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Faculty of Veterinary Medicine and Animal Science
Department of Clinical Sciences

Milking Routines and Prevalence of Mastitis in Dairy Farms in Tajikistan

Sandra Carlén

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Milking routines and prevalence of mastitis in dairy farms in Tajikistan

Mjölkningsrutiner och mastitprevalens hos mjölkkobesättningar i Tadzjikistan

Sandra Carlén

Supervisor: Elisabeth Rajala, Department of Clinical Sciences

Assistant Supervisor: Renee Båge, Department of Clinical Sciences
Ulf Magnusson, Department of Clinical Sciences
Nosirjon Sattorov, Institute of Biosafety Problems, Tajik Academy of Agriculture Sciences

Examiner: Johanna Lindahl, Department of Clinical Sciences

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SUMMARY

Tajikistan is the poorest of the former Soviet Union countries. Agriculture is important for the livelihood of the rural population and so is the dairy industry. In recent years, investment has been made in the dairy industry and by identifying areas of improvement, the economy of the country could be improved. The purpose of this study was to observe milking routines and to investigate the prevalence of mastitis in large dairy farms in the region around the capital city.

Eleven farms were visited in four different regions surrounding the capital, Dushanbe, and 281 cows were examined. The farms were visited during one milking where the routines were observed and noted in a protocol. Individual milk samples were collected and somatic cell count in the milk was determined by the California Mastitis Test (CMT). Cows with CMT three or higher had a plain clinical exam and questions regarding lactation number, lactation stage, amount of milk and known diseases were made.

The results of the study showed that only a few of the internationally recommended milking routines were applied. Out of seven routines that are identified as positive for production, udder health and milk quality, seven farms used two or less. All farms cleaned the udder and/or the teats in some way but none inspected the milk visually before milking. Regarding the mastitis results, almost 60% of the cows had mastitis and the prevalence was 35% on quarter level. No clear pattern was seen between milking routines and mastitis prevalence, but it should be noticed that the number of farms were too small to do statistical analyses.

There is a need for further studies regarding milking routines, milking technique, management, handling of the milk after milking and transport and processing of the milk to identify areas of improvement. Recommendations that would be possible to give to the farmers after this study regarding milking routines are: proper hand wash, visual inspection of the milk and drying of the teats as well as education in milking techniques and management.

SAMMANFATTNING

Tadzjikistan är det fattigaste av de forna Sovjetländerna och jordbruket har en betydande roll då en stor del av befolkningen bor på landsbygden och har jordbruk som huvudförsörjning. De senaste åren har en satsning gjorts på mjölkproduktion i större skala och en förbättring av mjölkproduktionen kan potentiellt förbättra landets ekonomi. Syftet med den här studien var att observera vilka mjölkningsrutiner som användes samt att undersöka prevalensen av mastit vid några större mjölkgårdar i huvudstadsregionen.

Under studien besöktes 11 gårdar i fyra olika regioner kring huvudstaden Dushanbe och 281 kor undersöktes. Varje gård besöktes vid ett mjölkningstillfälle och de mjölkningsrutiner som användes noterades i ett protokoll. Ett urval av korna på varje gård mjölkades och celltal i mjölken undersöktes med California Mastitis Test (CMT). På de kor som hade CMT 3 eller högre genomfördes även en enklare klinisk undersökning och frågor kring laktationsnummer, laktationsstadie, mjölkmängd och kända sjukdomar ställdes.

Resultatet av studien visade att endast ett fåtal av de internationellt rekommenderade mjölkningsrutinerna applicerades på gårdarna. Av sju rutiner som identifierats som positiva för produktion, juverhälsa och mjölkkvalité använde sju gårdar enbart två rutiner eller färre. Alla gårdar rengjorde juvret och/eller spenarna på något sätt men ingen av gårdarna inspekterade mjölken okulärt före mjölkning. Vad gäller antalet kor med mastit var prevalensen nära 60% på konivå och 35% på juverdelsnivå. Det sågs inget tydligt samband mellan mjölkningsrutiner och mastitprevalens men det bör nämnas att antalet gårdar var för litet för att kunna göra en statistisk analys.

Fler studier behövs kring juverhälsa, mjölkningsrutiner, mjölkningsteknik, skötsel samt hantering av mjölken längs hela produktionskedjan för att kunna identifiera förbättringsområden inom mjölkproduktionen i landet. Rekommendationer som är möjliga att ge efter den här studien angående mjölkningsrutiner är: ordentligt handtvätt före mjölkning, inspektion av mjölken före mjölkning, torkning av spenarna före mjölkning samt utbildning inom mjölkningsteknik och skötselrutiner.

