Prime Scholars Library

Full Length Research Paper

Available online at
https://primescholarslibrary.org/

Advances in Agriculture, Food Science and Forestry

Vol. 3 (1), pp. 8 - 17, January, 2015

An investigation of value issues related with dairy cows milk production in peri-metropolitan zones in Burkina Faso

Ghazanfar Ali Khan, Babar Shahbaz and Ijaz Ashraf

Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences, P.O. Box 7024, SE-750 07 Uppsala, Sweden.
[2]

Abstract

A survey study was carried out around two large cities in Burkina Faso to contribute to the understanding of the situation of local milk production and milk processing. Twenty-two dairy farms associated with nine dairy processing units were selected for the study. Two separate questionnaires were used to investigate the prerequisites for animal production and milk processing and the interviews were carried out from August to October 2006. Meanwhile, 110 milk samples from individual cows, 22 farm tank milk samples and nine dairy tank milk samples were analyzed. Results of the survey show that daily milk yield was 1 - 2 L per cow in sedentary traditional farms and 2 - 4 L per cow in semi-intensive farms. Milk temperature at dairy farm level (32.5 ± 4.6°C) was an important factor reducing milk quality before reaching the collection centre. According to the survey, the use of cottonseed cake in the diet resulted in higher milk yield per cow, both during the rainy and dry season (Chi-square = 9.32; P = 0.01). The use of crossbred cows was also related to higher daily milk yield per cow (Chi-square = 31.80; P = 0.001). It was concluded that more extensive supplementation of diets and cross-breeding would improve milk production in Burkina Faso. Furthermore, milk cooling systems on farm and at dairy processing level are needed.

Keywords: dairy farm, dairy processing unit, cow, milk, production.

INTRODUCTION

The population of Burkina Faso, as in many other African countries, is meeting serious problems of scarcity of food and malnutrition (Delgado et al., 1999). Sufficient Milk consumption is still low in Burkina Faso, it has been estimated to 10.2 litres/person/year in urban areas (Oudet, 2005 unpublished) without distinguishing between local and imported milk. Milk consumption in rural areas has not been estimated. The main species used for dairy production are cattle, goats and sheep.

In 2004 the Ministry of Animal Resources estimated the number of dairy cattle at 7,300,000 (MRA, 2004). The Fulani people in Burkina Faso have a centuries-long tradition of animal production and the majority of dairy animals are owned by the Fulani. In spite of the potential as a result of high number of dairy animals and the long tradition of the Fulani people of keeping animals, there is an annual import of powder milk of more than 20 million USD (MRA, 2001) . Furthermore, the growth in the urban population has led to a particularly high demand for dairy products in the cities and therefore dairy farms and small-scale dairy processing units are set up in the areas surrounding the cities (Hamadou et al., 2004). Milk production in Burkina Faso varies with season, with a higher milk production during the rainy season, and dairy products contribute substantially to the human diet during the rainy season. In the dry season, however, milk production is far from sufficient.

The most common dairy cattle in Burkina Faso today, as in most West African countries, is the *Bos indicus*,

also known as Zebu. It is well known that the Zebu has a low milk yield although it is difficult to estimate the exact yield, as the Zebu calves are usually allowed to suckle to stimulate milk let-down (Coulibaly and Nialibouli, 1998). The low milk yield is a problem, both for the farmers and consumers. In addition, Traoré et al. (2004) found very high somatic cell count (SCC) in Zebu milk. High SCC is associated with an increased risk of clinical mastitis, decreased milk yield and shorter shelf life of dairy products (Barnouin et al., 2004; Rodriguez et al., 2005). There is a great need for more knowledge about Zebu milk production. Bonfoh et al. (2005) were the first to publish data on Zebu milk composition. Their study was performed in Mali and showed Zebu cow milk composition of 4.3% fat, 3.6% protein and 4.8% of lactose (Bonfoh et al., 2005). More recently Sidibé-Anago et al. (2006) reported milk composition of 4.3% fat; 3.5% protein and 4.5% lactose in Zebu milk in Burkina Faso.

Very little data is available on dairy cows and dairy farms in Burkina Faso, and therefore the strengths and weaknesses in Burkina Faso milk production are unknown. This makes it difficult to help farmers to increase and improve dairy production. The purpose of this study was to investigate the prerequisites for milk production and milk handling at dairy farm and dairy processing unit level through a survey. In addition, milk samples were analysed to make data on milk composition available to researchers, farmers and the industry.

MATERIALS AND METHODS

Areas

The study was carried out from August to October 2006 around the two largest cities in Burkina Faso: the Ouagadougou area and the Bobo-Dioulasso area (Figure 1). The Bobo-Dioulasso area is located in the West of the country at coordinates 4º29´ longitude West and 11º18´ latitude North and has 900 to 1200 mm precipitation per year, which allows for intensive animal production during the rainy season. The Ouagadougou area is located in the central region of the country at the coordinates 1°28´ to 1°36´ longitude West and 12°20´ latitude North, with 700 to 800 mm precipitation per year. The distance between the two cities is 365 km.

Social survey

The study targeted both dairy farms and dairy processing units. The selection criteria for dairy processing units selected for this study were that they process local milk and they were willing to participate in the study. The study included nine dairy processing units; three in the Bobo-Dioulasso area and six in the Ouagadougou area. The inclusion criteria for dairy farms were that they were linked to one of the dairy processing units included in the study, that they were located no more than 50 km from the city and that they were willing to participate in the study.

