FARM FACTORS ASSOCIATED WITH MILK REJECTION AT DAIRY COOPERATIVES IN PERI-URBAN NAIROBI

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DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university.

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To

My son, Mwendwa, my parents Mr. and Mrs. Ndeto Kyallo, sister Kalekye, brothers Kyallo, Kiamba and Kiindu.

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ABSTRACT

Within the cooperative milk market chain, milk loss is estimated at between 1-5% on average, but can go up to 10% in the wet season when delivery rejections are common. In Kenya, most studies on milk losses have focused on milk spoilage along the milk market chain. This study was therefore conducted to identify practices at the farm level that contributed to milk spoilage hence rejection at the peri-urban dairy cooperative societies around Nairobi area. The objectives of the study were; to assess the main reasons of milk rejection at the dairy cooperatives, to determine milk quality control, tests at the dairy cooperatives and the implications of milk rejection at 80% ethanol and to determine the farm level factors associated with milk rejection at the dairy cooperatives in peri-urban Nairobi.

Four dairy cooperative societies were purposively selected for the study. A questionnaire was administered with the aim of identifying the main reasons for milk rejection at the cooperative societies. Smallholder farms having ≤ 10 dairy cattle were selected in the study. Dairy farmers who met this selection criterion were randomly selected from the records of the dairy cooperatives. A total of 181 farms were selected for the study. These farms were proportionately distributed in the four dairy societies and in the different collection centers based on the number of active members in the dairy societies.

Milk samples were collected both at the collection centers and at the farms. During the farm visits questionnaires were administered and relevant data collected. The

samples collected were subjected to 68% alcohol test, 80% alcohol test and mastitis testing using California Mastitis Test (CMT).

Data were analysed using descriptive statistic, Chi square statistic and logistic regression analysis. Comparison and level of agreement between the two tests (68% and 80% alcohol test) was determined using the Kappa Test. Prevalence for subclinical mastitis was also determined.

Tests routinely done by the dairy societies included organoleptic test, alcohol test and lactometer test. Milk rejection was mostly done after failing the alcohol and lactometer tests. The milk processing plants dictated the alcohol (ethanol) concentration used in all the dairy societies most of them using 80% as compared to 68% alcohol concentration recommended by the Kenya Bureau of Standards (KEBS). Comparisons were made between 68% ethanol and 80% ethanol test results. Kappa test was used to determine the usefulness and level of agreement between the two tests. The test result revealed a test comparison of 0.48 indicating that the two tests are agreeable and can be used for milk quality assessment as indicated by the KEBS. However, it should be noted that milk being rejected based on 80% alcohol test is not necessarily of bad quality but the need to use 80% should be addressed by the processing firms to the cooperatives and faremers.

The main reasons for milk rejection at the dairy societies were poor hygiene, sub-clinical mastitis and adulteration. Other causes were delay by the processors in collecting milk and lack of refrigeration facilities. Farmers who used plastic containers for milking were approximately two times more likely to have their

milk rejected compared to those who used aluminum/stainless steel containers ($p< 0.027$; Odds ratio =2.12). Those farmers who provided bedding to their animals reduced the chances of milk rejection by 45% compared to those who did not provide bedding ($p< 0.02$; Odds ratio =0.45). Farmers who did teat dipping reduced the chances of milk rejection by 10% as compared to those who did not do teat dipping ($p<0.026$; Odds ratio =0.1). Farmers whose bulk milk was CMT positive were three times more likely to have their milk rejected ($p<0.002$; O.R = 2.9) as compared to those whose milk was CMT negative. The apparent prevalence of sub-clinical mastitis from the bulk milk samples was 52%, while that of quarter sampling was 40%.

This study found that the use of 80% alcohol was more sensitive than 68% in determining milk of high keeping quality. For the milk to pass the 80% alcohol test, hygienic practices both at the farm level and at the cooperative societies should be improved to meet the standards set by the processors and hence reduce rate of milk rejection and improve quality of milk. There is therefore need to formulate and implement education and training on milk quality control targeting the cooperative societies, farmers and other stakeholders.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Most of the Kenya's 3 million dairy cattle are kept by smallholders in crop-livestock systems in areas of high and medium cropping potential (Thorpe *et al.*, 2000). In the Central highlands of Kenya, smallholder dairy systems provide livelihoods for more than 50% of the agricultural households (Omore, 1997; Staals *et al.*, 2002).

Large increases in demand for milk and dairy products in developing countries are projected for the next 25 years (Thorpe *et al.*, 2000). This increase in demand represents market opportunities for smallholder dairy farmers, such as those in Kenya, who own over 85% of the dairy cattle population in Eastern Africa (Thorpe *et al.*, 2000).

Dairy farmers are in the business of producing milk and should ensure safety and quality of their raw milk (FAO/IDF, 2004). To achieve this, dairy farmers need to ensure that good agricultural, hygienic and animal husbandry practices are employed (FAO, 2000). On-farm practices should also ensure that milk is produced by healthy animals under acceptable conditions in balance with the local environment (FAO/IDF, 2004).

Pathogenic organisms in milk can be derived from the cow itself, human handlers and the environment (FAO/IDF, 2004). Microorganisms from soil, litter, feed,

water, feaces and other items in the farm environment commonly contaminate the surface of the udder, teats from which they get into the milk during milking (Reneau *et al.,* 2003; Schreiner & Ruegg, 2003). Milk residues left on the surface of equipments and utensils provide nutrients that support growth of many organisms (Bryan, 1983). The high nutritive value of milk makes it an ideal medium for the rapid multiplication of bacteria, particularly under unhygienic production and storage at ambient temperatures (Giangiacomo, 2000).

Bovine mastitis is the most frequent disease in Kenyan dairy herds (Hamir *et al.*, 1978; Odongo & Ambani, 1989; Shitandi *et al.*, 2004) and particularly problematic in small scale dairy cattle (Omore *et al.*, 1997). Exposure to mastitic pathogens occurs when large numbers of bacteria are able to successfully colonize the teat end (Radostitis *et al.*, 2000). Mastitis organisms are classified as "contagious" or "environmental" based on the most common sites of exposure (Radostitis *et al.*, 2000). The udder of infected cows is the primary reservoir for contagious pathogens and uninfected cows are exposed to organisms present in milk that originated from infected udders of other cows. Milk droplets on milking liners, shared towels or the hands of milking technicians are common sources of exposure of clean udders to contagious pathogens (Ruegg, 2004). The sub-clinical nature of the mastitis results in costly infections of long duration (Radostitis *et al.*, 2000). Moisture, mud, and manure in cow housing areas especially in beddings are the primary reservoirs for environmental mastitis pathogens (Ruegg, 2004). Exposure to environmental pathogens often occurs in areas outside of the milking facility

such as, housing areas, pastures or walkways. When the teats and udder are wet and dirty, large numbers of theses bacteria have the opportunity to infect the udder (Shreiner & Ruegg, 2003).

Effective implementation of a milking routine that includes fore stripping, pre dipping, cleaning, adequate drying and effective post milking teat disinfection should be the goal of all dairy farmers (Ruegg, 2004). Increased emphasis on monitoring animal and facility hygiene is necessary to minimize the development of mastitis and to ensure that milk produced is of high quality and continues to meet consumer demands (FAO/IDF, 2004).

Milk quality control tests are essential components of any milk processing industry whether small, medium or large as they are designed to ensure that milk products meet accepted standards for chemical composition and purity as well as levels of different microorganisms (Giangiacomo, 2000). These tests are laid down guidelines as stated in the Milk Processing Guide series, Volume 2, published by GOV/FAO/TCP/KEN/ 6611. These tests include; organoleptic tests, the lactometer/density test, acidity tests, resazurin dye test and alcohol test among others. Failure by one or two of the required tests can lead to milk rejection by either the dairy cooperative societies or the processing plants. These are common platform tests used for detection of deterioration of milk

1.2 Problem Statement

Most smallholder dairy farmers in Kiambu District belong to dairy cooperative societies, primarily for the purpose of marketing their milk (Omore, 1997).

Additional benefits provided by some of these dairy cooperative societies include provision of inputs, financial and technical services. Most of the milk (58%) is sold locally (Ombui *et al.,* 1996) and the remainder delivered to milk processing plants. Within the cooperative milk chain, milk loss is estimated at between 1-5% on average, but can go up to 10% in the wet season when delivery rejections are common (FAO, 2000). Generally, rejection of farmers' milk by either the co-operatives or the processors is negligible during the dry season but can climb to very high levels during the wet season. Press reports put the rejection to as high as 35 percent (Muriuki, 2003). This high rate of rejection is an indication of an existing problem which should be evaluated further with the aim of identifying the main reasons of milk spoilage hence rejection at the dairy cooperative societies.

In Kenya, no study has been reported to identify farm practices associated with milk spoilage and hence rejection at the dairy cooperative societies. Post harvest losses in the dairy industry in Kenya don't seem to get attention beyond the issue of what is seen as unfair milk rejections by the processors especially during the wet season (Muriuki, 2003).

Due to this concern, identifying the practices at the farm level that contribute to milk spoilage will be of economic significance to smallholder farmers as it will help reduce losses incurred and thus increase the farmers' income.

Knowledge generated from this study will be used to design appropriate interventions and extension information, in order to improve on the socioeconomic well being of the farmers and the country as a whole. The smallholder farmers, the

milk processors, other milk dealers, the government and all those who could be involved in policy making are considered as the beneficiaries of results from this study.

1.3 Hypothesis

Milk rejection at the Dairy cooperative societies is associated with unhygienic milk production and poor handling practices at the farm level.

1.4 Objectives

1.4.1 Broad objective

To reduce milk spoilage as a result of farmers practices at the farm level and hence rejection of the milk at the Dairy cooperative societies.

