and Bulawayo province. Matabeleland region lies in the south-western part of Zimbabwe. The greater part of the region is in natural ecological region IV and other parts in natural region V. The region is favourable for cattle ranching because of the grassland (sweetveld) which is a characteristic of the region. Matabeleland consists mostly of the savanna (tropical grassland) and wooded savanna to the northwest of the city of Bulawayo. Annual rainfall ranges from 450 to 650 mm and is highly unreliable giving semi arid characteristics for the region. Farmers have to rely on irrigation facilities for pastures and crops. This makes agriculture very challenging and costly for the region. Most dairy feed is from bought in maize grain and concentrates. As a result, most dairy farmers in the region have small dairy herd compared to their counterparts in other regions of the country. The major city for the region is Bulawayo and second largest city after capital Harare. Bulawayo is located at the centre demarcating the two provinces. Most dairy farmers from both Matabeleland north and south are dotted within the 100km radius from Bulawayo city. Milk processing plants are in the city industrial areas and a few outside the city radius.

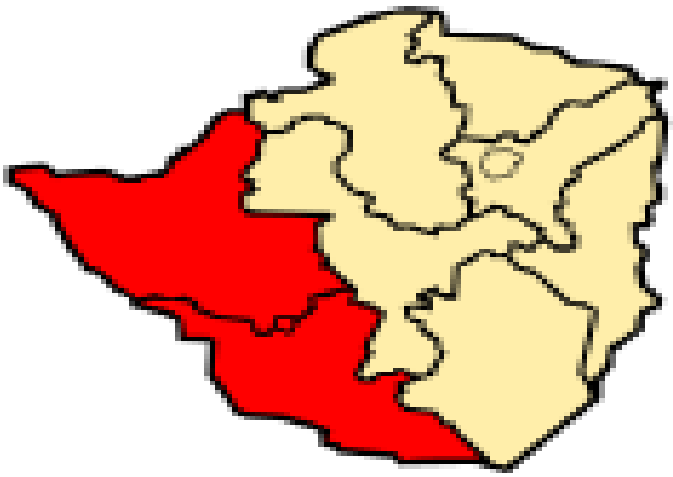

Figure 3.1 Map of Zimbabwe showing Matabeleland region in red.

3.2 Dairy Services as the regulating institute

Dairy Services is a government unit which falls under the Department of Livestock production and Development (DLP&D). The unit is mandated for regulating and monitoring of the entire dairy subsector. This is achieved through registration and inspection of all players involved in the dairy value chain. Besides regulatory enforcement the unit provides technical services like dairy herd improvements, training to all the actors in the dairy chain. Dairy Services has offices in all regions of the country for the purpose of executing its mandate which also includes product quality monitoring and proficiency testing and certification for dairy factory personnel and milk tanker drivers.

3.3 Research Framework

The structure of the research is to analyse raw milk transportation by Bulk Milk Collector (NDC), Bulk Milk Collector (Processor), Can Milk Delivery and Milk rejections so as to give recommendations for the objective of improving milk quality and reduce rejections related to raw milk transportation.

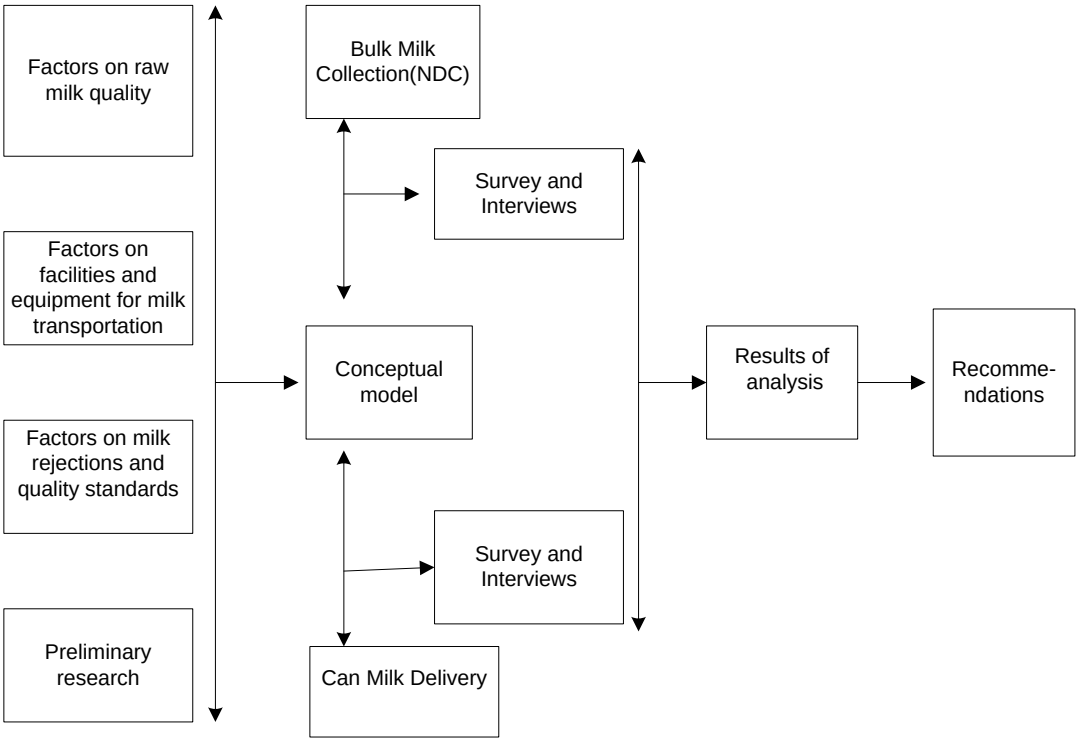

Figure 3.3 Research framework for the study

Source: (Verschuren and Doorewaard, 2010, p20)

3.4 Conceptual Framework

The conceptual framework is of value chain concept. Value chain is an analytical as well as an operational model. The model takes up the fact that a product is rarely directly consumed at the place of its production. Various activities like transformation, transporting and packaging are applied to the product before it reaches to the consumer. In participating in chain activities, actors incur costs. Some incur more costs than others depending on the investments and risks they have to bear (KIT and IIRR, 2008).In this study, the transporter has a role to maintain quality of milk to enable processing plants to process high quality products for the consumers. Some of the requirements for a value chain include coordination and collaboration of different actors, information flows as well as an enabling institutional environment.

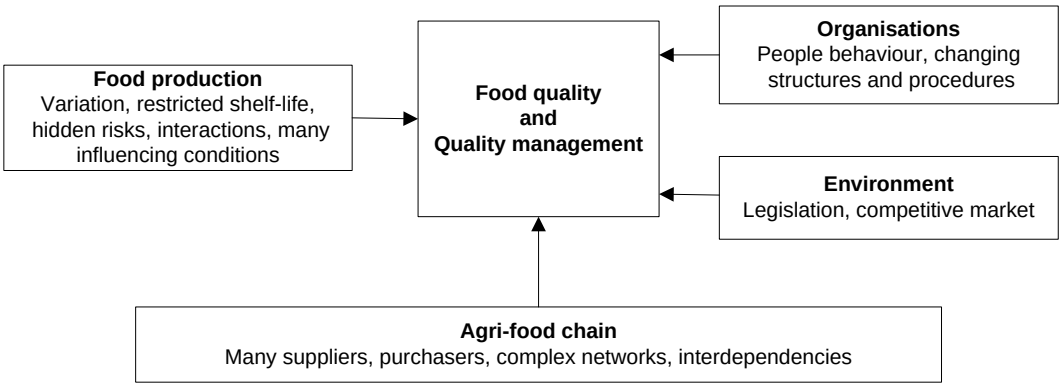

Figure3.4 Factors influencing food quality management.

Source: (Luning and Marcelis, 2009, p.21)

The demand of high quality raw milk by processors is influenced by the consumers who also require high quality dairy processed products. An influx of imported dairy products which are perceived by consumers as of high quality requires local processors to change the mind set of consumers to have trust in local products.
From the above figure it shows a number of factors which include characteristics of food production, production chain, demands and concerns of customers, people within their organisational and chain context affecting quality management. This is critical for the transporter to have in mind other players and their quality desires in the value chain.

3.5 Research Strategy

Desk study, survey and interviews were employed for the research.
The research has a qualitative and quantitative approach and was based on imperial data, literature and documents. A desk study was done before conducting the survey.
For the survey, thirty two farmers from Matabeleland region were selected for data collection and questionnaires were used to collect data. The criteria were to cluster farmers into 3 categories. Categories were based on whether a farmer is on Bulk Milk Collection (NDC), Bulk Milk Collection (Processor) or Can Milk Collection. 16 farmers on Bulk Milk Collection were randomly selected from both Matabeleland north and south provinces. 16 farmers on Can Milk delivery were randomly selected from both Matabeleland north and south as well. There are no distinctions or factor advantages for the producers in these different provinces hence the random selection. Questionnaires were focusing on how farmers are transporting their milk to processing plants, which milk processor they are supplying, containers used, volumes supplied, supply intervals, quality challenges, rejections of milk by the processor and cost of transportation.
Interviews with Quality Controllers from milk processing plants were conducted. The processing plants include Dairibord Zimbabwe Limited, Kershelmar Dairy and Umzingwane Milk Centre. Interviews with NDC Regional Manager (Bulk milk transporter), NDC driver, Dairibord Transport Manager were done as well.

Table 3.5 Data Sources

Sub Research Questions	Information	Source of information
a)	Quality standards of raw milk	Interview Dairy Services/regulations
b)	Raw milk tests	Interview with key informants Milk Processors/Dairy Services
c)	Milk quality factors	Literature review + Interviews with key informants
d)	Transportation costs	Survey + Interviews with key informants
e)	Quality assurance tests performed at farm and processing plants	Interviews with key informants
f)	Quality maintenance by processors	Interviews with Processors
g)	Milk transportation regulations	Dairy Services + interview with key informants

3.6 Data collection

A survey was employed to collect data from the farmers. Interviews with key informants were also used in collecting data from different milk processing plants and milk transportation companies.

Table 3.6 Clustering of farmers

Location	Number in sample (N)			Total
	BULK Milk Collection (NDC)	Bulk Milk Collection (Processor)	Can Milk Delivery (Farmer)	
Matabeleland north	4	4	8	16
Matabeleland south	4	4	8	16
Total	8	8	16	32

3.6.1 Survey

Farmers were clustered according to method of milk delivery to milk processing plant. The clusters included Bulk milk collection (NDC), Bulk Milk collection (processor) and can milk delivery done mostly by the farmers themselves.

Producers were selected from both Matabeleland north and south since these producers are scattered around the periphery of Bulawayo city where processing plants are located and Bulawayo being in between the two provinces. Producers on BMC were categorised in two to enable comparison within BMC since BMC is done by two different actors (NDC and Processors).

Questionnaires were developed to gather data from the farmers. The questionnaires focused on whether the farmer is on Bulk Milk Collection or Can delivery. Pretesting of the developed questions was done to make sure that the questions are understandable and can get the desired response from the farmers. Adjustments of questions were done for the questions which were not clearly formulated or understandable. Both closed and open questions were included on the questionnaires. Questionnaires covered the following aspects:- Delivery equipment, Volume at time of delivery, intervals, milk rejection, causes for rejection, time taken for milk delivery to processing plant, vehicle breakdowns, farmers general view on milk transportation, awareness of dairy regulations and costs for transportation.