Two questionnaires were designed for the survey, one for the dairy processing units, including aspects of milk processing and management of the dairy processing unit, and the other for the farms, covering management, animal production, milk production, hygiene practices and milk transport. The survey was conducted as interviews with the owner or manager of each dairy processing unit or dairy farm. One person visited all the dairy processing units and dairy farms and conducted the interviews at site level. The dairy processor or farmer was asked step by step about their activities. The questionnaires for dairy processing units and dairy farms included 10 and 48 questions, respectively. At farm level, the interview was conducted after milking. The questions included identification of the farmer, characteristics of animal production, milk production and milking technique, parameters of dairy cows, management of dry cows, calves, heifers and bulls and finally the manner of milk storage and transport. The questionnaires also included questions about differences in activities during the rainy and dry seasons.

Sampling and Laboratory measurement

In total 110 milk samples from individual cows, 22 farm tank milk samples and nine dairy tank milk samples were analyzed. Tank milk samples were taken at the end of milking, after mixing tank milk well. To test individual cow milk, five cows were selected randomly at each farm and a sample of milk was taken directly from teats, approximately half way through milking. Nine raw milk samples were also obtained at each dairy processing unit to check the composition of milk destined to be processed. The temperature, pH (pH meter, Metrohlm, 704 Ch- 9101, Herisau, Switzerland) and somatic cell count (fluorescent method, DeLaval Cell Counter, Tumba, Sweden) of the milk samples were measured immediately after sampling. The samples were then put on ice for transport to the laboratory (about 20 – 45 min, depending on the location of the dairy farm) and then frozen and stored at - 20ºC until determination of dry matter (DM), fat, protein, lactose and solid-non-fat (SNF) with mid-infrared spectroscopy (FMA 2001, Miris AB, Uppsala, Sweden).

Statistical analyses

The statistical analysis was performed with SPSS for Windows (version 14.02, © 1989 – 2005) . The variables in the two questionnaires were coded according to the SPSS coding system (Nancy et al., 2005). Logarithm transformation was performed on SCC data. Descriptive statistics were performed for all variables. Frequencies were established for qualitative variables and mean, standard deviation, minimum and maximum values were obtained for SCC, pH, temperature, fat, protein, lactose, DM and SNF. In the text, values are presented as mean ± standard deviation. Furthermore, the Chi-square test was used to test relationships between variables. Data for the two areas were compared with t-test. Differences were considered to be significant at the level $P < 0.05$.

RESULTS

Social survey – farm level

The study found two types of farmers. More than half of the farmers (N = 12) were specialized in animal production. The second category (N = 10) had their main occupation as employees in the public sector or traders, with dairy farming as a part-time business. Nineteen of the 22 farmers were between 30 and 60 years old. Two farmers were between 20 and 30 and one was 70 years old. The full-time farmers' education level was lower than

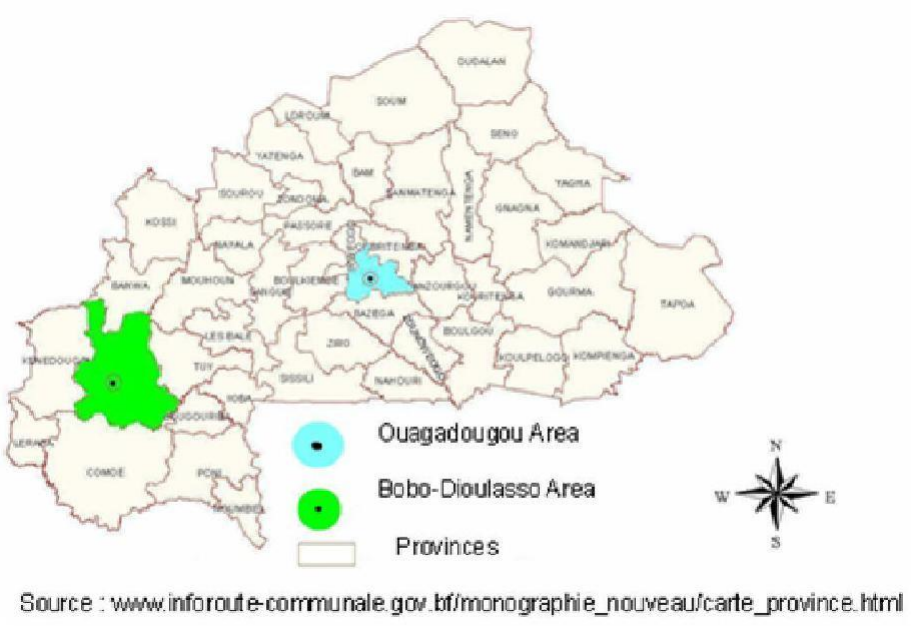

Figure 1. Map of Burkina Faso with study areas: Bobo-Dioulasso area and Ouagadougou area.

primary school, while the public sector workers/traders were educated to secondary school or university level. The full-time farmers had more than 10 years experience in farming and their herds were essentially composed of local breeds (LB), both *Bos indicus* and *Bos taurus.* The second category of farmers had 5 to 10 years of experience in farming, owned LB and cows that were crossbred with European and American breeds (LB x Montbéliarde; LB × Holstein F1; LB × Tarentaise) or African breeds with higher production than the Zebu (LB × Gudali).

Full-time farmers managed their animals according to their traditional knowledge, while new actors in the milk production field showed more interest in new management routines but seemed to lack the traditional knowledge and needed training in dairy farm management. The new actors were public sector workers and traders who had invested in dairy farms.

All farms used natural pasture all year around. Eleven of the 22 farmers made hay for feeding during the dry season and nine of the farmers had produced silage for their dairy cows at least once since they started milk production. Furthermore, more than 2/3 of the farmers in the study used cottonseed cake or cereal bran as concentrate during the dry season. According to the survey, the use of cottonseed cake in the diet was related to higher milk yield per cow both during the rainy and dry season (Chi-square = 9.32; P = 0.01). Thirteen farmers said that they had never received training or further education in milk production and recording systems. These farmers watered their dairy cows in the river. The other nine farmers used water either from a man-made or a drilled well, and watered their cows at the cowshed.