1.4.2 Specific objectives

1. To assess the main reasons for milk rejection at the dairy cooperative societies.
2. To determine milk quality control tests at the dairy cooperative societies and the implications of milk rejection when 80% ethanol is used for alcohol test.
3. To determine the farm level factors associated with poor milk quality and hence rejection at the dairy cooperative societies.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Milk Quality

The protein efficiency ratio of milk proteins is second to that of eggs, in regards to essential amino acids. In many parts of the world it contributes significantly to the wholesomeness of human diets especially during childhood. The increasing demand of milk and its products makes it one of the prime commodities for marketing and trade (Hempen *et al.,* 2004). Currently, Kenya's *per capita* availability of milk is 4 – 7 times higher than the other countries in the region (Thorpe *et al.,* 2000).

Besides its beneficial effects on nutrition, milk can act as a vehicle for the transmission of serious human diseases of bacterial (e.g. brucellosis, tuberculosis), viral (e.g. hepatitis), ricketssial (e.g. Q-fever) or parasitological (e.g. toxoplasmosis, giardiasis) origin. Milk is an excellent culture and protective medium for certain microorganisms, particularly bacterial pathogens, whose multiplication depends mainly on temperature and other competing microorganisms and their metabolic products. Where milk is produced under poor hygienic conditions and is not cooled, the main contaminants are usually lactic acid producers, which cause rapid souring. Lactic acid has an inhibitory effect on pathogenic bacteria but this cannot be depended upon to provide a safe milk product (Heeschen, 1994) as pathogenic bacteria produce toxins before the level of acid is adequate to inhibit them.

2.2 Managing for milk quality

Pathogenic organisms in milk can be derived from the cow itself, human handlers and the environment. Microorganisms from soil, litter, feed, water, feaces and other items in the farm environment commonly contaminate the surface of the udder, teats, the hair and skin of cows from which they can get into the milk during milking. Personnel, unhygienic milking procedures, equipment used for milking, filtering, cooling, storing, distributing milk and milk handlers are also important sources of contaminating microorganisms. Milk residues left on surface of equipments and utensils provide nutrients that support growth of many microorganisms, including pathogens (Bryan, 1983).

2.2.1 Exposure to mastitis pathogens

Bovine mastitis is the most frequent disease in Kenyan dairy herds (Hamir *et al.*, 1978; Odongo & Ambani, 1989; Shitandi *et al.*, 2004) and particularly problematic in small scale dairy cattle (Omore *et al.*, 1997).

Exposure to mastitic pathogens occurs when large numbers of bacteria are able to successfully colonize the teat end. Mastitis organisms are classified as "contagious" or "environmental" based on the most common sites of exposure (Radostitis *et al.*, 2000). The most common contagious mastitis pathogens are *Staphylococcus aureus, Streptococcus agalactiae* and *Mycoplasma bovis* but some strains of *Streptococcus uberis* may be transmitted by milk (Ruegg, 2004). Most strains of *Staph. aureus* and *Strep. agalactiae* are highly host adapted resulting in sub clinical mastitis. The sub clinical nature of the mastitis results in costly

infections of long duration. The udder of infected cows is the primary reservoir for contagious pathogens. Uninfected cows are exposed to organisms present in milk that originated from infected udders of other cows (Radostits *et al.,* 2000). Milk droplets on milking liners, shared towels or the hands of milking technicians are common sources of exposure of clean udders to contagious pathogens (Ruegg, 2004).

Environmental mastitis pathogens include coliform bacteria (such as *E. coli* and *Klebsiella* spp) and environmental streptococci (such as *Streptococcus uberis* and *Strep. dysgalactiae).* Moisture, mud, and manure in cow housing areas especially in beddings are the primary reservoirs for environmental mastitis pathogens (Ward *et al.,* 2002). Exposure to environmental pathogens often occurs in areas outside of the milking facility (such as housing areas, pastures or walkways). When the teats and udder are wet and dirty, large numbers of these bacteria have the opportunity to infect the udder (Shreiner and Ruegg, 2003).

2.2.2 Facility hygiene

Cleanliness of animal housing has a major influence on the rate of clinical and sub-clinical mastitis. Hygienic practices on herds with higher SCC values are generally poorer than hygienic practices on herds with lower SCC values (Barkema, et al., 1998). Manure handling, type of bedding and maintenance of cow beds all have significant influence on hygiene (Ruegg, 2004). Bedding management is the primary determinant of bacterial numbers on teat ends (Bey *et al.*, 2002). The presence of large numbers of bacteria in bedding often results in outbreaks of

environmental mastitis. High amounts of organic matter and moisture in bedding can support large numbers of bacteria. Sand bedding that is low in organic matter usually has the lowest bacterial populations. Anything that increases moisture content or the amount of organic matter in bedding will increase growth and exposure to mastitis pathogens. High amounts of organic matter and moisture in bedding can support large numbers of bacteria (Ward *et al.*, 2002).

2.2.3 Animal hygiene

The use of high concentrate diets has been associated with loose feaces and reduction in cow and facility cleanliness (Ward *et al.*, 2002). Several studies have identified relationships between cow cleanliness and measures of milk quality (Barkema *et al.*, 1998; Reneau *et al.*, 2003; Schreiner & Ruegg, 2003). These studies highlight the importance of maintaining cleanliness of areas that can come in contact with the udder. Significantly more environmental and contagious mastitis pathogens were recovered from milk samples obtained from cows with dirty udders as compared to cows with clean udders (Reneau, et. al., 2003).

2.2.4 Management of the milking process

Studies have shown that management of the milking process is often neglected. Reducing the labour turn over and frequent training of milking technicians can result in low rates of clinical mastitis. Effective implementation of a milking routine that includes fore stripping, pre- dipping, adequate drying and effective post milking teat disinfection should be the goal of all dairy farmers (Ruegg, 2004).

2.2.4.1 Effective Pre-dipping

Methods of pre-milking teat preparation have been extensively studied (Galton *et al.*, 1984; Ruegg & Dohoo, 1997). The use of pre-dipping using iodine has been demonstrated to reduce standard plate counts and coliform counts in raw milk by five and six fold, respectively, as compared with other methods of premilking udder preparation (Galton, *et al.*, 1986). Effective pre-dipping also contributes to improvements in food safety. It has been shown to reduce the rate of isolation of *Listeria monocytogenes* from milk filters by almost four-fold (Hassan *et al.*, 2000). It is important to recognize that sufficient time and contact of the disinfectant with the teat is necessary for effective reduction in bacterial numbers. Teat dips need to be properly formulated, completely applied to debris free teats, and allowed sufficient time (30 seconds) for action before removal (Ruegg, 2004).

2.2.4.2 Fore stripping

The examination of milk before milking is necessary to ensure that all the abnormal milk is diverted from the human chain. The use of fore stripping has been shown to significantly reduce by 2.5 and the risk of contamination of milk with *L. monocytogenes* (Hassan *et al.*, 2000). Teat cistern milk contains the highest concentration of bacteria of any milk fraction. Fore stripping is adequately performed when 2-3 streams of milk are expressed and is the most effective means to ensure adequate milk letdown. On a practical basis, when teats are clean, it may be best to fore-strip before teat end disinfection to reduce the opportunity to re-contaminate teat skin (Ruegg, 2003).

2.2.4.3 Adequate drying

Effective drying of teats is probably the most important step in hygienic pre-milking preparation. Herd level studies have shown that herds whose teats are dried have bulk tank somatic cell count (SCC) values of 44,000 cells /ml lower than those of the herds which do not utilize this practice (Moxley *et al.*, 1978). In another study, cleaning of teats without drying reduced bacterial counts by 35,000cfu/ml as compared to cleaning and drying of teats which reduced bacterial count by 12,500 cfu/ml (Galton *et al.*, 1986).

Cloth towels have the advantage of being more absorbent than paper towels but should be disinfected by washing with chlorinated water or very hot water and drying at high temperatures (Fox, 1997). The buildup of chemical residues on some towels made of synthetic fibers can reduce the absorbency and effectiveness of the towel (Ruegg, 2004).

2.2.4.4 Effective post-milking teat disinfection

Post-milking teat dipping is one of the most highly adopted practices in the dairy industry and it is the final hygienic defense against infection after milking is completed. The use of teat dipping reduced SCC values by 70,300 cells/ml in Quebec dairy herds (Moxley *et al.*, 1978).

Continued education of specialized milking staff about the principles of mastitis control is necessary to maintain excellent hygienic standards and minimize mastitis. Control of mastitis and production of high quality milk is dependent upon maintenance of excellent hygienic standards. Increased emphasis on monitoring

animal and facility hygiene is necessary to minimize the development of mastitis and to ensure that milk continues to meet consumer demands.

2.3 Milk testing and quality control

Milk testing and quality control is an essential component of any milk processing industry whether small, medium or large. The high nutritive value of milk makes it an ideal medium for the rapid multiplication of bacteria, particularly under unhygienic production and storage at ambient temperatures (Giangiacomo, 2000).

Milk quality control is the use of approved tests to ensure the application of approved practices, standards and regulations concerning the milk and milk products. The tests are designed to ensure that milk products meet accepted standards for chemical composition and purity as well as levels of different microorganisms (FAO/IDF, 2004).

Quality control and assurance must begin at the farm. This is achieved through farmers using approved practices of milk production and handling, observation of laid down regulations regarding use of veterinary drugs on lactating animals and regulations against adulterations of milk etc. They are able to evaluate the sanitary conditions of the animals and should be able to detect the presence of mastitis (FAO/IDF, 2004).

2.4 Techniques used in milk testing and quality control

2.4.1 Milk sampling

Liquid milk in cans and bulk tanks should be thoroughly mixed to disperse the milk fat before a sample is taken for any chemical control tests. Plungers and dippers are used in sampling milk from milk cans (FAO, 1979).