3.6.2 Observations

Observations were done during survey interviews to check whether the information given was relative to what was on the ground. Farmers were introduced as to the purpose of the interviews to avoid bias and narrating of other issues not relevant to the intended study. Around 50minutes was spent on each farm and 4 to 5 farms were visited per day.

3.6.3 Interviews

Interviews with Quality Controllers from milk processing plants were conducted. The processing plants include:

i. Dairibord Zimbabwe Limited - (Quality Controller)

The Quality controller for Dairibord is the person who is directly in charge of all product quality aspects at the processing plant. The person manages the processing plant laboratory where all raw milk and milk processed products are tested for approval. Raw milk rejection at plant intake or reception area is a decision directly under the Quality Controller.

Interview focused on milk rejections, milk quality standards, cleaning facilities, volumes received, intervals and opinion on dairy regulations and assistance rendered to producers for quality improvements and maintenance.

ii. Kershelmar Dairy - (Laboratory Manager)

The laboratory Manager for Kershelmar dairies performs the duties of a Quality controller. All raw milk supplied to the plant from farmers is accepted or rejected after the tests performed under the authority of the Laboratory Manager.
The interview focused on type of containers used by the producers, milk quality standards at the plant, Bulk truck vehicle condition. Raw milk rejections at the plant milk intake bay. Cleaning of facilities at milk intake, volumes received, collection intervals and assistance offered to producers for quality maintenance.

iii. Umzingwane Milk Centre – (Quality Controller)

The Quality controller controls raw milk and milk processed products quality for the centre.
Interview with the controller focused on type of containers used by producers, condition of containers, milk volumes received, intervals, milk quality standards and rejections of milk at the centre.

iv. NDC Regional Manager (Bulk milk transporter)

The regional manager is the head of the Bulk milk transportation cooperative. The manager is responsible for the vehicle fleet and staff of NDC for the entire region.
Interview was focusing on condition of vehicle fleet, cleaning of Bulk tanker trucks, cost of transporting milk, collection intervals and volumes collected from producers and challenges faced in transporting milk.

v. NFB logistic manager

NFB logistics is a transport company housed under Dairibord and 100% owned by Dairibord.
The logistics manager is the head of the vehicle fleet which include trucks for various product segments like bulk goods, containers and milk and other liquid products.
The interview was focused on collection intervals, volumes collected, condition of vehicles, Cleaning of vehicles and costs for milk transportation.

vi. Bulk milk truck driver

Interview with bulk milk driver was focusing on training for milk collection, condition of the vehicle, time taken from producer to processor, value put on milk quality.

3.7 Secondary data sources

Secondary data sources were used for Literature review and in other chapters of the study.
Literature review was mostly done at Wageningen library before the field study was conducted. Books, journals as well as digital library were greatly used for the desk study.
Reports from Dairy Services and processing companies also helped in executing the study. The reports were in cooperated into the study during field research and were provided by the key informants during the days of interviews.
More information on milk rejections was provided by Dairy Services Matabeleland region as the authority for approval of all milk rejection cases. Milk processing plants also provided milk rejection records as it is part of record keeping for company administration. These records assisted in highlighting trends and causes of rejections which were indicated on milk rejection records. Rejections were then compared with producer response on rejections.

3.8 Data analysis

Data for the research was analysed quantitatively and qualitatively. For quantitative analyses, data from surveys was coded to enable SPSS analysis. The research study had a value chain perspective and aim at improving performance of the entire milk chain. This means all the actors in the milk chain were considered and especially making transportation efficient and effective for quality milk to processing plants to achieve quality processed products for the consumers. PESTEC analysis was used to analyse political, economical, social,

technological, environmental and cultural factors affecting milk transportation and quality in the region. SWOT was also employed to analyse raw milk transportation in the region.

3.9 Limitations of the study

The sample size was limited to 32 dairy producers. This also limited the statistical tests conducted on the data collected from the survey and interviews which require large survey sample sizes. Collected data was therefore analysed mostly using tables, charts and graphs. National Dairy Cooperative bulk milk tank driver was the only one interviewed as other bulk milk tank drivers from processors could not be conducted due to the long time they spent in the farms. Resources to carry out the survey were limited as LP&D has vehicle and fuel challenges. The researcher was using a pool car which was mostly occupied with other duties for the department. Rescheduling of farm visits were frequently done though the researcher had a planned itinerary for farm visits before the actual field work started. The researcher explained the purpose of the study to the producers before the interviews were conducted. However, there are chances of biased response from producers due to fear of political victimisation as land and agricultural issues are heavily politicised at the moment.

CHAPTER 4: RESULTS

This chapter will look at results obtained from survey, interviews and observations carried out during the study.

4.1 PESTEC factors for raw milk transportation in Matabeleland region

The PESTEC tool is used to analyse ways in which external factors are influencing raw milk transportation in Matabeleland region.

Table 4.1 PESTEC analysis for raw milk transportation in Matabeleland.

Political	- ownership of companies - high import duties on imported vehicles
Economic	- high price of vehicle spare parts - limited access to credit from banks - unreliable power supplies - migration of trained personnel. - unreliable and old milk collection vehicles
Social	- increase in foreign products preference - vehicle spare parts thefts - limited commercialisation of dairy by local farmers
Technological	- obsolete dairy equipment - unmaintained telecommunication facilities - limited training facilities for drivers - poor state of roads
Environmental	- high average daily temperatures - prevalence of dusty conditions from eroded gravel roads
Cultural	- low value on milk quality standards - multipurpose use for milk transporting vehicle

The political situation in Zimbabwe is still unstable. Land redistribution has been ongoing for over a decade. There have been mass relocations from communal areas to commercial farms. As a result, production has been greatly affected in these formerly high production farms due to the new breed of farmers presently introduced in the farms. The challenge is now mostly with people who are continuously invading commercial farmers without government permission to occupy the farms. This has brought about uncertainties for most commercial producers and as a result a halt in investments and a decline in dairy herd with a consequence of low milk volumes. Hygiene standards have declined as procuring of new equipment is now uncommon with most producers. There is high use of old and obsolete equipment and telecommunication facilities have collapsed leading to poor communication between producers and processing plants. Use of cell phones has helped to some extent but the challenge remains with poor network in most of these farming areas.

Table 4.1.1 SWOT Analysis for raw milk transportation in Matabeleland region

Strength	**Weaknesses**
Existing road networks Presence of bulk milk tankers Producer Cooperative involved in milk transportation Processor involvement in raw milk transportation	Dilapidated road networks Frequent bulk tanker vehicle breakdowns Inefficient milk transportation system
Opportunities	**Threats**
Resuscitation of road networks Increase in milk volumes Procurement of new bulk tank trucks	Deterioration of road net work Collapse of dairy industry Political instability

Despite the challenges which are currently experienced in transporting raw milk from farms to processing plants, there are factors as indicated by the strengths and opportunities for raw milk transportation in the region. These are factors which could be taken advantage of in improving transportation system in the region.

4.2 Response from Regulatory Institute/Dairy Services pertaining milk transportation regulation

The regional dairy technician highlighted that milk must be transported within 72 hours after milking to processing plants. This means supplies within 3 days. This is the current regulation pertaining milk supplying age. The regional technician mentioned further milk quality deterioration if supplying interval is prolonged from the current 3 days.

"The quality of milk is not so good presently and early supplies to milk processing plants minimises further deterioration of the milk especially hygienic wise. Most producers have TBC well above the standard of 500 000 CFU/ml and keeping the milk at the farm bulk milk tank does not stop bacterial replication but only minimises and prolongs the freshness of milk. There is of course need to revise some of the dairy regulations to benchmark standards to suit the present producers and prevailing conditions as much of the regulations were set in the colonial era. The sector appreciates the role of the regulations but however the sector also feels that the economic conditions are still too harsh for the sector to thrive under such regulations and standards ".

a. Response from Dairy Services pertaining regulations

The regional technician indicated that the bulk milk tankers are being swabbed once per month to check the hygiene standards of the milk carrying compartments.
8 trucks were inspected for the month of July 2011. The table below indicates a summary of results for the tested trucks.

Table 4.1.2 Summary of swab results for Bulk milk Tankers

Truck	TBC	Coli	E.coli
1	TNTC	+ve	-ve
2	308	+ve	-ve
3	42	-ve	-ve
4	TNTC	+ve	-ve
5	10	-ve	-ve
6	0	-ve	-ve
7	0	-ve	-ve
8	TNTC	+ve	+ve

3 of the inspected trucks had Too Numerous To Count (TNTC) Total bacterial Counts (TBCs) and also tested positive on coliform test. One truck had 308 TBC and also tested positive on coliform test. Only one vehicle tested positive for E. coli test. Too numerous to count is an indication of poor cleaning of the bulk milk tanker. A positive test for coliform test and especially E. coli shows an extreme poor state of hygienic standards which could easily cause health problems for the public if consuming products handled by such facilities. The Dairy technician could not regularly inspect and swab the bulk tankers due to limited mobility and testing apparatus. This has also led to poor cleaning of the tankers by the transporters.

4.3 Milk processing plants supplied by dairy producers

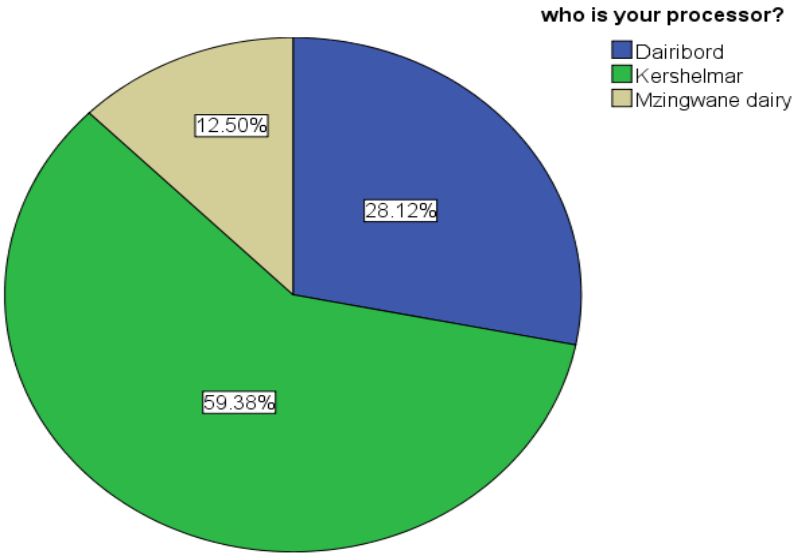

Figure 4.3 Number of producers supplying processors in Matabeleland

Majority of the producers, over half in the sample population supplied Kershelmar dairy. DZL is being supplied by less than half of the total producers captured for the study. The least number of producers from the study supply their milk to Umzingwane Milk Centre. Umzingwane is paying $0.45 per litre. The price is a flat payment without any premiums or penalties for quality of the milk. Kershelmar dairy is paying $0.56 per litre which is also a basic price without any premiums or penalties for the quality of milk. DZL is paying a basic price of $0.50 per litre but the price can range from $0.30 to $0.70 per litre due to penalties and premiums for the quality of milk.