CONTENT

INTRODUCTION

Tajikistan is the poorest of the former Soviet republics and suffered badly from the civil war during 1992-1997, after the independence in 1991 (CIA, 2017). More than 70% of the population live in rural areas and many of them are involved in the agricultural sector. Approximately 50% of the rural population live below poverty line and therefore an improvement in the agricultural sector may help reduce poverty (Lerman & Sedik, 2008, FAO 2017).

There are around 2.2 million cattle in Tajikistan and the average milk yield in private households is 3 liters per day (Sattorov, 2016). That is several times less than in neighboring countries and not even 1/10 of the milk yield of a cow in Sweden (Växa, 2017). With good hygiene and proper milking routines, farmers would be able to produce more milk of a better quality which would also improve the economy in rural areas (Sharif & Muhammad, 2008; Sattorov, 2016).

Poor milking routines can lead to production losses, contamination of the milk and a higher incidence of mastitis (Bruckmaier & Wellnitz, 2008). Mastitis is one of the economically most important diseases in dairy cows since it affects both milk yield and the quality of the milk (Sharif & Muhammad, 2008). The aim of this study was to observe what kind of milking routines were applied and to assess the prevalence of subclinical and clinical mastitis.

By identifying potential development areas for improvement of milking routines, recommendations can be given that will presumably help farmers to produce more milk of a higher quality.

LITERATURE REVIEW

Tajikistan

Tajikistan is a landlocked mountainous country that borders to Afghanistan, Uzbekistan, Kyrgyzstan and China. More than half of its 143 100 km^2 are 3000 meters or more above sea level (Landguiden, 2016). Approximately 35% of the land is agricultural land but only 6% is arable, the rest is mostly permanent pasture. It has an estimated population of 8.5 million inhabitants (CIA, 2017).

Figure 1. *Map of Tajikistan (source: geographic.org)*

Tajikistan has one of the lowest per capita GDPs of the former Soviet republics. After the independence from the Soviet Union in 1991, Tajikistan experienced a civil war between 1992-1997 that caused a severe damage to the economy and to the industrial and agricultural production (CIA, 2017). The country has worked hard in reducing poverty, from 83% living in poverty in 2000 it fell to 30% in 2016. Even so, the non-monetary poverty has not had the same progress. Access to education, heating and sanitation are services that are unequally distributed due to level of income and location. The development also meets resistance due to inadequate infrastructure, insufficient and unreliable energy supply, weak law enforcement and overly burdensome tax policy and administration (World Bank, 2016).

Agriculture in Tajikistan

More than 70% of Tajikistan's population live in rural areas and almost 50% of the rural population live below the poverty line (FAO, 2017). About 65% of the population is engaged in the agricultural sector but it represents only 23% of the national GDP. The main exports from the agricultural sector are cotton, fresh and dry fruits, vegetables and onions (FAO, 2017).

During the Soviet time, the agriculture was dominated by large collective and state farms which controlled 99% of the agricultural land and 96% of the arable land. Since the independence, there has been an alteration to a new kind of farm structure, the dekhan farms, which can be either individual, family owned, or collective. Household plots has also increased and control approximately 5-6% of the land while dekhan farms control 60%. The rest of the land remains in large enterprise farms (Lerman, 2008).

Since a large portion of the rural population is dependent of the agricultural sector, an improvement in agricultural performance has potential to improve the livelihoods of the rural population and therefore reduce poverty in the area (Lerman & Sedik, 2008). In 2007, the government started a reform program to strengthen the agriculture sector. In 2012 it was extended to the "Agrarian Reform Programme of the Republic of Tajikistan" with financial support from the European Union, and implementation aid from the Food and Agriculture Organization (FAO, 2016).

Lactation and milk ejection in dairy cows

The milk in the udder is mainly stored in the alveolar compartment (the alveoli and small milk ducts), and only up to 20% is stored in the udder cistern. To make the alveolar fraction available for milking, an active milk ejection is needed. This happens in response to an elevated oxytocin concentration in the blood. The binding of oxytocin to oxytocin receptors on the myoepithelial cells in the udder causes alveolar contraction and milk letdown (Bruckmaier & Wellnitz, 2008).

Oxytocin is released from the posterior pituitary gland as a response to tactile stimulation of the udder. Simultaneously, the local autonomic reflexes are triggered and results in a decrease of the tension of the smooth muscles surrounding the mammary ducts and teat sphincters (Wagner & Ruegg, 2002).

The oxytocin release may be disturbed by different reasons. Central inhibition, at the site of oxytocin release from the posterior pituitary gland, can occur due to emotional stress. This can occur when being switched from suckling to machine milking but also due to a stressful environment (Bruckmaier & Wellnitz, 2008). Incomplete or interrupted milking due to poor pre-stimulation or stressful environment is an economic loss, and residual milk is a medium for micro-organisms, potentially causing increased incidence of mastitis (Tančin & Bruckmaier, 2001).