2.4.2 Assessment of quality of raw milk

2.4.2.1 Milk adulteration

Adulteration of milk by adding water lowers its specific gravity (SG) towards that of water. On the other hand, adding solids such as flour/sugar and removing the butterfat (BF) increases its SG. Such interferences may introduce chemical and microbial health hazards into the milk besides affecting its nutritional and processing quality, palatability and market value. The SG depends on the solid content of the milk; the respective specific gravities of fat, solid-not-fat (SNF) and water are on the average 0.93, 1.6 and 1.0 (Omore *et al.*, 2005).

2.4.2.2 Milk bacteriological quality

According to the Kenya Bureau of Standards (KEBS), raw milk is considered of low quality if it contains >50,000 coliform and 2 million total colony-forming units per milliliter (cfu/ml). Raw milk from the udder of a healthy cow contains very few microorganisms and will generally have les than 1000 total bacteria per milliliter. However, soon after milking, the milk may be contaminated from the environment where milking is done and the handling equipment. The hygiene of the milk handler also influences milk quality. The detection of coliform bacteria in

raw milk indicates possible contamination from the udder, milk utensils or water supply (Gran et al, 2003, Omore *et al.*, 2005).

Storage temperature and time are also important in determining milk quality, as these influence the rate at which the bacteria will increase in number. Under tropical temperatures, a bacteria cell with a typical generation time of 20 minutes will multiply within 7 hours to 2 million cells, the threshold set by KEBS for total bacterial counts in raw milk. However, if the milk temperature were lowered to below $10^{o}C$, the same cell would multiply to only 32 cells within the same time (FAO, 1979).

Microbial load in milk may come from either the cows' udder or from external contamination. The primary cause of elevated milk cell counts is udder infection. Milk casein, milk fat and lactose decline as the cell count increases. Such decreases lessen the value of the whole milk. The increase in blood components that leak into the milk leads to increased conductivity of milk and off flavours as well. As a result, high cell content milk is less valuable raw milk for milk processors. (Inglais, 2001)

2.4.3 Common Milk Tests

These are approved tests used to ensure the application of approved practices, standards and regulations concerning the milk and milk products. Platform tests are designed to ensure that milk products meet accepted standards for chemical composition and purity as well as levels of different micro-organisms. These tests

are the laid down guidelines as stated in the Milk Processing Guide series, Vol. 2. Published by: GOV/FAO/TCP/KEN/6611 and they include:

2.4.3.1 Organoleptic tests

The organoleptic test permits rapid segregation of poor quality milk at the milk-receiving platform. No equipment is required, but the milk grader must have good sense of sight, smell and taste. The result of the test is obtained instantly, and the cost of the test is low. Milk that cannot be adequately judged organoleptically must be subjected to confirmatory tests which are more sensitive and objective.

Abnormal smell and taste may be caused by: atmospheric taint (barny/cowy odour), physiological taints (hormonal imbalance, cows in late lactation, spontaneous rancidity), bacterial taints, chemical taints or discolouring and lactic acid development (pH < 6.4)

2.4.3.2 Clot on Boiling (C.O.B) Test

Acidity decreases the heat stability of milk. The clot-on- boiling test is used to determine whether milk is suitable for processing, as it indicates whether milk is likely to coagulate during processing (usually pasteurization). It is performed when milk is brought to the processing plant — if the milk fails the test it is rejected. The test is quick and simple. It tests for milk that is too acidic (pH<5.8) or abnormal milk (e.g. colostrum or mastitis milk).

The test measures the same characteristics as the alcohol test but is somewhat more lenient (0.22 to 0.24% acidity, as opposed to 0.21 % for the alcohol test). It

has the advantage that no chemicals are needed. However, its disadvantage is that at high altitude milk (and all liquids) boils at lower temperature and therefore the test is even more lenient.

2.4.3.3 The Alcohol Test

Alcohol test is used as a platform test for rapid determination of elevated acidity of milk. The precipitation of casein by the alcohol is associated with degree of acidity in milk, the amount of rennet present and the balance of the milk salts.

Alcohol test detects acidity of 0.23% lactic acid or milk which is abnormal e.g. colostrums, late lactation etc. It is based on the fact that proteins in milk which has become sour, e.g. as a result of lactic acid formation by bacteria, become susceptible to alcohol precipitation. Proteins become unstable when the levels of acid and/or rennet are increased and are therefore easily precipitated by the alcohol. Colostrum milk, mastitic milk and milk contaminated by lactic-acid producing bacteria can result in a positive test. This is because the different proportion of salts in milk i.e. calcium and magnesium, citrates and phosphates are imbalanced causing milk to coagulate faster.

2.4.3.4 The Lactometer test

A Lactometer is a hydrometer (a device for measuring specific gravity) adapted to the normal range of the specific gravity of milk. It is usually calibrated to read in lactometer degrees (L) rather than specific gravity *per se.* (O'Mahony, 1988). The relationship between the two is:

(L / 1000) + 1 = specific gravity (sp. gr.)

Thus, if L = 31, specific gravity = 1.031.

The lactometer test is designed to detect the change in density of adulterated milk. When carried out together with butterfat tests, it enables the milk processor to calculate the milk total solids (% TS) and solids not fat (SNF). In normal milk SNF should not be below 8.5% according to Kenya Standards (KEBS No 05-l0: 1976). Kenyan standards requires milk to have a specific gravity of between1.026 -1.032, which implies a lactometer reading range of 26.0% -32.0%.

2.4.4 Other tests

2.4.4.1 The Alcohol-Alizarin test

The alcoholic-alizarin test consists in observing the color and modifications which 3 cc. of milk undergo when shaken with 3 cc. of neutral alcohol of 68 per cent strength saturated with alizarin (about 2 grams per liter) which acts as an indicator. Procedure for carrying out the test is the same as for alcohol test but this test is more informative. Alizarin is a color indicator changing color according to the acidity. Sour milk looks yellowish with small lumps or completely coagulated. Alkaline milk looks like lilac and it may be mastitis milk. Clots and flakes too, indicate mastitis milk. Mastitic milk shows a significant increase in sodium and a significant decrease in potassium, magnesium and calcium thus rendering it alkaline in nature.

2.4.4.2 Acidity test

Bacteria that normally develop in raw milk produce more or less of lactic acid. In the acidity test, the acid is neutralized with an alkaline (0.1N Sodium hydroxide) and the amount of alkaline is measured. From this, the percentage of lactic acid can be calculated. Fresh milk has also "natural acidity" which ranges between 0.16 to 0.18% and is associated with breed, lactation period among other factors. The milk components that are acidic and contribute to these normal acidity values are carbon dioxide, protein, phosphates and citrates. The higher the concentration of these components, the higher the acidity level observed. Therefore, fresh milk from a Jersey will have a higher acidity than fresh milk from a Holstein because the Jersey milk has a higher percentage of protein. Because the concentration of milk components that contribute to the acidity measurement is variable, a range of acidity levels must be considered normal in the absence of lactic acid produced by bacteria (Harris and Bachman 2003). Figures higher than this, signifies developed acidity due to the action of bacteria on lactose.

2.4.4.3 Resazurin dye test

The Resazurin test is used as a rapid indication of the bacterial content of milk. Resazurin gives milk a characteristic blue colour and the test is based on the ability of bacteria in the milk to reduce the blue dye. The quality of the milk is judged by noting the degree of colour change - from blue through mauve and purple and pink and finally colourless - after a stated period of incubation, or the time required reducing the dye to a predetermined colour.

The Resazurin test is ideal for testing milk at the point of delivery and for regular periodic checks on quality. Although it is most applicable to raw milk, it has also been used to test pasteurised milk, raw and pasteurised cream, foremilk samples for detecting mastitis plus the cleanliness of shipping cans and other containers.

Reading and Results in a 10 minute Resazurin Test:

Resazurin disc No.	Colour	Grade of milk	Action
6	Blue	Excellent	Accept
5	Light blue	v. good	Accept
4	Purple	Good	Accept
3	Purple pink	Fair	Separate
2	Light pink	Poor	Separate
1	Pink	Bad	Reject
0	White	Very bad	Reject

2.4.4.4 Freezing Point Determination

The freezing point of milk is regarded to be the most constant of all measurable properties of milk. A small adulteration of milk with water will cause a detectable elevation of the freezing point of milk from its normal average values of -0.54°C. Since the test is accurate and sensitive to added water in milk, it is used to detect whether milk is of normal composition or adulterated. It is more sensitive than lactometer specific gravity testing for added water.

2.4.4.5 California Mastitis Test (CMT)

The California Mastitis Test (CMT) is a rapid, accurate, animal-side test used to help determine somatic cell counts (SCC) (Leslie *et al,* 2002). The test involves mixing and swirling equal parts of triethanolamine (alkyl) sulphonate reagent (a

base stained with bromocresol violet) and milk in a milk paddle with a compartment for each quarter. The results are interpreted subjectively as –ve, trace, 1+, 2+ and 3+ based on the viscosity of the gel which forms (Klaustrup, 1975). The degree of reaction between the detergent and the DNA of cell nuclei is a measure of the number of somatic cells in milk. The relationship between SCC values and CMT values is not precise because of the high degree of variability in SCC values of each CMT score (Leslie *et al,* 2002).

The CMT test was developed to sample individual udder quarters to determine the presence of sub-clinical mastitis. The test can also be conducted on bucket and bulk tank milk samples to help determine somatic cell counts (SCC) of the entire herd (Schalm *et al.,* 1957).

The most important effects which mastitis has on the dairy industry are reduced milk yields and deleterious effects on the chemical and cytological composition of milk. In addition, it may result in the presence of bacteria and other infectious agents which may be harmful to humans, and mastitis therapy often resulting in the presence of antibiotic residues in milk, rendering it unsuitable for human consumption or further processing (Coetzer, et al., 1994).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was carried out in peri-urban areas of Nairobi namely; Kikuyu, Kabete, Sigona and Kiambaa.