Diseases were listed by all farmers as one of the major constraints to increasing milk production in Burkina Faso. Both full-time and part-time farmers said that they work with veterinarians when the animals need treatment against disease. They also listed the lack of grass during the dry season, lack of training and the small number of organized dairy farms as factors that limit the milk production.

The survey also found two types of dairy production systems. The first one was the sedentary, traditional, system characterized by keeping a higher number of animals and exclusively using natural pasture. In this system the herd is kept in a temporary location so that it can be changed between seasons when the farmer judges that it is unhygienic for the animals. The daily milk production was reported to be 1 to 2 L per cow. The farmers had more than 10 lactating cows, with some seasonal variation. The produced milk was sold to a dairy processing unit and this was an important source of income. Further, they were engaged in cropping around their houses and used crop residues and sometimes hay as feed for the animals. The second type of dairy production system was characterized by the use of a barn. Animals were turned out to natural pasture around the farm. The owner of this type of farm was most often a public sector worker or trader. In general, the number of animals was limited by the barn capacity or feed supply and the owner's ability to pay workers. The farms employed the labourers to manage the animals on pasture,

Table 1. Farmers' knowledge about lactating cows and calves.

Questions	Answers	Number of farmers
What is the calving interval (months); Unknown ; 9 - 12 months	Unknown	14
	9 - 12 months	8
At what age the farmer practices weaning of calves (months): never ; after six months	Never wean	16
	6 months	6
The weight of calf at the calving (kg): 0 to 10 ; 10 to 20 ; 20 to 30 ; more .	Never weigh	14
	10 and 20 kg	4
	20 and 30 kg	4
Utilization of artificial insemination or natural reproduction: yes ; never	Yes (only once)	12
	Never	10

during milking and for guarding the barn. This system is referred to as semi-intensive due to the constant use of concentrate, veterinary treatments of animals and the use of crossbred dairy cows. At these farms the milk production was estimated by the owners to be 2 to 4 L per cow and day. According to the owners, some of the crossbred cows had a daily production above 5 L.

The aim in both production systems was to sell the milk to a dairy processing unit. The current study found a clear relationship (Chi-square = 15.27; P = 0.002) between the education level of the farmer, the main activity of the farmer and the production system at the farm. Also, the main activity of the farmer was strongly related to the breed used (Chi-square = 14.71; P = 0.001). The survey found that farmers with a low education level were specialized only in animal production and kept local breeds for milk production, while the other farmers had secondary school and university education level and kept local breeds and crossbreds and had farming as a part-time activity.

The average number of cattle that the farmers owned was 76 ± 22 (mean ± std dev). Most of the animals were non-producing cows, calves, heifers and bulls, and the proportions of the different types of animals varied between farms. The number of bulls was usually one or two, and the maximum number of bulls at any farm was six.

According to the survey, the cows were used for reproduction for more than 10 years at eight of the farms, and between 6 and 10 years at nine farms. However, some farmers could not answer this question because they did not know how long they had kept the cows. Sixteen farmers said that the length of lactation was between 6 to 9 months while six farmers said that it was difficult for them to assess the length of lactation; that they milked the cows from calving and did not know for how long after calving. Twelve farmers said that they had applied artificial insemination only once while the other 10 had never tried the technique.

Weaning was practiced in six farms, while 16 farmers did not wean the calves. Weighing the calves at birth was not done on 14 farms, while eight of the farmers weighed calves at calving (Table 1). It was common (N = 19) to use calves for stimulating milk ejection before milking and sometimes also during milking. The cows were milked by hand on all farms. The full-time farmers milked their cows wherever the cow was standing when it was time to milk, or moved the cow to another unspecified location, for example to the shade under a tree. At the farms owned by part-time farmers cows were moved to a designated milking area and in some of these farms the cows were milked in the pen.

The study found different hand milking techniques; a) pull-down (15 farms), b) thumb-in (six farms) and c) full-hand grip (one farm). In the pull-down technique, the person milking pulls the teat towards the bucket when milk is expressed, while in the thumb-in technique the teat is pressed in the hand between the palm and the thumb, which is folded into the palm. With the full-hand grip technique, the all fingers are used and pressure is placed on the teat from teat base to teat end, without pulling the teat, by closing the hand around the teat gradually.

Milking was performed twice a day at 13 farms and once a day at nine farms. Most of the farmers (N = 21) said they milk all four teats, but one farmer said that he leaves one teat for the calf. Calves were allowed to suckle at the end of each milking at all farms, but the calves were separated from their dam during grazing. The milk was collected in a plastic bucket or calabash during milking at all farms. After milking, milk was stored in plastic rectangular 20 L containers at 19 of the farms and in aluminium churns at three farms. During the survey it was observed that milk was filtered before storage at 20 farms. The filter was made of metal, but the level of cleaning of the filter was not studied.

Hygiene around milking varied among farms. At 13 farms the udders were not cleaned before milking. Nine farmers cleaned the udders, but the person milking cleaned the udder when the cow was lying down and only if

there were faeces on the udder. After cleaning, the calf was presented to the cow and then allowed to come to its dam and to start suckling for stimulation of milk let-down. Suckling was allowed for one or two minutes, depending on cows and person milking. Hand milking began when ejection had started, judged by the person milking. In eight farms, it was observed that the person who performed the milking dipped their fingers in the bucket milk during milking. According to the answers of the farmers, teat dipping was done by two farmers to avoid infection and flies on teats after milking.