Milking routines

To be able to remove as much milk as possible from the udder, it is important that the milk ejection is activated during the entire milking process. Since most of the milk is contained in the alveolar fraction, milking without any kind of pre-stimulation can cause a reduction or even an interruption of milk flow before the alveolar milk has reached the cistern. This is called a bimodal milk flow curve. By using appropriate pre-milking routines, the milk ejection reflex is activated before removal of the cistern milk and there is a continuous milk flow when the milking starts (Bruckmaier & Blum, 1998). According to Sandrucci *et al.,* (2007), milking without pre-milking can lead to higher somatic cell count (SCC), longer

milking time, bimodality, lower milk flow rate and a lower milk yield. Other studies have shown similar results with the exception that milk yield was not affected when no pre-stimulation was used (Bruckmaier & Blum, 1998, O'Brien *et al.,* 2012). High SCC is often connected to inflammation of the udder.

National Mastitis Council (NMC, 2013), the global forum for education and international exchange of information related to udder health, milking management, milk quality and milk safety, have recommended milking procedures to prevent mastitis and maximize production and milk quality. The recommendations include:

- Low stress environment during milking
- Inspection of the foremilk and udder for mastitis
- Washing or pre-dipping of the teats with disinfectant
- Drying of the teats with an individual towel
- Start milking within 120 seconds after first stimulation
- Adjustment of milking units
- Shutting off vacuum before removing milking unit
- Teat dip post milking
- Hygiene
- Milking order (cows in first lactation being milked first and cows with clinical mastitis last etc.)

Milking environment and hygiene

The environment where the cow lives and is being milked is important both for the milking procedure and for the quality of the milk. Bruckmaier & Wellnitz (2008) explain the importance of a non-stressful environment to get a continuous milk ejection during the milking process. Milking in unfamiliar surroundings or emotional stress can cause an inhibition of the oxytocin release from the pituitary gland. This can lead to an incomplete emptying of the udder, and in the long term a lower milk yield.

The housing of the cows and the bedding affect the risk of infection with different kinds of bacteria. Loose housing systems have shown a higher risk of infection with *Escherichia coli*, while tie stalls are associated with cows infected with *Staphylococcus aureus*. Sawdust as bedding material is strongly associated with *Klebsiella* spp. infection but associated with reduced risk of infections with *Streptococcus uberis* (Ericsson Unnerstad *et al.,* 2009).

The body of literature supports that people that are milking should wear milking gloves to prevent spreading of bacteria. It is also recommended that high SCC cows and cows with

clinical mastitis should be milked last to avoid that healthy cows are milked with the same milking organs as infected cows (Dufour *et al.,* 2010).

Pre-milking routines

Pre-milking routines are used to ensure good hygiene, high quality milk and to stimulate the milk ejection reflex. Cleaning of the teats before milking has two major functions, to stimulate the milk ejection and to remove fecal contamination. Oliver *et al.* (2005) states that presence of foodborne pathogens in milk can be linked to fecal contamination during harvesting of raw milk. In a study made by Magnusson *et al.* (2006), they found that the best method was to clean the teats with a moist synthetic towel with or without soap, and then dry the teats with a paper towel, individual for all cows. This method reduced bacterial spore content in the milk with 96%, an important finding since bacterial spores in milk can cause processing problems for the dairy industry. Gibson *et al*. (2008) found that cleaning with an effective disinfectant and then drying was the most effective way to remove bacteria. The use of disinfectant is also what is recommended by the National Mastitis Council (NMC, 2013).

Some farms clean the whole udder with water, often directly from a hose. This can be quite effective but there is also a risk of spreading bacteria. Before milking, the teat canal is dilated and therefore bacteria can easily enter the udder. Wojcik *et al.* (2005) found that farms that cleaned the udder with water had a significant higher bulk tank somatic cell count (BTSCC) than the ones using towels.

Forestripping is the removal of several streams of milk and is used to inspect the milk, check for clinical mastitis and stimulate the milk ejection reflex (Wagner & Ruegg, 2002). Some studies have shown a higher BTSCC in farms that practice forestripping (Jayarao *et al.,* 2004), but in the review made by Dufour *et al.* (2010), it is discussed if this can be a consequence of farms with high BTSCC probably more often use forestripping to discover clinical mastitis.

The duration of the pre-stimulation is also important in order to have a continuous milk flow during the whole milking process. Weiss & Bruckmaier (2005) did a study where the optimal time for pre-stimulation was 90 seconds in udders with only a small amount of milk, whereas only 20 second was enough for well-filled udders.