The peri-urban areas under study are all located in Kiambu District which is adjacent to the northern border of Nairobi. The climate is mainly influenced by elevation. Altitude ranges from 1200 meters to the East and South bordering Nairobi and 2000 meters to the west bordering the Great Rift Valley. Annual average rainfall in Kiambu District ranges between 600 and 2500 mm. The higher areas usually receive relatively more rainfall than the lower ones. Fodder availability is directly linked to the level of rainfall. Many of the smallholder farmers practice mixed agriculture where small-scale livestock production is carried out alongside food and cash crop production.

3.2 Study population

The population of interest consisted of the smallholder dairy farmers in the study area. For purposes of this study, smallholder farms were considered as those having ≤ 10 dairy cattle.

Most smallholder dairy farmers in peri-urban Nairobi are members of Dairy Cooperative Societies, primarily for the purpose of marketing their milk. However, farmers benefit from additional services offered by these dairy cooperative

societies including provision of inputs, financial and technical services (Ombui *et al.*, 1996). Dairy societies were originally formed along existing divisional administrative boundaries with little geographical overlap.

3.3 Sampling procedure

3.3.1 Selection of the Dairy Cooperatives and the study farms

Four cooperative dairy societies were purposively selected for the study. This was based on convenience and logistic purposes. The selection of these dairy societies greatly reduced study costs, because of their proximity to the Veterinary Faculty of the University of Nairobi. Total membership in all the four dairy cooperative societies was 2285.

The second step was simple random selection of smallholder farmers from the list derived from the records of the dairy cooperative societies. The sampling frame was built from active society members who were delivering milk at the time of sampling. Active membership was defined as a member who was presently producing milk and consequently had an active account on the society's payroll. Although 177 was the calculated sample size, 181 farms were randomly selected for this study. These farms were proportionately distributed to each dairy society based on the number of active members and further equally distributed to the various collection centers of the four dairy societies (Table 1).

Table 1: Selection of small holder dairy farmers from the Four Dairy Societies

Dairy Society	Active Members	Distribution in percentage	Sample distribution
Kiambaa	1000	28	50
Kikuyu	650	29.8	54
Kabete	535	28	51
Sigona	105	18	26
Total	**2285**	**100**	**181**

Out of the total 2285 members of the four dairy cooperative societies, 181 small holder farmers were randomly sampled from their records. The sample size was determined by the formulae described by Martin *et al.*, (1987) i.e. $n=4pq/l^2$

Where n= sample size

4= the value of $Z\alpha$ required for confidence at 95%

p= prevalence of milk rejection (20%)

q= 1-p

l^2= precision

$n= 4*0.2*(1-0.2)/0.06^2$

= 177

3.3.2 Selection of processing plants

Three milk-processing plants were purposively selected as they were the main milk depots for the selected dairy cooperative societies. Since the processing plants perform routine milk quality tests, they are usually the first to detect any kind of milk spoilage. Milk rejection at the processing plants leads to milk testing at the cooperative level and hence rejection at the farmers' level by the dairy cooperative societies. The processing plants in the study included Brookside Processing plant, The New Kenya Cooperative Creameries and Spin Knit Dairy.

3.4 Data collection

3.4.1 Dairies and Processing Plants

In total, four dairy cooperatives were visited and technical staff interviewed using a questionnaire (Appendix 1). The same questionnaire was used to gather data at the milk processing plants where the milk from the dairies was delivered and processed.

3.4.2 Farm Level

A total of 181 small scale milk producers were randomly selected based on the sampling frame described earlier and follow up visits made. The randomly selected producers were equally distributed in the various collection centers of the selected dairy societies. Milk samples were first obtained from the collection centers before visiting the farms for questionnaire administration.

The respondent was the person most directly involved with milk production. Questionnaires were administered with the aim of identifying services offered to the small holder farmers by the cooperative societies and the farm risk factors which could be associated with milk spoilage hence rejection at the cooperative level (Appendix 2).

3.5 Milk sampling:

Milk sampling for quality control testing was done both at the cooperative delivery points and at the farm level.

3.5.1 Sampling at the dairies

Usually, dairy cooperative societies have milk collection centers distributed closer to the farmers for easier delivery of milk. These collection centers are important because they reduce the distance to be covered by the farmer to the dairies.

At the delivery points, samples of the delivered milk were collected into 10 ml universal bottles appropriately labeled.. The samples were transported to the University of Nairobi laboratory for quality testing. On arrival, they were subjected to both 68 % alcohol test and mastitis testing using California Mastitis Test (CMT). Both alcohol and CMT positive and negative samples were then followed up to the farm level where the questionnaires were administered and individual cow's udder milk sampled for CMT testing.

3.5.1.1 Quality tests on sampled milk

3.5.1.1.1 68% alcohol testing

Alcohol test is a rapid platform test used to determine elevated levels of acidity in milk. An increased level of acidity in milk is an indicative of low quality. Sixty eight percent ethanol concentration was used in this study because it is the recommended level of concentration of alcohol by the Kenya Bureau of Standards. As this test is quite sensitive, milk that tests negative is still good enough for processing.

Procedure: A syringe was used to draw two ml of milk and two ml of 68% alcohol solution in a test tube. The milk and alcohol were mixed and the results read by visual inspection of clots, coagulation or precipitation.

Interpretation: If the tested milk sample coagulated, clotted or precipitated, then the sample was said to be positive hence need for rejection. If the sample was still clear, then the sample was negative hence passed as good quality milk.

3.5.1.1.2 California Mastitis Test (CMT)

A CMT test was performed using a CMT paddle and reagent. A portion of the milk sample was inspected for clots, discoloration or wateriness before adding CMT (California Mastitis Test) reagent. The CMT reagent (DeLaval, Wroclaw, Poland) and the method were carried out as described (Schalm & Noorlander, 1957). Reactions were graded Negative, Trace, +1, +2, or +3 according to the Scandinavian recommendations (Klaustrup, 1975).

3.5.1.1.3 Comparing 68% and 80 % Ethanol testing

A total of 168 milk samples from randomly selected farms were collected at the delivery points into 10 ml universal bottles appropriately labeled. The samples were then subjected to alcohol test at both 68% and 80% concentration.

A test statistic known as Kappa was used to determine the usefulness and level of agreement between the two tests. In test comparisons the probability of being test positive is given by the apparent prevalence for each test. Hence the probability of both tests being positive is given by the product of the two apparent prevalences. Similarly, the probability of both tests being negative is given by the product of 1 minus the apparent prevalences of each test. The sum of these two probabilities gives the level of agreement expected by chance alone. Calculation of Kappa is as described in Martin et al., 1987.

A qualitative assessment of kappa suggests that if it is high, the tests are measuring what they purport to measure. If kappa is low, much uncertainty exists and in the absence of sensitivity and specificity data it is difficult to say which tests provide the more valid answers. In the comparison of tests, a kappa of at least 0.4-0.5 indicates a moderate level of agreement (Martin et al., 1987).

3.5.2 Sampling at the farm

Selection of individual cows for milk sampling was done. In farms with more than three milking cows, a maximum of three milking cows in each farm were randomly selected for teat sampling. Prior to teat sampling, cows were properly

restrained preferably in the milking parlor. The teat ends were cleaned and rubbed with cotton moistened in 70 % alcohol. Initial streams of milk were discarded and approximately 5mls of fore milk collected into the CMT paddle for mastitis testing using the CMT reagent. The reactions were then graded according to the Scandinavian recommendations (Klaustrup, 1975).

3.6 Data management and analysis:

Data were coded and entered in Ms Access 2003 (Microsoft Corporation, 2003). Data was then exported to Genstat® 7th Edition for both descriptive and statistical analysis.

Apparent prevalence for milk rejection was calculated as the number of milk samples testing positive to 68% alcohol divided by total number of milk samples tested. The level of agreement between the two tests was calculated using Kappa Test. Apparent prevalence for sub-clinical mastitis was calculated as the number of milk samples testing positive to CMT divided by total number of samples tested.

Associations between the potential farm factors of milk spoilage were assessed using the Chi-square statistic and the strength of the association determined using the odds ratio, in this case the antilog of estimates. Risk factors with $p>0.05$ were considered insignificant while those with $p<0.05$ were considered significant and were therefore included in the logistic regression (Dahoo *et al.*, 2003). After the univariate analysis, a multiple logistic regression technique, using the stepwise procedure was used to screen variables that could determine milk spoilage hence

rejection at 5% levels of significance. Risk factors with $p<0.05$ were considered significant and retained in the logistic regression. Interaction and confounding between the factors/variables were controlled analytically in the logistic regression modelling.

CHAPTER FOUR

4.0 RESULTS

4.1 Dairy Cooperative Societies

Dairy Societies included in the study were Kikuyu, Sigona, Kabete and Kiambaa. Of these, Sigona had the least number of active registered members (105) as compared to Kiambaa with the highest number of active members (1000). These societies had been purposively selected from a population of dairy societies serving the local dairy farmers in the study area. Most of the study farms (87.3%) made use of the various services offered by the dairy societies with artificial insemination being the most commonly utilized service (85.1%). Others included feeds on credit (64%) and loan acquisition, of which only a small proportion of the farmers (4.4%) used it (Table 2).

Table 2: Services offered to farmers by the dairy cooperative societies in Kiambu District, (June 2006-March 2007) and the number of farms utilizing them.