"We are currently receiving very low volumes of milk. Our payment system still encourages production of good quality milk. We offer penalties and premiums for Total Bacterial Count (TBC), Butterfat content (BF), and Somatic Cell Count (SCC). We wish producers could increase their production levels for us to increase our processing levels however our payment scheme still focuses on production of good quality milk".

b. Response from DZL Quality Controller

4.4 Awareness among producers on regulation for raw milk storage time.

Table 4.1.3 Response on raw milk storage time

Do you know regulation for milk age supplying limit?	No. of respondents	Percent(n=32)
Yes	20	63%
No	12	37%

Despite the majority of producers being aware of milk age supply limit, a considerable number of producers are not aware of the regulation. For the producers who are aware of the regulation, all of them (20) mentioned the correct 3 day limit. After registration of dairy premises for the producers, extension services on production practices and awareness on dairy regulations has rarely been done.

Table 4.1.4 Respondents opinion on usefulness of milk age regulation

Do you think regulation is of any help to farmer?	No. of respondents	Percent(n=32)
Strongly agree	8	25%
Agree	10	31%
Neutral	14	44%

A quarter of the producers strongly agreed on usefulness of regulation to have milk supplied to processors by within 3 days. 31% just agreed on the importance of the regulation. Close to half of the producers were neutral and could not say whether the regulation was useful or not.

4.5 Status of raw milk volumes in Matabeleland region

The reduction of dairy herds by most dairy producers has resulted in a decline in milk volumes produced in Matabeleland region.

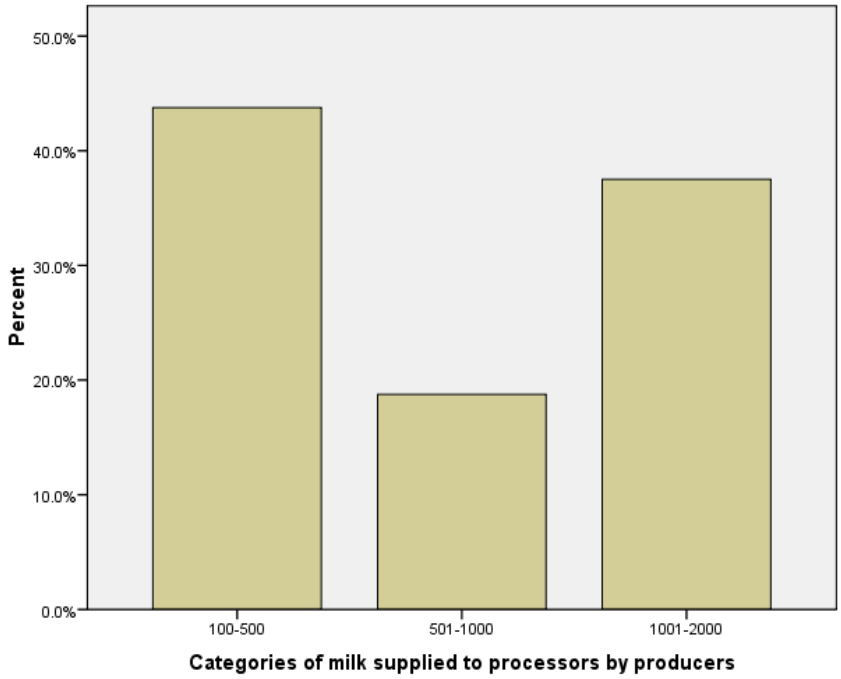

Figure 4.5 Raw milk categories supplied to processing plants

From the study population, the greater numbers of producers in the region are supplying 100 to 500 litres of milk per delivery to the milk processing plant. Producers in the category of 1001- 2000Litres per delivery are the second largest whilst producers supplying 501 – 1000L has the least number of producers. Producers who are in the 100-500liter supply category are mostly from can deliveries whilst those in the 501-100litre category are a mixture of both can and bulk. Producers supplying higher milk volumes of 1001-2000 are a few from bulk milk collection. These are large scale commercial dairy producers with big bulk milk tank or tanks at the farm.

4.5.1 Raw milk supplying intervals

Supply intervals are the number of days in between each delivery to the processing plant. Raw milk supplying intervals have a big contribution to milk quality status transported to processing plants.

Table 4.2 Producer milk supplying intervals to processing plants

Supplying intervals in days	Frequency	Percentage of producers (n=32)
Every 2nd day	2	6%
Every 3rd day	13	41%
Every 4th day	17	53%
Total	32	100%

Majority of farmers are having a milk supply interval of more than 4 days. This means milk is being collected from the farm well after the regulatory requirement. The Zimbabwean dairy regulations require milk to be supplied to processing plants within 72 hours after milking. Milk is supposed to be stored at 4°C at the farm. Long transportation time for milk which has over stayed at the farm would easily result in milk spoilage.

According to NDC regional manager, raw milk supplying intervals are wide apart due to low volumes which are currently produced by dairy farmers in the region. Producers are no longer willing to be collected on every second day or even third day as the cost is high in comparison to income from the collected milk volume.

"We used to collect milk every second day from most farmers and daily from a few big dairy farmers. Third day collection was minimal but now it is third day and fourth day collections which are more common. We could resort to daily or second day collection but the volumes and the cost have resulted in farmers not interested in these earlier collections".

c. Response from NDC regional manager on milk supplying intervals

4.5.2 Producer opinion on supply intervals

More than half of the respondents are not happy with the supply intervals. The producers expressed disappointment on the quality of milk which would be collected on fourth day and attributed penalties and rejections as a result of prolonged supplying intervals. However, despite being unhappy with the intervals, most of the producers said the cost for earlier intervals will not be bearable considering the current produced milk volumes. Slightly below half of the respondents are happy as some of the producers are collected within the 3 day supply regulation. Other producers are happy though they are supplying well after the 3 day interval citing low costs for the prolonged interval.

Table 4.2.1 Producer response on supplying intervals

Are you happy with the supplying intervals?	No. respondents	Percent (n=32)
Yes	14	44%
No	18	56%

4.6 State of facilities and equipment for raw milk transportation

The regional manager for NDC alluded to the fact that the fleet of vehicles was old and experiencing constant breakdowns. The cost of running the fleet has grown astronomically because of the age and condition of the vehicles. The manager said the 4 vehicles were enough to cater for the region if only the vehicles were in good condition. The transport cooperative does not have an employee for servicing the fleet of vehicles. The organisation is relying on hired mechanic and this is resulting in long hours on spot if the vehicle had a breakdown.

“The services we render to the region have become bad because of a cocktail of reasons which include vehicle breakdowns, unmaintained road networks, high staff turned over, and imported spare parts and chemicals for cleaning.
We have 4 trucks for carrying milk from producers to the milk processing plants. 3 of the trucks have a capacity of 30 000Litres. The fourth truck is smaller with a capacity of 15 000 litres. The trucks where well suited for the high milk volumes which used to be produced in the region but of late it’s the smaller truck which is more suitable though it is also too big compared to the current volumes and number of farmers. Processors have of late introduced trucks for milk transportation and that has reduced number of producers and consequently volume we are collecting from producers".

d. Response from NDC regional manager on state of equipment

4.6.1 Factors influencing raw milk spoilage during transportation

Various factors which include type of container, condition of containers, vehicle worthiness, time and temperature among others do contribute immensely to raw milk spoilage during transportation. Stainless steel containers facilitate easy of cleaning and sanitisation. Plastic containers are difficult to achieve effective cleaning and sanitisation. Cleanliness of containers contributes to hygienic quality of milk through bacterial load of the milk. Vehicle breakdowns with milk consignments results in souring of milk especially when vehicles does not have functioning cooling facilities.

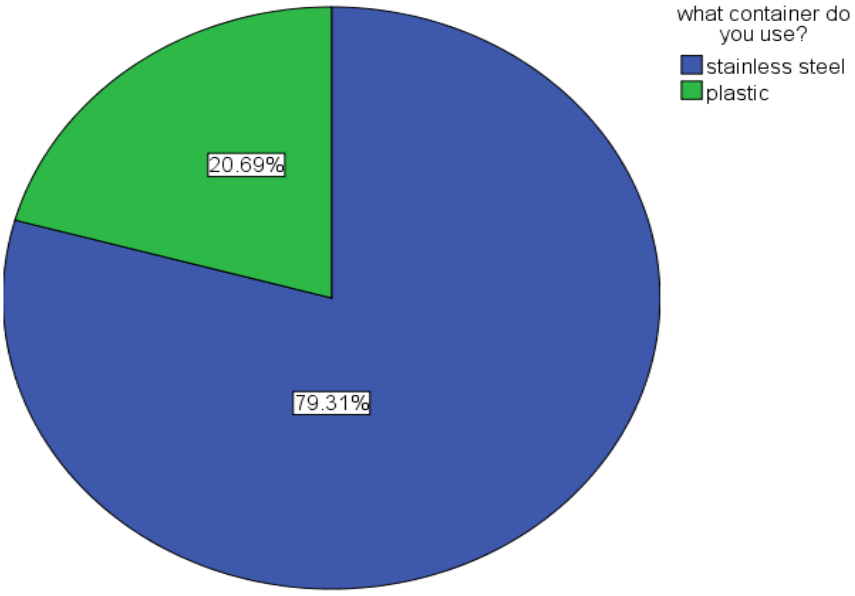

Figure 4.6 Type of containers used by Matabeleland producers

About a quarter of sampled producers in Matabeleland region use plastic containers to carry milk to processing plants. Slightly above three quarters of the producers are using stainless steel containers for raw milk transportation to processing plants. Although majority of these producers are using stainless steel containers, the condition of these containers is bad and no longer recommendable. Condition of plastic containers is also bad as most of them were formerly used for other substances and chemicals like cooking oil and paints.

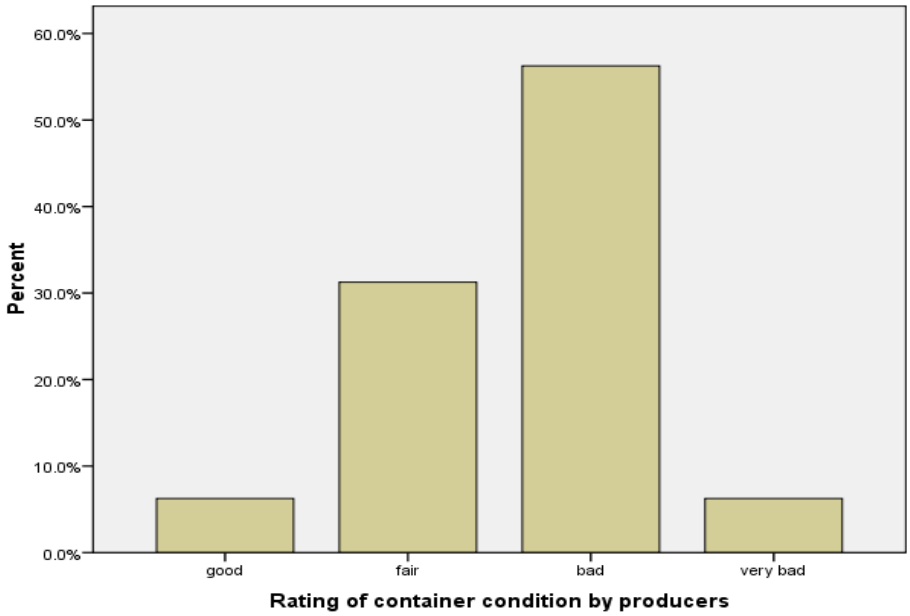

Figure 4.7 showing response on how is the condition of containers

Despite the majority of producers using the recommended stainless steel containers, majority of the containers are in bad state (56.2%). Cans are having rust and even depressions created by rust at the bottom of the can. Some of the lids are also rusty and deformed resulting in poor closure during milk transportation. 31.2% in fair state, that is smooth and easily cleanable, while only 6.2% of the producers have containers in good state and another 6.2% in very bad state with advanced rusty surfaces and cracks on most parts of the can. Plastic containers with dark spots not easily removable when cleaned with detergents.