Sandrucci *et al.* (2007) compared a milking routine with teat cleaning, forestripping and teat pre-dipping with no routines at all. The ones with this full routine showed greater milk yield per milking, greater peak milk flow rate, shorter total milking time and lesser bimodality. They also discovered that cows with bimodal milking curves had a higher SCC.

Postmilking routines

After milking, the teat canal remains dilated for 1-2 hours and it is possible for bacteria to enter during that time. It is therefore important that the teat is disinfected after milking and that the cow is in a clean environment (Jones & Bailey, 2006). Several studies show that teat-dipping with a disinfectant solution after milking has a significant connection with low SCC (Barkema *et al.,* 1998, Dufour *et al.,* 2010, Enger *et al.,* 2016). However, there are also studies reporting a higher incidence of clinical mastitis in farms with low SCC that practice

postmilking teat-dipping (Barkema *et al.,* 1999, Peeler *et al.,* 2000, Sharma *et al.,* 2011). Therefore, there could be a discussion if postmilking teat-dipping should be used at all farms or only the ones with a high SCC. Chassange *et al.* (2005) discuss the importance of cleaning the cups that are used for teat-dipping to prevent infection transfer between cows. A more hygienic alternative could be to use teat spray but then the user needs to make sure that the whole teat is covered. Peeler *et al.* (2000) also showed less incidence of clinical mastitis where cows were kept standing after milking by being fed. This is to prevent contamination while the teat canal still is open. Furthermore, there are several recommendations that you should milk cows with high SCC and clinical mastitis last in the milking order to prevent spreading of infection (Dufour *et al.,* 2010, NMC, 2013).

Somatic cell count and mastitis

Inflammation of the mammary gland is called mastitis regardless of the origin. It can be caused by infectious agents and their toxins, physical trauma or chemical irritants. In dairy cows, the main cause of mastitis is microorganisms, especially bacteria. When the bacteria enter the mammary gland, an inflammatory response is initiated, and neutrophils and phagocytes are attracted in large numbers to defeat the invading bacteria. Some of the leukocytes will pass into the lumen of the alveolus and create an increasing SCC (Jones & Bailey, 2006).

Measuring of SCC in milk is widely used around the world to monitor udder health and milk quality. A study by Nyman *et al,* (2017), shows that measuring of SCC is the best diagnostic tool for mastitis available today compared to other enzymatic tests. It is easy to use, has a low cost and most farmers are familiar with it.

Some studies have suggested a limit of 100 000 cells/ml for a healthy quarter, and research has shown that SCC over 200 000 cells/ml is a significant sign of negative impact on the udder and therefore is an indication of mastitis (Sharif & Muhammad, 2008, Sharma *et al.,* 2011). Since the elevation of SCC is an innate inflammatory response, factors such as stage of lactation, age, season and various stresses have only a minor effect on SCC as long as the udder is not infected at the same time. Only an insult with a proper inflammatory response has a significant impact on milk SCC, maybe except for normal diurnal variation (Harmon, 1994).

There are several methods that can be used to measure SCC, both direct and indirect. The most practiced method in field work is the California Mastitis Test (CMT), which can be used as an indirect analysis of SCC. It is considered a reliable quick test for clinical and subclinical mastitis (Grace *et al.,* 2017).

Since elevated SCC most often is connected with an infection of the udder, it also indicates an increased risk of clinical mastitis. High SCC affects the milk quality and composition, gives a shorter shelf life and causes other problems in the dairy industry (Millogo *et al.,* 2008). It is also known that high SCC is associated with a reduced milk yield (Sharif & Muhammad, 2008; Millogo *et al.,* 2009). Together with costs from treatment, discarded milk, risk of drug residues in the milk and premature culling, this makes mastitis one of the economically most important diseases in dairy farming (Sharif & Muhammad, 2008). Aside from the economic

cost of mastitis, Medrano-Galarza *et al.* (2011) point out that mastitis is a painful disease that often compromise animal welfare without the right treatment.

MATERIAL AND METHODS

Information for the literature review has been found using Google Scholar and Pubmed, by reading references in articles or publications provided directly by supervisors.

Study area and population

The study was conducted in the Direct Rule District (DRD) region around Dushanbe, the capital of Tajikistan. There are approximately 300 000 cows in the DRD region and about 17 large scale farms (more than 10 cows) (Sattorov, 2016). Five districts were visited: Sahrinav, Hisor, Varzob, Vahdat and Rudaki, that were all within reasonable driving range from the capital, and two large farms were to be visited in each district.