Societies/ No. of Farms studied	Number of farms utilizing a service				
	A.I service	Vet credit	Feeds on credit	Loans	None
Sigona (n=26)	22	8	18	0	1
Kabete (n=51)	29	4	26	4	8
Kikuyu (n=54)	43	2	20	1	9
Kiambaa (n= 50)	40	8	37	2	5
Total (n=181)	**134**	**22**	**101**	**7**	**23**

Of the four dairy societies visited, only Sigona had no recorded cases of milk rejection. Testing of milk by use of 68% alcohol in all the dairy societies was not done routinely; it was only done when the processing plants rejected the milk or when other societies and their retail outlets reported cases of milk spoilage (Diagram 1). From the existing records, a total of 850 liters of milk was rejected from the four dairy cooperative societies on a daily basis, representing a loss of 2.4% of the total milk delivered. More details on the amount of milk rejected are in table 2 below. From this, an estimated daily milk loss worth Ksh 13,000 can be calculated based on the average milk price Ksh 16.00 per liter at the time of the study.

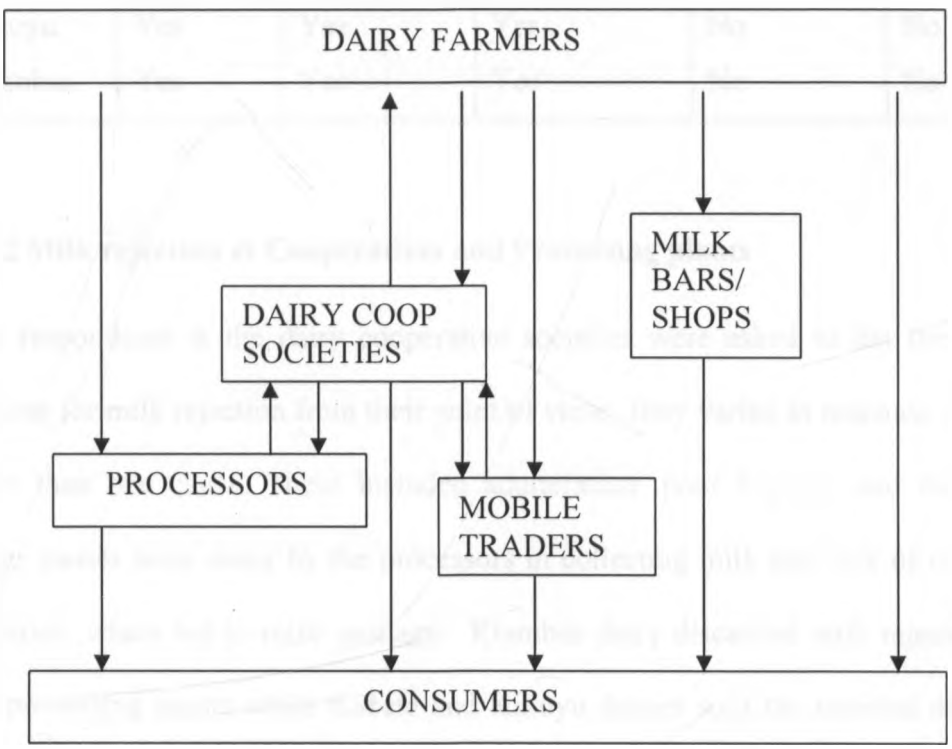
Table 3: Milk rejection from the four randomly selected dairy societies in Kiambu District (June 2006-March 2007)

Dairy Society	**Average milk collected daily (Liters)**	**Average milk rejected daily (Liters)**	**% Loss**
Sigona	950	0	0%
Kabete	6,100	100	1.6%
Kikuyu	5,250	150	2.9%
Kabete	12,000	600	5%
Total	**24,300**	**850**	**Av 2.4%**

From the records, tests routinely done by the dairy societies included organoleptic test, alcohol test and lactometer test. Alcohol-Alizarin and clot on boiling tests were reported only at the Sigona dairy. Milk rejection was done after failing the alcohol and lactometer tests (Table 4). The milk processing plants dictated the

alcohol concentration used in all the dairy societies. It ranged between 72% and 80% which is much higher than the 68% alcohol concentration recommended by the KEBS.

Diagram 1: Diagram showing flow of milk from farmer to processor and route of milk rejection from processors to farmers via the dairy cooperative societies (Modified from Omore *et al.*, 1999)



Key:

→ Shows flow of milk from producer (smallholder farmer) to the consumer

→ Shows direction of milk rejection from processors and/or trader to the dairy cooperative and finally to the farmer

Table 4: Milk quality tests performed in the four randomly selected dairy societies in Kiambu District (July 2006 – March 2007)

Tests / Dairy Societies	Alcohol	Lactometer	Organoleptic	Alcohol-Alizarin test	Clot on Boiling
Sigona	Yes	Yes	Yes	Yes	Yes
Kabete	Yes	Yes	Yes	No	No
Kikuyu	Yes	Yes	Yes	No	No
Kiambaa	Yes	Yes	Yes	No	No

4.1.2 Milk rejection at Cooperatives and Processing plants

The respondents at the dairy cooperative societies were asked to list the main reasons for milk rejection from their point of view. They varied in response giving more than one cause. These included adulteration, poor hygiene and mastitis. Other causes were delay by the processors in collecting milk and lack of cooling facilities, which led to milk spoilage. Kiambaa dairy discarded milk rejected by the processing plants while Kabete and Kikuyu dairies sold the rejected milk to pig-rearing farmers at a throw away price of Ksh 3.00 per liter. The farmers whose milk was rejected were stopped from further deliveries of milk and advised to seek professional advice on how to improve the quality. Their milk was reaccepted after it was certified to be okay.

Milk tests routinely performed at the processing plants included alcohol test, resazurin test and lactometer tests. Milk rejection was done after failure of any one of these tests as they depicted different reasons leading to milk rejection.

4.2 Milk Test Results

4.2.1 68% Alcohol Test results

Of the pooled milk samples collected at the delivery points 69 were positive on 68% alcohol test, converting to an apparent milk rejection prevalence of 38% (69/181). A total of 46 pooled milk samples (25%) were positive on both 68% alcohol and CMT testing. The household prevalence per dairy cooperative was: Kikuyu Dairy (54%); Kiambaa Dairy (44%), Kabete Dairy (24%), and Sigona Dairy (23%).

4.2.2 Sub clinical mastitis evaluation

Of the pooled milk samples taken at the delivery points, 52% (94/181) were positive on CMT. Positive results on CMT testing varied from traces to strong positives (table 5). Samples with CMT scores of positive 2 and 3 did not have any definite visible gross changes like clots. . This was because farmers usually sieve their milk before delivering it to the dairies, hence low chances of seeing any gross changes of milk at delivery.

Out of the 181 farms visited, a total of 394 milking cows were sampled for sub-clinical mastitis using CMT testing. The 394 cows had a total of 1574 functional quarters, with two cows having lost one quarter each from either past mastitis or teat obstruction. This left a potential total of 1574 quarters. Of the 1574 quarters screened, 60% (946 of 1574) were negative on CMT. Of the positive quarters, 19% (301 of 1574), 15% (235 of 1574), and 6% (92 of 1574) were Trace, 1+, and

2+, respectively, on the CMT scale. Therefore, based on the CMT screening test, quarter-level prevalence of sub-clinical mastitis was 40% (628 of 1574).

Table 5: CMT results of pooled milk samples from the smallholder dairy farmers in peri-urban Nairobi (June 2006-March 2007)

CMT results	Number of samples	Percentage
Negative	87	48
Trace	36	20
Positive 1	43	24
Positive 2	13	7
Positive 3	2	1
Total	181	100

4.2.3 Comparing Alcohol Tests (80% and 68%)

When a new test is developed or opted to be used, its results are often compared to those from the current and standard test i.e. comparing agreements between tests. Kappa test is used for this purpose and incorporates the observed level and chance (expected) level of agreement. Calculations are as described by Martin et al, 1987.

Dairy cooperatives use 80% ethanol concentration to test for milk acidity levels in order to reject or accept delivered milk. KEBS has however set the standard at 68% ethanol concentration. The increase in ethanol concentration by the cooperative societies is usually determined by the processing plants which buy the milk. For purposes of comparing 68% and 80% alcohol tests, 168 pooled milk

samples were collected and subjected to both 68% and 80% ethanol to test for their potential agreement. Results obtained were put in table 6 below.

Table 6: Agreement between two tests

		Standard test (68%)			Apparent
		+	-	Total	prevalence
New Test (80%)	+	128	20	148	0.88
	-	4	16	20	
		132	36	168	

Apparent prevalence, 0.79

Observed proportion agreement	(128+16/168) = 0.857
Chance proportion agreement (both +)	0.79 x 0.88= 0.695
Chance proportion agreement (both -)	0.21 x 0.12= 0.025
Chance proportion agreement	0.695+0.025= 0.720
Observed minus chance agreement	0.857- 0.720= 0.137
Maximum possible agreement beyond chance level	1- 0.720 = 0.280
*Kappa	0.137/0.280 = 0.48

*Kappa of 0.48 indicates a moderate level of agreement meaning that 48% of the poten agreement beyond chance was actually achieved.

4.3 Farm Management Practices

4.3.1 Response rate

A total of 181 farming households from the study area were interviewed for this study. A high percentage (75%; 135/181) of the respondents were either employees or relatives of the household head; only (25%; 46/181) were household heads.

4.3.2 Cattle categories in the farms

There were a total of 1023 cattle in the 181 smallholder dairy farms supplying milk to the four cooperative societies and only 40.6% were milking (Table 7). The different categories of cattle included calves, heifers, milking and dry cows.

Table 7: Categorization of cattle in the sampled smallholder dairy farms supplying milk to selected Dairy Cooperative Societies (June 2006-March 2007)

Cattle Category	Number in the farms		
	Total	Maximum	Mean
Calves	131	9	1
Heifers	270	13	2
Milking cows	415	7	2
Dry cows	207	3	1
TOTAL	**1023**		

4.3.3 Cattle Rearing Systems and Feeding

The various cattle rearing options practiced in the study farms included zero-grazing (92%; 167/181), mixed farming systems mainly open grazing and stall feeding (7%; 12/181) and open grazing (1%; 2/181).