Table 4.3 Storage of containers

Where do you store your containers?	No. of respondents	Percent (n=16)	Presence of rack
Main house	3	18.75%	2
Store room	2	12.50%	0
Dairy parlour	11	68.75%	9

18.75% of producers delivering on cans are storing milk containers in main house. 2 producers have racks for placing the cans out of the 3 that store cans in main house. 12.50% of the producers are storing milk containers in store room and none has rack for containers. Majority of the producers on can delivery (68.75%) are storing the milk containers in the dairy parlour. 9 of these producers have racks for placing the containers after washing. Milking cans should be placed on a rack upside down to facilitate complete dripping of the washing water from the can.

Table 4.3.1 Response on cleaning of milk cans

Do processors clean containers after emptying milk?	No. of respondents	Percent(n=16)
Yes	16	100%
No	0	0%

All the producers who are supplying processing plants using cans are having cans cleaned by the processor after emptying the milk. Producers were however complaining about the cleaning system saying the processors are simply rinsing the cans using water. Thorough cleaning using detergents and sanitizers has to be done by the producers themselves.

4.6.2 Responses on whether bulk trucks deserve transporting raw milk

Table 4.3.2 Bulk truck merit to transport raw milk

Opinion	Frequency	Percent
Totally disagree	2	37.5
Disagree	8	50
Neutral	6	12.5
Total	32	100

Half of the producers in the region disagree on worthiness of the vehicles transporting milk in the region.37.5% are neutral on worthiness of the vehicles while 12.5% totally disagree on worthiness of the vehicles.

4.6.3 Response from interview with NDC driver

Most drivers employed by NDC did not go through the proper procedure as stipulated by the dairy regulations pertaining raw milk transportation. The driver did not get training from the regulatory institute (Dairy Services). This means that the driver does not have a proficiency certificate as required by the regulations. There is a high rate of drivers leaving the organisation as is common with other sectors of the country. However, the driver mentioned the high value he put on milk quality during execution of his duties. The driver expressed concern with the frequent vehicle breakdown especially when loaded with raw milk. The driver attributed the breakdowns to age of the vehicles and condition of the roads. The driver also indicated limited availability of skilled mechanics to maintain the fleet of vehicles. The driver was not happy with the time taken carrying milk from farm to processing plant as a result of poor roads and vehicle condition. The driver also believed to the notion that NDC was incurring high operational costs as the vehicles require spare parts which are imported and charged at high prices.

NDC is deciding on buying smaller vehicles to carry milk from farms to processors. It might take some time but the organisation needs to make a quick decision pertaining the fleet of vehicles. The organisation is incurring high maintenance costs for the frequent breakdowns of vehicles. There is therefore the need to relook at possibilities of procuring new vehicles or getting a professional trained mechanic to service the vehicles.

"The vehicles are too old and experience regular breakdowns. It takes more than 5 hours to get the vehicle recovered after a breakdown with loaded milk. This is costing the organisation as milk is rejected after turning sour on arrival at processing plant. I was not trained on milk sampling but got acquainted the first days from the other drivers who have been transporting milk for some time. I have indicated to the manager the need for new vehicles but looks like there is no money or the organisation is still deciding on that venture".

4.6.4 Reasons for vehicle unworthiness

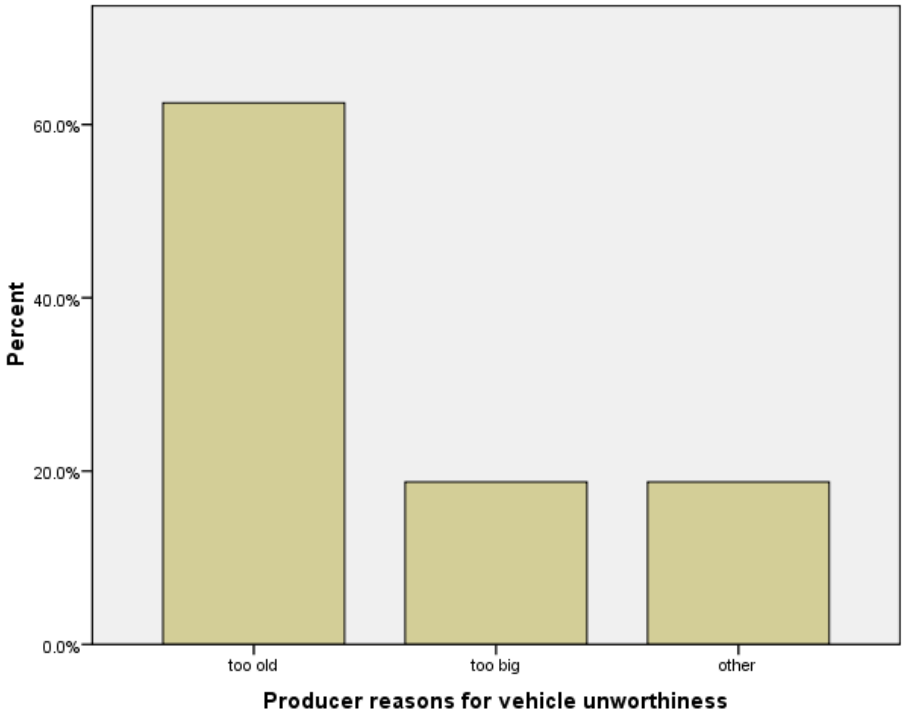

Figure 4.8 Reasons for vehicle unworthiness

Majority of the producers 62.5% from producers on bulk collection (n=16) concurred to the fact that vehicles are too old. The vehicles are said to have no rubber seals and lids can no longer close properly leading to high chances of milk contamination during transportation of milk from farms to processors.18.8% of producers cited that the vehicles are too big (30 000litres capacity) compared to the current production volumes. Producers mentioned that the vehicles could also have problems in managing the load given the condition of vehicles and roads even if producers were offering high milk volumes. Another 18.8% highlighted other reasons such as personnel or administration of the transportation companies or cooperative.

4.7 Time taken for raw milk supply from farm to processing plant

Table 4.4 Raw milk transportation time to processors

Time	Frequency	Percent
2 hrs	11	34
3 hrs	8	25
4 hrs	13	41
Total	32	100

Slightly more than half of the producers from the total sample are taking between 2 and 3 hours for their milk to be transported to milk processing plants. There is also a remarkable percentage of 40% taking 4 hours to have milk transported from the farm to processing plants. The bulk milk trucks collect 4 to 5 producers on each route and the whole truck would carry around 5 000 litres of milk for the 5 producers. The milk volume will be far below the 30 000Litres capacity of the bulk milk truck. This results in high costs and the need for smaller trucks to carry the current produced volumes. As a way of economising the route, the truck is

tempted to collect for a number of other producers thereby prolonging collection time to offloading time.

Table 4.4.1 Recording of milk collection time

Do drivers record time when milk is collected?	No. of respondents	Percent(n=16)
Yes	16	100%
No	0	0%

Bulk milk truck drivers are recording the time when milk is collected at the farm. The time is indicated on the sticker of the milk sample from that particular producer. All the producers on bulk collection 16 (100%) indicated that the drivers are recording time on sample before pumping milk from farm bulk tank into the truck bulk tank. The time is then related to offloading time when the bulk truck arrives at processing plant offloading bay. This gives an indication of time taken for the milk consignment to be transported from the farm to processing plant. The producers on bulk mentioned that they were not pleased with the offloading time at processing plant.

Table 4.4.2 Opinion on transportation time from farm to processor

	Frequency	Percent
Good	7	22
Neutral	9	28
Bad	13	41
Very bad	3	9
Total	32	100

22% have the opinion that transportation time from farm to processor is good. This is because milk is transported for mostly 2 hours for the producers with this opinion. Majority of producers sharing a good opinion on transportation time are mostly on can deliveries and a few from bulk milk collection. 28 % are neutral as they thought it is a matter of dealing with the available means and conditions. The producers highlighted difficulties in raising money as members of NDC to get new trucks as producers were not willing to be charged a higher price for milk collection. Greater percentage (41%) of the respondents have the view that transportation time is bad. 9% of producers have the opinion that transportation time from farm to processor is very bad as the truck is taking more than 4 hours and frequently breaking down resulting in milk turning sour before reaching processing plants.

4.7.1 Raw milk transportation costs

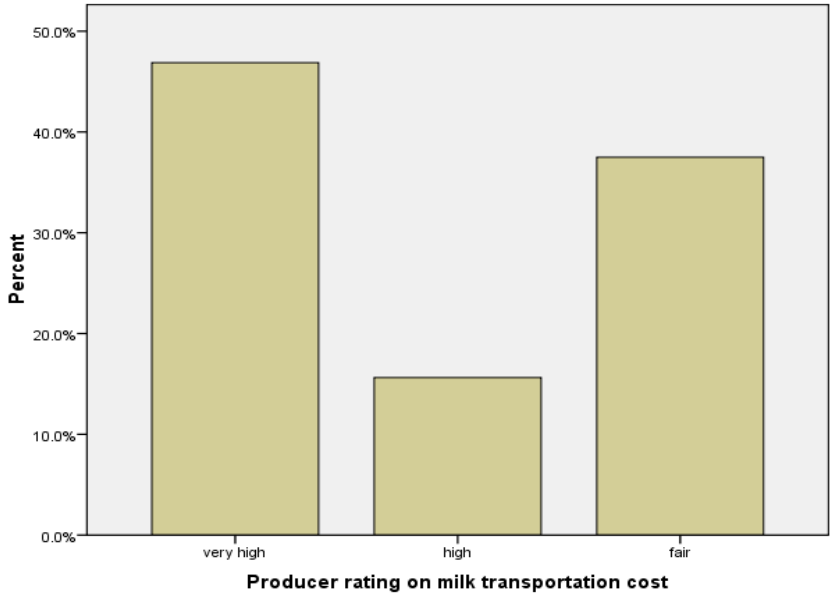

Figure 4.9 Opinion on transportation cost

High raw milk transportation costs in conjunction with low milk production volumes has resulted in most producers compromising quality by keeping raw milk for more days before supplying milk processing plants.47% of the producers regarded the transportation cost as very high. 36 % said the transportation cost is fair while 17% regarded the cost as high. The cost for raw milk transportation was regarded to as high and very high by most producers as the charge is mostly based on distance than volume collected from the producers. The fact that most producers are supplying 100- 500Litre per collection makes transportation expensive for them.