Eleven full-time farmers said that their cows yield 1 to 2 L per day during the rainy season and the total farm production per day is 20 L. The other 13 farms had slightly higher production, 2 to 4 L per cow and 40 L per day in total. The use of crossbred cows was related to higher daily milk yield per cow (Chi-square = 31.80; P = 0.001).

Twenty-one farmers had no cooling system and had to bring their daily milk yield to the dairy processing unit quickly. Thirteen farms used a bicycle for transporting the milk to the dairy processing unit. The transport time was between one and two h, depending on the distance between farm and dairy processing unit. Nine farmers used a motorcycle or car for milk transport which took one hour. The payment to farmers for one litre of milk differed between seasons. During the rainy season, 14 farmers sold milk at between 0.44 and 0.55 USD/L and the other eight farmers at between 0.55 and 0.66 USD/L. The milk price increased to between 0.55 and 0.77 USD for the 14 and 8 farmers, respectively, during the dry season.

Social survey – dairy unit level

Eight of the dairy processing units were located in the city, while one was situated in a village 30 km from the city. The owners/managers of six of the processing units in the cities had 5 to 10 years experience in milk processing, while two had more than 10 years experience. The owner of the dairy processing unit situated in the village had more than 15 years experience in dairy processing. All dairy processing units were privately owned and got milk for processing from farmers. In addition, some of the dairy processors were supplied with milk by milk collectors and some also had a farm of their own. The total quantity of milk processed per day varied between dairy processing units and from 100 to 150 L per day. Eight of the dairy processing units had five employees, while one unit had 10 employees. The survey found that seven units only processed raw milk, while two units sometimes used powder milk. The main techniques carried out at the dairy processing units were pasteurization and yoghurt production. Two of the dairy processing units occasionally made cheese. The dairy product marketing was done by providing information to consumers and shop managers and by participation in trade fairs. Also, social relationships were used for promoting the dairy products, for example family, friends, neighbours and social ceremonies (marriage or religious day celebrations). Six dairy processing units said they received financial support from the government.

Laboratory measurement

Figure 2 compares dairy farms in each area and show milk composition at farm level. Figure 3 compares SCC in individual cow milk and farm tank milk for each dairy farm. Udder cleaning before milking was related to SCC (Chi- square = 11.38; P = 0.01). In farm tank milk Log_{10} SCC was 4.85 ± 0.39 (10 007 cells/ml = anti Log_{10} SCC) at nine farms where farmers cleaned the udders before milking and Log_{10} SCC was 5.63 ± 33 (100 000 cells/ml = anti Log_{10} SCC) in 13 farms without udder cleaning.

Variation in milk temperature, pH and SCC of tank milk was observed among dairy farms. Table 2 shows the range in milk composition in farm tank milk. The only difference found among areas in farm tank milk composition was a higher fat content in the Ouagadougou area (P < 0.05). The temperature of farm tank milk varied from 25.6 to 34 °C in the Bobo-Dioulasso area and from 22.4 to 35.9°C in the Ouagadougou area (Table 2). No difference in SCC was observed between areas (Table 2), but Figure 3 indicates that SCC may have been higher in the Ouagadougou area. In individual milk samples, SCC varied between 5,000 and 800,000 cells/ml, while SCC in farm tank milk varied from 5,000 to 1,000,000 cells/ml.

The composition of milk samples from the dairy processing units is shown in Table 3. Milk temperature, pH, SCC, fat, protein, lactose, DM and SNF varied among the processing units. Bucket milk temperature and lactose content differed between areas (P < 0.05), with higher lactose content in the Bobo-Dioulasso milk and higher temperature in the Ouagadougou milk. No differences were observed between areas for pH, SCC, fat, protein, DM and SNF. The study showed a much higher fat content in tank milk in the Ouagadougou area than in the Bobo-Dioulasso area.

DISCUSSION

Milk production, milk yield and milk composition

The survey showed that milk production and milk processing still is an embryonic sector in Burkina Faso. There are clear differences in the management of dairy farms owned by traditional farmers and those owned by people who have moved into dairy production during the last decade. Similar conditions have been reported from Southern Senegal and from Nigeria (Dieye et al., 2005;

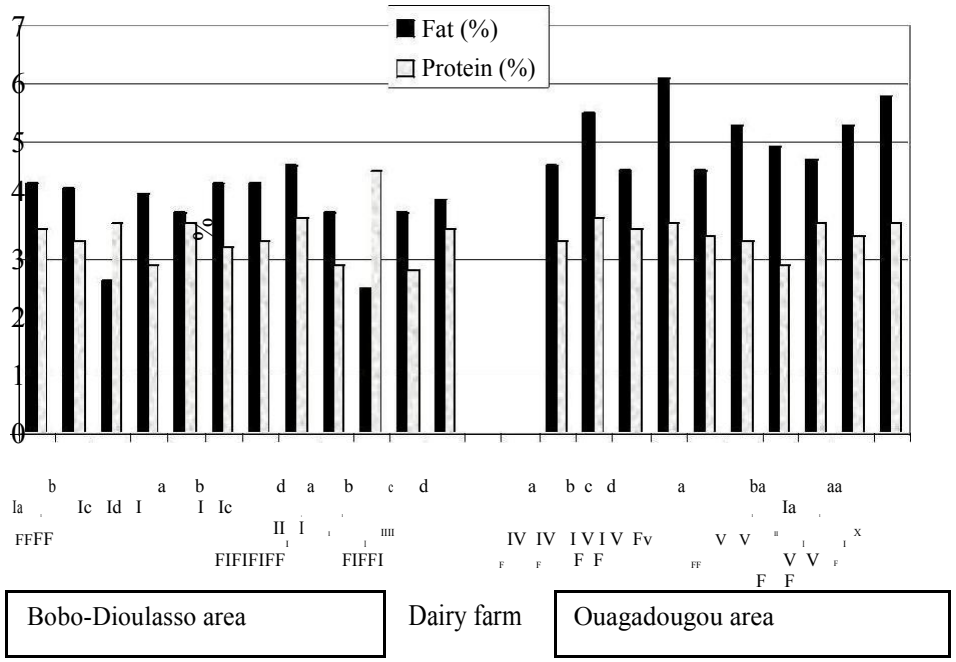

Figure 2. Average fat and protein content (%) in milk at different dairy farms.