Over 90 % (180/181) of the farmers gave supplemental feeding to their animals, which included salt licks, salt and mineral licks, molasses and vitamins (Table 8).

Table 8: Supplement feeding in 180 smallholder dairy cattle farms in peri-urban Nairobi (June 2006-March 2007)

Type of Supplement	Number of farms giving supplements	Percentage
Salt lick	59	32.6
Salt and mineral mix	161	88.9
Molasses	63	34.8
Vitamins	8	4.4

4.3.4 Farm Structure

Farm structures were categorized as either permanent structures with a well-enclosed wall and concrete floors or semi permanent structures with either concrete floors or earthen floors and walls made of iron sheets or timber. Three farmers (2%) kept their animals in the open fields without any kind of housing. Thirty percent (55/181) of the farmers kept their animals in permanent structures while the rest, 68% (123/181) had semi permanent structures. Hygiene was worse during the wet season compared to the dry season, especially in housing structures with earthen floors.

4.3.5 Use of Bedding

Bedding for animals was provided by the majority of the farmers (55.8%; 101/181). Forty four percent (80/181) of the farmers, however, did not provide bedding to their cows hence the cows lay on the soil. The most commonly used types of beddings were sawdust (37.6%; 38/101), grass (29.7%; 30/101), and wood shavings 16.8% (17/101). The least common used was wheat straw at

(15.9%; 16/101). The variation in the different types of bedding was dependent on what was available and affordable at any particular time (Table 9).

Table 9: Bedding types in 181 smallholder dairy farms in peri-urban Nairobi (June 2006-March 2007)

Bedding type	Count	Percentages
No bedding (Soil)	80	44.2
Sawdust	38	21.0
Grass	30	16.6
Wood shavings	17	9.4
Wheat Straw	16	8.8
Total	**181**	**100**

4.3.6 Cleaning of the Cow Sheds

All the farmers interviewed cleaned the cattle sheds. 21.5% of farmers (n=181) used disinfectants to clean the cattle sheds frequently as compared to 78.5% (142/181) of the households who used water only for cleaning the cattle pens. These farmers claimed that it was expensive to use disinfectants and only used them in cases of disease outbreaks.

4.3.7 Water Sources

Piped, borehole and stream water were the main water sources; very few farmers used rain water (Table 10). The variation in the different sources of water was due to the difference in location of the farmers.

Table 10: Sources of water for cattle in the smallholder dairy production system in peri-urban Nairobi (June 2006-March 2007)

Water source	Count	Percentages
Piped	25	36.7%
Borehole	26	38.2%
Stream	8	11.8%
Roof	3	4.4%
Well	6	8.8%
Total	**68**	**100.0%**

4.4 Milking Practices

Most of the farmers, 99.5% (180 / 181) cleaned the udder and teats before milking. The majority of these farmers 96.7% (174 / 180) used water alone while three percent of the farmers (6/180) added disinfectants to the cleaning water. Majority of the farmers (96.7%; 174/180) who cleaned the udder used reusable towels for cleaning the udder and teats.

Most of the farmers (72.4%; 131/181) washed their hands before milking. Out of the farmers that washed their hands, only 9.2% (12/131) used soap and water, while the majority (90.8%) used water only. Sixteen percent (29/181) of the study farms practiced fore stripping and 9% (16/181) practiced teat dipping. A relatively higher percentage (54.7%; 99/181) used aluminum / stainless steel buckets for milking while 45.3% (82/181) used plastic containers.

Dry cow therapy was practiced by 24.4% (44/181) farms with 97.7% of them infusing all the quarters with antibiotics. There was only one farmer out of the 44 who infused only the infected quarters with antibiotics (Table 11).

Table 11: Use of Dry Cow therapy in the smallholder dairy production systems in peri-urban Nairobi (June 2006-March 2007)

Dry cow therapy	Count	Percentage
No treatment	137	75.7
Infuse all quarters	43	23.7
Infuse only infected quarters	1	0.6
Total	**181**	**100**

4.5 Statistical Analysis

The study was a cross sectional study, where the smallholder dairy farm was the study unit and the dependent variable was milk rejection due to milk spoilage.

4.5.1 Univariable analysis using the chi-square (χ2) test

Associations between the dependent variable and each of the potential risk factors were first screened in a univariable analysis using χ^2 tests. A total of 15 variables were screened in the initial univariable analysis, six of those had a P-value of $\leq$ 0.05 (Table 12).

Table 12: Herd management variables associated (P<0.05) with milk rejection using 68% alcohol by univariate analysis of data from 181 smallholder dairy farms in peri urban dairies, Nairobi

Initial model variable	Variable Levels	Alcohol test proportion Yes	No	Chi-square test	P-value
CMT testing	Yes	46	48	9.70	*0.002
	No	23	64		
Milking container	Aluminium	30	69	5.66	*0.017
	Plastic	39	43		
Bedding availability	Yes	29	72	8.58	*0.006
	No	40	40		
Testing for mastitis	Yes	0	7	4.37	*0.036
	No	69	105		
Fore stripping	Yes	12	17	0.16	0.693
	No	57	95		
Teat dipping	Yes	1	15	7.56	*0.006
	No	68	97		
Udder cleaning	Bare hands	0	6	3.82	*0.051
	Reusable cloth	69	106		

*Shows variables to be significant (p<5%) at 95% level of confidence

4.5.2 Multivariable analyses

Six risk factors that had a *P*-value $\leq$ 0.05 were offered to the final logistic-regression model. These included absence of teat dipping, reusable towels, plastic container, bedding availability, CMT positive samples and lack of testing of milk for mastitis at farm level. Four remained in the final multivariable model with a *P*-value $\leq$ 0.05 (Table 13). Bedding availability, use of plastic containers, CMT positive milk and teat dipping were the significant variables that explained occurrence of milk rejection in the peri-urban dairies ($p<0.05$).

According to the model, farmers who used plastic containers for milking were approximately two times more likely for their milk to be rejected compared to those who used aluminum/stainless steel containers ($p< 0.027$; Odds ratio =2.12). Those farmers who provided bedding to their animals reduced the chances of milk rejection by 45% compared to those who did not provide bedding ($p< 0.02$; Odds ratio =0.45). Farmers who did teat dipping reduced the chances of milk rejection by 10% as compared to those who did not do teat dipping at all ($p<0.026$;Odds ratio =0.1). Farmers whose bulk milk was CMT positive were three times more likely for their milk to be rejected ($p<0.002$; O.R = 2.9) as compared to those whose milk was CMT negative.

Table 13: Final model: multivariable logistic-regression analysis of risk factors associated with milk rejection (68% alcohol testing) in smallholder farms (peri-urban Nairobi, June 2006-March 2007)

Variable	Level	*B*	S.E.$_b$	*P*-value	Odds ratio
CMT Testing	Negative	Ref.	Ref.	Ref.	1.00
	Positive	1.07	0.348	0.002	2.92
Container	Aluminium	Ref.	Ref.	Ref.	1.00
	Plastic	0.753	0.34	0.02	2.12
Bedding	No	Ref.	Ref.	Ref.	1.00
	Yes	-0.795	0.343	0.02	0.45
Teat dipping	No	Ref.	Ref.	Ref.	1.00
	Yes	-2.30	1.07	0.031	0.09

CHAPTER FIVE

5.0 DISCUSSION

In this study, milk quality was assessed by use of 68% alcohol test, the preferred test for milk rejection at the cooperative societies. This is a platform test used routinely by dairy cooperatives to determine elevated acidity of milk which could be due to the high levels of proteins in colostrum, high minerals in mastitic milk and milk contaminated by lactic-acid producing bacteria. It is the test of choice for milk rejection in these dairy societies because it is fast and easy to perform and at the same time is of high sensitivity. The recommended alcohol percentage is 68% v/v in water (KEBS), but this is rarely used. Most dairy co-operative societies use alcohol concentration in the range of 72% and 80% as dictated by the processing plants. Increase in ethanol percentage increases sensitivity hence the chances of accepting milk of good keeping quality. The alcohol test however, does not measure the number of bacteria present in milk but measures the concentration of acidic compounds in milk. A high acidity implies a high lactic acid content which, in turn could imply a high bacterial count (Harris *et al,* 2003) or a high soild contents in milk. The milk components that are acidic and contribute to these normal acidity values are carbon dioxide, protein, phosphates and citrates. The higher the concentration of these components, the higher the acidity level observed. Therefore, fresh milk from a Jersey will have a higher acidity than fresh milk from a Holstein because the Jersey milk has a higher percentage of protein. Because the concentration of milk components that contribute to the acidity

measurement is variable, a range of acidity levels must be considered normal in the absence of lactic acid produced by bacteria (Harris and Bachman, 2003).

If a high bacterial count is suspected because of the acidity level, the milk should not be rejected or diverted to other usage until the presence of high bacterial count has been confirmed by approved methods such as Standard Plate Count or Direct Microscopic Count (Giangiacomo, 2000). Bacterial quality of raw milk must be monitored since high quality milk is in the best interest of all segments of the dairy industry; however; use of milk acidity measurements such as the use of alcohol test to grade milk (reject or divert) can result in an injustice when a milk consignment has a high solids content. For instance, fresh milk from a Jersey will have a higher acidity than fresh milk from a Holstein because the Jersey milk has a higher percentage of protein (Harris and Bachman, 2003.