4.8 Raw milk rejections and quality standards

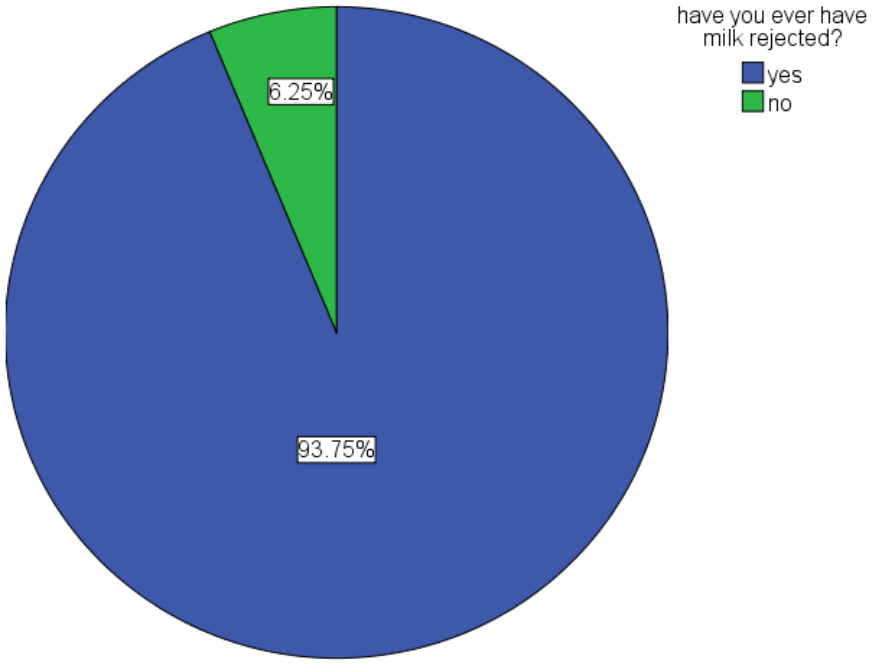

Figure 4.9.1 State of raw milk rejections by processing plants

Majority of producers are having milk rejected by the milk processing plants. This comprises of more than three quarters of the total producers. Less than a quarter of the producers have not yet had any milk rejection by the processing plant. For the producers who had milk rejected, this has been at least twice per month. Producers on cans had on average 2 cans amounting to over a 100 litres rejected per month. Bulk milk rejections have been amounting on average 1000 litres per producer per month. Around 4 000litres of milk per month is rejected for the entire bulk tank trucks.

Table 4.8 Causes for milk rejections by processing plant

Reason	Frequency	Percent
Sour milk	25	78
Added water	2	6
Foreign bodies	3	10
None	2	6
Total	32	100

4.8.1 Availability of portable water and cleaning materials

For the producers on can delivery, 15 have both hot and cold water facilities available at the farm. 1 of the producers on can delivery was having only cold water without a facility for hot water. All the producers on BMC were having both hot and cold water facilities. Facilities of both cold and hot water are a requirement for every dairy producer to have in order to facilitate effective cleaning of dairy utensils. There is a high percentage of butterfat residues which remain stuck on the surface of milk can after offloading at processing plant. Removal of the butterfat residues requires warm water and strong detergents to achieve cleanliness of the milk containers. Without hot water facility and recommended dairy detergents, it becomes almost impossible for a producer to achieve effective cleaning of dairy utensils.

Table 4.8.1 Producer use of detergents

Do you use detergents and sanitizers for cleaning of cans?	No. of respondents	Percent(n=16)
Yes	12	75
No	4	25
Total	16	100

For the producers on can delivery 75% are using detergents and sanitizers for cleaning the milk cans and other milk handling containers. 25% of the can producers are not using detergents and sanitizers for cleaning the milk handling equipment.

- DZL is cleaning the bulk milk trucks using CIP at the processing plant immediately after offloading the milk from the producers. NDC trucks used to be cleaned by the processor but of late the producers' cooperative has to clean the bulk trucks on its own. The regional manager mentioned that at times they have to just rinse the bulk tankers with cold and warm water since detergents and sanitizers may not be always available.
- Kershelmar dairy is cleaning the milk trucks after offloading the milk. Cleaning at Kershelmar dairy is done manually by Kershelmar workers at the milk intake bay. There is no use of detergents as cleaning is done by a hose pipe connected to a water tap.

4.8.2 Response of interviews with key informants

The regional manager for NDC highlighted that the bulk milk tankers used to be cleaned by the processor at intake bay. It is no longer the case as the cooperative has to clean the vehicles. The manager indicated complications with issues of payment for cleaning services which led to processors refusing to clean the vehicles for NDC. After offloading the milk at processing plant, the truck has to go for manual cleaning at NDC premises. Cleaning is done manually using a hosepipe. The vehicles are inspected and swabbed for tests every month end. Drivers for the trucks are trained on raw milk sampling procedures by Dairy Services officers and tested before being offered a certificate to drive a truck for bulk milk collection. Training includes checking for farm bulk tank temperature, functioning of farm bulk tank agitator, recording of collection time, date and milk volume and name of producer. Drivers are also trained on handling of milk samples from the farm until the samples reach testing laboratory. This includes the sampling kit comprising the cooler box and ice packs to be used by the driver during milk collections from the farms. NDC put the value of milk quality as very important though the cooperative is finding it hard to maintain high milk quality standards. Producers are charged according to the volume transported and the distance from farm to processing plant. The manager indicated that the money obtained is not enough to cater for all the transportation costs which include both fixed and running costs. This has resulted in poor maintenance of the vehicles and delays replacing the current old fleet of vehicles. The Manager also said the regulations regarding milk transportation are very relevant for maintaining milk quality and public health but also indicated the difficulties in keeping abreast with the regulations due to scarcity and prices of necessary parts and equipment.

4.8.3 Relationship between container and rejections

Table 4.8.3 Cross tabulation for supplying method and rejections

		have you ever have milk rejected?		
		yes	no	Total
what is your supplying method?	bulk NDC	8	0	8
	bulk processor	6	2	8
	can delivery	16	0	16
Total		30	2	32

There are 8 producers who have milk rejected by processing plant and being collected by bulk NDC tankers. 6 producers have milk rejected processing plant and being collected by bulk processor tankers. All the 16 producers on cans have milk once rejected by the processing plants. Producers on cans had on average 2 cans amounting to over a 100 litres rejected per month. Bulk milk rejections have been amounting on average to 1000 litres per producer per month. Around 4 000litres of milk per month is rejected for the entire bulk tank trucks.

4.9 Factors affecting milk quality

100% of the producers were having an idea about factors affecting their milk quality.

Table 4.9 different milk quality aspects challenging producers

What milk quality aspect do you consider your greatest challenge?	No. of respondents	Percent(n=32)
TBC	30	94
SCC	2	6
Total	100	100

A greater number of the producers have TBC as their biggest challenge 94% of the farmers. This has been fuelled by poor milk handling facilities and some bad practices by the dairy producers especially from the smallholder category. A smaller percentage, 6% have SCC as their biggest challenge. None of the producers mentioned either Butterfat or protein as greatest challenge though producers highlighted problems with the later two factors at times.

4.9.1 Milk temperature from the farm

The majority (53.1%) of producers have milk collected from the farm at 4°C. (Annex 8.i.) The second largest number has milk leaving farm at 10°C. A small number of producers (3.1%) have milk leaving the farm at 15°C.

The test shows that there is a significant difference in temperature from milk supplied from bulk tanks and that which is delivered by cans (Annex 8.i). The average milk temperature when collected from the farm for the sampled producers is close to 7°C.

Besides frequent load shedding by the electricity company at dairy farms, majority of the producers are having recommended milk temperature during collection time. Temperature maintenance has been enabled by the use of generators by most large scale commercial producers at their farms. This is however expensive as expressed by the producers due to prolonged time of power cuts and use of diesel for generators.

4.9.2 Milk temperature at offloading

One way anova

Table 4.9.2 Milk temperature at processor intake

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Bulk NDC	8	10.62	1.768	.625	9.15	12.10	10	15
Bulk processor	8	8.50	2.777	.982	6.18	10.82	4	10
Can delivery	16	13.06	3.750	.938	11.06	15.06	4	20
Total	32	11.31	3.605	.637	10.01	12.61	4	20

The average temperature for bulk NDC at offloading is 10.62°C. Average temperature for bulk processor at offloading is 8.5°C. For can delivery average temperature at offloading is 13°C. Bulk NDC has the highest temperature at offloading for the two bulk collection systems. Bulk processor has slightly lower temperature at offloading compared to NDC. Can milk delivery has the highest temperature at offloading and there is a significant difference of temperature between bulk and can deliveries (Annex 8.ii).

Table 4.9.3 Temperature maintenance during milk transportation

		Frequency	Percent
Valid	None	11	69
	Early delivery	5	31
	Total	16	100.0

69% of the producers on can delivery are not having any milk temperature maintenance measure during transportation of milk to processing plant. 31% of the can producers are using other means which most producers in this category mentioned early delivery as temperature maintenance measure.

4.9.3 Response from DZL Quality Controller

The processor is trying to maintain milk quality by assisting the producers on cleaning the containers after offloading milk at milk intake bay. The Quality controller indicated that at times the cans are just rinsed with warm water and producers have to further clean and sanitise the container for themselves. Quality of raw milk is very vital as it also determines the quality of milk products according to DZL Quality Controller. To maintain and urge production of good quality raw milk, DZL is offering premiums and also penalising poor quality milk. The processor is also offering stainless steel cans to its producers though the number of cans is limited. DZL is carrying out extension services to producers supplying them and train farmers on good dairy practices and dairy herd improvement services. The processor is also selling detergents and sanitizers to producers supplying them with raw milk. At intake, alcohol test, titration and specific gravity are tested for the raw milk before offloading the milk into plant milk silos. Most milk is rejected for failing the alcohol test and titratable acidity test and very few on foreign substances or other reasons. Facilities are still good at milk intake and maintenance is becoming costly as the plant is operating far below its maximum capacity due to low raw milk volumes. Milk cans are moved on the conveyor belt and washed automatically by water jets before collection by the producers immediately. Bulk milk truck is cleaned using CIP. The controller hinted that the cooperative (NDC) should procure new vehicles to be able to operate efficiently but went on to mention that the processors have already started venturing into milk transportation business and this might push NDC out of business. The informant mentioned the need to revise some regulations to enable producers to operate formally and highlighted economic hardships affecting the entire nation as not sparing the dairy sector especially frequent power cuts.

CHAPTER 5: DISCUSSION

This chapter will discuss factors affecting raw milk transportation and try to bring out elements hindering maintenance of milk quality during transportation and expound on approaches to improve milk handling and transportation. From conceptual framework of the study (Figure 3.4) factors affecting milk transportation at production level, organisations (people behaviour, changing structures and procedures), Environment and the dairy value chain perspective will be discussed.

Food Production

5.1 Status of raw milk supply volumes and intervals

Although majority of the producers 53.1% are supplying processors after the 3 day standard, a greater percentage (43.8%) of those producers are supplying less than 500litres at a time. 18.8% is supplying 501 – 1000litres at a time while 37.5% is supplying 1001-2000litres at a time. Producers who are supplying high quantities of milk per delivery are mostly those on bulk milk collection. Low milk volumes and cost for collecting milk from farms have resulted in supplies of well after required time intervals. The volumes collected have drastically declined as producers on bulk used to supply over 5 000liters on every second day collection according to dairy services technician. None of the producers is supplying milk to processors on a daily basis. A small percentage of 6.2% from the sampled producers is supplying on every second day. 40.6% is supplying on the third day which is within limit of the dairy regulations. A bigger proportion of the producers 53.1% are supplying processors on the fourth day which is well after the stipulated time according to the dairy regulation.