Table 2. Milk components, pH and temperature in tank milk at farm level (N = 22).

Variables	Bobo-Dioulasso area			Ouagadougou area		
	Mean ± sd	Minimun	Maximum	Mean ± sd	Minimum	Maximum
pH	6.72 ± 0.07 [a]	6.62	6.87	6.72 ± 0.06 [a]	6.58	6.81
T°C	30.0 ± 2.1 [a]	25.6	34.00	30.53 ± 4.8 [a]	22.4	35.9
SCC (Log_{10})	5.02 ± 0.41 [a]	4.41	5.74	5.36 ± 0.61 [a]	4.15	6.01
Fat (%)	3.85 ± 0.65 [a]	2.50	4.60	5.1 ± 0.56 [b]	4.50	6.10
Protein (%)	3.40 ± 0.45 [a]	2.80	4.50	3.43 ± 0.23 [a]	2.90	3.70
Lactose (%)	4.91 ± 0.19 [a]	4.60	5.30	4.76 ± 0.29 [a]	4.10	5.10
DM (%)	13.13 ± 0.78 [a]	11.4	14.40	13.69 ± 1.1 [a]	11.70	15.50
SNF (%)	9.01 ± 0.59 [a]	8.44	10.50	8.79 ± 0.3 [a]	8.16	9.32

[a,b] For each variable, the mean values with different superscripts are significantly different between areas (P < 0.05) and the mean values with the same superscript are not different between areas (P > 0.05).

Osotimehin et al., 2006). There is an interest in increasing milk yield through crossbreeding with imported breeds but problems with feeding, watering and climate adaptation are more common with imported breeds and crossbred animals than for local breed cows (Hansen, 2004). The current situation in Burkina Faso is similar to the situation in Nigeria and Zimbabwe (Ngongoni et al., 2006; Osotimehin et al., 2006) where the educational level of traditional farmers was less than primary school and who only used local breeds.

The large herds described by the traditional farmers require a lot of feed, more workers and more treatments against diseases than smaller herds with a higher proportion of lactating cows. The low proportion of lactating cows in the herd holds farm economy back. The six to nine-months lactations reported by 16 of the farmers in the survey, is not likely in these low-producing cows with limited access to feed (Auldist et al., 2007) . Also, once-daily milking, which was applied on some of the farms, is known to reduce lactation persistency (Rémond and Pomiès, 2005; VanBaale et al., 2005). Another unlikely statement by farmers is the common claim to work with veterinarians. This is unlikely to be true since there are very few veterinarians in Burkina Faso (Gauthier et al., 1999). It is possible that the farmers use the term veterinarian for anyone with training in the field of animal health.

Kaboré-Zoungrana et al. (1999) show that native grass-

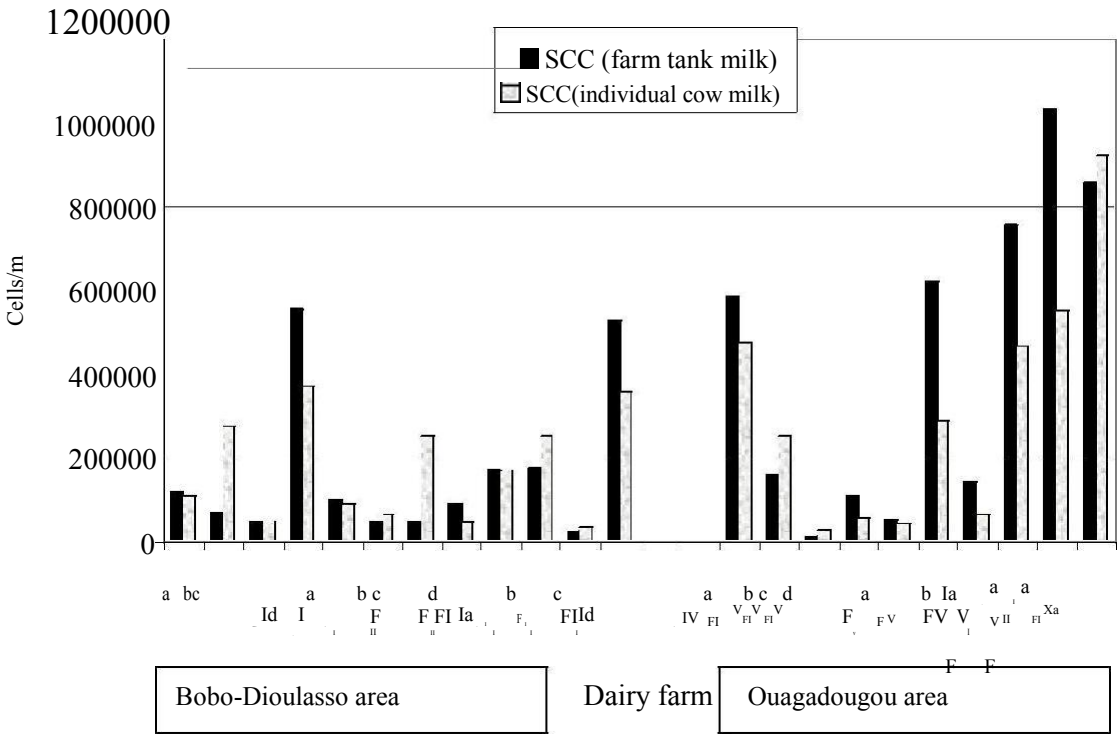

Figure 3. SCC in farm tank milk and average individual cow milk at 22 dairy farms.