A total of 850 liters of milk was rejected from the four dairies societies under study on a daily basis, representing a loss of 2.4% of the total daily milk collected. The most common causes of the milk rejection as per the dairy societies were adulteration and hygiene. If they suspected any unhygienic handling of milk or adulteration either by addition of water or solids, they performed organoleptic tests and/or density test by use of a lactometer for them to warrant rejection. Quality assessment by use of 68% alcohol was rarely done. In this study though, 68% alcohol test was performed on the milk samples collected to test for milk quality. Results indicated a high level of milk spoilage, 69/181 (38%). This is way above the reported cases of milk rejection which is 10% (Muriuki H.G, 2003). If the 68%

alcohol test was to be performed on a daily basis as per the requirements, there would be a total loss of 9,234 liters of milk considering that 38% of milk collected daily is to be rejected with 24,300 liters of milk being received per day in the four dairy societies. The total loss would amount to Ksh. 147,744 if calculated on the prevailing rate of milk per liter during that study period. This would lead to heavy milk losses especially to both the farmer and the dairy cooperatives. Post harvest losses in the dairy industry in Kenya don't seem to get attention beyond the issue of what is seen as unfair milk rejections by the processors especially during the wet season. But, following this study, it is evident that milk delivered to the dairies is of poor quality and this issue has to be addressed from the farm level.

Milk quality is directly affected by mastitis and also by milk equipment sanitation and milk storage and handling. Quality assessment by use of 68% alcohol indicated a high level of milk spoilage 69/181 (38%). The high prevalence was likely due to sub clinical mastitis and unhygienic milk production and handling practices at the farm level. The precipitation of the casein in milk by the alcohol appears to be intimately associated with the degree of acidity of the milk, the amount of rennet present and the balance of the milk salts. The greater the amount of acid or rennet present, the more readily will the casein be precipitated (Chavez et al, 2004). Abnormal milks such as colostrum, milk from diseased udders and from diseased cows, also produce a precipitate with alcohol. Such a precipitate, however, appears dependent on the proportions of the different salts in the milk. Milk acidity values can be used to screen, but any suspicion of high bacterial

numbers must be confirmed by approved standardized methods (Chavez et al, 2004).

A test statistic known as Kappa was used to determine the usefulness and level of agreement between the two tests (68% and 80% Alcohol tests). In test comparisons the probability of being test positive is given by the apparent prevalence for each test. The sum of these two probabilities gives the level of agreement expected by chance alone. Calculation of Kappa is as described in Martin et al., 1987. In the comparison of tests, a kappa of at least 0.4-0.5 indicates a moderate level of agreement (Martin et al., 1987). In this case, the kappa test result was 4.5 indicating moderate level of agreement. This means that both tests are agreeable and can be used for milk rejection without any bias.

California Mastitis Test was used to detect levels of sub-clinical mastitis both in pooled milk samples and in the individual quarters. The results obtained indicated that the apparent prevalence of sub-clinical mastitis in pooled milk samples was at 52% which is too high but within the range described by other workers. Various studies have demonstrated that sub-clinical mastitis is a prevalent disease in smallholder dairy herds in Kenya. Omore et al., (1996), estimated the prevalence of subclinical mastitis to be 70% with an average of 620,000 cells/ml of milk on small-scale dairy farms in Kenya. Other studies (Ngatia,1988 and Shitandi et al., 2004) estimated the prevalence of subclinical mastitis to be 55% and 63,5%. It was also observed that CMT positive milk was highly associated with milk rejection ($p<0.002$) with an odds ratio of 2.9. This implies that farmers whose milk was

CMT positive were three times more likely to have their milk rejected as compared to those farmers whose milk was CMT negative.

The associations between milk rejection and milking practices were determined. Milk rejection by use of 68% alcohol test was significantly ($p \leq 0.05$) associated with CMT positive milk, lack of teat dipping, type of milking container and bedding availability.

In this study, lack of teat dipping was significantly associated ($P \leq 0.031$, OR= 0.09) with milk contamination hence rejection. This meant that farmers, who did teat dipping, reduced their chances of milk rejection by 10%. Teat end sanitation, in this case, by use of iodophores is important in reducing the number of bacteria at the teat end before the milking, thus reducing transfer of organisms from cow to cow by the milkers' hands. Proper teat end disinfection can reduce teat surface bacteria by 75% (Galton *et al.*, 1984; Galton *et al.*, 1986; Ruegg *et al.*, 2000). Pre-dipping with a sanitizer was associated with reduced pathogen content in milk (Hassan *et al.*, 1999) and has been shown to be effective in the control of environmental pathogens (Pankey, *et al.*, 1987; Ruegg and Dohoo, 1997). While cleaning teats with water and wiping dry reduces the number of microorganisms on the teat skin, the reduction is significantly higher when teats are disinfected (Brito *et al.*, 2000). If iodine teat dips are used, low iodophor concentrations (0.5% or less) should be used since 1% iodophor has resulted in a mild increase in milk iodine content. Dips should contain up to 10-14% skin conditioner (e.g., glycerol, lanolin) for prevention of chapping (Jones, G M, 1998).

The choice of bedding material used on farms is dependent on many factors, including economics, animal health, manure management, and animal well-being. Bedding can influence the cows' hygiene and sub clinical intramammary infection rates (Schreiner & Ruegg, 2003) and hence the risk of bacterial contamination of milk (Sanaa *et al.*, 1993). The findings of this study shows that those farmers who provided bedding to their animals reduced the chances of milk rejection by 45% compared to those who did not provide bedding ($p< 0.02$; Odds ratio =0.45). Lack of bedding here means that the cows were lying directly on the earthen floor. In most of these farms where the cows lay directly on soil, the soil was muddy and hence increased the chances of contamination. Since most of these farms practiced zero grazing, the cows were more exposed to mud and cow dung contamination as compared to cows under open grazing system (Ellis *et al*, 2006). This increased the chances of udder and milk contamination and the risk of milk rejection due to improper udder cleaning; 97% of the farms used plain water without sanitizer to clean the teats before milking. Studies by Schreiner & Ruegg (2003) have shown that udder cleanliness score is related to isolation of pathogens from the milk in individual cows. Reneau *et al* (2005) also showed that increasing udder and hind leg cleanliness scores were positively associated with increased individual cow somatic cell count. Most work previously done has focused on the differences in bacterial counts in organic and inorganic bedding. Organic material has been associated with higher moisture contents hence increase in growth and exposure to mastitic pathogen (Ruegg, 2004; Zdanowicz *et al.,* 2004). In his study however, the level of organic matter and moisture in the beddings was not analyzed. More

research is needed to fully understand the transfer mechanisms of pathogen groups from the bedding to the udder, but in the mean time, these anecdotal reports confirm that dramatic improvements in udder health hence good quality milk can be achieved by lowering the teat end challenge from contaminated bedding, and bedding culture has a role to play in quantifying this challenge.

The equipment used for milking and storing the milk is also an important factor contributing to milk contamination hence milk rejection. More than 45% of the farms used plastic containers for milking. The use of plastic containers for milking and storing milk increased the likelihood of milk rejection by two fold. Milking container was significantly associated ($P<0.017$; O.R =2.1) with milk rejection. In this study, farmers used hot water to clean their milk containers either aluminium or plastic.

The common practice of use of plastic containers is unhygienic because these containers cannot be thoroughly cleaned as milk residues are easily left on them. Use of aluminum containers has been associated with milk of better hygienic quality (Mwangi *et al.*, 2000), as they are easy to clean and sanitize. Cleaning and sanitizing procedures can influence the degree and type of microbial growth on milk contact surfaces by leaving behind milk residues that support growth, as well as by setting up conditions that might select for specific microbial groups. More heat resistant bacteria may endure in low numbers on equipment surfaces that are considered to be efficiently cleaned with hot water. If milk residue is left behind as seen in plastic containers, growth of these types of organisms,

though slow, may persist. Significant build-up of these organisms to a point where they influence the total bulk tank count may take several days to weeks (Thomas *et al.*, 1966) though increases would be detected in Lab Pasteurization Counts.

The use of plastic containers in this study area was seen to be common because they are cheaper to buy as compared to aluminum /stainless steel containers. Most of the farmers however used plastic containers in the pretext that they are easily affordable while at the same time they know the importance of using aluminum containers.

Hand washing and udder cleaning before milking was not associated with milk contamination according to this study. This is contrary to what others have found out (Gran *et al.*, 2002). This can however be associated with confounding factors in the study. A follow up study is however recommended to confirm on the associations of these factors with milk contamination.

The use of reusable towels to clean the udder was however significantly associated with milk rejection ($p=0.051$). Cloth towels have the advantage of being more absorbent than paper towels but should be disinfected by washing with chlorinated water or very hot water and drying at high temperature (Fox, 1997). In this case, the use of reusable towels was significantly associated with milk contamination. This could be associated with improper washing, lack of sanitation and inadequate drying of the reusable towel. The presence of moisture is an important growth requirement for bacteria and wet towels do not adequately remove moisture (Ruegg, 2000). The

use of the same cloth in different milking cows could also lead to build up of dirt and bacteria hence milk contamination. It is recommended to use separate towels for different cows to minimize chances of cow to cow contamination.

It was also observed that very few farms used detergents during the cleaning operations of the houses, hands and udder before milking the cows. Cleaning teats with water and wiping dry reduces the number of organisms on the teat skin and the reduction is significantly higher when teats are disinfected (Brito *et a*l., 2000). The use of detergent however was not associated with milk rejection in this study because not enough data was available to be subjected for analysis. Lack of use of detergent may however further hinder the role of elementary hygiene practices as pointed out by Gran *et al* (2002) in the context of smallholder farms in Zimbabwe.

The quality of water used in the farm is important as it can reflect the hygienic quality of milk. Water used on the farm might also be a source of microorganisms, especially to microorganisms that could seed soiled equipment and/or the milk (Bramley and McKinnon, 1990). Studies by Bunfoh *et al,* (2003) have been able to directly associate water quality with milk quality. Quality of water in this study was not analysed because of financial constraints, however, water used in these farms should have been investigated because it was noted that less than 40% of the farms had access to disinfected tap water. In fact, the water used is generally drawn from wells and streams and is of doubtful hygienic quality. This could also lead to milk contamination as this is the same water used to clean the udder and milk utensils.