5.1.1 Opinion on supplying intervals

Despite the majority of producers supplying milk late to processors, a greater number of these producers 56% are not happy with this supplying interval (Table 4.2.1). The other 44% who are happy expressed the issue of cost saving though quality is compromised. Literature supports milk supply intervals of 3 days or less though it is possible to keep milk for even 7 days at the farm if the milk is of high quality.

5.2 Processors supplied by dairy producers in Matabeleland

59.38% of the producers from the total sample population are supplying milk to Kershelmar dairy (Figure 4.3). Kershelmar dairy is a privately owned milk processing company. DZL used to be owned by the government. Later DZL was privatised and now operate as a private company. Umzingwane Milk Centre is catering mostly for small holder producers. From the study, it is established that all the producers supplying the milk centre12.5% of the total sample use can delivery. Most producers delivering to the Milk Centre are using plastic containers and facing hygiene problems as reflected with the TBC. From literature, use of plastic containers is not advisable as effective cleaning of such containers is difficult to achieve. This was evidenced by observations during the study as most plastic containers had dark dirt spots. Producers supplying Kershelmar dairy (59.38%) and DZL (28.12%) are mostly on bulk milk collection. Producers on bulk milk collection are facing challenges of high Total Bacterial Count (TBC) and Somatic Cell Count (SCC). DZL has less producers on can milk delivery compared to producers on bulk milk collection. Kershelmar dairy also has less number of producers on can delivery compared to producers on bulk milk collection.

5.2.1 Temperature control

An immersion cooler is used for temperature control at Umzingwane Milk Centre. Temperature control is done after arrival of the milk from various producers before being processed into different dairy products. However, raw milk will have taken long time to reach the milk centre resulting in deterioration of milk quality before processing. Sustainable ways

of milk cooling at producer level may to a greater extend preserve milk quality before transportation to milk centre. The other big challenge with smallholder producers mostly delivering to Umzingwane Milk Centre is absence of cooling facilities at farm level. This gives a wide difference with large scale dairy producers who might have supplementary facilities to cool milk within 3 hours to a temperature below 4°C (Hogeveen and Meijering 2000). Transportation time and containers used for carrying milk to the centre will to a greater extend affect the milk delivered.

5.3 Status of containers and their condition

Stainless steel containers are used by a large number of the producers. A smaller proportion of the producers 20.69% use plastic containers. The containers are rusty, cracked and dirt to be used for raw milk transportation purposes. This is reflected by the greater percentage of 56.2% which regarded the condition of containers as bad. Another 6.2% from the producers referred to the containers as very bad while only 6.2% have good containers and about 31.2% have fair containers. Bad containers were either dirt and deformed while very bad containers were rusty and having cracks in addition to being dirty and deformed. I also observed that the containers were no longer suitable for carrying milk during the survey. Most producers supplying the Umzingwane Milk Centre were using plastic containers with dirty patches while those with stainless steel cans were rusty. The centre decided to procure some more stainless steel cans for the producers but numbers of cans are few compared to producers who need new cans.

5.3.1Storage of containers and cleaning

For the producers on can delivery, container storage was either in main house, store room or dairy parlour. Producers storing containers in store room had no racks to place the containers. For the 3 in main house 2 had racks and 9 had racks for the 11 producers storing containers in dairy parlour. Containers were mostly on conditions which expose them to contamination especially those stored in store room. There were presence of empty bags of stock feed and other chemical containers in the store room increasing chances of contaminating the milk containers with chemicals and stock feed. All the producers indicated that processing plants are rinsing the containers after empting the milk, however proper cleaning has to be done by the producer later on at the farm. This poses unhygienic container condition as some producers do not have facilities for both hot and cold water to effectively wash the cans. Detergents and sanitisers are proving to be a challenge to other producers.

Organisations

5.4 Evaluation of facilities and equipment for milk transportation

There has been reluctance in investing for raw milk transportation by most companies as the government is threatening to take over ownership of privately owned companies. This has caused reluctance by most privately owned transporters in procuring new vehicles or improvements in company assets and equipment. The government has also increased duties for imported vehicles a move which has resulted in use of old and road unworthy vehicles. Stainless steel cans are mostly used by farmers delivering milk on cans. Most farmers on cans expressed shortage of stainless steel cans resulting in usage of plastic containers for milk delivery. Majority of milk rejected from farmers delivering using cans was in plastic containers.

5.4.1 Milk spoilage during transportation

Milk transportation has shown to contribute to a great extend to milk spoilage. Most of the milk which has been rejected by milk processing plants had samples which indicate milk of good quality at farm level before transportation. Temperature control during transportation is not being effective due to the state of the vehicles both for bulk and own delivery. This is

also worsened by the long time taken to reach milk processing plants. The cold milk chain needs to be maintained from the farm until milk reaches processing plants. Facilities are limited for training drivers on procedures for milk sampling and handling during execution of their duties. Dippers, cooler boxes and ice packs and technicians for training drivers are not enough to offer services at the right time resulting in transporters opting to use untrained drivers due to driver shortages. Over half of the sampled producers 53.1% have milk leaving the farm at 4°C which is a recommended temperature for raw milk. The other 43.8% is also having milk leaving the farm at 10°C which is also not recommended. Raw milk temperature increases during transportation. When milk arrives at processor intake bay, milk temperature will be higher than temperature recorded at farm level. There are no measures for temperature maintenance during transportation for the majority of producers while a few use early deliveries to maintain good milk temperature.

5.5 Transportation costs

Smallholder dairy producers use dairy cows for other purposes like draught power which results in low production volumes from these cows. Little volumes are then transported to milk centres and transportation cost becomes high as the distance remains the same.

Reduced milk volumes have resulted in high milk transportation costs for NDC too. Distances from farmers to processors are long and the roads are bad leading to several vehicle breakdowns along the way. There is need to resuscitate the farm roads and protect the environment from further damage as a result of eroded roads. It is appropriate to realise that, in most cases, the contribution that mechanisation has made to agriculture has had adverse effects of harming the environment (Matthews 1991). This is also true with heavy bulk milk trucks using farm gravel roads. Fuel consumption is also high compared to the fee charged per litre for transporting the milk. In trying to cover the costs an increase in collection fee was implemented and this resulted in several farmers abandoning the bulk collection system to can delivery system. 46.9% of producers are regarding transportation cost taking a greater amount from the milk cheque and this is discouraging producers from using raw milk transportation companies. Another 15.6% of producers referred to transportation cost as high. This gives a total of 62.5% of the sampled producers not satisfied with the cost for raw milk transportation. This indicates a need for finding ways of reducing the cost for ferrying raw milk to processing plants.

5.5.1 Vehicle worthiness and reasons

Vehicle spare parts are sold at high prices and this is resulting in poor maintenance of the current fleet of raw milk transportation trucks. Thefts have risen due to economic hardships and most companies are losing assets and vehicle parts giving problems for efficient performance of the transporters. Competent personnel have migrated to neighbouring countries leaving companies with inexperienced staff. This has resulted in NDC using untrained drivers for raw milk collection against the dairy regulations which requires all drivers to be trained before transporting raw milk.

One of the greatest challenge to raw milk transportation from farm to processors is that of the vehicle which carry the milk. 50% of the producers disagree on worthness of the vehicles. Close to a quarter of the producers on bulk collection totally disagree on worthness of the vehicles. The producers not agreeing with worthiness of vehicles are close to three quarters of the sampled population. Above a quarter of other producers on bulk were neutral as they expressed difficulties with the current economic conditions.

In Matabelelland region, most of the vehicles are too old and expriencing frequent breakdowns. The bulk trucks are also too big in comparison to the current milk volumes produced by farmers. This has contributed to costly and inefficient raw milk transportation in the region. Decision is a process rather than a single act (Padberg, Ritson, Albisu 1997). This may be true for NDC as it is taking long time to replace the old vehicles. Greater percentage of the producers 62.5% cited the issue of vehicles being too old and having

constant breakdowns and at times when the bulk tankers are loaded with raw milk consignments.

5.6 Time taken for raw milk supplies

Raw milk transportation time should be as short as possible to avoid spoilage of milk on transit. 40.6% of the producers in the region have milk taking 4 hours and above to reach milk processing plants. 25% of the producers are taking 3 hours while the other 34.4% are taking 2 hours. There is none from the sampled producers who is having milk getting to processing plants within an hour or less. Raw milk is supposed to get to milk processing plants as soon as possible especially when carried by vehicles without milk cooling facilities to avoid deterioration of milk quality during transit.

5.6.1 Opinion on time taken

Most producers are not satisfied with the time taken to transport raw milk from farms to processing plants. The highest percentage of producers 41% (Table 4.4 and 4.4.2) is of the opinion that the time is bad. This is in relation to 4 hours which are taken for transporting milk from farm to processing plant. 9.4% regarded the time as very bad. This constitutes 50% of the producers regarding transportation time on the bad side. 28.1 % of the producers were neutral. The producers hinted on a cocktail of problems faced by the nation in transporting milk and thought the companies were trying their level best to offer the service. 21.9% referred to transportation time as good and these producers were mostly from those on cans and delivering the milk on their own. Longest transit time is common with the bulk transporters as compared to the can deliveries.

5.7 Raw milk rejections and causes

Roads linking the farms and main roads are in poor state resulting in dusty conditions which expose the milk to contamination during transit to processing plants. High temperature especially during summer season will speed up development of lactic acid resulting in souring of raw milk before reaching processors. The problem is encouraged by malfunctioning of cooling systems on bulk trucks and exposure of milk cans when transported to processing plants.

The majority of producers (93.8%) had milk rejected either twice or once per month by the processor. A small percentage of 6.2% did not have any rejection from the processors. Amongst the producers who said did not have milk rejection, some of them could not remember and this means the producers could have had milk rejected by processors a long time ago. The greatest number of rejection cases was due to milk which had turned sour. Sour milk rejections constituted 83.3% of the sampled producers. Rejections due to added water in milk constituted 6.7% of the producers while rejections due to foreign bodies in milk constituted 10 percent. Sourness of milk was mostly as a result of long delivery intervals and long transportation time and frequent breakdowns from the bulk trucks. Foreign bodies were mostly common in producers on cans though some bulk milk tankers had cases of foreign bodies in the milk too as well. Poor cleaning of the containers and bulk milk tankers leaves milk residues which increases spoilage of raw milk leading to rejections especially due to milk turning sour before reaching processing plant. Functional cooling facilities are needed for bulk milk tankers especially in tropical regions with high daily average temperatures.

5.8 Use of detergents and sanitizers

For the producers on can delivery, majority of the producers (75%) (Table 5.1.1) are using detergents and sanitizers for cleaning the milk cans. Producers also mentioned the difficulties in sourcing these chemicals as most of them are not locally available. This is evidenced by (25%) of the producers who are not using any detergents or sanitizers (Table 5.1.1). The producers mentioned that the chemicals are usually out of stock from sellers and have to wash containers without using detergents or sanitizers most of the time. The

situation is not recommendable as it is difficult to effectively clean milk cans without any detergent. The situation encourages spoilage of milk when handled by dirt containers.