Figure 2. *The DRD region (wikipedia.org)*

Figure 3. *Districts in the DRD region (life.ansor.info)*

The cows are mostly held in loose housing when not in pasture. There are many local mixed breeds and local breeds improved by insemination with Holstein or other high-producing breeds. Some farms also have pure Holstein cows. The local breed is small and low-producing compared to the Holstein. The cows are either hand milked by women or milked by machine.

Selection of farms and cows

We intended to visit ten farms, two in each district. On arrival to each district, a list of possible farms was provided at the local veterinary service and two farms were randomly chosen. In two of the districts, farms had recently closed or were in quarantine due to contagious disease. Due to these restrictions, there were no suitable farms in the Varzob district and only two in the Vahdat district. To get a big enough sample, two more farms were chosen from the Hisor district. Furthermore, one extra farm was chosen from the Rudaki district since one of the farms in this district only had 9 cows. The goal was to sample at least 384 cows during the study to estimate the prevalence of mastitis (clinical or subclinical) with an expected prevalence of 50%, a confidence interval of 95% and a desired absolute precision of 5% (Dohoo, 2009). This study was done in parallel to a mastitis prevalence and bacteriology study (Genfors, 2018), and the selection was primary done in regards to the other study.

At each farm as many animals as possible were sampled. The main goal was to sample at least ten percent of the lactating cows, but at the largest farm (500 cows) it wasn't possible without

too much inconvenience for the farmer. The animals were chosen randomly, in most farms we collected samples from every second cow. In the bigger farms which had machine milking we collected samples from the first four or last four cows in a row due to practical reasons.

Milk sampling and interviews

For each farm, there was a questionnaire about the general conditions on the farm such as breed, average milk yield, journal registration and milking equipment (Appendix 1).

In each cow, a clinical examination of the udder was performed and a small amount of milk from each udder quarter was tested with CMT. The Scandinavian CMT scoring from 1 (low SCC) to 5 (high SCC) was used, where 3-5 is considered indicative of subclinical or clinical mastitis and correspond approximately to a cell count from 400 000 to more than 5 000 000 cells/ml. From every cow that had a CMT ≥3, the temperature was taken and individual questions about lactation number, date of parturition, milk amount and current disease status were asked (Appendix 2).

Cows with CMT ≥3 that also had blood and/or lumps in the milk and/or a temperature higher than 39.2° C, and signs of tenderness, swelling and warmth of the udder at palpation, were assessed to have clinical mastitis. Cows that only had CMT ≥3 and none of the former clinical signs were assessed to have subclinical mastitis.

Observational study

On each farm, milking routines were observed for at least 15 minutes (Appendix 3). Both pre-milking routines and routines during milking were noticed. A scale (1-4) for cow cleanliness was used where 1= entirely clean, and 4= manure on at least a third of the rear part of the body. The cows were observed during milking and then a mean number of cow cleanliness was assessed for each farm.

The routines that were observed were hand wash, use of milking gloves, washing of the udder, wiping of the teats, inspection of the milk, udder stimulation, teat dipping after milking and time from first contact to milking.

RESULTS

General information

A total of 281 cows were sampled from 11 different farms. All farms that were included identified themselves as dekhan (6 farms) or enterprise (5 farms) farms. Four farms (36%) had pure Holstein breed and the other had local mixed breed, local breeds improved by insemination with Holstein or other high-producing breeds, or combinations of the different breeds (Figure 5). Both local breeds include local mixed improved and local mixed.