According to KEBS, when using the alcohol test, milk quality assessment at the dairy cooperatives and the processing plants should be by the use of 68% alcohol. This is however not followed. The processing plants dictate the alcohol percentage, which is usually between 72-80%. Some of the reasons advanced for use of a higher alcohol percentage include, collecting milk of higher quality which (a) can be processed into liquid milk (b) can be used to manufacture other milk products and (c) to reduce the rate of milk spoilage which, apart from hygienic milk handling, could also arises due to time taken for the milk to be transported to the processing plants.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

Within the limits of the data collected and information gathered in the study area, the following conclusions can be made.

1. The results obtained in this study indicate that in general, milk delivered to these dairy societies is of low keeping quality that leads to the high rate of rejection. The main reasons of milk rejection were sub-clinical mastitis (52% prevalence) and high reaction to 68% alcohol test (38%), indicating poor milking practices like lack of teat dipping, poor husbandry and unhygienic milk handling techniques at the farm level like use of plastic containers in milking and lack of proper cleaning of udder before milking. Other reasons contributing to milk rejection were adulteration and lack of cooling facilities both at farm and cooperative level.

2. Although the Kenya Bureau of Standards has recommended 68% alcohol as the standard, the processors use 80% alcohol concentration. This study found that the use of 80% alcohol was more sensitive than 68% in determining milk of high keeping quality. For the milk to pass the 80% alcohol test, hygienic practices both at the farm level and at the cooperative societies should be improved to meet the standards set by the processors and hence reduce rate of milk rejection.

Processors should therefore ensure that both cooperative societies and the farmers are informed on the importance of the higher alcohol percentage through offering extension services to the farmers focusing on the production of high quality

milk through the efficient cleaning of vessels, hands, udder and the housing large.

CHAPTER SEVEN

7.0 REFERENCES

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8.0 APPENDICES

Appendix 1: A survey on the main causes of milk loss at the cooperative level

1. NAME OF DAIRY: _____
2. LOCATION: _____
3. ADDRESS: _____
4. DATE: _____

1. Number of farmers registered in the cooperative society: _____

2. Number of active farmers? _____

3. How frequently do you receive milk from farmers?
   i) Daily ii) After a day iii) _____days in a week

4. On average, how much milk in Kg/liters do you receive on a daily basis? _____

5. Do you ever reject farmers' milk?
   i) Yes ii) No

6. On average, how much milk do you reject in a day? _____

7. Which tests do you use routinely?
   i) Organoleptic tests
   ii) Alcohol tests
   iii) Lactometer tests
   iv) Alcohol-Alizarin test
   v) Others. Specify

8. Which is the main test(s) that warrants rejection in this dairy? _____

9. Do you test milk daily?
   i) Yes ii) No

10. If not daily, what prompts you to test the milk?
    i) When milk is rejected by processing plant
    ii) Spoilt milk reports from retail outlets
    iii) Routine checking

15. From your observations, what are the main reasons for milk rejection in this dairy?
    i) Reasons _____

_____

_____

16. What do you do with spoilt milk?

i) Give it back to the farmers

ii) Discard it

iii) Sell for pig rearing

17. What advise do you give to farmers whose milk has been rejected?

i) To stop delivering the milk until it is okay

ii) Advice him/her to seek professional advice

iii) Others. Specify _____

iv) No advice at all

18. When milk is rejected during collection, is it

i) Returned immediately to the farmer OR

ii) Collected for further tests at the dairy

19. How much do you pay farmers per Kg/L for milk accepted? _____

20. What other services do you offer the farmers?

i) Feeds on credit

ii) A.I services

iii) Credit services

iv) Others. Specify_____

21. From your past records, which seasons/Months is milk mostly rejected? _____

22. Do you have any cooling facility in this dairy?

i) Yes

ii) No

23. If not, what happens to the milk left over from the previous day?

i) _____

24. Do you make any by-products from the milk?

i) No ii) Yes. Specify _____

Appendix 2: A survey on the main causes of milk loss at the farm level

Personal Information

1. Date (d/m/y): _____ Herd Questionnaire no._____
2. Dairy society _____ Owners name: _____
3. Farm ID/ Corporate number: _____Enumerators name: _____
4. P.O Box and Post office: _____

Part 1: General Information

5. What services of the Dairy Society do you make use of

   0) None
   1) Private AI services
   2) Private clinical veterinary care
   3) Buying feeds on credit
   4) Loans
   5) Cash advances on milk production
   6) Others: Specify _____

6. How many dairy cattle do you have in your farm?

   1)Calves_____

   2)Heifers_____

   3) Milking _____

   4) Dry _____

7. What is the size of your farm? _____ (Acres).
8. On your total farm area, what proportion is involved in dairying (housing, pasture etc.) ____ %.

9. How do your animals get access to forage?
   1) Grazing/ pasture
   2) Cut or purchased (Zero grazing)
   3) Combination of (1) & (2) above: Expound _____

10. Is housing / shelter available to the animals?
    0) No
    1) Yes

11. If yes, what is the type of housing/shelter?
    1) Closed i.e. roof & walls

2) Open, covered (roof, no walls)
3) Natural shelter: describe _____
4) Other: specify_____

12. If yes, what is the flooring type?
1) Earthen 2) Concrete 3) Wood 4) other: specify _____

13. If yes, how are the adult animals kept in housing?
1) Free (no stalls)
2) Free (with stalls)
3) Tied (no stalls)
4) Tied (in stalls)
5) Other: specify _____

14. Does your housing/ grazing differ between wet season and dry season?
0) No 1) Yes

15. Is bedding used in the housing area?
0) No 1) Yes

16. If yes, what kind of bedding is used?
1) Straw
2) Grass
3) Saw dust
4) Wood shavings
5) Others: specify: _____

17. Do you disinfect your housing as you clean it out?
0) No
1) Yes. Specify _____

18. What do you do with the manure from the housing area/ pens/ corral?
1) Used as fertilizer on crops
2) Sold
3) Used as fuel
4) Stored but not used
5) Other: specify_____

19. Do you feed grain /concentrates to your cattle
0) No
1) Yes

20. What is the source of the grain / concentrates you feed?
1) Home grown/ formulated
2) Purchased grain/ home mixing

3) Other: Specify _____

21. Do you prvide other nutritional supplements?

1) Yes 2) No

22. If yes, what type?

0) Salt lick
1) Salt and mineral mix
2) Molasses
3) Vitamins
4) Antibiotics
5) Others: Specify _____

23. How do your cows access water?
1) Provided in their housing units
2) Available on pasture/ grazing
3) Available in pen/corral
4) Others (specify) _____

24. What is the source of water in your farm?
1) Piped
2) Stream
3) Roof catchment and stored in tanks
4) Other _____

Part 2: Milking Procedure

25. Do you brush the side of the animal before cleaning?
1) Yes 2) No

26. Do you clean the udder & teats before milking?
1) Yes 2) No

27. If the udder is cleaned, what do you use?
1) Water alone
2) Water with disinfectant. Specify _____

28. What do you use for applying water on the udder?
1) Bare hands
2) Reusable towels

29. If udder is cleaned, is it dried?
0) Yes 1) No

30. If udder is dried, what is used?
1) Newsprint

2) Disposable paper towels
3) Reusable cloth towels
4) Others.(Specify) _____

31. Do you wash / clean your hands before milking?
0) No
1) Yes

32. If so, what do you use?
1) Water alone
2) Water and soap/disinfectant. Specify product _____
3) Dry towel
4) Other. Specify _____

33. If you do wash your hands, do you dry them before milking
0) No
1) Yes

34. If you dry your hands before milking, what do you use?
a) Newsprint
b) Disposable paper towels
c) Reusable towel
d) Other _____

35. Do you use milking jelly when milking?
0) No 1) Yes

36. What do use for milking, hand milking or machine milking?
1) Hand milking
2) Machine milking

37. Do you do fore striping before milking?
1) Yes 2) No

38. Where do you place your pail when milking?
1) Directly under the cow
2) At the side of the cow
3) Between your legs
4) Other. (specify) _____

39. After milking do you do teat dipping?
0) No
1) Yes

40. If yes, what product do you use? Name:_____

41. What kind of container do you use for milking/ storage of milk before taking to the dairy?
    1) Plastic
    2) Aluminum
    3) Other

42. Have you had cases of mastitis in the past one-year?
    1) Yes 2) No

43. How many cases? _____No. of cases.

44. Are the mastitis cases from the same animal or are they from different animals?
    1) Same animal 2) Different animals

45. How do you dry off (stop milking) your cows?
    1) Suddenly stop milking
    2) Gradually reduce milking

46. When you dry off a cow, what procedure / treatments do you perform?
    0) No treatments
    1) Infuse all quarters with antibiotic (Specify product ___)
    2) Infuse mastitic quarters only with antibiotics
    3) Other. Specify _____

47. Who does the milking on your farm/
    1) Employees
    2) Family members. Specify _____
    3) Both employee and family members

48. Did u have to dispose a cow(s) due to mastitis in the past year?
    0) No
    1) Yes. (Specify how many)_____

49. Approximately, how much do you spend per treatment of a case of mastitis (drugs & Professional fees) _____Ksh / per treatment

50. Do you test your milk for mastitis before taking it the dairies?
    0) No 1) Yes

51. If yes, what method do you use for testing
    1) Strip cup 2) Others, Specify _____

52. Has your milk ever been rejected by the dairies before?
    1) Yes 2) No

53. Were you told why?
    1) Yes 2) No

54. Was your milk ever tested for a second opinion?
    1) Yes 2) No

55. If yes, by who? _____

56. What were the results? _____