Table 3. Milk components, pH and temperature in the milk at dairy processing unit level (N = 9).

Variables	Bobo-Dioulasso area			Ouagadougou area		
	Mean ± sd	Minimun	Maximum	Mean ± sd	Minimum	Maximum
SCC (Log_{10})	5.22 ± 0.35 ^{a}	4.88	5.60	5.80 ± 0.21 ^{a}	5.48	6.00
pH	6.65 ± 0,07 ^{a}	6.60	6.70	6.77 ± 0.08 ^{a}	6.70	6.90
T°C	28.16 ± 1.3 ^{a}	26.70	29.20	31.88 ± 3.1 ^{b}	27.00	35.00
Fat (%)	4.83 ± 0.85 ^{a}	4.30	5.30	4.06 ± 0.36 ^{a}	3.60	4.60
Protein (%)	3.16 ± 0.90 ^{a}	2.20	4.00	3.46 ± 0.19 ^{a}	3.20	3.70
Lactose (%)	4.96 ± 0.49 ^{a}	4.40	5.30	4.41 ± 0.49 ^{b}	3.60	5.00
DM (%)	13.00 ± 1.56 ^{a}	12.00	15.00	13.19 ± 0.48 ^{a}	12.80	14.00
SNF (%)	8.85 ± 0.99 ^{a}	7.90	9.85	8.88 ± 0.46 ^{a}	7.89	9.02

$^{a, b}$ For each variable, the mean values with different superscripts are different between areas ($P < 0.05$), and the mean values with the same superscript are not different between areas ($P > 0.05$).

es and crop residues in Burkina Faso are low in crude protein, high in fibre and have low digestibility. Under such conditions farmers are advised to use cottonseed cake, cottonseed meal, maize or sorghum bran and 15 of the farmers in this study said they supplement diets with cottonseed cake. However, increasing the level of feed rich in sugar and starch increases the risk for rumen acidosis, with a risk of secondary problems with metabolic disturbances. In addition, using cottonseed cake for dairy cows involves a significant cost for dairy farmers (Bonfoh et al., 2003b).

Farmers, both in this survey and in Mali (Bonfoh et al., 2005), said that Zebu cows produce 1 - 2 L of saleable milk per day. The capacity of Zebu cows is higher if the milk for the calf is included. Sidibé- Anago et al. (2006) found that peak milk yield could be as high as 5 kg of saleable milk per day in the Burkina Faso breed of Zebu cow, including the milk consumed by the calf. The current study suggests that milk production could increase if the full-time farmers move towards the management system of the new farmers. The main changes to implement should be smaller dairy herds with a higher proportion of lactating cows and a higher number of crossbred cows. Furthermore, farmers should feed roughage of appro-

priate quality and also include cottonseed cake in the diets for the lactating cows.

The tradition is that the calf is used for stimulation of milk ejection and cows are milked by hand (Coulibaly and Nialibouli, 1998) and hand milking was seen at all farms in this study. According to Yilma et al. (2006), calf stimulation and suckling increase saleable milk compared with milking without suckling. Local cows like the Zebu could be milked without calf stimulation and suckling, but this results in lower volume of saleable milk (Combellas and Tesorero, 2003; Fröberg, 2005). Therefore, there is no reason to try to change the milking routine with restricted suckling in Burkina Faso. It is not likely that farmers in Burkina Faso will have access to machine milking soon, since it requires electricity, technical skills, and capital for investment. These requirements are limited in Burkina Faso today and probably will be for many years to come. However, it may be possible to improve the hand milking technique.

It is well known that milk composition is influenced by many factors such as breed, age, parity, stage of lactation, feeding, health, milking technique and the person milking. Milk composition (Table 2) was similar to what has been reported previously in Burkina Faso by Sidibé-Anago et al. (2006) under controlled feeding conditions and Mali by Bonfoh et al. (2005). The higher SCC in tank milk (Figure 3) can be explained by less efficient udder hygiene practices. However, several factors have to be studied further to explain the differences found among dairy farms and areas. Dairy processors could use the results from this study as background information for developing payment systems. Based on this study, fat and protein content in farm tank milk should be 4 to 4.5% and 3.4 to 3.5%, respectively. The large variation in milk fat content in tank milk between dairy farms (Table 2, Figure 2) can probably be explained by low milk yield, poor nutrition (natural pasture) and stage of lactation (Bonfoh et al., 2005; Ngongoni et al., 2006). Milk composition is affected by nutritional status. It is also affected by udder health and varies if milking routine changes from day to day.

Milk hygiene

Good hygienic quality of the milk for consumers requires good hygiene throughout the chain of milk production. In the current study, two main milk hygiene problems were identified; one was the lack of teat cleaning before milking and the other was the conditions for storing the tank milk. The routine of some persons milking of wetting their fingers in the bucket milk during milking is also a hygiene problem, especially if the person does not have clean hands. This practice was often observed at farms where it was not obvious that the people milking washed their hands before milking. Studies of total bacteria count could indicate at what level milk was contaminated and what effect contamination has on milk quality when milk reaches the consumer. The reason for putting fingers in the bucket milk during milking is that it is easier to milk with the pull-down technique if the teats and hands are wet. A similar observation concerning milk hygiene at farms was reported by Bonfoh et al. (2003a) and Hamadou et al. (2004).