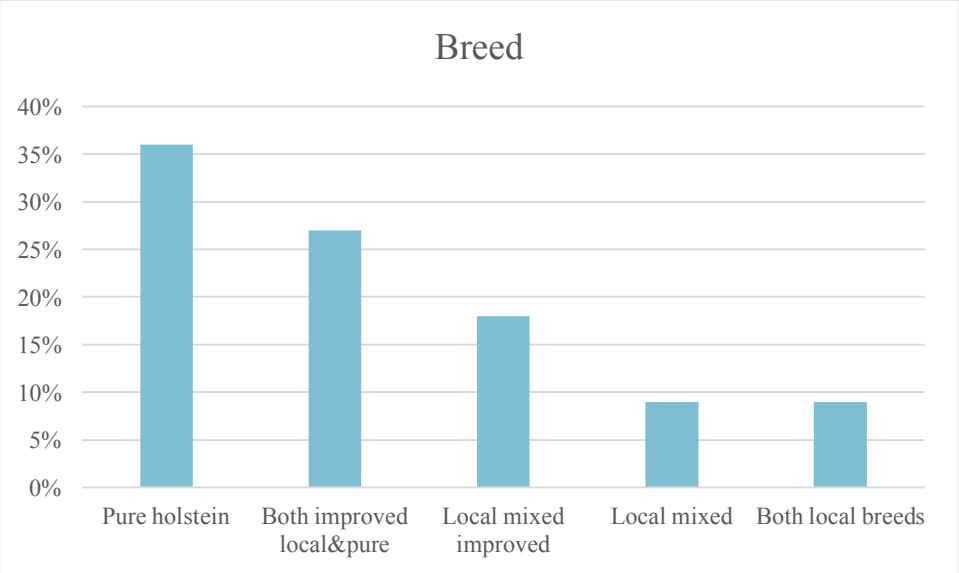

Figure 4. *Percentage of farms with the different breeds, n=11.*

The median number of parities in the examined cows were three, ranging from parity one to nine. At two farms (18%) the mean milk yield/cow/day was between 5-10 liters and at the rest of the farms it was more than 10 liters/cow/day. Three farms milked three times per day at the time of the visit, and the rest of the farms milked twice a day. Three farms (27%) had machine milking, the rest milked by hand. All farms but one separated cows with mastitis from healthy cows during milking. One farm did not feed the cows directly after milking, but all other farms did this. All farms had a journal for registration of animal health and reproduction.

Observation study

Milking routines

Observed milking routines are presented in Table 1.

Table 1. *Number of farms using different milking routines, N=11*

Routine	Category	Number (%)	Comment
Hand wash	Yes	6 (55%)	Only water, no soap
	No	5 (45%)	
Use of milking gloves	Yes	1 (9%)	
	No	10 (91%)	
Washing of the udder	Yes	2 (18%)	
before milking	No	9 (82%)	
Wiping of the teats	With hands and water	2 (18%)	
	With wet cloth	9 (82%)	Same cloth to many cows
Wiping teats dry	Yes	3 (27%)	Same cloth to many cows
	No	8 (73%)	
Inspecting milk	Yes	0 (0%)	
(forestripping)	No	11 (100%)	
Udder stimulation	Yes	4 (36%)	
	No	7 (64%)	
Time from the first contact to milking (sec)	0-30	4 (36%)	
	30-60	3 (27%)	
	>60	4 (36%)	
Teat dipping after milking	Yes	1 (9%)	
	No	10 (91%)	

Cow cleanliness

The distribution of cow cleanliness is shown in Figure 6. Most of the cows were scored 2 or 3, even if there were exceptions at each farm with both cleaner and dirtier cows.

Figure 5. *Cow cleanliness scale 4 (Photo taken by author)*

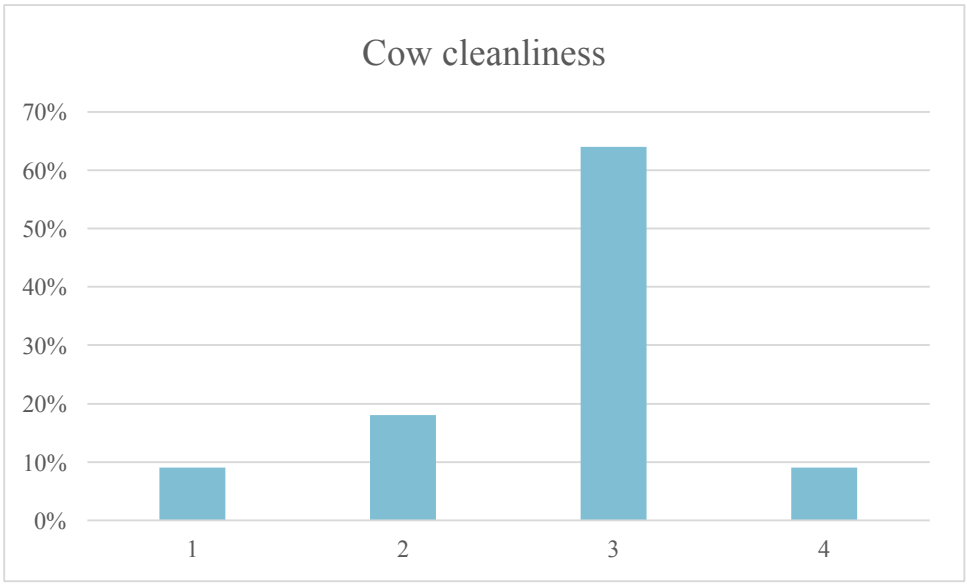

Figure 6. *Percentage of farms with different cow cleanliness scale, 11 farms observed.*

Sampling results

California Mastitis Test

Of the 281 cows that were sampled, 165 cows (59%) had CMT ≥3 in at least one quarter. There were 21 cows with one dry quarter, and of 1103 sampled quarters, 387 quarters (35%) had CMT ≥3.