5.8.1 Relationship between containers and rejections

16 of the producers on cans had milk once rejected by the processing plant. This means 100% for the sampled producers on can milk delivery. This gives a reflection of difficulties for the producers on cans to meet required milk quality standards by the processors and dairy regulations. For the producers on bulk NDC, all 8 producers were once rejected. This also gives an indication of challenges for bulk producers and NDC as a bulk milk transporter in meeting the required standards as anticipated by processors according to dairy regulations. 6 producers on bulk collection by processor were once rejected and 2 of them never rejected. In total 14 out of the 16 producers on bulk were once rejected while all the 16 producers on cans were once rejected. The indication is that producers on bulk are better on meeting expected milk quality standards compared to producers on can milk delivery. Among bulk milk collection, producers on processor bulk milk collection had less number of milk rejections in comparison to those on bulk NDC. Nevertheless, all categories of producers (bulk and cans) and milk transportation forms had insignificant differences in terms of performance in raw milk transportation (Table 4.8.3 and 4.9.2).

Environment

5.9 Regulation

The operating environment for the dairy sub sector is controlled by dairy regulations. Dairy Services is a government unit which monitor adherence to regulations by the actors in the dairy sub sector. The regulations are inscribed in the Dairy Act of Zimbabwe which is an act of parliament. There is need to review some dairy standards in developing countries in order to create consistency between related policies and legislation. This is also supported by literature especially for developing countries. The majority of producers are aware of milk supplying regulations. There are also a considerable number of producers who need to be trained about the milk regulations. Besides regulations being a requirement for producers to fulfil, the producers should be made aware as for the benefits and the bottom line behind such requirements. It is also indicated that the regulations need to be reviewed as most regulations are not being adhered to despite the fact that the producers are aware of them. Economic conditions are still not favourable for the producers and this is making it difficult for producers to follow the set regulations and standards. There are problems with milk quality especially TBCs and thus making it difficult to prolong milk storage at farm level.

5.9.1 Awareness on regulation for milk age supplying limit

The majority of producers as shown by the 63% respondents are aware of the limited time to keep the milk before supplying the processors. The smaller percentage of 37% is unaware of the regulation. The percentage for the unaware producers is however very big considering the fact that these producers are registered and also in the main milk chain for public consumption. This therefore requires extension services and milk processors to reach out to these producers to make them aware of the regulation and the benefits behind this cause. It is when the producers appreciate the usefulness of the regulation that they can adhere to the standard rather than the regulatory institutes policing it on producers. Raw milk spoilage could be reduced if milk is not stored for more days at the farm before being transported to processing plant.

5.9.2 Respondents opinion on usefulness of milk age regulation

On usefulness of the regulation, almost half of the sampled producers showed neutrality in their opinion. Most producers who were neutral expressed the concern with costs incurred in early deliveries though they appreciated milk quality attributes of early supplies. The neutral respondents also had the opinion that it could be well with supplying milk after 3 days of

storage as long as the milk could be within acceptable quality levels. Acceptable quality levels are difficult to meet as the total bacterial counts and somatic cell counts for both producers on bulk and can deliveries are high. The number of respondents with a neutral opinion shows the magnitude and danger of milk being kept for long at farms before being supplied to processing plants. 25% strongly agree and 31% agreed on usefulness of the milk age regulation. This means 56% of the producers agreeing supplying within stipulated time. The study shows that more than half of the producers delivering well after the 72hr recommended time. This includes producers on bulk and those on can deliveries.
Milk quality is greatly affected by milk delivery intervals. Despite milk being kept at recommended temperatures, bacterial replication is not completely stopped but only retarded to minimal levels. This implies that the longer the milk is kept at farm bulk tanks the more the deterioration of milk quality due to bacterial growth. Dairy regulations stipulate that milk should be delivered within 72hours after milking (3 days).

5.9.3 Milk transportation regulation

The regulation for milk transportation requires that the bulk milk tanker does not compromise the quality of milk during transit to processing plants. Most bulk milk tankers were not meeting all the stipulated standards according to the regulatory institute key informant and observations. Most trucks have worn out rubber seals at manholes and spray balls are tied by pieces of wire. Cleaning of the tankers is not being effective as most of these vehicles are failing hygiene test on several occasions. For the 8 trucks which were inspected and tested in the month of July, 3 of the trucks had TNTC TBCs and also tested positive on coliform test. One truck had 308 TBC and also tested positive on coliform test. Only one vehicle tested positive for E. coli test. This is a clear indication of poor hygienic standards for the bulk milk trucks. It is worse especially when milk carrying compartments are testing positive to *Escherichia* coli.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Survey, interviews and observations during the study were used to come up with conclusions and recommendations.

The study indicates that raw milk transportation in Matabeleland region is contributing to quality deterioration of milk. Milk volume collected from producers are low as 43.8% of the producers are supplying around 500liters or less on each delivery to the milk processing plant. Close to 19% of the producers are supplying 501 to 1000 litres to the processing plant on each delivery. 37.5% of the producers are supplying between 1001 to 2000litres on each delivery usually after third day. The later being the highest category of milk volumes supplied to processing plants by a producer on each delivery.

Although above half of the producers are having milk collected at recommended temperature of 4°C, raw milk is getting to processing plants at temperature far above 4°C. Raw milk transported by NDC bulk tankers is arriving at 11°C on average. Raw milk collected by bulk processor is reaching processing plants at 9°C on average while can deliveries arrive at processor intake bay at 13°C on average. The temperatures are far above 4°C which is the farm milk temperature and to be maintained during transportation until offloading at milk processing plant. Over half of the producers (53.1%) are supplying after 3 day supplying intervals. The regulation requires milk not to be stored for more than 3 days at the farm. Low milk volume produced by farmers are leading to wide supply intervals as producers try to accumulate reasonable volumes to deliver to processing plants.

Equipment used for carrying milk is not good as most producers are using rusty and old milk cans. Most producers are using stainless steel containers for raw milk transportation but the condition of these containers is no longer recommended for maintaining quality of milk. A big proportion of the producers are using plastic containers which are difficult to effectively clean and thereby compromising the quality of the raw milk.

There is a problem of the age of vehicles which are used to transport raw milk. The vehicles are too old and experiencing frequent breakdowns which further result in long raw milk transportation time from farms to processing plants. This is further made worse by the fact that these bulk milk tankers do not have functional cooling facilities. Raw milk is taking long time at the farms before being transported to milk processing plants. Volumes produced by dairy farmers are low compared to the carrying capacity of the bulk milk trucks. Raw milk transportation costs are high and producers are resorting to transporting milk own their own to processing plants. Maintenance of bulk milk trucks is high due to the age of the vehicles and the frequent breakdowns.

Processors do require milk which is fresh, without foreign bodies and added water.
Most producers have had raw milk rejected by the processors and the cause for rejections was mainly due to sour milk, added water and foreign bodies in the milk. Highest number of milk rejections has been from can producers. Majority of producers in the region are aware of dairy regulations relating to milk quality and raw milk transportation standards. The standards are however not being fully followed due to economic challenges faced by the dairy sub sector and the entire nation.

Organoleptic tests which include smell, taste, visual assessment are done at farm level by bulk milk tank driver whilst platform test like titration and specific gravity and double alcohol test are done in addition to organoleptic tests at processing plant milk intake bay.
Dairibord Zimbabwe Limited is offering premiums for low TBC and low SCC and penalising high TBC and SCC as a way of encouraging production of good quality milk from producers.

DZL is also procuring detergents which are sold to producers supplying milk to its plant as well as offering extension services to producers on dairy herd improvement services. All bulk milk tankers should be inspected and tested by Dairy services to get approval for transporting raw milk. Most bulk milk tankers are failing hygienic tests and drivers are executing duties without training from the dairy regulatory authority.

Land reform programme has resulted in decline in milk production volumes. Uncertainty of land, company ownership is suppressing investments and building up of dairy herd leading to poor transportation equipment and production of low milk volumes. Influx of dairy imports and scarcity of vehicle spare parts is also posing a challenge to the dairy sub sector.

6.2 Recommendations

Food production

- **Security of land tenure for dairy producers**

There is need to ensure security of tenure for dairy producers as uncertainties have negated building up of dairy herd and upgrading of dairy premises and facilities. This has consequently resulted in low milk volumes and difficulties in establishing a viable raw milk transportation service for milk transportation organisations.
There is a tendency of not valuing the quality standards for milk with most smallholder dairy producers. This is a result of limited knowledge on milk quality aspects. Training of dairy producers on milk quality standards and handling of milk needs to be carried out by the extension workers and processors as well to increase production and transportation of good quality milk to the processors. Milk transporting vehicle should not carry other commodities like meat and vegetables as these increase chances of milk contamination.

- **Milk deliveries**

Raw milk should be supplied early hours of the morning to milk processing plants to avoid high daily temperatures on transit later on during the day. All dairy producers using milk cans should have milk protected from direct sunlight during transportation. All smallholder producers should implement milk temperature control at farm before transportation of milk to processing plant. Dairy Services and processing plants should assist the producers in establishing sustainable ways for milk temperature control at smallholder level.

- **Milk payment system**

Although producers are finding it difficult to produce good quality milk, all milk processing plants should urge production of good quality milk through payments of premiums for good quality milk and penalties for poor milk. Milk processing plants should establish an extension unit to give advice to producers on clean milk production and milk handling procedures. Dairy Services has been offering such services but governments units are not sufficiently equipped with personnel and equipment. Therefore the need for the private sector to compliment government efforts in extension services as processors gets immediate benefits from good quality milk from producers.

Organisations

- **Procurement of new small bulk milk trucks**

NDC should buy new bulk milk trucks. The trucks should be of smaller sizes to carry current produced volumes economically. Maintenance costs are high for the current fleet of vehicles for NDC. Therefore, it is advisable to buy new vehicles as maintenance costs may be too costly compared to buying new vehicles in the long run. The actual monetary figures for maintaining old fleet or buying small trucks would however need further cost benefit analysis.

- **Procurement of milk cans and detergents**

ZDIT should assist in procurement of stainless steel containers in bulk from neighbouring countries. The cans will be sold to all registered dairy producers at a reasonable price compared to the one charged by unscrupulous dealers who are taking advantage of the local unavailability of the cans. All milk processing plants should buy detergents and sanitizers on behalf of all producers supplying these processors with milk. It is highly not recommendable for a dairy producer to operate without detergents for cleaning facilities and equipment used for milk handling.

Cleaning of bulk milk tankers should be done by milk processors despite the bulk tanker belonging to NDC. This improves on hygiene of milk tankers as the milk compartments would be washed immediately after offloading milk at plant intake bay.

- **Establishment of Milk Bulking Centres**

The volume of milk produced in the region is low and therefore the need to establish Milk Bulking Centres. The Milk Bulking Centre would facilitate early deliveries of raw milk from producers and also short intervals with economic volumes from the MBC to milk processing plant. Establishment of MBCs should be spearheaded by the ZDIT in conjunction with the associations for both large scale commercial dairy producers NADF and smallholder dairy producers SHODFAZ. Dairy Services Unit to oversee the layout of the infrastructure. Listed below would be the required facilities and personnel for establishment of the MBC.