The measure of milk temperature and pH is a simple test which small-scale dairy processing units could manage. The pH of farm tank milk was 6.72 ± 0.7 in the current study, which is a little higher than the pH range of 6.4 to 6.6 according to Singh (2004) and similar to the value of 6.74 ± 0.14 in Morocco (Sraïri et al., 2005). Milk pH gives an indication of milk hygiene and milk pH should not be lower than 6.6 or higher than 6.8 when milk temperature is 20°C (Walstra et al., 1999). Cooling milk after milking reduces the risk for the growth of milk bacteria (Sraïri et al., 2005) and high milk temperatures must be considered as favourable to the growth of bacteria in the milk. The high milk temperature in both areas increases the risk of bacteria. The lack of milk cooling systems in Burkina Faso is a serious problem for milk hygiene and food safety. It is important to investigate other possibilities than cooling to prevent bacteria growth, since cooling requires electricity which is not yet available throughout Burkina Faso. It may be possible to apply the lactoperoxidase system to milk in Burkina Faso. This is an enzymatic system that prevents bacterial growth (Kussendrager and Hooijdonk, 2000).

SCC in milk includes both white blood cells and epithetlial cells that slough off from the lining of the mammary gland during the normal course of milking (Harmon, 1994). SCC is related to incidence of mastitis and it is therefore a good measure of udder health. A high SCC indicates an udder health problem and milk with a high SCC is known to have shorter shelf life due to high activity of enzymes and high SCC also causes other problems for the dairy industry. Very high SCC has been reported in urban dairy farms in the Ouagadougou area previously; 5,385,000 ± 1,061,000 cells /ml (Traoré et al., 2004). In the Traoré et al. study (2004) the high SCC was associated with poor hygiene practices in urban dairy farms and a high density of animals in a small area. The lower SCC in the current study can be explained by the cows grazing each day, which may contribute to reducing SCC and mastitis problems. However, this situation does not indicate that farmers had only healthy cows, or that they know more about mastitis, because higher SCC were reported from some farm tank milk (500,000 or 1000,000 cells/ml). Mixing all milk in the same bucket without discarding milk from cows with poor udder health lowers the hygienic quality of all tank milk. SCC is also related to milk composition. It is well known that milk lactose content decreases when SCC increases (Linzell and Peaker, 1972; Berglund et al., 2007) and this was

seen in the current study, with higher lactose and lower SCC in the Bobo-Dioulasso area than in the Ouagadougou area.

Developing the dairy industry

In conclusion the study showed that the main challenge is to increase milk yield per cow in Burkina Faso and the survey suggests that this can be achieved by improving cow nutrition and milking routines and by improving production traits of local breed by crossbreeding with other breeds that are adapted to the climate of Burkina Faso. Milk production could increase if the full-time farmers move towards the management system practiced by new farmers, with a lower size of the dairy herd, higher number of crossbred cows, adequate amount and quality of roughage and provision of concentrates like cottonseed cake and cereal bran for lactating cows all year around.

Also, the emergence of small-scale dairy processing units seems to be an important factor in the development of an improved local milk production system (Mutukumira et al., 1996; Osotimehin et al. (2006). The survey found that most farmers sold raw milk to the dairy processing unit at an average price of 0.55 USD/litre during the rainy season, and that the price increased to 0.66 USD/litre during the dry season. In spite of this fairly good price, there is still a gap between raw milk production and the demand for milk for consumption. To solve this problem, milk production and the dairy industry need to be more intensive. The situation of dairy processing units can be described by the fact that milk production varies with season and the scarcity of milk during the dry season due to the lack of animal feed, limits productivity of the dairy processing units. This is not a good situation for the industry and it is important to achieve more evenly distributed milk production over the year.

Milking techniques need to be evaluated to identify the most efficient hand milking technique, since many farmers will be unable to acquire milking machines due to lack of electricity, technical skills and funds for investment. The study shows that there is no cooling system for milk in place in Burkina Faso today; therefore milk temperature is favourable for the growth of bacteria both at farms and dairy processing units. Promoting milk cooling or other systems that prevent bacterial growth is important to ensure food safety.

.

REFERENCES

Auldist MJ, Brien GO, Cole D, Macmillan KL, Grainger C (2007). Effect of varying lactation length on milk production capacity of cows in pasture-based dairying systems. J. Dairy Sci. 90: 3224-3241.

Barnouin J, Chassagne M, Bazin S, Boichard D (2004). Management practices from questionnaire surveys in herds with very low somatic cell score through a national mastitis program in France. J. Dairy Sci. 87: 3989-3999.

Berglund I, Pettersson G, Östensson K, Svennersten-Sjaunja K (2007). Quarter Milking for Improved Detection of Increased SCC. Reprod. Domest. Anim. 42: 427-432.

Bonfoh B, Wasem A, Roth C, Fané A, Traoré AN, Simbé CF, Alfaroukh, IO, Nicolet J, Farah Z, Zinsstag J (2003a). Les sources de contamination du lait local et les méthodes d'amélioration de sa qualité microbiologique à Bamako (Mali). Etudes et Recherches Sahéliennes No 8-9. Janvier–June 2003, pp.29-37 (In French).

Bonfoh B, Sall A, Diabaté M, Diarra A, Netoyo L, Yade M, Simbé CF, Alfaroukh IO, Farah Z, Zinsstag J (2003b). Viabilité technico-économique du système extensif de production et de collecte de lait à Bamako. Etudes et recherches sahéliennes N°8–9, Janvier-June 2003 (In French, English Abstract), pp. 173-184.

Bonfoh B, Zinsstag J, Farah Z, Simbé, CF, Alfaroukh IO, Aebi R, Badertscher R, Collomb M, Meyer J, Rehberger B (2005). Raw milk composition of Malian Zebu cows (*Bos indicus*) raised under traditional system. J. Food Compos. Anal. 18 February, pp. 29-38.