Table 2. *Number and proportion (in parenthesis) of cows and quarters with CMT ≥3.*

Farm number	Cows with CMT ≥3 (%)	Quarters with CMT ≥3 (%)
1	9 (56%)	25 (40%)
2	6 (38%)	15 (24%)
3	37 (93%)	93 (59%)
4	9 (38%)	15 (16%)
5	5 (56%)	7 (19%)
6	12 (67%)	31 (44%)
7	11 (85%)	24 (48%)
8	16 (53%)	36 (30%)
9	17 (49%)	32 (23%)
10	21 (53%)	51 (33%)
11	22 (55%)	51 (33%)
Total	165 (59%)	387 (35%)

Clinical mastitis

Of the 281 sampled cows, 23 (8%) had clinical mastitis.

DISCUSSION

The results from this study shows that some improvement can be done regarding milking routines in larger farms in Tajikistan in order to increase the production, and produce milk of a better quality. Out of seven routines that have been identified as positive in the literature review (hand wash, use of milking gloves, cleaning of the teats, wiping dry, forestripping, udder stimulation and teatdip postmilking), seven farms applied two or less. One farm used four out of the seven routines and one used five routines, but none used all of them. One general impression is that knowledge about hygiene and food safety is low among the farmers in Tajikistan. In conclusion, a good milking routine can be one step on the way to healthy cows that produce a large amount of milk without giving up either food safety or animal welfare.

Only one of eleven farms used milking gloves during milking, something that according to the review by Doufour *et al.* (2010) is recommended in most literature. A little more than half of the people milking washed hands before milking, but hand wash was only done with water, no soap. Proper hand wash with soap would have a positive effect on the general hygiene during milking. None of the farms inspected the milk before milking. Inspection of the milk would ensure that cows with divergent milk or clinical mastitis can be discovered and milked separately.

The duration of the pre-stimulation varied a lot between the different farms. Thirty-six percent of the farms had a pre-stimulation routine that lasted less than 30 seconds, and the same percent had a routine that lasted longer than 60 seconds. It is however not clarified in the current study whether the deviating pre-stimulation routines were based on active decisions or malpractice. The recommendation from the NMC is that milking should start within 120 seconds.

Wiping of the teats with a wet cloth was done before milking at a majority of the farms. All the farms used the same cloth for several cows. Less than one third dried the teats after cleaning, this was also done with the same cloth for many cows. Several studies have shown that cleaning of the teats and then drying with individual paper towels is an effective method to reduce microbial contamination (Magnusson *et al.,* 2006, Gibson k 2008, Elmoslemany *et al.,* 2010). Using a disinfectant is also proved to effectively decrease the microbial load on the teats and it is recommended by the NMC (Gibson *et al.,* 2008, Elmoslemany *et al.,* 2010, NMC, 2013).

Only one farm used teat-dipping after milking. This is recommended by the NMC (NMC, 2013) and is also connected with low SCC (Dufour *et al.,* 2010) and lower incidence of new infections with clinical mastitis (Enger *et al.,* 2016). However, this recommendation might not apply for farms with low SCC since there are studies reporting higher incidence of clinical mastitis when using postmilking teat-dipping in farms with low SCC (Barkema *et al.,* 1999, Peeler *et al.,* 2000).

All farms claimed that they were milking cows with clinical mastitis last but according to observations made by the author, this was not always the case. It is important to milk

clinically infected cows last to prevent spreading of pathogens between cows (Dufour *et al.,* 2010, NMC, 2013).

All farms kept a journal of health and reproduction data. This is an important aid to keep track of the status of the farm and be able to compare the results with earlier years or other farms. Journal keeping is also a good assistance in strategic breeding and investment planning (Doris, 2012).

No clear pattern was seen between milking routines and mastitis prevalence, but it should be noticed that the number of farms were too small to do statistical analyses.

The prevalence of subclinical mastitis in this study was close to 60% and 35% on cow and quarter level respectively. These findings are similar to the study by Abdul *et al.* (2014) in Punjab, India, where the prevalence was 58% on cow level and 31 % on quarter level, but higher than the study done by Ayano *et al.* (2013) where the prevalence was 41% on cow level. Both studies used CMT to detect subclinical mastitis.

It is well established that high SCC is connected to lower milk yield and an increased risk of clinical mastitis (Millogo *et al.,* 2008, Sharif & Muhammad, 2008, Dufour *et al.,* 2010, Sharma *et al.,* 2011). It is difficult to calculate the economic loss due to high SCC or clinical mastitis as demonstrated in the review made by Seegers *et al.* (2003). A case of clinical mastitis cause in average a loss of 375 kg milk per lactation if it occurs in the second month of lactation in a high-producing Holstein cow (Seegers *et al.,* 2003). Another cost is the treatment of the cow and the fact that there is a higher risk of culling a cow that has had clinical mastitis. The greatest economic loss is due to discarded milk and a decreased milk yield (Hagnestam-Nielsen & Østergaard, 2009). There is also an animal welfare aspect that not should be forgotten.