- Building to accommodate 2 by 5 000 litre tanks.
- A small room equipped with simple raw milk testing apparatus.
- A person to conduct raw milk acceptance tests at MBC.
- A room for a security guard to man the premises
- A standby generator in case of power cut.

The establishment of the MBC will be carried out with the advice of Dairy Services officials who are the custodians of dairy sub sector to ensure compliance of the MBC with dairy regulations. Establishment of MBCs is necessitated by the fact that Umzingwane Milk Centre is catering for buying raw milk from smallholder producers and processing the milk into dairy products as well. There is therefore the need to cater for commercial dairy producers who are presently producing low milk volumes. Low milk volumes have become prominent and that is making it uneconomic to be transported by bulk trucks from individual farms to processing plants.

Environment

- **Review of regulations and personnel recruitment by Dairy Services**

The government froze all government posts as a way of trying to reduce government expenditure from civil servants salaries. The situation has resulted in understaffing of most government units and in particular Dairy Services unit. The government should unfreeze vacant posts and fill them with new staff members. This will enable training and offering of proficiency certificates to bulk milk tankers by Dairy Services officials before being assigned for their milk collection duties. This is the procedure required to be followed by dairy regulations for bulk milk tanker drivers. A review of dairy regulations is necessary for training and proficiency testing to be conducted by private players from the industry.

Agri- food chain

- **Interdependency on bulk tanker cleaning**

Milk processors should assist NDC in cleaning of bulk milk tankers. The Cooperative does not have proper facilities for tanker cleaning hence the need for processors to safe guard milk quality by offering tanker cleaning services. The value chain concept should be encouraged where actors work together for enhancing functioning of the entire milk chain.

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Annex 1. Questionnaire for producers on bulk milk collection

Milk Delivery Method: BMC (NDC) _____BMC (Processor) _____

1) Which processor do you supply?
a. Dairibord_____ b. Kershelmar_____c. Mzingwane Dairy_____

2) Delivery interval:
a. Daily_____ b. Every 2nd day _____ c. 3rd day _____ d. 4th _____

3) How much milk is delivered at a time?
a.100 - 500 L_____ b. 501 – 1000 L_____ c.1001 – 2000 L_____ d. >2000 L_____

4) Are you happy with the supplying intervals?
a. Yes_____ b. No_____

5) Why are you happy or not with the interval?

6) Do you know regulation for milk age supplying limit?
a) Yes_____ b. No_____

7) What does the regulation say?

8) Do you think the regulation is of any help to the farmer?
a. Strongly agree____ b. Agree___c. Neutral__ d.Disagree____ e.Strongly disagree_____

9) Do you think the vehicles are worthy transporting milk?
a. Totally agree___ b. Agree___ c. Neutral___d. Don't agree___ d. Totally Disagree___

10) Why are vehicles worth or not worthy transporting milk?
a. Too old__ b. Too small___ c. Too big___ d. Other____

11) Do the drivers record the time when milk is collected?
a. Yes_____ b. No____

12) What time does it take for your milk to be transported from farm to processing plant?
a. 1hr ____ b. 2 hrs_____ c. 3 hrs_____ d. >3hrs_____

13) What is your opinion about the time taken transporting milk to the processing plant?
a. Very good__ b. Good__ c. Neutral___ d. Bad___ e. Very bad__

14) Do you check if bulk milk tanker has functioning cooling facility before loading milk?
a. Strongly check___ b. Check___ c. Never check

15) Do driver always take sample before loading milk into bulk tanker?
a. Yes_____ b. No____

16) What bulk tank/container is used to carry milk?
a. Stainless steel _____ b. Aluminium _____ c. Plastic _____ d. Other____

17) How is the condition of containers?
a. Very good ____ b. Good_____ c. Fair_____ d. Bad_____ e. Very bad_____

18) What is your opinion on cost for transporting milk to processing plant?

a. Very high___ b. High____ c. Fair_____ d. Low_____ e) Very Low____

19) Do you have an idea about factors affecting your milk quality?
a. Yes_____ b. No_____

20) What milk quality aspect would you consider to be your greatest challenge?
a. TBC _____b. SCC_____ c. Butterfat_____ d. Protein_____

21) Have you ever had your milk consignment rejected by processor?
a. Yes_____ b. No_____

22) If yes, what was the cause for milk rejection?
a. Sour milk_____b. High TBC____c. Added water____ d. Foreign bodies____e. Other___

23) At what temperature is milk transported to milk processing plant?
a. 4°C__ b. 10°C__ c. 15°C__ d. 20°C___

24) At what temperature does milk reach to milk processing plant?
a. around 4°C__ b. around 10°C___ c. around 15°C___ d. 20°C____

Annex 2. Questionnaire for producers on cans

1) Which processor do you supply?
a. Dairibord_____ b. Kershelmar_____c. Mzingwane Dairy_____

2) Delivery interval:
a. Daily_____ b. Every 2nd day _____ c. 3rd day _____ d. 4th _____

3) How much milk is delivered at a time?
a.100 - 500 L_____ b. 501 – 1000 L_____ c.1001 – 2000 L_____ d. >2000 L_____

4) Are you happy with the supplying intervals?
a. Yes_____ b. No_____

5) Why are you happy or not with the interval?

6) Do you know regulation for milk age supplying limit?
a) Yes_____ b. No_____

7) What does the regulation say?

8) Do you think the regulation is of any help to the farmer?
a. Strongly agree____ b. Agree___c. Neutral__ d.Disagree____ e.Strongly disagree_____

9) What time does it take for your milk to be transported from farm to processing plant?
a. 1hr ____ b. 2 hrs_____ c. 3 hrs_____ d. >3hrs_____

10) What is your opinion about the time taken transporting milk to the processing plant?
a. Very good__ b. Good__ c. Neutral___ d. Bad___ e. Very bad__

11) What bulk tank/container is used to carry milk?
a. Stainless steel _____ b. Aluminium _____ c. Plastic _____ d. Other____

12) How is the condition of containers?
a. Very good ____ b. Good_____ c. Fair_____ d. Bad_____ e. Very bad_____

13) Do processor clean milk containers after emptying the milk?
a. Yes____ b. No_____

14) Where do you store your milk containers?
a. In main house___b. In store room___ c. In dairy parlour__

15) Does the place have a rack for storing milk containers?
a. Yes_____ b. No____

16) Do you use detergents and sanitizers for cleaning?
a. Yes____ b. No_____

17) Do you have facilities for hot and cold water?
a. Yes_____ b. No_____

18) What is your opinion on cost for transporting milk to processing plant?
a. Very high___ b. High____ c. Fair_____ d. Low_____ e) Very Low____

19) Do you have an idea about factors affecting your milk quality?
a. Yes_____ b. No_____

20) What milk quality aspect would you consider to be your greatest challenge?
a. TBC _____b. SCC_____ c. Butterfat_____ d. Protein_____

21) Have you ever had your milk consignment rejected by processor?
a. Yes_____ b. No_____

22) If yes, what was the cause for milk rejection?
a. Sour milk_____b. High TBC____c. Added water____ d. Foreign bodies____e. Other___

23) At what temperature is milk transported to milk processing plant?
a. 4°C__ b. 10°C__ c. 15°C__ d. 20°C___

24) At what temperature does milk reach to milk processing plant?
a. around 4°C__ b. around 10°C___ c. around 15°C___ d. 20°C____

25) What measures do you use to maintain temperature during milk transportation?
a. Refrigerated containers__ b. Shades for open trucks__ c. Non___ d. Other___

Annex 3. Check list for Transporter

Vehicles		
How many vehicles are required to offer sufficient service to the region?		
What is the condition of your vehicles?		
What is the maximum time on the road a vehicle is taking to recover after breakdown?		
What are the factors hindering efficient service to the farmers?		
What strategies have you set up to counteract milk transportation challenges?		
What do you think needs to be done to ensure good milk transportation services?		
What do you think makes transportation inefficient?	Cleaning,drivers,roads etc	
Cleaning		
What method of cleaning is being used for the bulk milk tankers?	e.g CCP/Manual	
Who does the cleaning for the bulk milk tankers?		
What are the intervals for cleaning of the bulk milk tankers?		
Testing		
How often do you carry out swabs on the vehicles?		
Drivers		
What training is given to drivers/ samplers?		
Quality Maintenance		
What procedure is used for monitoring temperature of milk from collection to delivery?		
What temperature is milk transported to milk processing plant?		
What temperature does milk reach to milk processing plant?		
What value do you put on milk quality?	Important/ Unimportant	
Billing clients		
How do you charge farmers for the transportation services?		
How current billing affects services?	e.g profit, loss, BE	
Regulations		
What is your opinion on milk transportation regulations?	e.g relevant/ irrelevant	

Annex 4. Check list for Processors

Raw milk tests		
What platform tests do you carry out at milk intake ?		
Quality		
What measures have been established to protect milk intake area from undesirable elements?		
What detergents and sanitizers are used at milk intake area?		
What value do you put on milk quality?		
What motivates production of quality milk and products?	demand, self satisfaction etc	
What assistance do you offer to the farmers to produce high quality milk?	Training, detergents	
What do you think needs to be done by the sector to ensure a good milk transportation service?		
Rejections		
What is the rejection process for milk of poor quality?		
Equipment/Facilities		
What is the condition of facilities at milk intake?		
What milk handling equipment cleanings procedures are in place?		
Do you have wash facilities for milk containers from farmers?		
What assistance do you offer to farmers for a good milk transportation services?		
Is there provision for hot and cold water		
Regulations		
What is your opinion on regulation and standards on quality?		

Annex 5. Check list for Regulatory Institute/Dairy Services

Regulations		
What are the current milk transportation standards?		
What is your opinion on transportation standards and milk quality?		
What does the sector say about the regulatory standards?		
Is there a need to change the current standards?		
Bulk tanker inspections		
What test do you do on bulk milk tankers?		
What is the condition of the tankers?		

Annex 6. Check list for Bulk Milk Truck Driver

Training		
Where you trained for milk sampling?		
Vehicle condition		
How is the condition of vehicles?		
Are vehicles worthy transporting milk?		
Transportation time		
What is your opinion on transportation time?		
Value for milk quality		
What value do you put on milk quality?		

Annex 7. Bulk tanker swab and inspection form

Truck Number				
Registration number				
Compartment A	TBC	Coli	E.coli	Comments
Lid A				
Manhole A				
Rubber seal condition				
Sprayball condition				
Compartment B				
Lid B				
Manhole B				
Rubber seal condition				
Sprayball condition				
Inlet valve A				
Outlet valveA				
Inlet valve B				
Outlet valve B				
Overall comments:				

Annex 8. Survey and interview results

i. What milk temperature from farm?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	17	53.1	53.1	53.1
	10	14	43.8	43.8	96.9
	15	1	3.1	3.1	100.0
	Total	32	100.0	100.0	

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
what milk temperature from farm?	32	6.97	3.326	.588

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
what milk temperature from farm?	11.852	31	.000	6.969	5.77	8.17

ii. What milk temperature at intake point?

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	116.062	2	58.031	5.868	.007
Within Groups	286.812	29	9.890		
Total	402.875	31			

iii. Equipment used for raw milk handling and transportation in Matabeleland region





DAIRI


KershelmaR
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