Combellas J, Merbis, Tesorero (2003). Cow-calf relationship during milking and its effects on milk yield and calf live weight gain. Livest. Res. Rural Dev. 15: 3.

Coulibaly M and Nialibouli O (1998). Effect of suckling regime on calf growth, milk production and off take of Zebu cattle in Mali. Trop. Anim. Health Prod. 30: 179-189.

Delgado CL, Rosegrant MW, Steinfeld H, Ehui S, Courbois C (1999). The Coming Livestock Revolution. FAO/Department of Economic and Social affairs. p. 11.

Dieye PN, Duteurtre G, Sissokho MM, Sall M, Dia D (2005). Linking local production to urban demand: the emergence of small-scale milk processing units in Southern Senegal. Livest. Res. Rural Dev. 17: 4.

Fröberg, S (2005). Study on Restricted Suckling in Dual Purpose and Dairy Breed Cattle in Mexico. Swedish University of Agricultural Sciences, Dep. Anim. Nutr. Manag., Report 264 ISSN 0347-9838, ISBN 91-576-6855-8, Uppsala.

Gauthier J, Siméon M, Haan C de (1999). The Effect of Structural Adjustment Programmes on the Delivery of Veterinary Services in Africa. p. 12

Hamadou S, Marichatou H, Kamuanga M (2004). Croissance désordonnée des élevages périurbains et approvisionnement de la ville de Bobo de Bobo-Dioulasso: problématiques et hygiène. Etudes et Recherches Sahélienne, N°8-9, pp. 107-115.

Hansen PJ (2004). Physiological and cellular adaptations of Zebu cattle to thermal stress. Anim. Reprod. Sci. pp. 82-83, pp. 349-360.

Harmon RJ (1994). Physiology of mastitis and factors affecting cells counts. J. Dairy Sci. 77: 2103-2112.

Kaboré-Zoungrana C, Toguyeni A, Sana Y (1999). Ingestibilité et digestibilité chez le mouton des foins de cinq graminées tropicales. Revue d´Elevage et de Médecine Vétérinaire des Pays Tropicaux, 52:147–153. (In French, English Abstract).

Kussendrager KD, van Hooijdonk AC (2000). Lactoperoxidase: physico-chemical properties, occurrence, mechanism of action and applications. Review. Br J Nutr. 2000 Nov. 84 Suppl 1: S19-25.

Linzell JL, Peaker M (1972). Day-to.-day variation in milk composition in the goat and cow as a guide for detection of subclinical mastitis. British Vet. J. 128: 284-295.

MRA (Ministère des Ressources Animales)(2004) Deuxième Enquête Nationale sur les Effectifs du Cheptel (ENEC II) Burkina Faso p. 23.

Mutukumira, AN, Dube DMJ, Mupunga EG, Feresu SB (1996). Smallholder milk production, milk handling and utilization: A case study from the Nharira/Lancashire farming area, Zimbabwe. Livest. Res. Rural Dev. 8(1): 8.

Nancy LL, Karen CB, George A, Morgan (2005). SPSS for intermediate statistics: use and interpretation. 2 ed. p. 233.

Ngongoni NT, Mapiye C, Mwale M, Mupeta B (2006). Factors affecting milk production in the smallholder dairy sector of Zimbabwe. Livest. Res. Rural Dev. 18: 5.

Osotimehin KO, Tijani AA, Olukomogbon EO (2006). An economic analysis of small scale dairy milk processing in Kogi State, Nigeria. Livest. Res. Rural Dev. pp. 18-11.

Rémond B, Pomiès D (2005). Once-daily milking of dairy cows: a review of recent French experiments. Anim. Res. 54: 427-442.

Rodriguez ACO, Caraviello DZ, Ruegg PL (2005). Management of Wisconsin dairy herds enrolled in milk quality teams. J. Dairy Sci. 88: 2660-2671.

Sidibé-Anago AG, Ouédraogo GA, Ledin I (2006). Effect of partly replacing cottonseed cake with *Mucuna* spp. (Var Ghana) hay on feed intake and digestibility, milk yield and milk composition of Zebu cows. Trop. Anim. Health. Prod. 38: 563-570.

Singh H (2004). Heat stability of milk. International Journal of Dairy Technology vol. 57, N°2/3 May/August 2004.

Sraïri MT, Alaoui IH, Hamama A, Faye B (2005). Relations entre pratiques d'élevage et qualité globale du lait de vache en étables suburbaines au Maroc. Revue Méd.Vét.. (In French, English Abstract). 156: 155-162.

Traoré A, Hamidou H, Tamboura H, Bayala B, Rouamba DW, Yaméogo N, Sanou M (2004). Prévalence globale des pathologies majeures liées á la production laitière bovine en système d`élevage intra-urbain à Hamdallaye (Ouagadougou). (B.A.S.E: Biotechnology, Agronomy, Sociology and Environment). pp. 3-8. (In French).

VanBaale JM, Lance HB, Robert JC, Doris L, Jennifer T (2005). Impact of increasing milking frequency in early lactation and its effect on lactation persistency with and without rbST. Proc. 7th Western Dairy Manag. Conf., March 9-11, 2005, Reno, NV p 13.

Walstra P, Guerts TJ, Noomen A, Jellema A, van Boekel MAJS (1999). Dairy technology: Principles of milk properties and processes. Marcel Dekker, Inc. New York, p. 10.

Yilma Z, Gojjam Y, Shumye M (2006). Milk production level and calf-rearing system affecting Boran, Ethiopian zebu cattle breed, cow-calf performance. Livest. Res. Rural Dev. 18: 5.