There were two main difficulties during the study - to find enough large farms to visit and the language barrier. As always, to perform interviews through an interpreter is challenging, especially when using technical terms not used in everyday language. Therefore, sometimes information might have been misinterpreted or got lost in translation, for instance this might have been true regarding the statements from the milk workers regarding their awareness about mastitis. Due to logistic limitations and quarantines, it was not always possible to perform a perfect random selection. It was sometimes hard to select which cows to sample without interfering too much with the work on the farm, for example the four last cows in one row were sampled during machine milking, but this is not likely to interfere with the results.

The current study highlights several milking routines and management routines that can be improved in order to increase productivity and milk quality. Some improvements can be difficult to implement due to infrastructure difficulties, for example access to proper teat-dipping solutions or milking gloves in Tajikistan. Recommendations that would be possible to give to the farmers are: proper hand wash, inspection of milk and drying of the teats as well as education in milking techniques and management. Further studies regarding milking routines, milking technique, management, handling of the milk after milking and transport and processing of the milk is recommended to identify areas of improvement.

The incidence of subclinical mastitis was not very high compared to other studies, but it is well known that it has a negative impact on milk yield, milk quality and milk processability. Therefore, more effort should be put to identify cows with subclinical mastitis and to find risk factors for the disease. This could be one step towards producing more milk and of a better quality, and in the end to help improve the economy in the area.

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APPENDIX 1

General questions

Question	Response	Comment
1. Type of farm	1. Enterprises 2. Breeding 3. Dekhkan farm 4 Small householder	
2. Stable type (when/if not in pasture)	1. Tied-up 2. Loose-housing 3. Combination 4. In pasture	
3. The goal for the dairy herd size.	1. For subsistence 2. Expand the herd 3. Reduce the herd 4. As saving scheme 5. Trading commodity	
4. Breed	1. Local, mixed 2. Local, mixed improved 3. Pure 4. Both local breeds 5. Both pure and mixed local 6. Both pure and improved local 7. All three kinds	
5. Cow identification	1. No specific id/Signalement 2. Name 3. Tag/Id-number 4. Name and Id-number	
6. Age at first calf	1. < 25 months	

	2. 25-35 months (2-3 years) 3. >36 months (3 years or more) 4. Unknown	
7. Milk yield/day at the moment **Average/cow in L**	1. <5 2. 5,1-10 3. >10 4. Unknown	
8. Average weaning age of calf	1. 0-3 months 2. >3 months 3. Natural weaning 4. Unknown	
9. How long is the dry period before calving?	1. < 1 month 2. 1-2 months 3. > 2 months 4. No dry period	
10. System of registration/ journal applied	1. Yes 2. No	
11. If yes, specify which type of	1. Animal health 2. Reproduction 3. Production/Economy	
12. Milking equipment	1. By hand 2. Automatic 3. By hand and automatic	
13. How often are the cows milked (per day)?	1. Once 2. Twice 3. Three times	
14. Are the cows divided into specific groups during milking?	1. Yes 2. No	
15. If yes, which groups do you have?	1. Cows that recently had a calf 2. Cows with mastitis 3. Cows with a high milk	

	yield 4. Cows in the end of lactation 5. Other, specify in comment	
16. Are the cows fed after milking?	1. Yes 2. No	

APPENDIX 2

Questions related to individual cows with CMT 3 or more

17. Time after calving	1. 0-3 months 2. 3-6 months 3. 6-12 months	
18. How many calves has she had?	Write number of calves	
19. How much milk/day?	1. <5 2. 5-10 3. >10 4. Unknown	
20. Known illness? If yes, which one?	1. Yes 2. No	
21. Is she being treated with antibiotics? What kind? (Show the bottle or brand name)	1. Yes 2. No	

APPENDIX 3

Observational form

25. Cow cleanliness	1 2 3 4	
26. Handwash before milking	Yes No	
27. Use of milking gloves	Yes No	
28. Washing of the udder	Yes No	
29. Wiping of the teats	1. With wet cloth 2. With dry cloth 3. No wiping 4. Same cloth to all/many cows 5. One cloth/cow 6. Teat dipping	
30. Wiping dry	Yes No	
31. Is the milk inspected before machine is put on?	Yes No	
32. Is the udder stimulated?	Yes No	
33. Time from first contact to machine is put on	1. 0-30 s 2. 30-60 s 3. > 60 s	
34. Teat dipping postmilking?	Yes No	